SCHOOL OF BASIC AND APPLIED SCIENCES

GALGOTIAS UNIVERSITY

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COURSE BOOK
School of Basic and Applied Sciences -2020
Volume-2

Curriculum and syllabus for

School of Basic and Applied Sciences

GALGOTIAS UNIVERSITY

(Under the Uttar Pradesh Private Universities Act No. 12 of 2019)

CONTENTS

(Established under Galgotias University Uttar Pradesh Act No. 14 of 2011)

School of Basic and Applied Sciences

Program: M.Sc. Chemistry

Scheme: 2020 – 2022

Curriculum

Semester 1									
Sl. No	Course Code	Name of the Course					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MSCH 5001	Stereochemistry & Reaction mechanisms	4	0	0	4	30	20	50
2	MSCH5002	Basic concepts and principles of Inorganic chemistry	4	0	0	4	30	20	50
3	MBS24T1101	Basic Concepts of Physical Chemistry	3	0	0	3	30	20	50
4	MBS24T1102	Basic Analytical Chemistry	3	0	0	3	30	20	50
5	MSCH 5005	Computer Applications for chemistry	2	0	0	2	30	20	50
6	MSCH 5006	Organic chemistry Lab – I	0	0	4	2	50	-	50
7	MSCH 5007	Inorganic chemistry Lab – I	0	0	4	2	50	-	50
8	MSCH5031	Computer Applications for chemistry Lab	0	0	2	1	50	-	50
9		Soft Skills				0			
10		Computer Awareness				0			
		Total	16	0	10	21			
Semester II									
Sl No	Course Code	Name of the Course					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MSCH 5008	Organic Spectroscopy	4	0	0	4	30	20	50
2	MBS24T1103	Reaction mechanism and Basics of group theory	3	0	0	3	30	20	50
3	MSCH 5024	Physical Chemistry-II	4	0	0	4	30	20	50
4	MBS24T1104	Techniques in Analytical Chemistry	3	0	0	3	30	20	50
5	MSCH 5012	Physical chemistry Lab – I	0	0	4	2	50	-	50
6	MSCH 5013	Analytical chemistry Lab – I	0	0	4	2	50	-	50
7		BEC (B1)				3			
8	MBS28T2111	Research Methodology	2	0	0	2	30	20	50
9		IPR				1			
		Total	16	0	8	24			
Semester III									
Sl No	Course Code	Name of the Course			Assessment Pattern				
			L	T	P	C	IA	MTE	ETE

1	MSCH 6040	Summer Internship*	0	0	0	2	50		50
2	MBS24P2998	Major Project- Phase I	0	0	0	6	50		50
3		Campus to Corporate				2			
	Total		0	0	0	10			
Semester IV (Organic Specialization)									
Sl No	Course Code	Name of the Course					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MSCH6001	Photo chemistry & Pericyclic reaction	4	0	0	4	30	20	50
2	MSCH6002	Reagents and Heterocyclic Chemistry	4	0	0	4	30	20	50
3	MSCH6003	Chemistry of Natural Products and Retrosynthesis	4	0	0	4	30	20	50
4	MBS24TXXX	(Elective)	3	0	0	3	30	20	50
5	MSCH 6005	Organic chemistry Lab – II	0	0	8	4	50		50
6	MBS24P2999	Major Project-Phase II	0	0	0	6	50		50
		Total	15	0	8	25			
Semester IV (Inorganic Specialization)									
Sl No	Course Code	Name of the Course					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MSCH 6006	Organometallic Chemistry	4	0	0	4	30	20	50
2	MSCH 6012	Spectroscopic techniques in Inorganic Chemistry	4	0	0	4	30	20	50
3	MSCH 6009	Bio-Inorganic Chemistry	4	0	0	4	30	20	50
4	MBS24TXXX	(elective)	3	0	0	3	30	20	50
5	MSCH 6010	Inorganic chemistry Lab – II	0	0	8	4	50		50
6	MBS24P2999	Major Project-Phase II	0	0	0	6	50		50
		Total	15	0	8	25			
Semester IV (Physical Specialization)									
Sl No	Course Code	Name of the Course					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MSCH6021	Applied Electrochemistry	4	0	0	4	30	20	50
2	MSCH6022	Chemical Kinetics and Surface Chemistry	4	0	0	4	30	20	50
3	MSCH6023	Molecular Spectroscopy	4	0	0	4	30	20	50
4	MBS24TXXX	(Elective)	3	0	0	3	30	20	50
5	MSCH6025	Physical chemistry Lab –II	0	0	8	4	50	-	50
6	MBS24P2999	Major Project-Phase II	0	0	0	6	50		50
		Total	15	0	8	25			
Semester IV (Analytical Specialization)									

			L	T	P	C	IA	MTE	ETE
1	MSCH6031	Electroanalytical methods	4	0	0	4	30	20	50
2	MSCH6032	Quality control and quality assurance	4	0	0	4	30	20	50
3	MSCH6033	Advanced Instrumentation methods	4	0	0	4	30	20	50
4	MBS24TXXX	(Elective)	3	0	0	3	30	20	50
7	MSCH6034	Analytical chemistry Lab -II	0	0	8	4	50		50
6	MBS24P2999	Major Project-Phase II	0	0	0	6	50		50
		Total	15	0	8	25			

List of Electives

Sl No	Course Code	Name of the Electives					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MBS24T5101	Polymer chemistry	3	0	0	3	30	20	50
2	MBS24T5102	Industrial chemistry	3	0	0	3	30	20	50
3	MBS24T5103	Solid State chemistry	3	0	0	3	30	20	50
4	MBS24T5104	Environmental analytical chemistry	3	0	0	3	30	20	50
5	MBS24T5105	Bio-organic Chemistry	3	0	0	3	30	20	50
6	MBS24T5106	Advanced Green Chemistry	3	0	0	3	30	20	50
7	MBS24T5107	Carbon Materials	3	0	0	3	30	20	50
8	MBS24T5108	Advance Metallurgical Sciences	3	0	0	3	30	20	50
9	MBS24T5109	Industrial Biochemistry	3	0	0	3	30	20	50

SEMESTER-I

Name of The Course	**Stereochemistry and Reaction Mechanisms**				
Course Code	**MSCH5001**				
Prerequisite	**B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects.**				
Corequisite	**To be having basics of stereochemistry and reaction mechanisms**				
Antirequisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives:The course introduces about the organic chemistry and students would be acquainted with the basics of organic chemistry, stereochemistry and reaction mechanism. Demonstrate and practice the mechanism of various name reactions and will be able to construct a mechanism for applications in various fields of organic chemistry. This course will further helps to carry out carrier in the field of research and development in the core areas of organic chemistry.

Course Outcomes

CO1	**Interpret and discuss stereo chemical concepts including type of projections, CIP system enantiomeric relationship R and S, E and Z and nomenclature and stereochemistry in allenes, spiranes and biphenyls. (K4)**
CO2	**Illustrate conformational analysis in cyclohexanes, compare the stereospecific and stereoselective reactions. (K3)**
CO3	**Determine the mechanism and role of reaction intermediates in organic reaction including classical and nonclassical carbocation, neighbouring group participation, carbanion, carbene, niterne and benzyne. (K4)**
CO4	**Compare and differentiate between types of addition, elimination and substitution reaction and describe SN1, SN2 and SNi mechanism with stereochemistry. (K5)**
CO5	**Distinguish various name reaction with example and interpret major and minor product of variety of organic reaction.(K4)**
CO6	**Combine the concepts for new trends and developments in stereochemistry and reaction mechanism.(K6)**

Text Book (s)

1. L.Finar, Organic Chemistry. Vol.2, 6thedition, PearsonIndia, New Delhi, 2002.
2. Peter Sykes, A Guidebook to Mechanisms in Organic Chemistry, 6thedition, PearsonIndia, New Delhi, 2009.

Reference Book (s)

1. P.S. Kalsi, Stereochemistry – Conformation and Mechanism, 6th edition, New Age International Ltd.,India, 2005.
2. S.N.Sanyal., Reactions, Rearrangement and Reagents, BharatiBhawan Publisher, India, 2014.
3. E.L. Eliel, Stereochemistry of carbon compounds, Wiley India (P) Ltd., India, 2008.
4. J. March, M. B. Smith, March's Advanced Organic Chemistry: Reactions, Mechanisms and Structure, 6th edition, John Wiley&Sons, New York, 2007.
5. S.M. Mukherji and S.P Singh., Reaction Mechanism in Organic Chemistry, Macmillan Publishers India, 3rd Edition, 1990.
6. Solomons&Fryhle, Organic Chemistry; 10th edition, Wiley & Sons, 2009.
7. J. Clayden, N. GreevesandS. Warren, Organic Chemistry, Oxford University Press, 2nd edition, 2012.

Unit-1 General Chemistry	8 hours
Stereoisomerism: concept of chirality and symmetry elements. Projections: Newman, Sawhorse and Fischer projection - formulae and inter conversions, Nomenclature: Cahn - Ingold - Prelog system of nomenclature (DL, RS and EZ system), Numerical problems based on specific optical rotation, racemic modification, molecules with one, two or more chiral centres.	
Unit-2 Stereochemistry	**10 hours**
Stereochemistry of ring system: Stereochemistry of allenes, spiranes, biphenyls, and bridged biphenyls. **Conformational analysis: Conformations and stability of cyclohexanes and some substituted cyclohexanes, cyclohexenes, cyclohexanones, decalins.** Stereospecific and stereoselective synthesis (elementary examples), Cram's rule, Chiral separation and asymmetric synthesis.	
Unit-3 Reaction Intermediates	**7 hours**
Carbanions: Generation, structure and stability, **Radicals: Generation, structure, stability and reactions, radical cations and radical anions.** **Carbenes: Formation and structure, reactions involving carbine.** **Nitrenes: Generation, structure and reactions of nitrenes.** Benzynes: Generation, structure and reactions (SNAr).	
Unit-4 Types of Organic Reactions	**15 hours**
Aliphatic & Aromatic Nucleophilic Substitution: • The SN_1 and SN_2 mechanism, reactivity effects of substrate structure, attacking nucleophile, leaving group and reaction medium. • The SNAr and benzyne mechanism, Reactivity effect of substrate, structure, leaving group and attacking nucleophile. **Aliphatic & Aromatic Electrophilic Substitution:** • Bimolecular mechanisms - SE_2 and SE_1, The SE_1 mechanism, electrophilic substution accompanied by double bond shifts. • The arenium ion mechanism, orientation and reactivity, energy profile diagrams. **Elimination Reactions & Addition Reactions:** • The E_2, E_1 and E1cb mechanisms, Orientation of the double bond. • Reactivity-effects of substrate structures, attacking base, the leaving group and the medium. • Mechanism and orientation in pyrolytic elimination. **Addition to Carbon-Carbon & Carbon-Hetero Multiple Bonds:** • Hydrogenation of aromatic rings hydroboration, Michael reaction. • Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acid esters and nitriles. • Mechanism of condensation reactions involving enolates - Aldol, Claisen, Mannich, Benzoin, Perkin Stobbe reactions. • Mechanism of rearrangement reactions - Hofmann; Schmidt; Lossen; Curtius; Beckmann reactions	
Unit-5: Name Reactions and Mechanism	**08 hours**
Favorskii reaction; Stork enamine reactions; Sharpless asymmetric epoxidation; Ene reaction; Barton reaction; Hofmann- Loffler-Freytag reaction; Shapiro reaction; Baeyer villager reaction; Chichibabin reaction	
Unit-6: Recent Advances in Stereochemistry and Reaction Mechanisms	**04 hours**

Recent Advances in the Stereoselective Synthesis, and advances in Catalytic enantioselective fluorination and reaction mechanism.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Basic Concepts and Principles of Inorganic Chemistry**				
Course Code	**MSCH 5002**				
Prerequisite	**B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects.**				
Co-requisite	**To be aware of basics of inorganic chemistry, periodic element and bonding.**				
Anti-requisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives:The course introduces about the inorganic chemistry and students would be acquainted with the basics of transition metals, organometallic compounds, transition metal complexes and metal-ligand bonding and their applications in various fields of inorganic chemistry. This course will further helps to carry out carrier in the field of research and development in the core areas of Inorganic chemistry.

Course Outcomes

CO1	**Apply knowledge of chemistry of s and p block group elements and synthesis, properties and applications of few main group compounds in many fields. (K3)**
CO2	**Explain the properties of aqueous solutions systems and the theories describing the behaviour of acids and bases in aqueous systems. (K2)**
CO3	**Analyze general properties, separation techniques of lanthanides and actinides and applications of rare earth elements in industries. (K4)**
CO4	**Develop an understanding of stereochemistry and nomenclature of co-ordination compounds.(K3)**
CO5	Apply the knowledge of crystal field theory, molecular orbital theory and its great importance in inorganic chemistry**.(K3)**
CO6	**Elaborate the knowledge of recent advancement in the field of Inorganic chemistry. (K6)**

Text Book (s)

1. **F. A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, 6th Edn., (1999), John-Wiley & Sons, New York.**

2. **James E. Huheey, Inorganic Chemistry, 4th Edn., (1993), Addison Wesley Pub. Co., New York**

Reference Book (s)

1. **Inorganic Chemistry, James E House, 2008, Elsevier.**

Unit-1 Introduction 12 hours	
Unit I: Compounds of s and p block elements Lithium chloride, Lithium carbonate, Boranes , Carboranes, Carbazide , Borazine, Silicates and Aluminosilicates, Peroxo compounds of Boron ,Carbon and Sulphur, compounds of Sulphur and Nitrogen, Interhalogen compounds of Pseudohelogen and polyhalide ions, Noble gas compounds (Xe)	
Unit-2 10 hours	
Unit II: HSAB Theory **Classification of acids and bases as hard and soft; HSAB principle, theoretical basis of hardness and softness; Lewis-acid base reactivity approximation; donor and acceptor numbers, E and C equation; applications of HSAB concept.**	
Unit-3 10 hours	
Unit III: Inner transition elements Chemistry of Lanthanides and actinides: Occurrence, periodicity, general properties, causes and consequences of lanthanide contraction, applications of rare earth elements. Comparison of general characteristics of lanthanides and actinides.	
Unit-4 10 hours	
Unit IV: Basic concepts of co-ordination Classification of ligands, chelation, co-ordination number, stereochemistry and nomenclature of co-ordination compounds, polynuclear or bridged complexes , inner- metallic complexes, Werner's theory , EAN concept	
Unit-5 10 hours	
Unit V: Metal Ligand Bonding Limitations of crystal field theory, molecular orbital theory: octahedral, tetrahedral and square planer complexes, π- bonding and molecular orbital theory, explanation of position of the ligands in spectrochemical series using MOT, Comparision with CFT.	
Unit-6 Recent Advancement in Inorganic Chemistry	**4 hours**
Water treatment materials, Toxic chemicals in wastewater	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Basic Concepts of Physical Chemistry**
Course Code	**MBS24T1101**

Prerequisite	**B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects.**				
Corequisite	**Knowledge of basic physical chemistry**				
Antirequisite					
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

The course introduces about the physical chemistry and students would be acquainted with the concepts of quantum chemistry, phase rule, kinetics and surface chemistry and their applications in various fields of chemistry. This course will further helps to carry out carrier in the field of research and development in the core areas of chemistry.

Course Outcomes

CO1	**Interpret and discuss the basic concepts of quantum chemistry including Schrodinger wave equation, particle in 1D box, particle in 3D box, concept of degeneracy, hydrogen atom etc. (K4)**
CO2	**Illustrate partial molar quantities and phase rule and compare excess functions of non ideal solutions.(K3)**
CO3	**Determine different rate laws and role of collision theory and transition theory (K4)**
CO4	**Compare and differentiate between types of sols, surfactants and macromolecules and describe methods of determining molecular weights.(K5)**
CO5	**Distinguish various Type of radioactive decay, Decay Kinetics,and interpret Critical size of thermal reactor.(K4)**
CO6	**Discuss recent advancements in different fields of physical chemistry (K6)**

Text Books:

1. Physical Chemistry - P.W. Atkin, ELBS fourth edition.
2. Chemicals Kinetics, K.J. Laidler (Tata Mc. Graw Hill) 1998
3. Basic Chemical Thermodynamics, E. Brian Smith (ELBS) 1990
4. Elements of Nuclear chemistry – H.J. Arnikar, fourth edition Wiley Eastern Ltd.

Unit-1 Introduction	**10 Lectures**
Quantum Mechanics Historical development of quantum theory principle of quantum mechanics, wave particle duality, uncertainty principles, Schrödinger equation, operators simple system – free particle, Particle in a box, Two dimensional, Three dimensional box, Hydrogen like atoms, atomic orbital.	
Unit-2	**10 Lectures**
Thermodynamics - I Chemical potential and Entropies, Partial molar quantities: Partial molar free energy, Partial molar volume and Partial molar heat content and their significances. Determinations of the partial molar quantities. Phase Rule: Derivation of phase rule from the concept of chemical potential. Application of Phase Rule to three components system.	
Unit-3	**08 Lectures**

Chemical Kinetics - I Methods of determining rate laws, collision theory of reaction rates, steric factor, Arrhenius equation and activated complex theory, kinetic and thermodynamic control of reactions, ionic reactions, kinetic salt effects, steady state kinetics, unimolecular reactions and their treatments.	
Unit-4	**11 Lectures**
Colloids and Macromolecules **Sols, Lyophilic and lyophobic sols, properties of sols, coagulation.Sols of surface active reagents, surface tension and surfactants, critical micelle concentration. Macromolecules: Mechanism of polymerization, Degree of polymerization and molecular weight, methods of determining molecular weights**	
Unit-5	**09 Lectures**
Nuclear and Radiation Chemistry **Type of radioactive decay, Decay Kinetics, Detection & measurement of radiation Elements of radiation chemistry, interaction of radiation with matter, Nuclear Reactor: Natural uranium reactor, thermal reactor, the Breeder reactor, nuclear waste management.**	
Unit VI: Recent Advancement in Physical Chemistry	**04 Lectures**
Comparative study of classical, statistical and quantum mechanics, applications of thermodynamic principles in ecology, applications of chemical kinetics, applications of nuclear energy in sustainable development	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**BASIC ANALYTICAL CHEMISTRY**				
Course Code	**MBS24T1102**				
Prerequisite	**B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects**				
Co-requisite	**A course that covers gravimetric and volumetric techniques, pH metric titrations, centrifugation techniques and spectrophotometric analysis.** **Knowledge related to the introductory instrumental analysis with a focus on precision and accuracy of experimental data.**				
Anti-requisite					
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

The course introduces about the analytical chemistry and students would be acquainted with the concepts of its theory, chemical methods including techniques of gravimetric, volumetric and separation instrumental analysis with a focus on precision and accuracy of experimental data.This course will further helps to carry out carrier in the field of research and development in the core areas of chemistry.

Course Outcomes

CO1	**Assess analytical method for a specific purpose, and evaluate sensitivity, important sources of interferences and errors.**
CO2	**Explain the theoretical principles and important applications of classical analytical methods within titration (acid/base titration, complexometric titration, redox titration).**

CO3	**Acquire the various techniques of quantitative and qualitative analysis such as voltammetry, high frequency titration.**
CO4	**Calculate titration errors for method evaluation, and perform statistical evaluation of results from classical and instrumental chemical experiments and analyses.**
CO5	**Make scientific reports from chemical experiments and present the results in a transparent manner.**
CO6	**Elaborate the knowledge of recent advancement in the field of Analytical Chemistry.**

Text Book (s)

1. 1Day R.A. and Underwood A.L., " quantitative analysis," 1999, 6th edition, prentice hall of India
2. Christian G.D., :Analytical Chemistry", 2004, 6th ed., John Wiley & Sons Inc
3. Skoog D.A., West D.M, Holler F.J. and Crouch S.R., Fundamentals of analytical chemistry", 2004, 8th Ed., Thomson Brooks/Cole.

Reference Book (s)

Vogel's textbook of quantitative chemical analysis, 6th edition.

Vogel's textbook of quantitative chemical analysis, 7th edition

Unit I: INTRODUCTION TO ANALYTICAL CHEMISTRY	**10 hours**
Scope and objectives, General steps in chemical analysis, Introduction to methods of detecting analytes (Physical, Electromagnetic radiations, Electric charge), Propagation of measurement uncertainties (in accuracy and precision). Useful statistical test: test of significance, the F test, the student's test, the chi-test, the correlation coefficient, confidence limit of the mean, comparison of two standard values, comparison of standard deviation with average deviation, comparison of mean with true values, significant figures, regression analysis (least square method for linear and non-linear plots), statistics of sampling and detection limit evaluation and Calibration.	
Unit II: Volumetric analysis	**08 hours**
Definitions: Titrimetry, Volumetric titrimetry, Gravimetric titrimetry, The equivalence point, the end point, Classification of volumetric methods, theory of indicators and buffers, Equilibria, Principles, Aqueous and non-aqueous acid-base titration, Redox titrations, Complexometric titrations, Precipitation titration, Typical problems in volumetric titrimetry, Sigmoidal Titration Curves, The Henderson-Hasselbalch Equation.	
Unit III Gravimetric analysis	**10 hours**
A. Precipitation methods, B. Volatilization methods. (The analyte or its decomposition products are volatilized at a suitable temperature. The volatile product is then collected and weighed, or, alternatively, the mass of the product is determined indirectly from the loss in mass of the sample. e.g., Determination of the sodium hydrogen carbonates content of antacid tablets) C. Properties of precipitates and precipitating reagents: Particle size, Filterability of Precipitates (factors that determine particle size). Colloidal Precipitates (coagulation of colloids, peptization of colloids, treatment of colloidal precipitates). Crystalline Precipitates (particle size and filterability). Co-precipitation (surface adsorption, mixed-crystal formation, occlusion, and mechanical entrapment, co precipitation errors). Precipitation from Homogeneous Solution (The use of the technique of Homogeneous solutions to effect precipitation). D. Drying and Ignition of precipitates. E. Practical gravimetric procedures.	
Unit IV: Measurement of pH and pH metry	**7 hours**
Introduction, Determination of pH, Introduction to Ion Selective Electrodes, Instrumentation, The pH scale, Buffer solutions, calculation of pH values of buffer mixtures, Hydrolysis of slats. pH of hydrolysed salt solution, Degree of hydrolysis, Determination of degree of hydrolysis, The theory of indicators, Application of pH Measurement, Ionic equilibria involving complex ions.	
Unit V: CENTRIFUGATION METHODS	**6 hours**
A. Introduction B. Sedimentation and relative centrifugal force C. Different types of rotors. D. Density gradient E. Types of centrifugation techniques.	

Unit VI. Recent developments in the analytical techniques	**4 hours**
This unit will cover the latest development in the area of volumetric and gravimetric analysis , pH metry and centrifugation methods as per latest literatures	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Computer Applications for Chemistry**				
Course Code	**MSCH5005**				
Prerequisite	**B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects**				
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		2	**0**	**0**	**2**

Course Objectives:Introduce the basic concepts computer science and application areas to explore both theoretical and practical knowledge of programming such as Fortan, C and MATLAB.Understand the concepts of data analysis and chemical application fields.

Course Outcomes

CO1	**Grapes the knowledge of computer science in chemical applications filed. (K2)**
CO2	**Apply the knowledge of FORTRAN and C+ programming to write down short codes for finding chemical reaction.(K3)**
CO3	**Apply software's like Gaussian and MATLAB for real time data analysis of chemical problems.(K3)**
CO4	**Perform programming for finding various chemical reasons and energies calculation.(K4)**
CO5	**Apply data analysis in various chemical application fields.(K3)**
CO6	**Discuss recent software used in chemical research. (K6)**

Text Book (s)

2. The Art of Scientific Computing. W. H. Press, S. A. Teukolsky
3. V. Rajaraman, *Fortran 90*, Prentice Hall (India), New Delhi (1997)
4. C. Xavier, Fortran 77 and Numerical Methods, New Age International Pvt. Ltd. Publishers, New Delhi (1994)

Reference Book (s)

8. S. Lipschutz and A. Poe, Schaum's Outline Series – Theory and Problems of Programming with Fortran including structured Fortran, Mc Graw Hill Book Company, Singapore (1982)
9. K. V. Raman, *Computers in Chemistry*, Tata McGraw Hill (1993).

Unit-1Basic about the computers and programming6hours

Introduction of software and hardware, basic about the operating systems, introduction of programming languages, flow chart, algorithms , Chemical Applications of computers – Computational Chemistry-Chemometrics.
Unit-2 FORTRAN or C Programming6 hours
Types of Constants and Variables in Fortran, Dimension, Data Type, COMMON and EQUIVALENCE statements, Arithmetic and Logical IF, IF-THEN- ELSE constructs, 'DO' statement, Various types of 'I/O' statements, Library functions, Statement functions, Function subprograms and subroutine subprograms. **Or** **Introduction; style of C language ,character and key words, variables and constants in C, arithmetic , relational , logical and bitwise operators in C, ternary, cast, & and * pointer operators, Size of operator input and output in C : content , conditional and switch statement in C; break and continue statement in loop. Storage classes in C functions array and pointers C, structure and unions, types of statement , preprocessor- define and includes simple programming in C.**
Unit-3MATLAB 6 hours
Features of MATLAB –Basics of MATLAB programming – Array operations in MATLAB – Loops and execution control- Working with files: Scripts and Functions-Plotting and programming input and output.
Unit-4Drawing Tools 6 hours
CHEMDRAW: Introduction –installation –Tools-Structure types – Drawing Structure – Drawing Bonds of Different Types – Drawing Schemes
Unit-5 Data Analysis 6 hours
Bioinformatics: Introduction to Bioinformatics – Bioinformatics tools are emerging for describing DNA genomics, etc.
Unit-6 Recent Software in chemical research 3 hrs
Chemdraw, python, ADMET, pKCSM

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**ORGANIC CHEMISTRY LAB-1**				
Course Code	**MSCH 5006**				
Prerequisite	**B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects**				
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		0	**0**	**4**	**2**

Course Objectives:

To introduce different experiments to test basic understanding of Organic Chemistryconcepts.

Course Outcomes

CO1	Safe laboratory practices by handling laboratory glassware, equipment, and chemical reagents.

CO2	Separate organic compounds in different phases.
CO3	Perform single and two stage preparation.
CO4	Make use of soxhlet extractor and steam distillation assembly for Purification of organic compound.
CO5	Synthesis, purification and characterization of aspirin, Diels-Alder adduct.

Text/Reference Books

1. A. I. Vogel - A Textbook of Practical Organic Chemistry, 5th Edition, 1989
2. W.L. Jolly, Synthesis and Characterization of Organic Compounds, Prentice Hall.
3. John Leonard, Barry Lygo, Garry Procter, Advanced Practical Organic Chemistry, CRC Press Published January 8, 2013.
4. N K Vishnoi, Advanced Practical Organic Chemistry, Vikas Publishing, 3rd edition.

Separation, purification and identification of organic compounds:

- **Separation of mixtures of organic compounds:**
    1. Separation of liquid mixture of liquid mixture of toluene and o-toluidine.
    2. Separation of a mixture of o-cresol and benzoic acid.
    3. Separation of a mixture of anthracene and p-bromobenzoic acid.

  Separation by Chromatographic Techniques:
    4. To separate mixture of methyl orange and methylene blue by TLC.
    5. Separation of mixture of sugars by paper chromatography.
- Purification by appropriate methods
- Identification of organic compounds

Continuous Assessment Pattern

Internal Assessment (IA)	End Term Test (ETE)	Total Marks
50	50	100

Name of The Course	**INORGANIC CHEMISTRY LAB-1**				
Course Code	**MSCH 5007**				
Prerequisite	**B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects**				
Co-requisite	**This lab course covers the synthesis and characterization of inorganic compounds and quantitative analysis of elements in mixtures and the inorganic synthesis, purification and study of various chromatographic techniques.**				
Anti-requisite					
		L	**T**	**P**	**C**
		0	**0**	**4**	**2**

Course Objectives:To introduce different experiments to test basic understanding of Inorganic Chemistryconcepts.

Course Outcomes

CO1	**Recognize basic laboratory rules and basic principles of lab safety.(K2)**

CO2	**Carry out qualitative analysis to identify acidic and basic radicals.(K4)**
CO3	**Estimate ions in binary mixtures of metal ions involving volumetric and gravimetric methods. (K4)**
CO4	**Prepare and determine percent purity of various inorganic complexes. (K3)**
CO5	**Perform chromatographic technique (paper chromatography). (K3)**

Text Book (s)

1. Vogel's Textbook of Quantitative Analysis, Revised, J. Bassett, R.C. Denney, G.H.H. Jeffery and J. Mendham, elbs.

2. Synthesis and Characterization of Inorganic Compounds, W.L. Jolly, Prentice Hall

Reference Book (s)

1. Synthesis and Characterization of Inorganic Compounds, W.L. Jolly, Prentice Hall

Unit-1 Qualitative analysis
Qualitative estimation of the inorganic mixture for eight radicals including interfering acid radicals, their combinations and insoluble oxides, sulphates and halides.
Unit-2 Quantitative analysis of mixtures
Separation and determination of binary mixture of metal ions: Cu-Ni, Ni-Zn, Cu- Ag etc, involving volumetric and gravimetric methods.
Unit-3 Chromatographic techniques
Separation of cations and anions by: **I) Paper Chromatography**
Unit-4 Synthesis of Inorganic compounds Part-1
Preparation of selected inorganic compounds and their studies by I.R, electronic, Mossbauer (wherever applicable) and their physical and chemical properties . **a. Sodium trioxalateferrate(III) $Na_3[Fe(C_2O_4)_3]$** **b. Potassium Chlorochromate ($KCrO_3Cl$)** **c. Iron(III) hexacyanidoferrate(II) $Fe_4[Fe(CN)_6]$**
Unit-5 Synthesis of Inorganic compounds Part-2
Preparation of selected inorganic compounds and their studies by I.R, electronic, Mossbauer (where ever applicable) and their physical and chemical properties. **d. HexaamineNickel(II)Chloride $[Ni(NH_3)_6]\ C_{l2}$** **e. Pottasium tri oxalate Chromate (III) ($K_3[Cr(C_2O_4)_3].3H_2O$)**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
50		50	100

Name of The Course	**Computer Applications for Chemistry Lab**				
Course Code	**MSCH5031**				
Prerequisite	**B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects**				
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		0	**0**	**2**	**2**

Course Objectives: Perform basic concepts computer science and related experiments. To explore both theoretical and practical knowledge of programming such as Fortan, C and MATLAB. Understand the concepts of data analysis and chemical application fields using CHEMDRAN.

Course Outcomes

CO1	**Grapes the knowledge of computer science in chemical applications filed. (K2)**
CO2	**Apply the knowledge of FORTRAN and C+ programming to write down short codes for finding chemical reaction.(K3)**
CO3	**Apply software's like Gaussian and MATLAB for real time data analysis of chemical problems.(K3)**
CO4	**Perform programming for finding various chemical reasons and energies calculation.(K4)**
CO5	**Apply data analysis in various chemical application fields.(K3)**

Text Book (s)

5. The Art of Scientific Computing. W. H. Press, S. A. Teukolsky
6. V. Rajaraman, *Fortran 90*, Prentice Hall (India), New Delhi (1997)
7. C. Xavier, Fortran 77 and Numerical Methods, New Age International Pvt. Ltd. Publishers, New Delhi (1994)

Reference Book (s)

10. S. Lipschutz and A. Poe, Schaum's Outline Series - Theory and Problems of Programming with Fortran including structured Fortran, Mc Graw Hill Book Company, Singapore (1982)
11. K. V. Raman, *Computers in Chemistry,* Tata McGraw Hill (1993).

Basic Programming
Types of Constants and Variables in Fortran, Dimension, Data Type, COMMON and EQUIVALENCE statements, Arithmetic and Logical IF, IF-THEN- ELSE constructs, 'DO' statement, Various types of 'I/O' statements, Library functions, Statement functions, Function subprograms and subroutine subprograms. Or Introduction; style of C language ,character and key words, variables and constants in C, arithmetic , relational , logical and bitwise operators in C, ternary, cast, & and * pointer operators, Size of operator input and output in C : content , conditional and switch statement in C; break and continue statement in loop. Storage classes in C functions array and pointers C, structure and unions, types of statement , preprocessor- define and includes simple programming in C.

MATLAB **Features of MATLAB -Basics of MATLAB programming - Array operations in MATLAB - Loops and execution control- Working with files: Scripts and Functions-Plotting and programming input and output.**
Drawing Tools
CHEMDRAW: Introduction –installation –Tools-Structure types – Drawing Structure - Drawing Bonds of Different Types - Drawing Schemes

Continuous Assessment Pattern

Internal Assessment (IA)	End Term Test (ETE)	Total Marks
50	50	100

SEMESTER-II

Name of The Course	**Organic Spectroscopy**				
Course Code	**MSCH5008**				
Prerequisite	**B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects**				
Corequisite	**Basic knowledge of organic Chemistry.**				
Antirequisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives:To introduceabout the organic spectroscopy and students would be acquainted with the basics of UV, IR, NMR, Mass, ESR and Raman spectroscopy. Demonstrate and Practice the method of spectroscopic techniques, and will be able to construct a relational comparison of method, techniques for analysis & characterization of organic molecules. This course will further helps to carry out carrier in the field of research and development.

Course Outcomes

CO1	**Generalize the basic concepts of electromagnetic radiation, Apply & characterize samples by UV spectroscopic techniques. (K3)**
CO2	**Demonstrate and Practice the method of IR spectroscopic techniques and sample recording for analysis. (K3)**
CO3	**Correlate the method of NMR spectroscopic technique for characterization and analysis. (K4)**
CO4	**Apply the method of mass spectroscopic technique, recording samples & appraise the recent developments in the field of characterization. Construct a relational comparison of method, techniques for analysis & characterization. (K6)**
CO5	**Conclude and Practice the method of ESR spectroscopic techniques, collection and their recording for analysis.(K4)**
CO6	**Compile modern spectroscopic techniques (K6)**

Text Book (s)

1. D.L. Pavia, G.M. Lampman, G. S. Kriz, Introduction to Spectroscopy third edition,Thomson, India, 2007.
2. P.S. Kalsi, Spectroscopy of Organic Compounds, 6th edition, New Age International, India, 2014.
3. Y.R. Sharma, Elementary organic spectroscopy: principle and chemical applications, S.Chand, India, 2010

Reference Book (s)

1. W. Kemp, Organic Spectroscopy, 3rd edition, Palgrave Macmillan, London, 1991.
2. D.H. Williams, I. Fleming, Spectroscopic Methods in Organic Chemistry, 6th edition, McGraw-Hill Education, U.K., 2007.
3. L.D.S. Yadav, Organic Spectroscopy, Anamaya Publishers, India, 2009.
4. B.R. Puri, L.R Sharma, M.S. Pathania, Principles of Physical Chemistry, Vishal Publishing co. India, 2006.
5. B.K. Sharma, Spectroscopy, Krishna Prakashan Media(P) Ltd. India, 1999.
6. R.M., Silverstein, F.X. Webster, Spectroscopic identification of organic compounds, 6th edition, Wiley India (P) Ltd., India, 2009.
7. R. V. Parish, NMR, NQR, EPR and Mössbauer Spectroscopy in Inorganic Chemistry, Ellis Harwood.

Unit-1 General Introduction of Spectroscopy andUV-Visible Spectroscopy	**10 hours**
General spectroscopic introduction, basic principle and Instrumentation of UV-vis, absorption law, absorption bands, theory of electronic spectroscopy, types of electronic transitions, chromophore auxochromeeffect,Redandblueshifts,hypoandhyperchromiceffect,woodwardrulesforconjugated dienes and □-□ unsaturated carbonyl groups, extended conjugated and automatic sterically hindered systems and heterocyclic compounds.	
Unit-2 Infra Red(IR)Spectroscopy	**10 hours**
Introduction, basic principle and instrumentation, selection rules, normal modes of vibration, group frequencies, overtones, hot bands, factors affecting the bond positions and intensities, characteristic vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols, amines and carbonyl compounds (ketones, aldehydes, esters ,amides, acids anhydrides , lactones , lactams and conjugated carbonyl compounds) effect of hydrogen bonding, solvent effect, linear harmonic oscillator, vibrational energies of diatomic molecules, zero point energy, force constant and bond strength.	

Unit-3 NuclearMagneticResonance(NMR)Spectroscopy 12 hours	
^{1}HNMR, basic principle and instrumentation, relaxation process (spin-spin relaxation and spin-lattice relaxation), shielding and deshielding effects, chemical shift, factors influencing chemical shift (inductive effect, anisotropic effect, van der wall's deshielding and hydrogen bonding), peak area, splitting of signals, spin-spin coupling, calculating he ratio in the height of the signals, coupling constant, nulcear overhauser effect (NOE), heteronuclear coupling, shift reagent in NMR spectroscopy and, ^{13}C NMR, two dimensional fourier-transform NMR, magnetic resonance imaging (MRI).	
Unit-4 Mass Spectroscopy	**12 hours**
Basic principle and Instrumentation, unit mass and molecular ions; metastable ions or peaks,importance of metastable peaks, nitrogen rule, base peak, isotopic mass peaks, McLafferty rearrangement, fragmentation mode (hemolytic cleavage, hydrolytic cleavage, Retro Diel's-Alder reaction and hydrogen transfer rearrangement), mass spectra of hydrocarbon, alkenes, cycloalkanes, alkynes, aromatic compounds, phenols, ethers, acetals, ketals, aliphatic aldehydes, ketones, esters and halogenated compounds. Combined problems on UV, IR, NMR and Mass.	
Unit-5 Electron Spin Resonance (ESR) and Raman Spectroscopy	**8 hours**
Introduction, limitation of ESR, difference between ESR and NMR, instrumentation, hyperfine interactions and analysis, sensitivity, choice of solvent, study of free radicals, electronic structure and hyperfine splitting, applications. Raman spectroscopy: Introduction and basic principle.	
Unit-6 Recent Advances of Spectroscopy In Chemical Applications	**3 hours**
Modern Spectroscopy techniques for the analysis of organic or inorganic compounds	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Reaction Mechanism and Basics of Group Theory**				
Course Code	**MBS24T1103**				
Prerequisite	**B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects**				
Corequisite	**Basic knowledge of Inorganic Chemistry**				
Antirequisite					
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives

1. **To impart the knowledge of key concepts to understand reaction mechanism.**
2. To present a comprehensive introduction to important inorganic theories with a focus on inorganic concepts.

Course Outcomes

CO1	**Explain the various structural properties, preparation methods and vibrational spectra of Carbonyl and Nitrosyl complexes. (K2)**
CO2	**Interpret the different types of substitution reaction mechanism and factors associated with these. (K3)**
CO3	**Describe the concept of 'Trans effect' and the various types of electron transfer mechanisms. (K2)**
CO4	**Differentiate between various metal clusters and study their applications.(K4)**
CO5	**Identify and distinguish between different symmetry elements and symmetry operations. (K4)**
CO6	**Compile recent advances in the field of symmetry elements and their applications. (K6)**

Text Book (s)

- F. A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, 6th Edn., (1999), John-Wiley & Sons, New York.
- James E. Huheey, Inorganic Chemistry, 4th Edn., (1993), Addison Wesley Pub. Co.,New York.

Reference Book (s)

- **N.N.Green Wood and A. Eafnshow: Chemistry of the element, Pergamon.**

Unit-1 : Metal π-complexes	**8 Lecture**
Metal carbonyls. Preparation, structure and bonding in metal carbonyls, vibrational spectra of metal carbonyls for bonding and structural elucidation. Metal nitrosyls. Preparation, bonding, structure and important reactions of transition metal nitrosyl.	
Unit-2Reaction mechanism of Transitions metal complexes	**8 Lecture**
Energy profile of a reaction (transition state or activated complex) nucleophilic and electrophilic substitution, factors responsible for including SN_1 and SN_2 reaction, Lability and inertness of octahedral complexes according to VBT and CFT. Acid and base hydrolysis: factor affecting hydrolysis, base hydrolysis, conjugate base mechanism (SN1 cB) Evidences in favour of conjugate base mechanism, anation reactions, Substitution reaction without metal-ligand bond cleavage with Special reference to Co(III) complexes.	
Unit-3Substitution in square planar complexes	**8 Lecture**
Trans effect, mechanism of substitution reaction, polarization and π bonding theory. Redox reaction.Electron transfer reaction, mechanism of one electron transfer reaction, outer sphere reaction, Inner sphere reaction, bridge intermediate mechanism.	

Unit-4Metal clusters	8 Lecture
Definition, types :Carbonyl cluster of low nuclearity (M= Co, Ru, Os), high nuclearity (M= Rh, Ru, Ni) and Carbon encapsulated clusters (M=Fe, Ru, Os). Carbonyl cluster: synthesis and reactions (reduction, oxidation and legand substitution) Halide type Cluster: di, tri, tetra &hexa nuclear halide cluster. Chevrel cluster and zitl ion (cluster without ligand).	
Unit-5Basics of Group Theory	**8 Lecture**
Molecular symmetry:Symmetry elements and symmetry operations, definition of group and .its characteristics, subgroups, classes, similarity transformation. Products of symmetry operations, equivalent atoms and equivalent symmetry elements, relations between symmetry elements and operations, classes of symmetry operations, point groups and classification. Symmetry:Optical activity and dipole moment.	
Unit 6 Recent Applications in group theory	**3 Lecture**
Modern application of group theory in various metal clusters	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Physical Chemistry II				
Course Code	MSCH5024				
Prerequisite	B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects				
Corequisite	Basic Knowledge of thermodynamics, kinetics and spectroscopy				
Antirequisite					
		L	T	P	C
		4	0	0	4

Course Objectives: To impart the knowledge of key concepts of statistical thermodynamics, reaction mechanism, electrochemistry, spectroscopic techniques and photochemical phenomenon to explain its applications.

Course Outcomes

CO1	Determine advanced studies of statistical thermodynamics.
CO2	Illustrate different methods of reaction mechanism and discuss various factors affecting rate of the reaction
CO3	Interpret basic equations of electrochemistry and predict the reaction mechanism based on surface charge.
CO4	Analyze and solve problems in chemistry through spectroscopic techniques
CO5	Explain photochemical phenomenon and apply knowledge to explain applications in photochemical energy conversion.
CO6	Compile recent applications in photochemical energy conversion.(K6)

Text Books:

1. Physical Chemistry - P.W. Atkin, ELBS fourth edition.
2. Chemicals Kinetics, K.J. Laidler (Tata Mc. Graw Hill) 1998
3. Fundamentals of Photochemistry- K. K. Rohatgi-Mukharjii, Wiley Eastern
4. Fundamentals of molecular spectroscopy: C.N. Banewell and E.Mc. Cash

References:

1. Electrochemistry- S. Glasstone, D
2. Statistical Thermodynamics, L.K. Nash
3. Basic Chemical Thermodynamics, E. Brian Smith (ELBS) 1990
4. Physical Chemistry molecular approach, D.Mcquarie and J. Simom(Viva) 2000
5. Electrochemistry by Carl H. Hamann, Andrew Hamnett and Wolf Vielstich, Wiley 1998
6. Photochemistry – J. G. Calverts and J. N. Pitts, John-Wiley & Sons

Unit-1 Introduction	10 Lectures
Statistical Thermodynamics Statistical Thermodynamics: Concepts of distribution, thermodynamic probability and most probable distribution. Ensemble averaging, postulates of ensemble averaging. Canonical and microcanonical ensembles, Boltzmann distribution of particles. Partition function: translational, rotational, vibrational partition functions, thermodynamic properties of ideal gases in terms of partition function.	
Unit-2	10 Lectures
Catalysis Acid - Base catalysis - mechanism of acid - base catalyzed reactions - Bronsted catalysis law. Catalysis by enzymes - rate of enzyme catalyzed reactions - effect of substrate concentration, pH and temperature on enzyme catalyzed reactions - inhibition of enzyme catalyzed reactions. Study of surfaces - Langmuir and BET adsorption isotherms.	
Unit-3	10 Lectures
Electrochemistry Metal/Electrolyte interface : OHP and IHP, potential profile across double layer region, potential difference across electrified interface; Structure of the double layer : Helmholtz-Perrin, Gouy-Chapman, and Stern models. Butler-Volmer equation under near equilibrium and non-equilibrium conditions, exchange current density, Tafel plot. Polarizable and non-polarizable interfaces.	
Unit-4	10 Lectures
Molecular Spectroscopy Width and intensity of spectral transitions, Fourier transform. Microwave spectroscopy, rotation spectra of di – and poly- atomic molecules, Stark effect. Infra-red spectroscopy: Harmonic and an-harmonic oscillator, vibrational spectra of di – and poly - atomic molecules, nuclear spin effect, application. Raman Spectroscopy: polarization of light and Raman effect, Electronic spectroscopy of molecules: Born–Oppenheimer approximation.	
Unit-5	10 Lectures
Photochemistry Absorption of light and nature of electronic spectra, electronic transition, Frank-Condon principle, selection rules, photochemical reactions, Photo physical phenomena: Electronic structure of molecules, electronically excited singlet states, construction of Jablonski diagram, photo-physical pathways of excited molecular system (radiative and non-radiative), fluorescence, and phosphorescence, fluorescence quenching, Stern-Volmer relation.	
Unit 6 Latest trends in Photochemical reactions	3 Lectures
Recent advances in applications in photochemical energy conversion.	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks

30	**20**	**50**	**100**

Name of The Course	**Techniques in Analytical Chemistry**				
Course Code	**MBS24T1104**				
Prerequisite	**B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects**				
Co-requisite	**This course covers data analysis, extraction and separation techniques, various industrial techniques such as sample preparation and analysis.** **Separation and identification techniques: extraction, chromatography, and spectroscopy**				
Anti-requisite					
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:To introduce and make them able to interpret and analyse about the various methodologies for solvent extraction, chromatographic techniques, spectroscopic data, thermometric titration methods.

Course Outcomes

CO1	Determine various methodologies for solvent extraction. (**K2**)
CO2	Illustrate different chromatographic techniques for analysis of reaction mixtures.(K3)
CO3	**Interpret various spectroscopic data for sample analysis. (K3)**
CO4	**Analyze the constituents of a reaction mixture by thermometric titration methods. (K4)**
CO5	**Compile the recent developments in the analytical techniques (K6)**

Text Book (s)

D.A. Skoog, *Principles of Instrumental Analysis*, 5th Edition (1998), Saunders CollegePublishing, Philadelphia, London.

2. G.W. Ewing, *Instrumental Methods of Chemical Analysis*, 5th Edition (1978), McGraw HillBooks Co., New York.

3. R.L. Pecsok, L. D. Shields, T. Cairns and L.C. Mc William, *Modern Methods of ChemicalAnalysis*, 2nd Edition (1976), John Wiley, New York.

4. Gurdeep R. Chatwal, Sham K. Anand, Instrumental Methods of Chemical Analysis, 5 th edition (2013),Himalaya Publications, ISBN: 978-93-5051-531-0

Reference Book (s)

1. Gael Sofer, Laris Hagel, Handbook of Process Chromatography, I st Edition, ISBN-13: 978-0126542660, Academic Press
2. J.H. Kennedy, *Analytical Chemistry: Principles*, 2nd Edition (1990), Saunders Holt, London

Unit-1 Introduction	**10 hours**

Unit I: Analytical Separation Involving Solvent Extraction: Introduction, Nature of the separation process, Separation by precipitation, Separation based on control of Activity, Inorganic precipitant, Organic Precipitant, Separation of Constituents present in trace amounts, Separation by Electrolytic precipitation, Application of Extraction procedures
Unit-2 10 hours
Unit II: Chromatographic Techniques: Principle of chromatography, Classifications of chromatography,Techniques of Paper, Column and Thin layer Chromatography, Gas chromatography, High- performanceliquid chromatography.
Unit-3 14 hours
Unit III: Spectroscopy Theory, Instrumentation and applications of X-rays (emission, absorption, diffraction and fluorescence methods), Atomic absorptionSpectroscopy, Atomic fluorescence spectrometry, Atomic emission spectrometry, UV-visible molecular absorption spectrometry (instrumentation and application), Molecular luminescence spectroscopy (fluorescence,phosphorescence, chemiluminescence).
Unit-4 10 hours
Unit IV: Thermal Analysis Theory, methodology and applications of thermogravimetric analysis(TGA), Differential Thermal Analysis (DTA), and Differential scanning calorimetry (DSC).Principles, techniques and applications of thermometric titration methods.
Unit 4 Recent developments in the analytical techniques 4 hours
This unit will cover the latest development in the area of chromatography , spectroscopy , thermal techniques and polarography as per latest literatures

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Physical Chemistry II Lab			
Course Code	MSCH5012			
Prerequisite	B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects			
Corequisite				
Antirequisite				
	L	T	P	C
	0	0	4	2

Course Objectives:To introduce and make them aware about quantitative analysis, potentiometric, conductometric,solubility product of reactants by pH metric method and kinetic analysis of chemical reactions.

Course Outcomes

CO1	Recognize basic laboratory rules and basic principles of lab safety.

CO2	**Carry out quantitative analysis to identify strength of acids and bases in a reaction mixture.**
CO3	**Perform potentiometric and conductometric studies of reaction mixtures**
CO4	**Estimate dissociation constant and solubility product of reactants by pH metric method.**
CO5	**Perform kinetic analysis of chemical reactions**

Text Books

1. Experimental Physical Chemistry –R.C. Das, B. Behera

Experiment -1
Determination of the strength of strong and weak acids in a givenmixture using a conductometer
Experiment -2
Kinetic study of acid hydrolysis of an ester
Experiment -3
Kinetic study of Saponification of ethyl acetate with sodium hydroxide
Experiment -4
Determination of solubility and solubility product of sparingly soluble salt (e.g. PbSO4, BaSO4) conductometrically
Experiment -6
Determination of the dissociation constant of a weak acid by pH metric method
Experiment -7
Determination of strength of halides in a mixture potentiometrically
Experiment -8
Determination of order and rate constant for autocatalytic reaction between Potassium permanganate and Oxalic acid
Experiment -9
Phase Diagram and critical solute temperature of phenol water system

Continuous Assessment Pattern

Internal Assessment (IA)	End Term Test (ETE)	Total Marks
50	50	100

Name of The Course	**Analytical CHEMISTRY LAB-1**				
Course Code	**MSCH 5013**				
Prerequisite	**B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects**				
Co-requisite	**Experimental work in related areas of chemical analysis and instrumentation; acid/base titrations, pH measurements, complexometric titrations, ion-selective electrodes; spectrophotometric analysis.**				
Anti-requisite					
		L	**T**	**P**	**C**
		0	**0**	**4**	**2**

Course Objectives:To introduce and make them aware about analysis techniques, analysis, and interpretation.

Course Outcomes

CO1	**Recognize basic laboratory rules and able to perform Complexometric K2**
CO2	**Analyse Na and K from binary mixture vs flame photometry (K4)**
CO3	**Perform gravimetric analysis of reaction mixtures. (K3)**
CO4	**Estimate functional groups in organic compounds using IR spectroscopy. (K4)**
CO5	**Perform colorimetric analysis of dyes using UV spectrophotometer. (K3)**

Text Book (s)

Experimental Physical Chemistry –R.C. Das, B. Behera.

Vogel's Textbook of Quantitative Analysis, Revised, J. Bassett, R.C. Denney, G.H.H. Jeffery and J. Mendham, elbs.

Reference Book (s)

3. Synthesis and Characterization of Inorganic Compounds, W.L. Jolly, Prentice Hall.

Unit-1 Complexometric titrations and flame photometry
• **Estimation of glucose by complexometric titration.** • **Estimation of Na and K from binary mixture vs flame photometry**
Unit-2 Gravimetric analysis
• **Estimation of Ni-DMG by gravimetric analysis**
Unit-3 Spectrophotometric analysis Part-1
• **Determination of functional groups in organic compounds using IR spectroscopy** • **Determination of iron in iron tablet using extractive spectrophotometry**
Unit-4 Spectrophotometric analysis Part-2
• **Verify Beer-Lamberts Law and determine concentration of given dye colorimetrically**
Unit-5 Water Analysis
• **Estimation of hardness of the given water sample.** • **Estimation of the amount of 'DO' in the given water sample.**

Continuous Assessment Pattern

Internal Assessment (IA)	End Term Test (ETE)	Total Marks
50	50	100

Course Code	Course Name	L	T	P	C
MBS28T2111	RESEARCH METHODOLOGY	2	0	0	2

Course Objective:

To understand the procedures in research, the different types of procedures to make the experiments viable. To acquire sound knowledge of the various types of analysis and how to use statistics in analyzing and interpreting the obtained data.

Course Outcome:

On completion of this course the students will be able to understand the procedures in research, the different types of procedures to make the experiments viable. They get a good knowledge of the various types of analysis and how to use statistics in analyzing and interpreting the obtained data.

CO1	Understand the Principles of Scientific Research and different steps involved in doing research.
CO2	Know how to design research and frame up different steps in design.
CO3	**Appraise the application of sampling through statistics.**
CO4	**Build up the method for data collection and analyse the data.**
CO5	Develop the Concept of hypothesis preparation.
CO6	Develop the statistical analysis indulges in modern research for drug designing.

Course Contents:

Unit – 1: Principles of Scientific Research **6 Lectures**

Research and research methodology, Procedures in research, Identification of the problem - Literature survey - Reference collection - Familiarity with ideas and concept of investigation - Qualitative and Quantitative analysis - Results - Synopsis writing - Art of writing a Research paper and Thesis.

Unit – 2: Research Design, Sampling & Probability **5-Lectures**

Research Design: Features of a Good Design, Different Research Designs, Sampling: Principles, methods, types of sampling, rationale for using a particular sampling procedure, Probability: Classical definition of Probability.

Unit – 3: Data collection & analysis **6- Lectures**

Types of Data, Collection of Data, double blind procedures, incidence and prevalence studies, Data Analysis: Measures of Central Tendency, Measures of Dispersion, Measures of Asymmetry,

Unit-4: Correlation and Regression **5-Lectures**

Methods of correlation, Types of correlation (Pearson r& Rho); Regression analysis, linear regression, Non-linear regression.

Unit – 5: Hypothesis and Statistics 5-Lectures

Hypothesis Testing: Problems and hypothesis, variables and type of variables, Parametric and nonparametric statistics; level of significance, the various nonparametric tests with sample.

Unit 6: Recent research advances 3 lectures

Descriptors, Quantitative structure-activity relationship (QSAR) , Quantitative structure-property relationship(QSPR), Drug designing.

Text Books:

1. **K. Ramakant; Elementary Statistics in a world of applications, Goodyear California Pub. Co.,1979.**
2. **K. D. Broota, Experimental designs in psychological research, Wiley eastern, New York, 1992.**
3. **Guilford, Statistics in Psychology and Education, McGraw hill, New York, 1986.**
4. **Katz and Kahn, Research in Behavioural Sciences, Methuen, USA, 1979.**

Reference Books:

1. **Kerlinger, F., Foundations of Behavioural Research, Surjeet Publications, Delhi, 1983.**
2. **Rajamanickam, M., Statistical Methods in Psychological and Educational Research, Concept Publishing Co. New Delhi, India, 1983.**
3. **Smith, Jonathan, A. (Ed.), Qualitative Psychology: A Practical Guide to Research Methods, Sage Publications, 2003.**
4. **Woodworth and Schlosberg, Experimental Psychology, Methuen and co. ltd, London, 1971.**

Mode of Evaluation

Quiz, Assignment, Seminar and Written Examination

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Minor Project/Summer Internship**				
Course Code	**MSCH 6040**				
Prerequisite	**B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects**				
Corequisite	**Basic knowledge of research aptitude**				
Antirequisite					
		L	**T**	**P**	**C**
		0	**0**	**0**	**2**

Course Objectives: The minor project is aimed at training students in practical workshops and to prepare them for their major project in the upcoming semester.

Course Outcomes

At the end of the course, the student will be able to:

1. Review the literature for the topic of theproject.(K2)
2. Operate instruments neatly for analysis and discuss their experimentalresults.(K3)
3. Validate the specification of instrumental techniques and interpretation ofdata.(K5)
4. Used ICT tools to prepare project reports and present it using

Powerpoint presentation.(K6)

5. Develop the skills to work within a small team to achieve a common researchgoal.(K6)

Continuous Assessment Pattern

Internal Viva (IA)	External Exam (ETE)	Total Marks
50	50	100

SEMESTER-III

Major Project- Phase I

Name of The Course	**MAJOR PROJECT**				
Course Code	**MBS24P2998**				
Prerequisite	**B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects**				
Corequisite	**Knowledge of research methodology**				
Antirequisite					
		L	**T**	**P**	**C**
		0	**0**	**0**	**16**

Course Objectives:

The major project will help the students to have a hand on experience and practical knowledge of the theory papers studied so far. It will enable them to tackle practical problems and expose them to industrial experience.

Course Outcomes

CO1	Survey literature for the topic of the project.**(K4)**
CO2	Correctly interpret the literature review before starting any individual experiment **(K3)**
CO3	Propose novel reaction routes and pathways for an chemical reaction**(K6)**
CO4	Interpret the results and data obtained from any experiment clearly, interpret the results and data obtained; records experiments orderly for future reference and draw clear and logical conclusions & assemble in presentations and reports.**(K4)**
CO5	**Demonstrate leadership skills and effective teamwork while working and prepare themselves for their future career in industry or academics (K6)**

Continuous Assessment Pattern

Internal Assessment (IA)	External Assessment (ETE)	Total Marks
50	50	100

SEMESTER-IV
(ORGANIC SPECIALIZATION)

Name of The Course	**Photochemistry and Pericyclic reaction**				
Course Code	**MSCH6001**				
Prerequisite	**B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects**				
Corequisite	**Students should have the basic knowledge of various chemical reactions**				
Antirequisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives:To introduce and make them aware about photochemistry various photochemical reactions, pericyclic reactions, its typeand applications in chemical reactions.

Course Outcomes

CO1	**Deduce thedifferent principles of photochemistry, with illustration of the absorption, emission processes andjabolonski diagram. (K4)**
CO2	**Determine the photochemical reactions of carbonyl compounds in presence of light.(K4)**
CO3	**Identify and explain the photochemical reactions of alkenes and aromatic compounds.(K4)**
CO4	**Illustrate the pericyclic reactions, its type and frontier orbital, orbital symmetry correlation approaches used in pericyclic reactions. (K3)**
CO5	**Employ the knowledge in the field of chemical synthesis. (K3)**
CO6	**Analyze the recent applications of photochemical reactions in organic synthesis (K6)**

Text Book (s)

T1. D. John Coyle, Introduction to Organic Photochemistry, John Wiley & Sons, Chichester, 1998.
T2. J. Singh and J. Singh, Photochemistry and pericyclic Reactions, New Age International (P) Ltd. New Delhi, 2nd edition, 2006.

Reference Book (s)

1. C.H. Depuy and O.L Chapman, Molecular Reactions and Photochemistry, 2ndEdition, Prentice-Hall of India (P) Ltd., New Delhi, 1988.
2. F.A. Carey and R.J. Sundberg, Advanced Organic Chemistry:Part A, 5thEdition, Springer US, 2007.
3. I. Fleming, Pericyclic Reactions, 1ST edition, Oxford University Press, Oxford, 1998.
4. S. Sankaraman, Pericyclic Reactions- A Textbook, Wiley-VCH, Weinheim, 2005.

Unit-1Basics of Photochemistry 8 hours
Absorption, excitation, photochemical laws, quantum yield, quantum efficiency, spin multiplicity, excited state (Jablonski diagram), Photolytic cleavage, Frank-Condon principle, photochemical stages-primary and secondary processes/effects.
Unit-2Photochemistry of Carbonyl Compounds 12 hours
Norrish type-I cleavage of acyclic, cyclic and β, γ-unsaturated carbonyl compounds, Norrish type-II cleavage. Hydrogen abstraction: Intramolecular and intermolecular hydrogen abstraction, photoenolization. Photocyclo-addition of ketones with unsaturated compounds: Paterno-Buchi reaction, photodimerisation of α, β-unsaturated ketones, rearrangement of enones and dienones, Photo-Fries rearrangement.

Unit-3Photochemistry of Alkenes and Aromatic Compounds 10 hours
Photochemistry of alkenes and related compounds, isomerization, Di-π-methane rearrangement and cycloadditions. Photochemistry of aromatic compounds, ring isomerization and cyclization reactions.
Unit-4 Pericyclic Reactions14 hours
Classification, electrocyclic, sigmatropic, cycloaddition, chelotropic and ene reactions, Woodward Hoffmann rules, frontier orbital and orbital symmetry correlation approaches.
Unit-5 Pericyclic reactions in organic synthesis8 hours
Pericyclic reactions in organic synthesis such as Claisen, Cope, Diels-Alder and Ene reactions (with stereochemical aspects), introductory dipolar cyclo-addition reactions.
Unit VI: **Application of photochemical reactions in recent organic synthesis** **4 lecture hours**
Recent advances in the photochemical and pericyclic reactions in organic synthesis.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Reagents and Heterocyclic Chemistry				
Course Code	MSCH6002				
Prerequisite	**B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects**				
Corequisite	**Knowledge of basic of reaction mechanisms**				
Antirequisite					
		L	**T**	**P**	**C**
		4	0	0	4

Course Objectives: This course offers extensive study of various reagents used in the organic synthesis.

Course Outcomes

CO1	**Illustrate the mechanism and stereochemistry of reduction reactions in Organic Chemistry using various reducing reagents. (K3)**
CO2	**Discuss about the mechanism and stereochemistry of oxidation reactions in Organic Chemistry using various oxidising reagents and use them in organic synthesis. (K3)**
CO3	Analyze the utility of various organic reagents in the areas of organic, pharmaceutical, analytical, and medicinal chemistry. **(K4)**

CO4	**Discuss the nomenclature, synthesis and reactions of various five and six-membered heterocyclic compounds. (K2)**
CO5	**Determine the mechanism, structure and synthesis of different medicinal drugs and discuss their side effects. (K4)**
CO6	**Compile the green reagents used for Organic synthesis as well as for pharmaceutical industry. (K6)**

Text Book (s)

1. W. Carruthers, Some Modern Methods of Organic Synthesis, 3 rd edition, Cambridge UniversityPress, New York, 1998.
2. I.L. Finar, Organic Chemistry, Vol. I, 6 th Edition, Pearson India, New Delhi, 2002.
3. L.F. Fieser and M. Fieser, Reagents for Organic Synthesis, Vol. 1-16, Wiley-Interscience, New York and London.
4. J. March, M. B. Smith, March's Advanced Organic Chemistry: Reactions, Mechanisms and Structure, 6 th edition, John Wiley & Sons, New York, 2007.
5. H.O. House, Modern Synthetic Reactions, 2 nd edition, W.A. Benjamin, U.S.A., 1972.
6. J. Clayden, N. Greeves and S. Warren, Organic Chemistry, Oxford University Press, 2 nd edition, 2012.

Reference Book (s)

7. T.L. Gilchrist, Heterocyclic Chemistry, 3 rd edition, Addison-Wesley Longman Ltd., England, 1997.
8. R.K. Bansal, Heterocyclic Chemistry, 5 th edition, New Age International Publisher, New Delhi, 2015.
9. Ashutoshkar, Medicinal Chemistry, 4 th edition, New Age International Publisher, New Delhi, 2013.

Unit I: Reducing Reagents **10 lecture hours** Complex metal hydride reductions: $LiAlH_4$ and $NaBH_4$; reduction of aldehydes and ketones,stereochemistry of ketone reduction, Reduction of conjugated systems: Birch reduction.Hydroboration, Miscellaneous: Tributyltin hydride, Wilkinson's catalyst, Wolf Kishner reduction.
Unit II: Oxidising Reagents **10 lecture hours** Oxidation with peracids: Oxidation of carbon-carbon double bonds (Sharpless epoxidation),carbonyl compounds, allylic carbon-hydrogen bonds.Oxidation with selenium dioxide and Osmium tetraoxide, Woodward and Prevost, hydroxylation.

Unit III: Reagents and Reactions **8 lecture hours**

- Gilman’s reagent – Lithium dimethylcuprate
- Lithiumdiisopropylamide (LDA)
- Dicyclohexyl carbodiimide (DDC)
- 1,3-Dithiane (Umpolung reagent)
- Peterson’s synthesis
- Bakers yeast
- DDQ

Unit IV: Heterocyclic compounds **14 lecture hours**

Nomenclature, five membered rings (furan, thiophene, pyrrole and its derivatives, condensed pyrroles(Indole), azoles (Five membered rings with two or more hetero atoms).
Pyridine: Synthesis, structure and reactions (Chichibabin reaction and Hofmann exhaustive degradation reaction).
Quinoline : Synthesis and reactions (Skraup, Friedlander, ConardLimpach and Knorr quinoline synthesis, Pfitzinger reaction).

Unit V: Medicinal Chemistry **10 lecture hours**

Mechanism of action at molecular level, Structure and Synthesis and side effects of following types ofdrugs:
Sulphonamides : Sulphanilamide, Sulphadiazine
Antiseptics : Chloramine-T, Dettol
Anticancer agents : Taxol
Anesthetics : Benzocaine
Tranquillizers : Chloropromazine,
Antipyretics & Analgesics : Novalgin, Paracetamol,
Antimalarials : Chloroquine, Mepacrine

Unit VI: Recent Advancement in Organic Reagents and Medicinal Chemistry 04 lecture hours

Reagents used for Green Chemical Processes, Green Synthesis approach of analgesic, antibiotic and anticancer drugs.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Chemistry of Natural Products**				
Course Code	**MSCH6003**				
Prerequisite	B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects				
Corequisite	**Basic knowledge of functional group reactions and their different mechanism.**				
Antirequisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives: This course offers extensive study of various methods for structure determination, synthesis and properties of natural products.

Course Outcomes

CO1	Determine the structure, stereochemistry, spectroscopic techniques and synthesis of terpenoids. **(K4)**
CO2	Analyse the structure, stereochemistry, spectroscopic techniques, synthesis and biosynthesis of alkaloids. **(K4)**
CO3	Deduce the structure and synthesis of various steroids. **(K4)**
CO4	Illustrate the structure determination and synthetic methods for the preparation of different flavonoids. **(K3)**
CO5	**Compile the advance therapeutic uses of different natural products (K6)**

Text Books

1. N.R. Krishnaswamy, Chemistry of Natural Products: A unified Approach, 2nd edition, Universities Press, Hyderabad, 2010.
2. S.G. Warren and P. Wyatt, Organic Synthesis: The Disconnection approach, 2nd edition, Wiley, Chichester, 2010

Reference Books

1. J. H. Furhop and G. Penzillin, Organic Synthesis-concept, methods and starting materials VerlagChemie, Weinheim, 1983.
2. A.Rahman and M.I. Choudhary, New Trends in Natural Product Chemistry, Harwood Academic Publishers, Amsterdam, 1998.
3. R.O.C.Norman and J. M. Coxon, Principles of Organic Synthesis, Blackie Academic and professional, New York, 1993.

4. F. A. Carey and R. J. Sundberg, Advanced Organic Chemistry: Part B Reactions and Synthesis, 5th edition, Springer, New York, 2007.

5. S. V. Bhat, B.A. Nagasampagi, M. Sivakumar, Chemistry of Natural Products, Revised edition, Narosa publishing house, New Delhi, 2014.

Unit I: Terpenoids	**10 lecture hours**
Classification, nomenclature, occurrence, isolation, general methods of structure determination, isoprene rule. Structure determination, stereochemistry and synthesis of the following representative molecules: Camphor and Longifolene.	
Unit II: Alkaloids	**14 lecture hours**
Definition, nomenclature and physiological action, occurrence, isolation, general methods of structure elucidation, classification, role of alkaloids in plants.Structure, stereochemistry, synthesis and biosynthesis of Morphine Reserpine and Quinine.	
Unit III: Steroids	**13 lecture hours**
Occurrence, nomenclature, basic skeleton, diel's hydrocarbon and stereochemistry. Isolation, structure determination synthesis and biosynthesis of Cholesterol, Testosterone and Estrone.	
Unit IV: Flavonoids	**9 lecture hours**
Biosynthesis of flavonoids and related polyphenols, Acetate and schikimic acid pathways, structure and synthesis of apigenin, luteolin, quarcetin and diadzen.	
Unit V: Applications of Natural Products as therapeutic agents	**4 lecture hours**
Recent advances in the isolation, synthesis and bio-medical aspects of different natural products	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Organic chemistry Lab – II**				
Course Code	**MSCH6005**				
Prerequisite	**B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects**				
Corequisite	**Knowledge of fundamental of reaction mechanism of organic Chemistry**				
Antirequisite					
		L	**T**	**P**	**C**
		0	**0**	**8**	**4**

Course Objectives:
To make the student to acquire practical skills in the determination of organic compound preparations. To acquaint the students with the determination Isolation of organic compound from natural sources.
Course Outcomes

CO1	**Students will achieve knowledge regarding fundamentals of organic compounds and the methods used to identify organic compounds.**
CO2	**Illustrate and extract and characterize different organic compounds from plant products.**
CO3	**Analyze and perform the reactions like acetylation, benzoylation and bromination for synthesis of organic compounds.**
CO4	**Design new synthetic route and synthesize organic molecules.**
CO5	**Operate the instruments handled in the laboratory efficiently and safely.**

Text Book (s)
Text: Arthur, I. V. *Quantitative Organic Analysis*, Pearson

- Organic preparations
    1. Acetylation (Preparation of Aspirin from salicylic acid)
    2. Alkylation (Preparation of Anisole from sodium phenoxide)
    3. Benzoylation **(**Preparation of phenyl benzoate)
- Isolation of organic compound from natural sources:
    4. Isolation of Caffeine from tea leaves
    5. Lactose and Casein from milk
    6. Glucose from cane sugar.
- Two step preparations
- Three steps preparation
- Separation, identification and derivatization of organic compounds
- Polymeric synthesis

Continuous Assessment Pattern

Internal Assessment (IA)	**End Term Test (ETE)**	**Total Marks**
50	**50**	**100**

Major Project-Phase II

Name of The Course	MAJOR PROJECT				
Course Code	MBS24P2999				
Prerequisite	B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects				
Corequisite	Knowledge of research methodology				
Antirequisite					
		L	T	P	C
		0	0	0	16

Course Objectives:

The major project will help the students to have a hand on experience and practical knowledge of the theory papers studied so far. It will enable them to tackle practical problems and expose them to industrial experience.

Course Outcomes

CO1	Survey literature for the topic of the project.**(K4)**
CO2	Correctly interpret the literature review before starting any individual experiment **(K3)**
CO3	Propose novel reaction routes and pathways for an chemical reaction**(K6)**
CO4	Interpret the results and data obtained from any experiment clearly, interpret the results and data obtained;records experiments orderly for future reference and draw clear and logical conclusions&assemblein presentations and reports.**(K4)**
CO5	**Demonstrate leadership skills and effective teamwork while working and prepare themselves for their future career in industry or academics (K6)**

Continuous Assessment Pattern

Internal Assessment (IA)	External Assessment (ETE)	Total Marks
50	50	100

SEMESTER-IV
(INORGANIC SPECIALIZATION)

Name of The Course	Organometallic Chemistry				
Course Code	MSCH6006				
Prerequisite	B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects				
Corequisite	Advance knowledge of Inorganic Chemistry				
Antirequisite					
		L	T	P	C
		4	0	0	4

Course Objectives:

1. **To impart the knowledge of key concepts of Organometallic chemistry.**
2. **To present a comprehensive introduction to inorganic chemistry.**

Course Outcomes

CO1	**Differentiate the Organometallic compounds with different ligands. (K2)**

CO2	**Describe the preparation and structure of metal complexes having unsaturated groups. (K2)**
CO3	**Illustrate the synthesis methods of trasition metal complexes having metal hydrogen bond. (K3)**
CO4	**Interpret the structure and reaction of the cyclopentadienyle and related metal complexes (K3)**
CO5	**Compare the methods to prepare the various metal complexes. (K4)**
CO6	**Compile recent advances in organometallic chemistry (K6)**

Text Book (s)

- F. A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, 6^{th} Edn., (1999), John-Wiley & Sons, New York.
- James E. Huheey, Inorganic Chemistry, 4^{th} Edn., (1993), Addison Wesley Pub. Co., New York.

Reference Book (s)

- . R.H. Crabtree, The Organometallic Chemistry of the Transition Metals, 1^{st} Edn.(1988), John-Wiley & Sons, New York.
- J. P. Collman, L. S. Hegedus, J. R. Norton and Richard G. Finke, Principles and Applications of Organotransition Metal Chemistry, 1^{st} Edn.(1987), University Science Books, Mill Valley, California.

Unit-1 : Metal Carbonyls	**10 Lecture**
Semibridging carbonyl group; metal nitrosyl carbonyls; tertiary phosphines and arsines as ligands; carbenes and carbynes.	
Unit-2 Complexes of Unsaturated Molecules	**10 Lecture**
Preparation, bonding and structures of alkene, alkyne, allyl, dienyl and trienyl complexes; reactions with special reference to organic synthesis.	
Unit-3 Transition Metal Compounds with M-H bonds	**10 Lecture**
Synthesis methods , Hydridospecies, terminal metal hydride bonds , hydrogen bridge bonding.	
Unit-4 Chemistry of cyclopentadienyle and related complexes	**10 Lecture**
Ferrocene –Structure and reactions, complexes of Benzene with Chromium and Molibdenum.	
Unit-5 Transition Metal Compounds in Homogeneous Catalysis	**10 Lecture**
Hydrogenation , hydroformylation and polymerization; Waker process.	
Unit-6 Recent advances in organometallic chemistry	**3 lectures**
Latest trends and applications in the field of organometallic chemistry	

Continuous Assessment Pattern

Internal Assessment (IA)	**Mid Term Test (MTE)**	**End Term Test (ETE)**	**Total Marks**
30	**20**	**50**	**100**

Name of The Course	**Spectroscopic Techniques In Inorganic Chemistry**
Course Code	**MSCH 6012**
Prerequisite	**B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects**
Corequisite	
Antirequisite	
	L **T** **P** **C**
	4 **0** **0** **4**

Course Objectives:To impart the knowledge of key concepts of Spectroscopic Techniques in Inorganic Chemistry

Course Outcomes

CO1	**Analyze the structure and magnetic behaviour of metal complexes using NMR spectroscopy. (K4)**
CO2	**Learn and interpret about the various concepts and structural applications of ESR spectroscopy with respect to metal complexes. (K3)**
CO3	**Illustrate the role of Mossbauer spectroscopy and to employ them for structural interpretation of Iron and Tin complexes. (K3)**
CO4	**Describe the structure and symmetry of the various inorganic molecules using IR spectroscopy. (K2)**
CO5	**Interpret the concept of Mass spectroscopy in structural elucidation of various complex compounds. (K3)**
CO6	**Compile the modern Spectroscopic Techniques in Inorganic Chemistry (K6)**

Text Book (s)

- **F E. A. V. Ebsworth, D. W. H. Rankin and S. Cradock, Structural Methods in Inorganic Chemistry, 1st Edn.(1987), Blackwell Scientific Publications, Oxford, London.**
- **R. S. Drago, Physical Methods for Chemists, (1992), Saunders College Publishing, Philadelphia.**
- **R. S. Drago, Physical Methods in Inorganic Chemistry, 1st Edn.(1971), Affiliated East-West Press, New Delhi.**
- **K. Nakamoto, Infrared and Raman Spectra of Inorganic and Coordination Compounds, 4th Edn. (1986), John Wiley & Sons, New York.**
- W. Kemp, Organic Spectroscopy, 3rd Edn. (1991), MacMillan, London.

Reference Book (s)

1.K. Nakamoto, Infrared and Raman Spectra of Inorganic and Coordination Compounds, 4th Edn. (1986), John Wiley & Sons, New York.

2.W. Kemp, Organic Spectroscopy, 3rd Edn. (1991), MacMillan, London.

Unit I:NMR Spectroscopy	**(12 Lecture)**
(i) Use of Chemical shifts and spin-spin couplings for structural determination, (ii) Double resonance, and Dynamic processes in NMR, (iii) Decoupling phenomenon, Nuclear Overhauser Effect, DEPT spectra and structural applications in ^{13}C NMR, (iv) Lanthanide shift reagents, (v) ^{1}H NMR of paramagnetic substances.	

Unit II:Electron Spin Resonance Spectroscopy	**(10 Lecture)**
Basic principle, Hyperfine splittings (isotropic systems); the g-value and the factors affecting thereof; interactions affecting electron energies in paramagnetic complexes (Zero-field splitting and Kramer's degeneracy); Anisotropic effects (the g-value and the hyperfine couplings); The EPR of triplet states; Structural applications to transition metal complexes.	
Unit III: Mössbauer Spectroscopy	**(10 Lecture)**
Basic principle, conditions for Mossbauer spectroscopy, Spectral parameters (Isomer shift, electric quadrupole interactions, magnetic interactions), temperature-dependent effects, structural deductions for Iron and Tin complexes, miscellaneous applications.	
Unit IV: Infrared Spectroscopy	**(10 Lecture)**
Basic principles and advantages of IR spectroscopy, applications of vibrational (IR) spectroscopy in investigating (i) symmetry and shapes of simple AB_2, AB_3 and AB_4 molecules on the basis of spectral data, (ii) mode of bonding of ambidentate ligands (Thiocyanate, Nitrate, Sulfate and Urea).	
Unit V: Mass Spectrometry	**(10 Lecture)**
Fingerprint applications and the interpretation of Mass spectra, effect of isotopes on the appearance of mass spectrum, recognition of the molecular ion peak; Ionization techniques (EI and FAB).	
Unit VI: Recent advances in Spectroscopic Techniques in Inorganic Chemistry	(4 **Lecture)**
Modern Spectroscopic Techniques in Inorganic Chemistry	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Bio inorganic chemistry**				
Course Code	**MSCH6009**				
Prerequisite	**B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects**				
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives:To impart the knowledge of key concepts of biomolecules and interaction with inorganic elements, complex formation and their biological importance.

Course Outcomes

CO1	**Understand the role of metals in biochemical reactions ,Catalysis of phosphate transfer& muscle contraction in biological system.(K2)**

CO2	Discuss and demonstrate the activity of Iron, copper and molybdenum proteins in biological activities.(K3)
CO3	Analyzeand demonstrate the activity of metaloenzyme in biological activities. (K4)
CO4	Analyze and demonstrate the properties ofIron storage and transport of proteins.(K4)
CO5	Estimate the Interaction of metal complexes with DNA & chemotherapeutic agents. (K5)
CO6	Compile recent advances in Bio-inorganic Chemistry (K6)

Text Book (s)

1. M. N. Hughes, Inorganic Chemistry of Biological Processes, 2nd Ed.(1981), John-Wiley & Sons, New York.
2. W. Kaim and B. Schwederski, Bioinorganic Chemistry: Inorganic Elements in the Chemistry of Life, An Introduction and Guide, (1995) Wiley, New York.

Reference Book (s)

1. S. J. Lippard and J. M. Berg, Principles of Bioinorganic Chemistry, (1994) University Science Books.
2. I. Bertini, H. B. Grey, S. J. Lippard and J. S. Valentine, Bioinorganic Chemistry, (1998) Viva Books Pvt. Ltd., New Delhi.

Unit I: Alkaline earth metal ions and biological systems 12 lecture hours
General introduction of the role of metals in biochemical reaction,Catalysis of phosphate transfer by Mg^{2+} ion, Ubiquitous regulatory role of Ca^{2+} - muscle contraction.
Unit II:Iron, copper and molybdenum proteins : 10 lecture hours
Anti-oxidative functions (cytochrome P-450, catalases and peroxidases), Nitrate and nitrite reduction (NO_3^- and NO_2^- reductase), Electron transfer (cytochromes, blue copper proteins and iron-sulfur proteins), Synthetic models of iron-sulfur proteins, molybdo-enzymes – molybdenum cofactors (molybdenum-pterin complexes), nitrogen fixation through metal complexation–nitrogenase, Photosynthesis (PS-I and PS-II).
Unit III: Metalloenzymes 10 lecture hours
Functions and significance of following metalloenzymes :urease, hydrogenase, and cyanocobalamine .
Unit IV: Interaction of metal complexes with DNA 10 lecturehours
Biological function and importance of DNA probe and chemotherapeutic agents.
Unit V: Iron storage and transport proteins 10 lecture hours
Detailed Structure , biological function and significance of following proteins : Ferritin, transferritin and hemosiderin.
Unit VI Recent trends in Bio-inorganic Chemistry 4 lectures
Advancement in bio-inorganic chemistry

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Inorganic Chemistry lab-II				
Course Code	MSCH6010				
Prerequisite	B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects				
Corequisite					
Antirequisite					
		L	T	P	C
		0	0	8	4

Course Objectives:

1. **To impart the knowledge of key concepts of preparation of co-ordination compounds.**
2. **To present a comprehensive introduction to inorganic chemistry.**

Course Outcomes

CO1	**Learn and recognize the basic laboratory safety rules and to practice them properly while performing experiments. (K2)**
CO2	Synthesize inorganic coordination compounds. (**K6**)
CO3	Inspect the mixture of rare earth elements. (**K3**)
CO4	**Distinguish and estimate the constituents of a mixture by gravimetric and volumetric techniques. (K5)**
CO5	**Examine the stability constant and composition of complex. (K4)**

Text Book (s)

- Vogel's Textbook of Quantitative Analysis, Revised, J. Bassett, R.C. Denney, G.H.H.Jeffery and J. Mendham, elbs.
- Synthesis and Characterization of Inorganic Compounds, W.L. Jolly, Prentice Hall

Reference Book (s)

- . Synthesis and Characterization of Inorganic Compounds, W.L. Jolly, Prentice Hall

Unit-1 :

Part-1

Preparation of some Inorganic coordination compounds

a. **Potassium trioxalatochromate(III).**
b. **Cuprous tetraiodomercurate(II).**
c. **Tetraamminecarbonatocobalt(III) nitrate.**

Unit-2

Part-2

Preparation of some Inorganic coordination compounds

a. **Pentaamminechloridocobalt(III) chloride.**
b. **Tris(acetylacetonato)manganese(III) ion**
c. **Cis& trans potassium diaquodioxalatochromate(III)**
d. **Prussian Blue($Fe_4[Fe(CN)_6]$)**

Unit-3
Analyze the given mixture for four rare elements.
Unit-4
Estimation of three constituent in the given mixture (Two gravimetrically and one volumetrically).
Unit-5
Determination of stability constant and composition of complex by Job's method

Continuous Assessment Pattern

Internal Assessment (IA)	End Term Test (ETE)	Total Marks
50	50	100

Major Project-Phase II

Name of The Course	**MAJOR PROJECT**				
Course Code	**MBS24P2999**				
Prerequisite	**B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects**				
Corequisite	**Knowledge of research methodology**				
Antirequisite					
		L	**T**	**P**	**C**
		0	**0**	**0**	**16**

Course Objectives:

The major project will help the students to have a hand on experience and practical knowledge of the theory papers studied so far. It will enable them to tackle practical problems and expose them to industrial experience.

Course Outcomes

CO1	Survey literature for the topic of the project.**(K4)**
CO2	Correctly interpret the literature review before starting any individual experiment **(K3)**
CO3	Propose novel reaction routes and pathways for an chemical reaction**(K6)**
CO4	Interpret the results and data obtained from any experiment clearly, interpret the results and data obtained;records experiments orderly for future reference and draw clear and logical conclusions&assemblein presentations and reports.**(K4)**
CO5	**Demonstrate leadership skills and effective teamwork while working and prepare themselves for their future career in industry or academics (K6)**

Continuous Assessment Pattern

Internal Assessment (IA)	External Assessment (ETE)	Total Marks
50	50	100

SEMESTER-IV
(PHYSICAL SPECIALIZATION)

Name of The Course	**Applied Electrochemistry**				
Course Code	**MSCH6021**				
Prerequisite	**B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects**				
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives:To impart the knowledge of key concepts, importance and role ofelectrochemistry and their role in energy generation, energy devices and kinetics.

Course Outcomes

CO1	**Describe the working of fuel cells, hydrogen cells and other electrochemical cells. (K2).**
CO2	Explain about battery performance and energy density of various batteries .(K2)
CO3	**Compare the properties of electrical double layer and its effect on electrical properties (K2)**
CO4	Assess the corrosion and stability of metals(K4)
CO5	Develop knowledge about the working of fuel cells, hydrogen cells and other electrochemical cells. (K5)
CO6	Compile the recent applications of electrochemistry. (K6)

Text Books

1. J.O'M. Bockris and A.K.N. Reddy, Modern Electrochemistry, Vol. 1 & 2A and 2 B, (1998) Plenum Press, New York.

Reference Books

1. "Fuel Cells : Their electrochemistry". McGraw Hill Book Company, New York.
2. An Introduction to Electrochemistry by S. Glasstone.
3. Electrolytic Solutions by R. A. Robinson and R. H. Strokes
4. Physical Chemistry by P. W. Atkins. ELBS.

Unit I:Electrochemical Energy Generation **12 lecture hours** History of fuel cells, Direct energy conversion by electrochemical means. Maximum intrinsic efficiency of an electrochemical converter. Physical interpretation of the Carnot efficiency factor in electrochemical energy converters. Power outputs. Electrochemical Generators (Fuel Cells): Hydrogen oxygen cells, Hydrogen Air cell, Hydrocarbon air cell, Alkaline fuel cell, Phosphoric and fuel cell, direct NaOH fuel cells, applications of fuel cells.
Unit II: Electrochemical Energy Storage **10 lecture hours** Properties of Electrochemical energy storers: Measure of battery performance, Charging and discharging of a battery, Storage Density, Energy Density. Classical Batteries : (i) Lead Acid (ii) Nickel-Cadmium, (iii) Zinc manganese dioxide. Modern Batteries : (i) Zinc-Air (ii) Nickel-Metal Hydride, (iii) Lithium Battery, Future Electricity storers : Storage in (i) Hydrogen, (ii) Alkali Metals, (iii) Non aqueous solutions.

Unit III: Corrosion and Stability of Metals **10 lecture hours** Surface mechanism of the corrosion of the metals; Thermodynamics and the stability of metals, Corrosion current and corrosion potential –Evans diagrams. Inhibiting Corrosion: Cathodic and Anodic Protection. (i) Inhibition by addition of substrates to the electrolyte environment, (ii) by charging the corroding method from external source, anodic Protection, Organic inhibitors, Passivation: Structure of Passivation films, Mechanism of Passivation
Unit IV :Electrode Kinetics **10 lecture hours** **Review of Butler-Volmer treatment. Polarizable and non-polarizable interfaces. Multistep reactions- a near equilibrium relation between current density and over potential, Concept of rate determining step. Determination of reaction order. Stoichiometric number, and transfer coefficient. Electrocatalysis–comparison of electrocatalytic activity. Importance of oxygen reduction and hydrogen evolution reactions and their mechanisms.**
Unit V: Electrical Double Layer **10 lecture hours** **Thermodynamics of double layer, Electrocapillary equation, Determination of surface excess and other electrical parameters- electrocapillarity, excess charge capacitance, and relative surface excesses. Metal/ water interaction- Contact adsorption, Complete capacity potential curve, Specific adsorption, Adsorption isotherm, rate of adsorption, Semiconductor/ electrolyte interface, Capacity of space charge, Mott-Schottky plot.**
Unit VI: Recent applications of electrochemistry **4 lecture hours** **Advances in recent trends in electrochemistry**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**CHEMICAL KINETICS AND SURFACE CHEMISTRY**				
Course Code	**MSCH6022**				
Prerequisite	**B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects**				
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives:To impart the knowledge of keytechniques of fast reaction kinetics, catalytic activity micelles and theories of emulsions.

Course Outcomes

CO1	Illustrate the techniques of fast reactions kinetics.**(K3)**
CO2	Discuss the reactions taking place in solutions and generalize the effect of different factors on the rate of these reactions.**(K2)**
CO3	Generalize the significance of different types of adsorption: derivation, experimental verification and catalytic activity of surfaces.**(K3)**
CO4	Discuss the classification and different characteristics of micelles. **(K2)**
CO5	Generalize the theories and applications related with emulsions. **(K3)**
CO6	Compile the recent advances in chemical kinetics and surface chemistry (K6)

Suggested Reading

1. K.J. Laidler, Chemical Kinetics, 3rd Edition (1967), Harper & Row Publishers, New York.
2. Introduction to colloid and surface chemistry by D. J. Shaw.
3. M. J. Pilling and A.P.W, Seakins, Reaction Kinetics, (1998) Oxford Science Publication, New York.

7. J. Rajaram and J.C. Kuriacose, Kinetics and Mechanism of Chemical Transformation, Ist

Edition (1993), MacMillan India Ltd., New Delhi.
5. B. G. Cox, Modern Liquid Phase Kinetics, (1994) Oxford University Press, Oxford.
6. Kinetics and Mechanism by A. A. Frost and R. G. Pearson
7. Physical chemistry of surfaces: A. W. Adamson.
8. Theory of adsorption and catalysis by Alfred Clark.

Unit I: Fast Reactions Techniques 10 lecture hours **Kinetics of fast reactions-Study of reactions by relaxation method: Temperature and pressure jump, flow method: Plug flow method and Stopped flow method, Flash photolysis and Shock tube** **method.**
Unit II: Reactions in Solutions 12 lecture hours **Reaction between ions; Effect of solvent (single & double sphere models), interpretation of** **frequency factor and entropy of activation, influence of ionic strength, salt effect and reaction mechanisms. Reactions involving dipoles. Influence of pressure on reaction rates in solution. Significance of value of activation. Influence of substituents on reaction rates. Electronic theories**

of organic reactivity. Linear free energy relationships. The Hammett equation, significance of σ and ρ. The Taft equation
Unit III: Adsorption and Surface Phenomenon 12 lecture hours **Physisorption and chemisorption, adsorption isotherms, Langmuir and B. E. T. equation and significance in surface area determination, surface films, states of insoluble films, L. B. films and their application, adsorption from solution, adsorption types, surface excess concentration, Gibb's adsorption equation : derivation, significance and experimental verification , catalytic activity of surfaces.**
Unit IV : Micelles 10 lecture hours **Surface activity, surface active agents and their classification, micellisation, critical micelle concentration thermodynamics of micellisation , factors affecting cmc, methods of determination of cmc, reverse micelle , solubisation of water insoluble organic substances , use of surfactants in oil recovery.**
Unit V: Emulsions 8 lecture hours **Types of emulsion, theories of emulsion and emulsion stability, identification of emulsion types, inversion emulsion, microemulsion: theory and application**
UnitVI: Recent trends in chemical kinetics and surface chemistry 4 lecture hours **Recent Advances in the field of chemical kinetics and surface chemistry**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Molecular Spectroscopy**				
Course Code	**MSCH6023**				
Prerequisite	**B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects**				
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives:To impart the advanced knowledge of instrumentation by different spectroscopic techniques for molecular structure determination and their real time applications.

Course Outcomes

CO1	Illustrate molecular spectroscopy as an important tool to understanding molecular structure and its characteristics.(K3)
CO2	Categorize different electromagnetic regions and instrumentation of various modern spectrometers. (K4)
CO3	Evaluate the theoretical knowledge of the various spectroscopic methods on the basis of the examples.(K5)
CO4	Acquire the skill to determine the functional groups present in unknown molecules.(K4)
CO5	Solve and interpret the results obtained from different spectroscopic methods.(K4)
CO6	Compile recent trends in **Molecular Spectroscopy (K6).**

Suggested Reading

1. Fundamentals of molecular spectroscopy : C.N. Banewell and E.Mc. Cash.
2. Vibrational Spectroscopy: Theory and Applications, D.N. Sathyanarayana, New Age International Publishers, New Delhi (2000).
3. Electronic Absorption Spectroscopy and Related Techniques, D.N. Sathyanarayana, Universities Press, Bangalore (2001).
4. Organic spectroscopy, W. Kemp, ELBS London, 2000.
5. Mass spectroscopy a foundation course. K Downard, RSC, Cambridge, 2004.

Unit I: Ultraviolet and Visible Spectroscopy **10 lecture hours** Classification of electronic transitions, Terminology, Fourier transform, Substituent and solvent effects, UV spectral study of alkenes, polyenes, enones and aromatic compounds. Emperical rules for calculating λ max.
Unit II: IR- Spectroscopy **12 lecture hours** Sampling techniques, Group frequencies, factors affecting group frequencies, Bond order, Mass effect, Conjugation, Inductive, resonance, steric effects, intramolecular interactions. Application of IR in the study of H-bonding and tautomerism. Complimentarity of IR and Raman. Identification of the following organic compounds by IR: Alkanes, Alkenes, Alkynes, Aromatic compounds, Aldhydes, Ketones, Alcohols, Acids and its derivatives; Amines, Esters, Alkyl halides and Nitro compounds; Problems using UV and IR.
Unit III: Raman and Electronic Spectroscopy **12 lecture hours** Raman Spectroscopy: Introduction, Rotational Raman spectra, Vibrational Raman Spectra, polarization of light and Raman effect, structure elucidation from combined Raman and IR spectroscopy, applications in structure elucidation. Electronic spectroscopy of molecules: Born – Oppenheimer approximation, electronic spectra of diatomic molecules, vibrational coarse structure, rotational fine structure dissociation energy and

dissociation products, electronic structure of diatomic molecules, molecular photoelectron spectroscopy, application.
Unit IV : Nuclear Magnetic Resonance Spectroscopy 10 lecture hours   **Introduction, Magnetic properties of nuclei-Resonance condition, Nuclear spin, population of nuclear spin levels and NMR isotopes, Relaxation methods, Instrumentation and sample handling; Classical approach and FT-NMR. Chemical shift, Factors influencing chemical shifts : electronegativity and electrostatic effects; Mechanism of shielding and deshielding in alkanes, alkyl halides, alkenes, aromatic compounds, carbonyl compounds and annulenes. Equivalence of protons-chemical and magnetic equivalence; Spin-spin interactions.**
Unit V: ESR, Mossbauer and Mass Spectroscopy 8 lecture hours   **Basic principles and applications of ESR, Mossbauer and Mass Spectroscopy.**
Unit VI: Recent trends in Molecular Spectroscopy 4 lecture hours   **Recent advances in molecular structure determination and their real time applications**

Continuous Assessment Pattern

Internal Assessment (IA)	**Mid Term Test (MTE)**	**End Term Test (ETE)**	**Total Marks**
30	**20**	**50**	**100**

Name of The Course	**Physical Chemistry lab-II**				
Course Code	**MSCH6025**				
Prerequisite	**B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects**				
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		0	**0**	**8**	**4**

Course Objectives:To impart the knowledge and concepts ofphase diagram of binary system, rate constant and distribution coefficient by performing experiments.

Course Outcomes

CO1	Understand the of acid catalyzed hydrolysis. (**K2**)
CO2	Interpret different techniques as potentiometric titration, spectrophotometry, pH metery.**(K3)**
CO3	Validate adsorption isotherms and determine degree of hydrolysis, rate constant, saponification number and comparison of acid strengths. (**K5**)
CO4	Evaluate physical parameters like distribution coefficient, molecular weight by cryoscopy method and equilibrium constant by distribution method.(**K4**)
CO5	Determination of the solubility of salts. (**K4**)

Suggested Reading

Advanced Practical Physical Chemistry; Twenty-second Edition; J.B.Yadav; Goel Publishing House, Merrut, 2005.

Course Contents:

1. Phase diagram of a binary organic system (Naphthalene and Diphenyl).
2. Rate constant of acid catalyzed hydrolysis of sucrose by polarimetric method.
3. Potentiometric titrations
4. Spectrophotometry (Jobs method)
5. pHmetry.
6. Adsorption of acetic acid on charcoal to verify Freundlich adsorption isotherm.
7. Degree of hydrolysis of urea hydrochloride by kinetics method.
8. Rate constant of acid catalyzed hydrolysis of sucrose by chemical method.
9. Saponification of ethyl acetate with sodium hydroxide by chemical method.
10. Comparison of acid strengths through acid catalyzed methyl acetate hydrolysis
11. Distribution coefficient of I2 between two immiscible solvents.
12. Molecular weight of a non-electrolyte by cryoscopy method.
13. Equilibrium constant of KI + I2 ⇌KI3 by distribution method.
14. Determination of solubility and solubility product of sparingly soluble salt conductometrically.

Continuous Assessment Pattern

Internal Assessment (IA)	End Term Test (ETE)	Total Marks
50	50	100

Major Project-Phase II

Name of The Course	**MAJOR PROJECT**				
Course Code	**MBS24P2999**				
Prerequisite	**B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects**				
Corequisite	**Knowledge of research methodology**				
Antirequisite					
		L	**T**	**P**	**C**
		0	**0**	**0**	**16**

Course Objectives:

The major project will help the students to have a hand on experience and practical knowledge of the theory papers studied so far. It will enable them to tackle practical problems and expose them to industrial experience.

Course Outcomes

CO1	Survey literature for the topic of the project.**(K4)**
CO2	Correctly interpret the literature review before starting any individual experiment **(K3)**
CO3	Propose novel reaction routes and pathways for an chemical reaction**(K6)**
CO4	Interpret the results and data obtained from any experiment clearly, interpret the results and data obtained;records experiments orderly for future reference and draw clear and logical conclusions&assemblein presentations and reports.**(K4)**
CO5	**Demonstrate leadership skills and effective teamwork while working and prepare themselves for their future career in industry or academics (K6)**

Continuous Assessment Pattern

Internal Assessment (IA)	External Assessment (ETE)	Total Marks
50	50	100

SEMESTER-IV
(ANALYTICAL SPECIALIZATION)

Name of The Course	**Electroanalytical methods**				
Course Code	**MSCH6031**				
Prerequisite	**B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects**				
Corequisite	**Knowledge of basic Analytical Chemistry**				
Antirequisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives:To impart the knowledge about the biosensors, electrophoresis, various electrochemical phenomenon and their industrial importance.

Course Outcomes

CO1	Employ some understanding of the professional and safety responsibilities in pollution monitoring, trace metal estimation etc.**(K3)**
CO2	Define the theoretical skills used in the field of biosensors.**(K1)**
CO3	Develop some basic understanding of electrophoresis.**(K2)**
CO4	Apply their knowledge in electrochemistry and related areas in industry as well as in research.**(K3)**
CO5	Understand some basic techniques used in electrochromatography and electrogravimetry.**(K1)**
CO6	Compile recent advances in Electroanalytical methods (K6)

Text Books

1 .D.A. Skoog, F.J. Holler and T. A. Nieman, Principles of Instrumental Analysis, Thomson Asia Pvt Ltd., Singapore, Sixth reprint, 2005.

1. .A.J. Bard and L.R. Faulkner, Electrochemical Methods, John Wiley and Sons, 2nd Edition, 2004.

Reference Books

1. S.M. Khopkar, Basic Concept of Analytical Chemistry, Wiley Easter, 2nd Edition, 2000.
2. L. Barret et al, Vogel's Textbook of Quantitative Inorganic Analysis, ELBS (Longmann's Ed.), 1998

Unit I:Ion-selective electrodes 12 lecture hours **Working principles and applications– Theoretical considerations – Types of ion-selective electrodes – Properties of ion-selective electrodes – Sources of errors – Construction and working of cation specific electrodes for analysis of cadmium, lead, arsenic and anion specific electrodes for fluoride, chloride and sulphide ions; Application of ion selective electrodes in different fields such as pollution monitoring, trace metal estimation, agriculture and food and pharmaceuticals.**
Unit II: Bio-sensors in analysis 10 lecture hours Introduction – basic components – bio-sensors – bio-sensors based on chemoreceptors - biocatalytic bio-sensors – immunological bio-sensors – building blocks for bio-sensors – base devices for metabolism bio-sensors – amperometric and potentiometric bio-sensors – calorimetric bio-sensors.
Unit III: Electrophoresis 8 lecture hours

Principle of electrophoresis; Principles and applications of Paper electrophoresis or zone electrophoresis, Capillary electrophoresis, capillary zone electrophoresis.
Unit IV: Voltammetry 14 lecture hours **Introduction to voltammetry –Three electrode potentiostat – circuit diagram and working of potentiostat – Single sweep voltammetry, cyclic 53oltammetry – Randles-Sevcik equation, Criteria for reversible and irreversible processes – methodology and applications** **Description and general principles involved in stripping techniques – Anodic Stripping, Cathodic Stripping and Adsorptive stripping voltammetry – processes and applications.**
Unit V: Electrochromatography and Electrogravimetry 8 lecture hours **Micellar electrokinetic chromatography and capillary electrochromatography, principle ,theory and applications of electrogravimetry.**
Unit VI: Recent advances in Electroanalytical methods 4 lecture hours **Applications of different Electroanalytical methods**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Quality Control and Quality Assurance**				
Course Code	**MSCH6032**				
Prerequisite	**B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects**				
Corequisite	**Knowledge of basic Analytical Chemistry**				
Antirequisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives:To impart the knowledge about the principle and laws of quality control, quality assurance and quality management and to develop the skills of process selection and unit operation in chemical industry.

Course Outcomes

CO1	Describe basic principles and laws related to quality control, quality assurance and quality management. **(K2)**
CO2	Illustrate the standard operating procedures for quality control .**(K3)**
CO3	Develop knowledge of the working principles of automated quality control.**(K4)**
CO4	Describe the principles of process selection and unit operation in chemical industry.**(K2)**
CO5	Employ their knowledge of Green chemistry to modify existing industrial methodologies.**(K3)**
CO6	Compile recent advances in skills for quality assurance (K6)

Text Books

1. Statistical Quality Control, D.C. Montgomery, John Wiley & Sons, 5th edition, 2005.

2. Production and Operations Management, M. K. Starr, Biztantra, Delhi, 2004.

Reference Books

1. QA Manual, D.H. Shah, Business Horizons, 2000

2. Total Quality Management, D.H. Besterfield, C. Besterfield-Michna, G.H. Besterfield, M.

Besterfield -Sacre, Pearson Education, Inc., 3rd Edition, 2003.

Unit I:An Introduction to Quality Management system - 10 lecture hours Concept of quality, Quality control and quality assurance; Quality dimensions and costs of quality; Economics of quality Control; Materials management; Current trends in quality management – ISO 9000 and its series, Laws related to quality control; Product development and project management.
Unit II:Quality assurance and Control 10 lecture hours Standard operating procedure (SOP), Good laboratory practice (GLP), Concept of six sigma and overview of TQM; Basics of sampling, sampling procedure, sampling based on physical state and hazards in sampling pre-concentration methods; Introduction to statistical quality control (SQC), Process capability assessing methods, techniques in SQC, roles of SQC in QCQA of process industry.
Unit III: Automation in Analytical Chemistry - 10 lecture hours Instrumental parameters for automated instruments, sample conditioning. Automated process control, automated instruments in process control systems, automation in chemical industry, flow injection analysis, automation in process quality control and quality assurance;
Unit IV:Quality control/Quality Assurance in Process Industry 12 lecture hours Outlines of QA in chemical industries; Flow sheet preparations, principles of process selection and unit operation; Basic raw materials and route for the manufacture of important organic and inorganic products; Flow sheets, engineering aspects and QC/QA measures of manufacture of ammonium nitrate, DDT, Bulk drugs Paracetamol/Asprin. Case studies on QC/QA in industries manufacturing plastics, petrochemicals and dyes.
Unit V:Green Chemistry 10 lecture hours Principles and concepts of green Chemistry; Sustainable Development and green chemistry, Atom Economy, examples of atom economic and atom uneconomic reactions, reducing toxicity, Organic solvents: environmentally benign solutions, solvent free systems, supercritical fluids (only introduction) Ionic liquids as catalysts and solvents, Emerging green technologies, photochemical reactions (advantages and challenges) examples, Chemistry using microwaves, sonochemistry, electrochemical synthesis
Unit VI: Advancement in skills for quality assurance 4 lectures Recent trends in the field of quality assurance and green chemistry

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**ADVANCE INSTRUMENTATION METHODS**				
Course Code	**MSCH6033**				
Prerequisite	**B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects**				
Corequisite	**Knowledge of spectroscopy**				
Antirequisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives: To impart advanced knowledge in instrumentations methods for chemical analysis.

Course Outcomes

CO1	Determine various spectroscopic techniques for quantitative and qualitative analysis. (K2)
CO2	Describe principle and instrumentation of Infra-Red, Electron, 1H NMR, 13C NMR and Mass spectroscopy. (K3)
CO3	Investigate structures on these techniques. (K5)
CO4	Identify structure of organic compounds by NMR techniques. (K4)
CO5	Analyze reaction sequences by using spectroscopic technique. (K4)
CO6	**Compile the recent instrumentations methods for chemical analysis. (K6)**

Text Books

(1) Gary D. Christian, Analytical chemistry, 6th edition, John Wiley & Sons, Inc New York, 2004.
(2) H.A. Willard, L.L. Merrit, J.A. Dean, Von Nostrand, Instrumental methods of analysis, 7th Edition, CBS Publishers, 1986.

Reference Books

2. D.A Skoog, D.M. West, Holt Rinahart Winston, Principles of Instrumental Analysis, New

York, 1988.

3. D.A. Skoog, F.J. Holler and T. A. Nieman, Principles of Instrumental Analysis, Thomson

Asia Pvt Ltd., Singapore, Sixth reprint, 2005.

4. D. A. Skoog, D. M. West and F. J. Holler, Nieman, Analytical Chemistry, Third reprint,

Thomson Asia Pte ltd., Singapore, 2005.

Unit I: Infra-red spectroscopy 10 lecture hours **Introduction, Theory of Infrared Absorption Spectroscopy , Linear Molecules, Symmetric Top Molecules, Asymmetric Molecules, Instrumentation, Single beam and double beam spectrophotometers, Modes of vibrations of Atoms in Polyatomic molecules, Factors which influence vibrational frequencies, Selection Rules, Finger print region, Applications of IR, Limitations of Infrared Spectroscopy.**
Unit II:Electron spectroscopy 8 lecture hours **X-ray photoelectron spectroscopy (XPS), Ultra-Violet photoelectron spectroscopy (UPS), Atomic emission spectroscopy (AES)Principle, Theory, Instrumentation, Measurements,**

Surface sensitivity, Chemical states and chemical shifts, Detection limits, Sample size, Sample preparations, Advanced instrumentation aspects, Industry use, applications
Unit III: Electron Microscopy 8 lecture hours **TEM (Transmission electron microscopy), SEM, STM and AFM** **Introduction, Theory, Instrumentation, Imaging methods, sample preparation, modifications, resolution limits, typical applications.**
Unit IV:Nuclear Magnetic Resonance Spectroscopy 10 lecture hours **Theory, Instrumentation, chemical shifts, solvents used in NMR, Interpretation, Limitations of NMR spectroscopy, Applications of ^{1}H and ^{13}C NMR technique for structure determination of typical organic molecules, Solid state NMR (MAS)**
Unit V: Mass Spectrometry 14 lecture hours **Introduction – instrumentation – ion production -EI, CI, FD and FAB – factors affecting fragmentation – ion analysis – ion abundance – mass spectral fragmentation of organic compounds – common functional groups – molecular ion peak – meta stable peak – base peak – Mc Lafferty rearrangement, nitrogen rule, high resolution mass spectrometry.**
Unit VI: Recent instrumentations methods 4 hours **Advancement in recent instrumentations methods for chemical analysis**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**ANALYTICAL CHEMISTRY LAB – II**				
Course Code	**MSCH6034**				
Prerequisite	**B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects**				
Corequisite	**Knowledge of spectroscopy**				
Antirequisite					
		L	**T**	**P**	**C**
		0	**0**	**8**	**4**

Course Objectives:To impart advanced practical knowledge in analytical methods for various chemical analysis.

Course Outcomes

CO1	Use instruments and suitable analytical techniques for the identification of various compounds (K3).
CO2	Determine the values of BOD, COD, TDS and alkalinity of water samples collected from different areas (K4).
CO3	Analyze different ions accurately using spectrophotometry, potentiometric, thermogravimetric and voltametric methods (K4).
CO4	Operate the instruments efficiently and safely (K3).
CO5	Validate the various spectroscopic techniques (K5).

Suggested Reading

5. Qualitative Analysis by Vogel

Course Contents:

1. Inorganic quantitative Analysis: Experiments based on

- Redox Titrations
- Iodometric Titrations
- Complexometric titration
- Gravimetric analysis

2. Conductometry for the Analysis of Aminoacids
3. Differential Pulse Polarography
4. Multiple Analytes by Stripping Voltammetry
5. Automobile Exhausts by FTIR Spectrophotometry
6. Thermogravimetric Studies of Zeolites
7. Determination of metal ions by spectrophotometric and potentiometric methods
8. Determination of total alkalinity, BOD, COD and Total solids
9. Determination of requirement of coagulants
10. Determination of anions and silicates using spectrophotometric and ion analyzer potentiometric methods.
11. Bioassaying and Environmental Analysis by Potentiometric and Voltammetric Methods
12. Amperometric Titrations

Continuous Assessment Pattern

Internal Assessment (IA)	End Term Test (ETE)	Total Marks
50	50	100

Major Project-Phase II

Name of The Course	**MAJOR PROJECT**				
Course Code	**MBS24P2999**				
Prerequisite	**B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects**				
Corequisite	**Knowledge of research methodology**				
Antirequisite					
		L	**T**	**P**	**C**
		0	**0**	**0**	**16**

Course Objectives:

The major project will help the students to have a hand on experience and practical knowledge of the theory papers studied so far. It will enable them to tackle practical problems and expose them to industrial experience.

Course Outcomes

CO1	Survey literature for the topic of the project.**(K4)**
CO2	Correctly interpret the literature review before starting any individual experiment **(K3)**
CO3	Propose novel reaction routes and pathways for an chemical reaction**(K6)**
CO4	Interpret the results and data obtained from any experiment clearly, interpret the results and data obtained;records experiments orderly for future reference and draw clear and logical conclusions&assemblein presentations and reports.**(K4)**
CO5	**Demonstrate leadership skills and effective teamwork while working and prepare themselves for their future career in industry or academics (K6)**

Continuous Assessment Pattern

Internal Assessment (IA)	**External Assessment (ETE)**	**Total Marks**
50	**50**	**100**

List of ELECTIVES

Name of The Course	**Polymer chemistry(Elective)**				
Course Code	**MBS24T5101**				
Prerequisite	**B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects**				
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

- To introduce the student to polymers, their synthesis, reaction mechanism and kinetics.
- To introduce the student to the methods of molecular weight determination of polymers and their properties.
- To introduce the students to synthesize, compare the properties and application of various resins /polymers.

Course Outcomes

CO1	**Understand the basic concepts about polymers & mechanism of polymerization.**
CO2	**Analyze the Kinetics and metallic mechanism of co-ordination polymers.**
CO3	**Analyze and evaluate molecular weight of polymers, properties by various techniques and methods.**
CO4	**Synthesize, compare the properties and application of various resins /polymers.**
CO5	**Develop & compare the properties ofvarious newly developed conducting & bio polymers.**
CO6	**Compile the recent advances in polymer chemistry**

Text Book (s)

1. F.W.Billmeyer, TextBook of Polymer Science, 3rd edition, Wiley, Singapore 2009.
2. V.R.Gowariker, N.V.Viswanathan and J.Sreedhar, Polymer Science, Wiley Eastern, New Delhi, 1988.

Reference Book (s)

1. H.F. Mark, Encyclopedia of polymer science and technology, 4th edition, John Wiley & Sons, New York, 2014.
2. Paul. G. Flory, Principle of Polymer chemistry, Ist edition, Cornell university press, U.S.A., 1995.
3. Joel R. Fried, Polymer science and Technology, 3rd edition, Prentice Hall, New Jersey, 2014.

Unit I: Addition and Condensation Polymerization10 Lectures 8 lectures

Monomers, repeat units, degree of polymerization, linear, branched and network polymers. Condensation polymerization: Mechanism of stepwise polymerization. Kinetics and statistics of linear stepwise polymerization.

Addition polymerization: Free radical, cationic and anionic polymerization.

Unit II: Co-ordination Polymerization 10 lectures

Kinetics, mono and bimetallic mechanism of co-ordination polymers, co-polymerization: block and graft co-polymers, kinetics of copolymerization, types of co-polymerization, evaluation of monomer.

Unit III: Molecular Weight and Properties 10 Lectures

Polydispersion: Average molecular weight concept, number, weight and viscosity average molecular weights, measurement of molecular weights, gel permeation chromatography, viscosity, light scattering, osmotic and ultracentrifugation methods. Polymer structure and physical properties, crystalline melting point T_m, glass transition temperature, determination of T_g, relationship between T_m and T_g .

Unit IV: Properties of Polymers 6 lectures

Polyethylene, polyvinyl chloride, polyamides, polyesters, phenolic resins, epoxy resins and silicone polymers. Functional polymers

Unit V: Application of Polymers 6 lectures **Applications of Fire retarding polymers and electrically conducting polymers. Biomedical polymers – contact lens, dental polymers, artificial heart, kidney, skin and blood cells.**
Unit VI: Recent advances in polymer chemistry 4 lectures **Recent applications in the field of polymer chemistry**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Industrial chemistry(Elective)**				
Course Code	**MBS24T5102**				
Prerequisite	**B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects**				
Corequisite	**Advance knowledge of Inorganic Chemistry**				
Antirequisite					
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

- To introduce the student about various water treatment processes
- To introduce the student about various petroleum and petrochemical products
- To introduce the student about various mineral processing and metal finish technologies.
- To introduce the student about refractories, cement, glass and protective coatings.

Course Outcomes

CO1	**Utilize their knowledge in treatment of hard water and waste water through sewage treatment plant (STP), Effluent treatment plant (ETP) etc.**
CO2	**Understand the petroleum resources, petroleum composition, nature of crude oil, types of crude oil, and its general processing.**
CO3	**Explain the types of minerals in India, mineral processing and the types of metal finish technology.**
CO4	**Understand the classification, properties, raw material composition of refractories.**
CO5	**Recognize the types of coating and differentiate paints, varnishes and lacquers.**
CO6	**Compile recent advances in industrial chemistry**

Text Book (s)

1. **P. C. Jain, M. Jain: Engineering Chemistry, Dhanpat Rai & Sons, Delhi.**
2. **S. S. Dara: A Textbook of Engineering Chemistry, S. Chand & Company Ltd. New Delhi.**

Reference Book (s)

6. Industrial Chemistry by B.K. Sharma, GOEL Publishing House, Meerut

Unit I: Water treatment	**8 lectures**
Hardness of water, softening methods: lime soda method and ion exchange method, demineralization, desalting (electrodialysis and reverse osmosis method) primary, secondary and tertiary treatment of waste water. Estimation of biological and chemical oxygen demand. Design and functioning of sewage treatment plant (STP), Effluent treatment plant (ETP).	
Unit II: Petroleum and Petrochemical products	**8 lectures**
Petroleum resources, petroleum composition, different types of crude oil, general processing of crude oil- fractionation and stripping, thermal decomposition process, Cracking process- thermal and catalytic, Aviation fuel, gasoline, Diesel, Kerosene, LPG, Synthetic petrol. **Petrochemicals** – Types of petrochemicals. Manufacture, properties and uses of acetone, acetylene, ethylene, ethyl hexanol and 61sopropanol.	
Unit III: Metallurgical processes and metals	**10 lectures**
Minerals in India, mineral processing. Manufacture and applications of metal alloys, iron and steel, (Iron, steel alloy, tool steel and stainless steel), copper and its alloys. Metal finish technology: Eletro refining of metals, electroplating, surface treatment technology, surface coats. Electrodeposition, electroplating, hot dipping, metal cladding, immersion plating, metal spraying, vapour deposition, chemical and organic coating.	
Unit IV: Cement and Glass	**8 lectures**
Cement. Types and composition of cement, raw material, manufacture chemistry of setting cement, additives, and reinforced cement concrete, high performance concrete. Glass. Introduction, chemical and Physical properties of glass, raw materials and manufacture annealing and finishing, types of glasses – optical glass, borosilicate glass, high silica glass, safety glass, fiber glass, glass laminates, glass wool.	
Unit V: Protective coatings	**10 lectures**
Metallic coatings metal cladding, organic coating- Paints,Varnishes- oleoresinous and spirit varnishes, lacquers, difference between Paints, Varnishes and Lacquers, classification, formulation and preparation of paints, raw materials for paints: resinous binders, pigments- their classification, white, coloured, metallic and luminous pigments, drying oils, solvents, plasticizers and other additives, paint and film properties.	
Unit VI: Recent Advances in industrial chemistry	**4 lectures**
Recent Applications of industrial chemistry	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Environmental analytical chemistry (Elective)**
Course Code	**MBS24T5104**
Prerequisite	**B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects**
Corequisite	**Knowledge of Analytical Chemistry and toxicology**
Antirequisite	

	L	T	P	C
	3	0	0	3

Course Objectives:

- To introduce students about toxicology and associated terms, exposure types and factors influencing toxicity, toxicity tests in animals
- Provide knowledge about water pollution, water quality parameters, analysis and treatment methods
- Knowledge about different phases, factors affecting and chemical analysis of soil
- To impart knowledge about various food ingredients with food adulteration and analysis. .
- learn how to evaluate laboratory and pathologic testing.

Course Outcomes

CO1	**Recognize different types of toxic substances, their responses and analyse toxicological information**
CO2	**Recognize the origin of wastewater and water pollution, quality requirement of water, analysis and treatment methods.**
CO3	**Acquire the knowledge of phases of soil, factors affecting the composition and concentration of salts in soils, Soil Sampling, Physical Analysis of various soil parameters.**
CO4	**Acquire the knowledge of various food ingredients and Pesticide analysis in water and food products.**
CO5	**Discuss various parameters of body fluids, and get an idea about the analysis in concerned field of clinical chemistry with various products.**
CO6	**Compile recent trends in Environmental analytical chemistry**

Text Books

1. S.M. Khopkar, Basic concepts of analytical chemistry, Wiley Eastern, 2nd Edition, 2000.
2. Ayodhya Singh, A textbook of Environmental Chemistry, 1st Edition, Campus Books International, New Delhi, 2000.

Reference Books

1. Sajeev, Moorthy and Kaliappan, Food and Bioprocess engineering, Anamaya Publishers, New Delhi, 1st Edition, 2005.

Unit I: Environmental toxicology **8 Lectures** Classification of Toxic agents, Acute and Chronic exposure-Route, site, duration and frequency of exposure. Toxico Kinetics-absorption, distribution, metabolism, excretion and influencing factors. Ld50, Ed50, Mechanism of action, Factors influencing toxicity, toxicity tests in animals-Acute, sub acute and chronic tests, mutagenicity, 62eratogenicity and carcinogenicity tests
Unit II: Water Analysis **8 Lectures** Types & Effects of water pollution,. Objectives of analysis- parameters for analysis- colour, turbidity, total solids, conductivity, acidity, alkalinity, hardness, chloride, sulphate, fluoride, silica, phosphates and different forms of nitrogen. Measurements of DO, BOD and COD.
Unit III: Soil Analysis: **8 Lectures** Introduction of phases of soil, Factors affecting the composition and concentration of salts in soils. Relation of particle size and texture with the nutrients present in the soil, Soil Sampling, Physical Analysis (porous nature, water absorbing capacity, pH, conductivity, cation exchange capacity and its determination)

Unit IV: Food Analysis **10 Lectures** Food Ingredients:Moisture, ash, crude protein, fat, fibre, carbohydrates crude, **Food adulteration & Analysis: Common adulterants in food, contamination of food stuffs. Microscopic examination of foods for adulterants. Pesticide analysis in water and food products.Extraction and purification of samples. HPLC, Gas chromatography for organophosphates. Chromatographic techniques for identification of chlorinated pesticides in food products**
Unit V:Pathological Analysis **6 Lectures** **Clinical Chemistry – Composition of blood-collection and preservation of samples.Serum electrolyt blood glucose, blood urea nitrogen, uric acid, albumin, globulins, Cannabinoids, barbiturates, acid and alkaline phosphatases.**
Unit VI: Recent trends in Environmental analytical chemistry **4 lectures** **Recent Applications in Environmental analytical chemistry**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Solid State Chemistry (Elective)**				
Course Code	**MBS24T5103**				
Prerequisite	**B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects**				
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives: To impart advanced knowledge in solid state chemistry covering crystal growth, preparation, properties and kinetics for their major applications.

Course Outcomes

CO1	Categorize various crystal structures and predict their properties.
CO2	Describe the various preparative routes of crystal structure.
CO3	Determine the factors affecting kinetics of reactions.
CO4	Determine the optical and conducting properties of metals, insulators and semi-conductors.
CO5	Interpret the magnetic properties of different crystal structures.
CO6	Compile recent advances in Solid State Chemistry

Text Books

1. 1. Principals of solid state, H. V. Keer, Wiley Eastern.
2. A.R. West, Solid State Chemistry and its Applications, (1984) John Wiley and Sons, Singapore.
3. Puri, Sharma and Pathania, Principles of Physical Chemistry, Vishal Publishing Co.

Reference Books

1. A guide to laser in chemistry by Gerald R., Van Hecke, Keny K. Karokitis
2. Solid state chemistry, N. B. Hannay
3. Solid state chemistry , D. K. Chakrabarty , New Age International
4. An Introduction to Crystallography : F. G. Philips
5. Crystal Structure Analysis: M. J. Buerger
6. Electronic processes in materials : L. U. Azroff and J. J. Brophy, Elements of X-ray Diffraction by B. D. Cullity, Addison- Weily

Unit-1 Introduction	**08 Lectures**
The Solid State Types of solids, isomorphism and polymorphism, laws of crystallography, lattice types, X-ray diffraction, Bragg's equation, Miller indices, Bragg Method, identification of unit cells from systematic absence in diffraction pattern, structure of simple lattice and X-Ray intensities	
Unit-2	**08 Lectures**
Preparation of Materials **Purification and crystal growth, zone refining, growth from solution, growth from melt and preparation of organic semiconductors for device applications.**	
Unit-3	**08 Lectures**
Solid State Reactions General principle, types of reactions: Additive, structure sensitive, decomposition and phase transition reactions, tarnish reactions, kinetics of solid state reactions, factors affecting the reactivity of solid state reactions.	
Unit-4	**08 Lectures**
Electronic Properties and Band Theory Metals, insulators and semi-conductors, free electron theory and its applications, electronic structure of solids, band theory, doping in semiconductors, p-n junction, super conductors, optical properties, photo-conduction and photoelectric effects	
Unit-5	**08 Lectures**
Magnetic Properties **Basic magnetic properties: Diamagnetism, paramagnetism, ferromagnetism and antiferromagnetism, ferrimagnetism, hysteresis, magnetic symmetry and structures, magnetic resonance**	
Unit-6 Recent trends in Solid State Chemistry	**4 lectures**
Recent advances and applications of solid state chemistry	

Continuous Assessment Pattern

Internal Assessment (IA)	**Mid Term Test (MTE)**	**End Term Test (ETE)**	**Total Marks**
30	**20**	**50**	**100**

Name of The Course	**Bio-organic Chemistry**				
Course Code	**MBS24T5105**				
Prerequisite	**Students should qualify B.Sc. and advanced knowledge of Chemistry**				
Corequisite	**Students should have fundamental knowledge of Organic Chemistry.**				
Antirequisite					
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:The course reviews to understand the organic chemistry of biomolecules like amino acids, peptides, nucleic acids and carbohydrates and enzyme action.

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Course Outcomes:

CO1	**Interpret the organic chemistry of carbohydrates (K5)**
CO2	**Illustrate the organic chemistry of amino acids and peptides (K2)**
CO3	**Identify the mechanism of action of enzymes (K3)**
CO4	**Analyse the organic chemistry of coenzymes (K4)**
CO5	**Assess the bio-organic chemistry of lipids and nucleic acids (K5)**
CO6	**Compile the recent applications of Bio-organic Chemistry (K6)**

Text Book (s)

- P. Y. Bruice, Organic Chemistry, 5thEd., Pearson, 2014.
- D.V.Vranken and G.A. Weiss, Introduction to Bioorganic Chemistry and Chemical Biology, 1st Ed., Garland Science, 2012.

Reference Book (s)

- T. K. Lindhorst, Essentials of Carbohydrate Chemistry and Biochemistry, 3rdEd., Wiley 2007.
- N. Sewald and H.D Jakubke, Peptides: Chemistry and Biology, 2ndEd. Wiley, 2009.

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Unit-1: Carbohydrates	**8hrs**
Classification of carbohydrates, configuration, redox reactions of monosaccharides, KilianiFischer synthesis, Ruff degradation, hemiacetals and cyclic structure of monosaccharides, glycosides, anomeric effect, reducing and non-reducing sugars, disaccharides and polysaccharides.	
Unit-2: Aminoacids, peptides and proteins	**10hrs**
Amino acids: acid base properties, isoelectric point, separation, resolution of racemic mixtures of amino acids, asymmetric synthesis Peptide bonds,peptide synthesis. Proteins: primary, secondary, tertiary and quaternary structures, protein denaturation, natural β-amino acids and β-peptides; β-turn peptidomimetics, β-lactam based peptidomimetics.	
Unit-3: Enzymes	**7hrs**
Classification of enzymes, enzyme catalysis and kinetics, nucleophilic, acid, base and metal-ion catalysis, the catalytic triad, mechanisms of carboxypeptidase A, serine proteases and lysozyme, enzyme inhibition, Industrial biocatalysts.	

Unit-4:Organic chemistry of coenzymes	**7hrs**
Niacin and its role in redox reactions, mechanisms for pyridine nucleotide coenzymes, flavin adenine dinucleotide and flavin mononucleotide, pyridoxal phosphate and its role in decarboxylation, transamination and racemization of amino acids.	
Unit-5: Bioorganic Chemistry of lipids &Nucleic Acids	**8hrs**
Fatty acids structure and classification, structure andfunction of prostaglandins, tri-acyl glycerol, structure and functions of phospholipids,spingomyelin, plasmologens and glycolipids. Nucleic acids: nucleosides and nucleotides, conformation of sugar-phosphate backbone, hydrogen bonding by bases, the double helix,A, B, and Z double helices, stability of double helix, replication, transcription and translation, DNA intercalators, chemical synthesis of DNA, catalytic RNA, siRNA, micro RNA, synthesis and applications of unnatural nucleosides. Structure of Peptide Nucleic Acid.	
Unit VI: Recent applications of Bio-organic Chemistry	**4 lectures**
Recent trends and applications of Bio-organic Chemistry	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Advanced Green Chemistry**				
Course Code	**MBS24T5106**				
Prerequisite	**Students should have the basic and advanced knowledge of green chemistry needs and the limitations pursuing green chemistry and also the existing problems faced by our environment.**				
Co-requisite	**This part of course provides introduction to green chemistry aspects and the approaches to be adopted for greener synthesis. Students will understand the significance of green chemistry in industries specially to provide cleaner energy**				
Anti-requisite					
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

Course Outcomes

CO1	**Explain the basic concepts and need of green chemistry. (K2)**
CO2	**Utilize green chemistry tools and its principles for sustainable development. (K3)**
CO3	**Identify the role of catalysis in green chemistry. (K3)**
CO4	**Discover the application of green chemistry in real world.(K4)**
CO5	**Explain the various green technologies in academics and industries**
CO6	**Compile the recent developments in Advanced Green Chemistry**

Text Book (s)

1. Anastas, P.T. & Warner, J.C. Green Chemistry- Theory and Practical, Oxford University Press (1998).
2. Matlack, A.S. Introduction to Green Chemistry, Marcel Dekker (2001).

3. Cann, M.C. &Connely, M.E. Real-World cases in Green Chemistry, American Chemical Society, Washington (2000).
4. Sharma, R.K. &Bandichhor, R. Hazardous Reagent Substitution, Royal Society of Chemistry, Green Chemistry Series (2018).
5. Ryan, M.A. &Tinnes, M. Introduction to Green Chemistry, American Chemical Society, Washington (2002).

Reference Book (s)

1. Sharma, R.K., Sidhwani, I.T. & Chaudhari, M.K. Green Chemistry Experiments: A Monograph I.K. International Publishing House Pvt. Ltd. New Delhi, Bangalore ISBN 978-93-81141-55-7 (2013). 7.

2. Lancaster, M. Green Chemistry: An Introductory Text RSC publishing, 2nd Edition ISBN 978-1-84755-873-2 (2010).

Unit-1 8 hours
Unit I:Green Chemistry: An introduction **History of emergence of Green Chemistry through some industrial disasters, Environmental movements for public awareness and some important environmental laws, Definition of Green Chemistry, Need for Green Chemistry, Goals of Green Chemistry.**
Unit-2 8 hours
Unit II: Green Chemistry: An interdisciplinary approach towards sustainable development **Green Chemistry advances towards a sustainable future, Green Chemistry v/s Environmental Chemistry, Green Chemistry and its interdisciplinary nature, Twelve Principles of Green Chemistry and their illustrations with examples. Green energy and sustainability.**
Unit-3 8 hours
Unit III: Role of Catalysis in Green Chemistry **Catalysis for Green Chemistry with examples. Catalytic oxidation using H_2O_2, Bio-catalysis, Photocatalysis, Green reagents, Green solvents including solvent free synthesis of some organic compounds and inorganic complexes, alternative sources of energy, atom economy concept.**
Unit-4 10 hours
Unit IV: Application of Green Chemistry in real world cases **Wealth from waste, Industrial case studies Green Nanotechnology, Greener approaches for nanoparticle synthesis Pharmaceutical industries: The largest waste producer problems and solutions through Green Chemistry benefits of greening industries, Next generation catalyst design, Microwave assisted synthesis etc.**
Unit-5 6 hours
Unit V: Green Chemistry: Emerging Trend **Need for Academia-Industry collaborations, study of biomimetic catalysts, zero waste technology.**
Unit-6 4 hours
Recent developments and applications of Advanced Green Chemistry

Name of The Course	**Carbon Materials**
Course Code	**MBS24T5107**
Prerequisite	**Chemistry as major or one of the subjects along with Physics, Mathematics and Biology/any branch of biosciences as minor subjects at B.Sc. level.**

Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives: To give in-depth insight of carbon nano materials about preparation, synthesis, methods of purification and its major applications.

Course Outcomes

CO1	**Simplify and discuss basic science behind the properties of materials at the 68anometer scale. (K4)**
CO2	**Interpret different methods of preparation, methods of purification and applications fullerenes.(K5)**
CO3	**Conclude the various preparation, purification methods and applications of carbon nano tube.(K5)**
CO4	**Compare various methods of DLC synthesis its properties, application in the field of polymer metical and lubricants science. (K4)**
CO5	**Distinguish the methods of preparation, purification and applications of graphene and its oxide. K4)**
CO6	**Compile recent applications of carbon materials (K6)**

Text Book (s)

1. The Chemistry of Nanomaterials, C.N.R. Rao, A. K. Cheetham, Achim Muller Anthony K. Cheetham , John Wiley & Sons Inc, 2004, ISBN: 978-3-527-30686-2.
2. In Introduction to Nanotechnology C P Poole, Frank J. Owens, John Wiley & Sons, 2011, ISBN 978-81-265-1099-3.
3. Introduction to Nanoscience and Nanotechnology, KK Chattopadhyay, A N Banerjee, Phi Learning Pvt Ltd., New Delhi, 2012, ISBN-978-81-203-3608-7.

Reference Book (s)

1. Carbon Materials and Nanotechnology, Anke Krueger, Wiley –VCH Verlag GmbH & Co., 2010, ISBN-10: 3527318038.
2. Gold nanoparticles in biomedical applications: recent advances and perspectives Lev Dykmana and Nikolai Khlebtsov, Chem. Soc. Rev., 2012, **41**, 2256–2282.

Nanotechnology Science Innovation & Opportunity, Lynn E Foster, Pearson publication, 2008, ISBN-9788131711187.

Unit-1: Introduction	**08 hours**
Definition of Nano, Scientific revolution-atomic structure and atomic size, emergence and challenges of nanoscience and nanotechnology, size, shape effects, large surface to volume ratio, surface and size effects on the properties.	
Unit-2 Fullerenes	**08 hours**
Introduction of fullerenes, structures of C60, C70 and higher fullerenes, synthesis, purification, properties, characterization and applications of fullerenes.	
Unit-3 Carbon Nano tubes (CNT)	**10 hours**

Introduction of Carbon nanotube (CNT), structure, synthesis and functionalization, single- and multi- wall CNT,characterizationpurification and major properties; applications of CNT for energy storage (such as Hydrogen), Use of nanoscale catalysts to save energy and increase the industrial productivity.
Unit-4 Diamond like Carbon (DLC) 08 hours
Introduction of DLC, structure of DLC, synthesis, purification, properties, characterization and applications, and use in polymer coatings, lubricants, and medical applications.
Unit-5 Graphenes 08 hours
Introduction of Graphene, structure, synthesis and functionalization of Graphene, properties and applications such as in the field of electronics, electrochemical deposition, and use as graphene Oxide.
Unit-6 Recent advances in carbon materials 4 hours
Recent advances and applications of carbon materials

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Advanced Metallurgical Sciences**				
Course Code	**MBS24T5108**				
Prerequisite	**B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects**				
Co-requisite	**Basic knowledge of Physical Chemistry and some portions of important metallurgical terms**				
Antirequisite					
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives

1. Provides an overview of Materials Science and Engineering as a basis for understanding how structure/property/processing relationships are developed.
2. Illustrates the role of materials in modern society by case studies of advances in new materials and processes.

Course Outcomes

CO1	**Explain the basic thermodynamics concepts and various rules related to the metallurgical concepts.(K2)**
CO2	**Identify the relationship between various solution models and thermodynamics of multicomponent systems.(K3)**
CO3	**Interpret the concepts of multicomponent systems and phase diagrams.(K2)**
CO4	**Analyse the thermodynamics of transformations and all the related terminologies. (K4)**
CO5	**Analyse the concepts of heterogeneous thermodynamic systems and factors involved. (K4)**
CO6	**Compile recent advances in Metallurgical Sciences (K6)**

Text Book (s)

- Physical Chemistry of Metals: L.S. Darken and R.W. Gurry
- Thermodynamics of Solids: R.A. Swalin
- Principles of Extractive Metallurgy: H.S. Ray

Reference Book (s)

- Phase Transformations in Metals and Alloys: D.A. Porter and K.E. Easterling.
- W.D. Callister, Jr., "Materials Science and Engineering, An Introduction" Wiley – 7th Edition.

Unit-1 : Basic Introduction	**10 Lecture**
Basics: First, second and third laws of thermodynamics, free energy, Maxwell's relations, Clausius Clayperon equation, phase diagram, phase equilibrium, phase rule.	
Unit-2 : Solution and equilibrium concepts	**12 Lecture**
Free energy of solutions, Chemical potential, solution models, quasichemical theory, Solution models, regular, sub-regular, cluster variation models, multi-parameter models, quasi-chemical theory, multicomponent systems, Unary, binary and multicomponent systems, phase equilibrium, evolution of phase diagrams, metastable phase diagrams, calculation of phase diagrams, thermodynamics of defects.	
Unit-3 : Thermodynamics of Transformations	**12 Lecture**
Melting and solidification, precipitation, eutectoid, massive, spinodal, martensitic, order disorder transformations and glass transition. First and second order transitions, glass formation, Peritectic solidification and metastable equilibrium.	
Unit-4 : Heterogeneous Systems	**8 Lectures**
Thermodynamics of heterogeneous systems, Equilibrium constant, Ellingham diagrams and their application to commercially important reactions.	
Unit-5: Recent advances in Metallurgical Sciences	**4 lectures**
Advanced Metallurgical Sciences with recent applications	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Industrial Biochemistry**				
Course Code	**MBS24T5109**				
Prerequisite	**Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.**				
Corequisite	**Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.**				
Antirequisite					
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

The course aims to integrate the knowledge of biochemistry and molecular biology with those of microbiology and biochemical engineering, with emphasis on their application to the biotechnological processes.

Course Outcomes

CO1	**Demonstrate the industrial bioprocesses technology, downstream processing.**
CO2	**Describe the process of fermentation.**
CO3	**Demonstrate the various ways of food processing.**
CO4	**Describe the process of BIOSAFETY, IPR**
CO5	**Discuss the general principles of Quality Control and Good Manufacturing practices in food industry.**
CO6	**Compile recent advances in Industrial Biochemistry**

Text Book (s)

- DobleMukesh and Kumar Anil, Biotreatment of industrial effluents.
- Wackett, L.P. and Hershberger, C.D. Biocatalysis and Biodegradation, Microbial Transformation of Organic Compounds, 2001 P.-171-190. ISBN 1-55581-179-5. ASM Press Washington D.C.
- WulfCrueger and AnnelieseCrueger, Biotechnology, Panima Publishing company New Delhi.
- Rainbow C. and Rose A.H., A.P., Biochemistry of Industrial micro-organisms.
- P. F. Stanbury, A. Whitaker and S. Hall, Principles of Fermentation Technology.

Reference Book (s)

- Bioethics and Biosafety, 1st edition (2008), M. K Sateesh, I K International Pvt Ltd, ISBN-13: 978-8190675703.
- Biosafety and Bioethics, 1st edition (2006), Rajmohan Joshi; Isha Books ISBN-13: 978-8182053779.
- Bioethics and biosafety in biotechnology, 1st edition (2007), V. Sreekrishna; New Age International (P) Ltd., ISBN-13: 978-8122420852.
- P. F. Stanbury, A. Whitaker and S. Hall, Principles of Fermentation Technology.
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Unit-1Introduction to industrial bioprocesses technology (10 hours) **Definition and scope of Industrial Biochemistry,A historical overview of Industrial fermentation processes- traditional and modern biotechnology, Organism, processes and products related to modern biotechnology, Types of Bioreactors, Parameters for Bio process, bioprocess monitoring, downstream processing.**
Unit-2Basics of fermentation (08 hours) **Biochemical Basis and Development of Industrial Fermentation process: screening and selection of the organisms for the production of biologically important compounds, Strain improvements, Detection and production of fermentation products, Fermentation media, Scale up of fermentations**
Unit-3Food biochemistry (12 hours) **Introduction to different categories of food; constituents of food products and their functional properties; introduction to food processing; intermediate moisture food; food spoilage; intrinsic and extrinsic factors affecting the quality and life of food material; food storage and preservation techniques; food poisoning and intoxication; by-product utilization and scale up; molasses and alcohol production.**
Unit-4Biosafety, IPR (10 hours) **Historical background, introduction to biological safety cabinets, primary containment for biohazards, biosafety levels of specific microorganisms, recommended biosafety levels for infectious agents and infected animals. Intellectual property rights (IPR)**

Unit-5QC and GMP (10 hours) **General principles of Quality Control and Good Manufacturing practices in food industry, Determination of shelf – life of food products, Food Adulteration – Common food adulterants, their harmful effects and physical and chemical methods for their detection, Role of ISI Agmark and FDA in food industry.**	
Unit-VI Recent advances in Industrial Biochemistry 4 hours **Recent trends and applications of Industrial Biochemistry**	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

(Established under Galgotias University Uttar Pradesh Act No. 14 of 2011)

School of Basic and Applied Sciences

Program:M.Sc. Environmental Science

Scheme: 2020 – 2022

Curriculum

Sl. No	Course Code	Name of the Course	L	T	P	C	IA	MTE	ETE
Semester 1									
Sl. No	Course Code	Name of the Course					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MEV101	Introduction to Environmental Studies	4	0	0	4	30	20	50
2	MEV102	Biodiversity and Conservation Biology	4	0	0	4	30	20	50
3	MEV103	Environmental Hazards and Pollution	4	0	0	4	30	20	50
4	MEV104	Environmental Geology	4	0	0	4	30	20	50
5	MEV105	Disaster management	4	0	0	4	30	20	50
6	MEV131	Environmental Science Lab-I	0	0	4	2	50	-	50
			Total Credits			22			
Semester II									
Sl No	Course Code	Name of the Course					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MEV201	Environmental Impact and Risk Assessment	4	0	0	4	30	20	50
2	MEV202	Environmental Toxicology and Health	4	0	0	4	30	20	50
3	MEV203	Resource Management	4	0	0	4	30	20	50
4	MEV204	Environmental Chemistry	4	0	0	4	30	20	50
5	MEV231	Environmental Science Lab-II	0	0	4	2	50	-	50
6	XXXX	BEC (B1)				3			
7	MBS26T2111	Research Methodology				2	30	20	50
8	XXXX	IPR				1			
			Total Credits			24			
Semester III									
Sl No	Course Code	Name of the Course					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MEV341	Summer Internship*	0	0	0	2	50		50
2	MBS26P2998	Major Project Phase-I	0	0	0	6	50		50
3	XXXX	Campus to Corporate				2			
			Total Credits			10			
Semester IV									
Sl No	Course Code	Name of the Course					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MEV401	Environmental Biotechnology	4	0	0	4	30	20	50
2	MEV402	Green Technology	4	0	0	4	30	20	50
3	MEV431	Environmental Science Lab-III	0	0	4	2	50	-	50
4	MBS26P2999	Major Project Phase-II	0	0	0	6	50		50
5	MBS26T5XXX	*Electives	3	0	0	8	30	20	50
			Total Credits			24			

List of Electives:

Basket-1 (Sem-III)

		Methodologies for Environmental Studies							
Sl No	Course Code	Name of the Electives					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MBS26T5101	System Analysis and Modelling	3	0	0	3	30	20	50
2	MBS26T5102	Remote Sensing and GIS	3	0	0	3	30	20	50
3	MBS26T5103	Methodology Lab I - Practical on System Analysis and Modelling	0	0	2	1	50	-	50
4	MBS26T5104	Methodology Lab II - Practical on Remote Sensing and GIS	0	0	2	1	50	-	50

		Waste management							
Sl No	Course Code	Name of the Electives					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MBS26T5105	Solid and Hazardous Waste Management	3	0	0	3	30	20	50
2	MBS26T5106	Waste Water Management	3	0	0	3	30	20	50
3	MBS26T5107	Waste management Lab I - Practicals on Solid Waste	0	0	2	1	50	-	50
4	MBS26T5108	Waste Management Lab II - Practicals on Waste Water Treatment	0	0	2	1	50	-	50

		Environment and society							
Sl No	Course Code	Name of the Electives					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MBS26T5109	Rural Society and Development	3	0	0	3	30	20	50
2	MBS26T5110	Urban Ecosystem	3	0	0	3	30	20	50
3	MBS26T5111	E&S Lab I - Field Work on Rural Development	0	0	2	1	50	-	50
4	MBS26T5112	E&S Lab II - Field Work on Urban Ecosystem	0	0	2	1	50	-	50

Detailed Syllabus

SEMESTER-I

Name of The Course	**Introduction to Environmental Studies**				
Course Code	**MEV101**				
Prerequisite	**B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry**				
Corequisite	**Environmental Science**				
Antirequisite					
Theory Lectures:		**L**	**T**	**P**	**C**
54		**4**	**0**	**0**	**4**

Course Objectives:This course reviews the basic concepts in Environmental Science and gives an overall awareness about the earth, atmosphere, water and the biotic components that constitute our ecosystem

Course Outcomes

CO1	**Describe the Environment and concept of ecosystem. K2**
CO2	**Explain the structure, composition of atmosphere and reasons of air pollution. K2**
CO3	**Interpret the water quality parameters and standards. K3**
CO4	**Identify the biodiversity patterns and Hotspots. K4**
CO5	**Illustrate the reasons of Global warming, climate change and Environmental Impact Assessment. K3**
CO6	**Identify the recent environmental issues in the world (K4)**

Text Book (s)

1. Principles Of Environmental Science. McGraw-Hill Higher Education. Cunningham, W.P., Saigo, B.W. and Cunningham, M.A. 2001.
2. Environmental Science: A Global Concern (Vol. 412). Boston, MA: McGraw-Hill. Glasson, J. and Therivel, R. 2013.
3. Introduction To Environmental Impact Assessment. Routledge.

Reference Book (s)

1. Anjaneyulu, Y. 2004. Introduction to Environmental Science. B. S. Publications. Barrett, E.C. 2013.
2. Introduction To Environmental Remote Sensing. Routledge. Botkin, D.B. and Keller, E.A. 1995. 3.Environmental Science Earth as a Living Planet, (9th Ed). Wileyplus. Chiras, D.D. 2001.
3. Environmental Science, 6Ed., Jones and Bartlett Publishers. Cunningham, W. and Cunningham, M.A. 2010.

Unit-1 Introduction to the Environment	**10 hours**
Introduction to the Environment. Acquisition, transformation and utilization of energy: the geochemical, biogeochemical and hydrological cycles. Concept of ecosystem.	
Unit-2Atmosphere	**10 hours**
Atmosphere: structure and composition. Air pollutants and their emission sources. Aerosols and Smogs. Air quality standards. Tropospheric ozone. Air pollution in Indian cities.	
Unit-3 Water and hotspots	**10 hours**
Water: quantity and quality. Parameters and standards; Demands. Rain water chemistry. Surface and subsurface waters in India. Environmental hotspots related to water in India.	
Unit-4 Soil and Land use	**8 hours**

Soil and Land use: Climate and soil profile, Mineral matters in soil. Soil classification. Soil distribution in India. Land use in India. Impact of soil loss and land cover on biogeochemical cycles. Biodiversity. Problems and issues in biodiversity. Biodiversity status and patterns and hotspots. Conservation and utilization of biodiversity.
Unit-5 Global warming and climate change 10 hours
Global warming and climate change. Recent records of climate change. Impact of climate change on Indian environment. Measures to cope with climate change. Mineral and energy resources. Impact of mining and other human activities on the environment. Environmental impact assessment and environmental audit: an introduction. Environmental policy matters and law.
Unit-6: Current Environmental Concerns: 6 hours **Overpopulation and urban sprawl. Deforestation and desertification. Pollution. Waste Disposal.**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Biodiversity and conservation biology**				
Course Code	**MEV102**				
Prerequisite	**Introduction to biodiversity and conservation biology**				
Corequisite	**Environmental Science and Biology**				
Antirequisite					
Theory Lectures:		**L**	**T**	**P**	**C**
56		**4**	**0**	**0**	**4**

Course Objectives:

The objective of this course is to provide students with an understanding of the problems associated biodiversity conservation worldwide, to give hand-on experience in conservation methods, and their benefits to bring ethical awareness in relation to biodiversity and conservation biology.

Course Outcomes

CO1	**Demonstrate importance of diversity at different levels of biological organization. K2**
CO2	**Explain basic concept of ecological and biological processes that ensures long-term stability of ecosystems. K2**
CO3	**Illustrate the various biodiversity perameters.K3**
CO4	**Explain the methods for measurement of species diversity and molecular diversity. K2**
CO5	**Analyze the values of biodiversity and scientific approaches for conservation that can lead to sustainable development. K4**
CO6	**Explain the innovative steps and latest trends in biodiversity. K5**

Text Book (s)

- Loreau, M., and Inchausti, P. 2002. Biodiversity and Ecosystem functioning: Synthesis and Perspectives. Oxford University Press, Oxford, UK.
- Pandit, M.K. 2017. Life in the Himalaya: An Ecosystem at Risk. Harvard University Press.

- Primack, R.B., 2002, Essentials of Conservation Biology, 3 rdEdn.,Sinauer Associates, Sunderland, Ma. USA.
- Sodhi, N. S., Gibson, L., and Raven, P. H. 2013. Conservation Biology: Voices from the Tropics. John Wiley and Sons Ltd.: UK.
- Wilson, E. O. 1993.Diversity of Life. Harvard University Press, Cambridge, MA.

ReferenceBook (s)

- Biju, S.D. and Bossuyt, F. 2003. New frog family from India reveals an ancient biogeographical link with the Seychelles. Nature, 425: 711-714.
- Daily, G.C., Ed. 1997. Nature's Services: Societal Dependence on Natural Ecosystems. Island Press, Washington.
- Dobson, D.C. 1996. Conservation and Biodiversity. Scientific American Library, New York, NY.
- Groombridge, B., and Jenkins, M. 2000. Global Biodiversity: Earth's Living Resources in the 21 st Century. World Conservation Press, Cambridge, UK.
- IUCN. 2004. Red list of threatened species. A global species assessment. IUCN, Gland, Switzerland.

Unit-1 Biodiversity	**10 hours**
Concepts: Organic evolution through geological time scale. Levels of organisation in the biological world – molecules to ecosystems, biomes to the biosphere. Levels of Biodiversity: Community diversity (alpha, beta and gamma biodiversity), Gradients of Biodiversity (latitudinal, insular), ecosystems diversity: biomes, mangroves, coral reefs, wetlands and terrestrial diversity (equilibrium mix of G and W). Species diversity: richness and evenness; magnitude of biodiversity (Global and Indian); global biodiversity hot spots; geography of species; species richness gradients and their drivers; mountain biodiversity and richness gradients; drivers of species richness through ages with specific reference to India.	
Unit-2 Benefits of Biodiversity	**12 hours**
Direct and indirect benefits from biodiversity including ecosystem services, bio-prospecting (molecular techniques like RAPD, RFLP, AFLP, DNA sequencing etc). Genetic diversity: sub species, breeds, race, varieties and forms. Variation in genes and alleles at DNA sequence levels (selected case studies). Microbial diversity and useful prokaryotic genes. Speciation (amount of genetic variation is the basis of speciation). Consequences of monotypic agricultural practice (Detailed case studies). Threats to Biodiversity: Species extinctions and their drivers – deforestation, landuse changes, overexploitation, biological invasions; habitat loss; projection of species extinction using species area relationship model. Human intervention and Biodiversity loss: Global Environmental changes, land in water use changes.	
Unit-3 Biodiversity conservation	**8 hours**
History of Conservation movements: International and National. Ecologically relevant parameters(viable population, minimum dynamic area, effective population size, metapopulations); reproductive parameters in conservation (breeding habitats, mating systems, inbreeding depression, genetic bottlenecks, genetic constraints).	
Unit-4 Conservation methods	**10 hours**
IUCN categorized-endangered, threatened, vulnerable species. Red data book and related documentation. Methods of conservation. In situ (Biosphere reserves, National Parks,	

Sanctuaries, Sacred groves, etc.) &ex situ (Botanical gardens, Zoological gardens, Gene banks, Pollen, seed and seedling banks, tissue culture and DNA banks etc) modes of conservation.hotspots. Conservation and utilization of biodiversity.

Unit-5 Benefits of conservation 10 hours

Biodiversity as a source of food and improved varieties; source of drugs and medicines; Aesthetics and cultural benefits. Sustainable development. Ecosystems services (maintenance of gaseous composition of the atmosphere, climate control by forests and oceanic systems, Natural pest control, pollination of plants by insects and birds, formation and protection of soil, conservation and purification of water, nutrient cycling).

UNIT-6: Latest advances in biodiversity and conservation: (6Lectures)

Innovative steps in conserving biodiversity, hotspots of research activities over the past several decades, social awareness, planning, and advancement in conservation tools and techniques, Gathering and monitoring information about biodiversity, modern tools and technologies to monitor the biodiversity.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Environmental Hazards and Pollution**				
Course Code	**MEV 103**				
Prerequisite	**B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry**				
Corequisite	**Environmental Science and Chemistry**				
Antirequisite					
Theory Lectures:		**L**	**T**	**P**	**C**
54		**4**	**0**	**0**	**4**

Course

Objectives: This course gives an overview of the different types of pollution affecting the different components of the ecosystem and discusses ways of managing such environmental hazards

Course Outcomes

CO1	**Describe the Environment and hydrological hazards**
CO2	Identify global climate change driven environmental hazards and manmade hazards.
CO3	**Explain the disasters and hazard management**
CO4	**Explain the air and water pollution causes and monitoring and control of air and water pollution.**
CO5	**Interpret the soil quality analysis. Illustrate the reasons of soil, noise and marine pollution.**
CO6	**Choose the advance techniques to solve the environmental problems.**

Text Book (s)

- Principles Of Environmental Science. McGraw-Hill Higher Education. Cunningham, W.P., Saigo, B.W. and Cunningham, M.A. 2001.
- *Milnes, R. (2014). Environmental engineering: principles and practice. Hoboken: Wiley.*
- Introduction To Environmental Impact Assessment. Routledge.

Reference Book (s)

- Anjaneyulu, Y. 2004. Introduction to Environmental Science. B. S. Publications. Barrett, E.C. 2013.
- Introduction To Environmental Remote Sensing. Routledge. Botkin, D.B. and Keller, E.A. 1995.
- Environmental Science Earth as a Living Planet, (9th Ed). Wileyplus. Chiras, D.D. 2001.
- Environmental Science, 6Ed., Jones and Bartlett Publishers. Cunningham, W. and Cunningham, M.A. 2010.

Unit-1 Introduction **10hours**
Floods, droughts, Water contamination, melting of snow, Arsenic problem, Tsunamis, cyclones, hurricanes, Ice sheets, global lake outburst floods.
Unit-2 10 hours
Global climate change driven environmental hazards, Cloud bursts, landslides, Lake or dam break, Man made hazards, Bhopal gas tragedy, Chernobyl disasters., Frost hazards in agriculture, Epidemics , wildfires.
Unit-3 10 hours
Risk assessment, Vulnerability analysis, Hazards policies and agencies, Land use classification, Role of GIS and remote sensing in surveillance, monitoring and risk assessment, Hazardous waste control, Hazardous waste treatment.
Unit-4 10 hours
Natural and anthropogenic sources of air pollution, Gas laws governing the behaviour of pollutants, Methods of monitoring and control of air pollution, SO_2, NO_X, CO, Methods of monitoring and control of air pollution, SO_2, NO_X, CO, Analysis of water quality, standards , sewage, Waste water treatment and recycling, Water quality standards.
Unit-5 10 hours
Soil pollution: Chemical and bacteriological sampling as analysis of soil quality, Soil pollution control, industrial waste effluents and heavy metals and their interactions with soil components, Noise pollution – sources of noise pollution. Marine pollution: Sources of marine pollution and its control, Effects of pollutants on human beings, plants. Air quality standards, measurement and indices of noise pollution.
Unit 6 Advances in Environmental Hazards and Pollution 4 hours
In the unit recent developments and research will be discussed in the areas of Environmental Hazards and Pollution.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Environmental Geology				
Course Code	MEV104				
Prerequisite	B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry				
Corequisite	Environmental Science, Chemistry, Geology				
Antirequisite					
Theory Lectures:		L	T	P	C
50		4	0	0	4

Course Objectives: This course introduces whole-Earth materials & processes with a focus on the formation of & human interaction with superficial environments. It discusses phenomena such as volcanoes, earthquakes, wasting, flooding, desertification, & climate change.

Course Outcomes

CO1	Explain the utilization of all natural resources and minimization of their degradation.
CO2	Explain different geological methods to minimize the destructive potential of natural processes and to sustain a healthy biosphere on earth.
CO3	Discuss the concept of resources, their availability and methods of recycling.
CO4	Identify the impact of urbanization on natural hazards and discuss the methods to cope with natural processes.
CO5	Explain the significant usage of land for construction and waste disposal.
CO6	Aware about the natural hazards and how to take preventive measures.

Text Book (s)

Keller, E.A. 1996. Introduction to Environmental Geology, Prentice Hall, Upper Saddle River, New Jersey.

Kesler, S. F. 1994. Mineral resources economics and the environment. Upper Saddle River, NJ: Prentice Hall.

Reference Book (s)

Owen, O.S., Chiras, D.D., Reganold. John P. 2002. Natural Resource Conservation, 7th Ed., Prentice Hall, Upper Saddle River, New Jersey

Skinner, Brian J., Porter, Stephen C. 1995. The Dynamic Earth: An Introduction to Physical Geology, Casebook, 3rd Edition (Paperback), John Wiley, New York

Slaymake, Olav, (Ed). 2000. Geomorphology, Human Activity and Global Environmental Change. John Wiley, New York.

Unit-1Planet Earth	8 hours
Earth in the solar system; differentiation of the earth into core, mantle, crust, hydrosphere and atmosphere; rock-forming, ore-forming and soil-forming minerals; energy, mineral, water and soil resources.	
Unit-2Earth processes	10 hours

Earth quakes, Landslides and Floods ,Geological cycle,Rock cycle, Hydrological cycle, Biogeochemical cycles, Rivers and their relation to geology and climate; erosional, transportational and depositional processes of water, air, waves and glaciers.
Unit-3 Resources 12 hours
Renewable and Alternative Energy Sources: Solar energy, solar power, photovoltaic cells; Wind power; Geothermal energy; Ocean energy; Fuel cells. Fossil Fuel. Bio Energy: Biomass conversion processes; Biodiesel; Environmental consequences of biomass resource harnessing. mineral and water resources; geological constraints in their availability and use; environmental consequences of their exploitation to air, water, soil, climate and life. EIA of mineral development, recycling of mineral resources.
Unit-4 Natural hazards 12 hours
Floods, landslides, earthquakes-tsunami and volcanism, cyclones, coastal erosion and sea level changes; impact of urbanization on the rate of these processes; general methods to identify the hazard potential, to mitigate and to cope with natural processes.
Unit-5 Land use 8 hours
Land evaluation and land use planning for construction and waste disposal; Methods of site selection and evaluation, global imperatives, soil erosion,; Desertification and its associated problems and control.
Unit-6 Recent Advancements in Environmental Geology 4 hours
Prediction of Natural hazards, Advance technology for Dissemination of forecast to end users, Disaster management policy during Natural hazards, Post disaster Health impact

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Disaster Management				
Course Code	MEV105				
Prerequisite	B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry				
Corequisite	Environmental Science, Chemistry, Geology				
Antirequisite					
Theory Lectures:		L	T	P	C
50		4	0	0	4

Course Objectives: This course introduces whole-Earth materials & processes with a focus on the formation of & human interaction with superficial environments. It discusses phenomena such as volcanoes, earthquakes, wasting, flooding, desertification, & climate change.

Course Outcomes

CO1	Describe the concept of hazard and disaster and its impacts.
CO2	Relate the implication of different form of natural disaster such as geological, hydrological and Climatic.
CO3	Illustrate and interpret man-made disaster and gain insights about it.
CO4	Determine the various ways of disaster, assistance and relief camps, mitigation and preparedness, programme planning and management.

CO5	**Estimate impact and risk analysis, role of GIS and remote sensing in surveillance, monitoring, risk assessment, estimation of losses and planning.**
CO6	**Combine the concepts for new trends and developments in disaster research and preparedness.**

Text Books:

1. G. F. White (Ed). 1974. Natural Hazards – Local, National, Global. Oxford University Press.
2. V.T. Chow. 1964. Handbook of Applied Hydrology. McGraw-Hill.
3. A. N. Strahler and A. H. Strahler. 1973. Environmental Geoscience – InteractionBetween Natural Systems and Man. Santa Barbara, California: Hamilton Publishing.
4. P. Reining. 1978. Handbook of Desertification Indicators. Washington D.C.: AmericanAssociation for the Advancement of Science.
5. K. S. Valdiya. 1987. Environmental Geology. Tata McGraw-Hill.

References:

- VibhasSukhwani,V., Shaw R. 2020, Operationalizing crowdsourcing through mobile applications for disaster management in India, Progress in Disaster Science, 5 (1-9).
- Wang, C., Wu, J , He X,Ye M, Liu W and Tang R. (2019) Emerging Trends and New Developments in Disaster, Research after the 2008Wenchuan Earthquake Internationl Journal of Environmental Research and Public Health; 16 (29).
- Blaikie, P., Cannon, T., Davis, I. and Wisner, B. 2003. At Risk: Natural Hazards, People's Vulnerability and Disasters (2nd Ed.). Abington: Routledge.
- Bell, F.G. 2003. Geological Hazards: Their Assessment, Avoidance and Mitigation. CRC Press.
- Bilham, R. 2004. Earthquakes in India and the Himalaya: tectonics, geodesy and history. *Annals of GEOPHYSICS*, *47*(2-3).
- Blaikie, P., Cannon, T., Davis, I. and Wisner, B. 2014. At Risk: Natural Hazards, People's Vulnerability and Disasters. Routledge.
- Burton, I. 1993. The Environment as Hazard. Guilford Press.
- Margottini, C. and Casale, R. 2004. Natural disasters and sustainable development. Environmental Science Series, Springer.
- Henrry J.G. and Heinke , G.W. 2004, Environmental Science and engineering, Pearson education, Delhi, India.
- Shroder, J. & Wyss, M. (eds). 2014. Earthquake Hazard, Risk and Disasters (1st Edition). Elsevier.
- Smith, K. 2003. Environmental Hazards: Assessing Risk and Reducing Disaster. Routledge.
- Watts, M. 2017. On the poverty of theory: natural hazards research in context. In Environment (pp. 57-88), Routledge.
- Allen, S.K., Linsbauer, A., Randhawa, S.S., Huggel, C., Rana, P. and Kumari, A. 2016. Glacial lake outburst flood risk in Himachal Pradesh, India: an integrative and anticipatory approach considering current and future threats. *Natural Hazards*, 84: 1741-1763.
- Hewitt. K. 1997. Regions of Risk, Longman Press.

- Henrry J.G. and Heinke , G.W. 2004, Environmental Science and engineering, Pearson education, Delhi, India.
- Shroder, J. & Wyss, M. (eds). 2014. Earthquake Hazard, Risk and Disasters (1st Edition). Elsevier.
- Smith, K. 2003. Environmental Hazards: Assessing Risk and Reducing Disaster. Routledge.
- Watts, M. 2017. On the poverty of theory: natural hazards research in context. In Environment (pp. 57-88), Routledge.

Unit-I: Concept of Hazard and Disaster	**(8 Lectures)**
Concept of Hazard, disaster, risk, vulnerability, exposure and response. Distinction between natural disaster and anthropogenic environmental disturbances and Hybrid disaster.	
Unit-II: Natural Disaster	**(10 Lectures).**
Geological Disaster: **Earthquakes – a plate tectonic perspective and seismic zonation, Volcanoes – types and geographical distribution, Mass-movement.** ***Hydrological* Disaster*:*** **Floods, Droughts, Tsunami; Cyclones, Hurricanes; Cryosphere – distribution, melting of snow, ice and ice-sheets, avalanches, Glacial Lake Outburst Floods (GLOF), case study of disasters.** ***Atmospheric/Climatic* Disaster*:*** **Extreme weather events, Cloud-bursts, Landslides; Lake or Dam break/ breach; Global Climatic Change driven environmental hazards**	
Unit-III: Anthropogenic Disasters	**(8 Lectures)**
Impacts of anthropogenic activities such as rapid urbanization, injudicious ground water extraction, sand mining from river bank, deforestation, Biophysical Hazards: Frost Hazards in agriculture, epidemics, wildfires, Technological Hazards: Nature and significance. Lessons from Bhopal and Chernobyl disasters.	
Unit-IV: Disaster Assistance and Relief Camps	**(10 Lectures)**
Disaster assistance technological assistance, relief camps, organization, camp layout, food requirement, water needs, sanitation, security, information administration, firefighting camping and tent pitching, rope, knots and their use, rescue, emergency rescue, disaster education, alternatives and new directions: conceptualizing disaster recovery, mitigation and preparedness, programme planning and management.	
Unit- V: Impact and Risk Analysis of Disasters	**(10 Lectures)**
Human and ecological impacts; Risk assessment and vulnerability analysis; National preparedness and adaptation strategies; policies and agencies; role of GIS and remote sensing in surveillance, monitoring, risk assessment, estimation of losses and planning. Role of government **bodies such as NDMC and IMD; role of armed forces and media in disaster management; role of space technology in disaster management; case study.**	
Unit-VI: Recent New Advancement in Disaster Management	**(4 Lectures)**
Emerging Trends and New Developments in Disaster Research, Operationalizing crowd sourcing through mobile applications for disaster management in India.	

Continuous assessment

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**ENVIRONMENTAL SCIENCE LAB-I**				
Course Code	**MEV131**				
Prerequisite	**B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry**				
Corequisite	**Analytical Chemistry**				
Antirequisite					
Practical Lectures:		**L**	**T**	**P**	**C**
18		**0**	**0**	**4**	**2**

Course Objectives: In this course the students will learn experimental techniques to determine the concentration of pollutants in the environment.

Course Outcomes:

CO1	**Collect and store the effluent samples.**
CO2	**Estimate the strength of Dissolved Oxygen, BOD, COD, Heavy metals in water sample.**
CO3	**Determine the sound level.**
CO4	**Analyze the air quality.**
CO5	**Plan to visit sites for in-situ or ex-situ studies.**

Text Book (s):

1. V.P. Kudesia. 1997. Air Pollution. PragatiPrakashan.
2. M.H. Rao and H.V.H. Rao. 1998. Air Pollution. Tata McGraw Hill Publication.
3. B.R. Gurjar, L. T. Molina and C. S. P. Ojha. 2010. Air Pollution. CRC Press. Preparation of coordination compounds

Reference Book (s):

1. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.

Unit-1 **3 hours**
Collection, processing and storage of effluent samples.
Unit-2 **5 hours**
Estimation of total dissolved solids, Hardness, dissolved oxygen, BOD and COD in waste water sample, heavy metals analysis in sludge and waste water sample.
Unit-3 **3 hours**
Determination of sound level and air analysis for particulate matter.
Unit-4 **5 hours**
Estimation of species abundance of plants, Measurement of chlorophyll, Transpiration and water balance in plants under polluted conditions.
Unit-5 **2 hours**
Visit to a local polluted site, in-situ or ex-situ conservation centre/Environmental Education Centre/ Social Service Organization, ICT in Environmental Science.

Continuous Assessment Pattern

Internal Assessment (IA)	**Mid Term Test (MTE)**	**End Term Test (ETE)**	**Total Marks**
50	**-**	**50**	**100**

SEMESTER-II

Name of The Course	Environmental Impact and Risk Assessment			
Course Code	MEV201			
Prerequisite	B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry			
Corequisite	Environmental Science			
Antirequisite				
Theory Lectures:	L	T	P	C
54	4	0	0	4

Course Objectives:This course reviews the environmental impact and risk assessment and studies thoroughly different methods involved in EIA and the types of assessment processes.

Course Outcomes

CO1	Define the environmental risks and to describe the concept and components of EIA. (K2)
CO2	Explain the EIA processes and management techniques and analyze the EIA methods in advance. (K2)
CO3	Interpret the processes of environmental auditing and document planning. (K3)
CO4	Categorize the assessment techniques and describe the role of control boards. (K4)
CO5	Describe the environment protection laws and illustration of environment legislations in various countries. (K2)
CO6	Aware about the advance methods of the EIA (K6)

Text Book (s)

1. Blaikie, P., Cannon, T., Davis, I. and Wisner, B. 2003. At Risk: Natural Hazards, People's Vulnerability and Disasters(2nd Ed.).
2. Abington: Routledge. Brown, K. 2015. Resilience, Development and Global Change. London: Routledge Glasson, J. and Therivel, R. 2013.
3. Introduction To Environmental Impact Assessment. Routledge.
4. Morris. P. &Therivel. R., 2001, Methods of environmental impact assessment.

Reference Book (s)

1. Ed. Spon Press, New York, With a chapter on GIS and EIA by A.R. Bachiller& G. Wood, p. 381-401.
2. Grumbine, R.E. and Pandit, M.K., 2013. Threats from India's Himalaya dams. Science, 339:36-37.
3. Pandit, M.K. and Grumbine, R.E., 2012. Potential effects of ongoing and proposed hydropower development on terrestrial biological diversity in the Indian Himalaya. Conservation Biology, 26: 1061-1071.
4. Petts, J. 1999. Handbook of Environmental Impact Assessment. Vol. 1, Blackwell Science

Unit-1Introduction to environmental risks and impact analysis	8 hours
Defining environmental risk in different perspectives, Risk Assessment v/s Environmental Impact Assessment, Environmental education programmes and public awareness, Environmental management system (EMS): ISO-14000, Basic concept and principles and purpose of EIA, origin and development of EIA, short term and long term objectives of EIA, EIA 2006 Notification (GOI). Components of EIA, screening, notification, public participation, impact statement, review of EIA Analysis and alternatives, Environmental Impact Statement and Environmental Management Plan.	
Unit-2 Process and Methods of EIA	**8 hours**
Stages, Scoping, Alternatives, Impact Identification, Establishing the Environmental base line, Impact prediction, evaluation and mitigation, Criteria and standards for assessing significant Impact,	

Cost- Benefit Analysis and valuation of Environmental impacts, Public Participation, EIA monitoring and auditing, EIA Method: ADHOC Method, Check list, Matrix and network method, merits and demerits of EIA.	
Unit-3Environmental monitoring and audit	**10 hours**
Environmental clearance for establishing industries, Environmental Audit: General approaches to environmental auditing, audit methods, benefits of environmental auditing. On-site and post – audit activities, Guidelines and policies, Document planning and Environmental documentation, environmental monitoring, post project audit, recent trends in environmental monitoring, environmental ethics, Environmental audit of river valley projects, mines, cement industry, nuclear power, thermal power, wind energy, dams and highway construction.	
Unit-4Types of Assessment processes	**10 hours**
Air quality Assessment; Water Impact Assessment; Social Impact Assessment; Ecological Impact Assessment; Landscape and visual Impact Assessment; Environmental Impact of surface and underground mining of metals, minerals and fossil fuels, Environment impact assessment: State environmental appraisal committee and state, environmental Assessment authority and their role in environmental clearance of projects, Powers and functions of central and state pollution control boards.	
Unit-5Current issues in EIA and Environment Laws	**14 hours**
Environmental taxes, Worldwide spread of EIA, EIA regulations in India, Life cycles Assessment, Strategic Environmental Assessment, Environmental organization and agencies, Environmental Law I: International Environmental protection laws. 6 Environmental Law II: Environmental protection laws in India and their enforcement, Recent National and International efforts for Environmental management, International trade and environment; Trade Related Intellectual Properties (TRIPs), Intellectual Property Rights (IPRs), Corporate environmental ethics.	
Unit-6 Recent advancement in the process of EIA	**4hours**
In this unit discuss the recent research in the area of Environmental impact assessment.	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Environmental Toxicology and Health**				
Course Code	**MEV202**				
Prerequisite	**Introduction to toxicants and their effect on human health**				
Corequisite	**Biochemistry, Chemistry and Environmental science**				
Antirequisite					
Theory Lectures:		**L**	**T**	**P**	**C**
54		**4**	**0**	**0**	**4**

Course Objectives:

The objective of this course is to provide students with an understanding of the problems associated with indiscriminative use of chemicals worldwide, to give hand-on experience in toxicity testing, and to bring ethical awareness in relation to environmental pollution and degradation.

Course Outcomes

CO1	**Discuss the sources, origins of various toxic materials and heavy metals present in environment. (K2)**

CO2	Explain the adverse effect of toxic chemicals on Environment. (K2)
CO3	Develop perspective on the movement of toxicants in different components of environment, in different levels of biological organization and in trophic transfer across the food chain (K2).
CO4	Demonstrates the relationship between types of contaminants and effect on human health (K3).
CO5	Trains on the methods used to assess the ecotoxicological impact and human health issues **due to increase in the levels of contaminants in environment (K3).**
CO6	Aware about the new remediation techniques for toxic elements (K6)

Text Book (s)

Toxicology

- Colin, W. 2014. Ecotoxicology: Effects of Pollutants on the Natural Environment, 1st (ed), CRC Press
- Sparling,D.W.2017. Basics of Ecotoxicology, 1stEdn CRC Press.
- Newman, M.C. 2015. Fundamentals of Ecotoxicology: The Science of Pollution, 4thEdn. CRC Press.

Environmental Health

- Centeno, J.A., Finkelman, R.B., Fuge, R., Lindh, U. and Smedley, P. eds., 2013. Essentials of Medical Geology (p. 820). New York, NY, USA, Springer.

Reference Book (s)

- Hauser-Davis, R.A. and Parente, T.E. eds., 2018. *Ecotoxicology: Perspectives on Key Issues*. CRC Press.
- Walker, C.H., Sibly, R.M., Hopkin, S.P., Peakall, D.B. 2017. Principles of Ecotoxicology. 4thEdn. Taylor & Francis, London.
- Moore, G.S. 2002. Living with the Earth: concepts in Environmental Health Science (2nded.), Lewis publishers, Michigan

Unit-1Major classes of Toxic Chemicals and their toxicity Potential 10 hours **Toxic chemicals in the environment – air, water & their effects, Pesticides in water, Biochemicals aspects of arsenic, cadmium, lead mercury, carbon monoxide, ozone, PAN pesticide, Organics, Organometallics, Gases, Nano-materials, Ecotoxicity challenges of selected contaminants of recent origin.**
Unit-2Entry and Movement of Toxicants into Ecosystems and Environment 12 hours **Mode of entry of toxic substance (surface waters, land, atmosphere), Fate of Toxicants in Ecosystems and Environment: Biotransformation, Bioaccumulation & Bio-magnification; Role of biotic and abiotic interactions, biotransformation of xenobiotics detoxification, Carcinogens in air, chemical carcinogenicity, mechanism of carcinogenicity, Environmental carcinogenicity testing.**
Unit-3Toxicant Effects 8 hours **Cellular, organismic, population & ecosystem-level effects; Global Effects – Acid rain, Insecticides, MIC effects. Concept of major, trace and Rare Earth Element (REE)- possible effects of imbalance of some trace elements, Epidemiological issues goitre, fluorosis, arsenic poisoning.**
Unit-4Biochemical and Molecular Toxicology 10 hours

Metabolism of selected ecotoxicants; Role of enzymes, genes and growth regulators, Quantitative and qualitative assessment of biochemical and molecular ecotoxicity. **Toxicity Testing and Bio-monitoring: Concept of dosimetry: lethal, sub-lethal & chronic tests, dose response curves, LC50, MATC-NOEC, Brief statistical methodology. Test organisms used in bioassays, Types of bio-monitoring and significance of biomarkers and bio-indicators**
Unit-5Environmental Health10 hours Toxicology & Epidemiology and occupational health. Sources: Solid & Hazardous wastes, untreated sewage, Automobile exhausts, Industrial Effluents, Industrial emissions into atmosphere, Agricultural run-off of Pesticides. Carcinogens, Mutagens, Asbestos issues. Human adaptation to cold and hot climates, high altitude environment and man-made environments. Water pollution – Caused diseases (Gastroenteritis, Hepatitis, etc.). Air pollution caused diseases (allergies, respiratory diseases). Food-borne diseases (Food poisoning, parasites etc).
Unit-6 Recent advancement in the remediation of toxic elements 4 hours
In this unit discuss the new techniques for the remediation of toxic elements.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Resource Management**				
Course Code	**MEV203**				
Prerequisite	**B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry**				
Corequisite	**Environmental Science and Chemistry**				
Antirequisite					
Theory lectures:		**L**	**T**	**P**	**C**
54		**4**	**0**	**0**	**4**

Course Objectives:Natural resource management refers to the management of natural resources such as land, water, soil, forest, wildlife, mineral and energy, with a focus on how management affects the quality of life for both present and future generation.

Course Outcomes

CO1	**Explain Natural resources and types of natural resources.**
CO2	Discuss how and where the Earth's resources are generated, how they are extracted and used, and how these activities impact Earth's environment.
CO3	**Explain broadly about the conservation and management of different types of Natural resources.**
CO4	**Develop the ability to conserve and manage natural resources in day to day life.**
CO5	**Develop perspectives on sustainability of natural resources.**
CO6	**Aware about the resources management. K6**

Text Book (s)

Craig, J.R., Vaughan, D.J. Skinner, B.J. 1996. Resources of the Earth: Origin, Use, And Environmental Impact, (2nd Ed). Prentice Hall, New Jersey.

Klee, G.A. 1991. Conservation of Natural Resources. Prentice Hall Publ. Co., New Jersey.

Owen, O.S, Chiras, D.D. &Reganold, J.P. 1998. Natural Resource Conservation – Management For Sustainable Future, (7thEdn.), Prentice Hall.

Reference Book (s)

Agarwal, B. 2010. Gender and Green Governance, Oxford and Delhi: Oxford University Press.
Brosius, P.J., Tsing, A.L. and Zerner, C. (eds.). 2005. Communities and Conservation: Histories and Politics of Community-Based Natural Resource Management. Rowman Altamira.

Unit-1Natural Resources and Management	**8 hours**
Introduction to natural resources and their consumption patterns .Supply and demand of natural resources. Types of natural resources: renewable and non-renewable resources. Resource management meaning & concept, Time frame. Approaches to natural resource management.	
Unit-2Water and Forest Resource Management	**10 hours**
Management of fresh water ecosystem conservation strategies for non-renewable energy resourses, Water Management, Ganga Action Plan, Yamuna Action Plan, Environmental priorities in India, Watershed development, rainwater harvesting , Management of waste resources, Management of forests, effects of deforestation and it's control.	
Unit-3Land and Wildlife Management	**12 hours**
The nature of soil, characteristics and value. Soil formation, soil profile and soil classification. Soil fertility. Soil conservation and sustainable agriculture: nature of soil erosion; factors affecting soil erosion by water and its control. Alternative agriculture, sustainable agriculture. Land use and environmental problems of soil. Soil surveys and Land use planning. Wildlife Management & conservation efforts for threatened species.	
Unit-4Minerals Resource Management	**8 hours**
Minerals resources, their use, mining and sustainability. Genesis of mineral deposits: endogenous and exogenous processes and their time frame. Environmental impact of mineral production. Mineral conservation strategies: the resource cycle.	
Unit-5Energy Resource Management	**12 hours**
Non-renewable energy resources: patterns of consumption, issues and options. Global energy source: an overview. Fossil fuels: reserves of coal, its classification and basic geology. Environmental impact of coal mining. Reserves of oil and gas, basic geology. Environmental impact of their production and consumption. Nuclear energy, its sources. Nuclear power plants. Nuclear waste disposal. Geothermal energy: water dominated and vapour dominated systems.Types of renewable energy source and their environmental significance. Sustainable development of energy resources.	
Unit-6 Recent advancement in resource management	**4 hours**
Discuss about the recent research work done to save resources.	

Continuous Assessment Pattern

Internal Assessment (IA)	**Mid Term Test (MTE)**	**End Term Test (ETE)**	**Total Marks**
30	**20**	**50**	**100**

Name of The Course	**Environmental Chemistry**				
Course Code	**MEV204**				
Prerequisite	**B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry**				
Corequisite	**Organic Chemistry, Bio-chemistry, Analytical Chemistry, Geology**				
Antirequisite					
Theory Lectures:		**L**	**T**	**P**	**C**
50		**4**	**0**	**0**	**4**

Course Objectives: The course encompasses basic knowledge of organic and analytical chemistry and basic bio-chemistry required in the thorough study of Environmental Science. It also reviews different aspects of Geochemistry and chemistry of environmental pollutants required to understand the environmental issues.

Course Outcomes

CO1	**Describe and recognize the fundamentals of environmental chemistry. (K2)**
CO2	**Identify the concepts of geochemistry and correlate its environmental aspects. (K2)**
CO3	**Generalize and illustrate the properties of environmental chemistry. (K3)**
CO4	**Interpret the various aspects of pollution chemistry and waste management techniques. (K2 and K3)**
CO5	**Develop the understanding of various environment instrumentation techniques and analyze their principles for environment assessments. (K4)**
CO6	**Adapt new techniques in area of geochemistry and pollutant chemistry. K6**

Text Book (s):

1. Environmental Instrumentation and Analysis Handbook – R.D. Down and J.H. Lehr
2. Environmental Analysis and Instrumentation – N. Rajvaidya and D. K. Markande
3. Environmental Monitoring and Analysis – Dr. Aradhana Salpekar.
4. A Text book of Environmental Science – Prabhat Patnaik

Reference Book (s):

1. Elements of Environmental Chemistry – J. Hussain.
2. Grumbine, R.E. and Pandit, M.K., 2013. Threats from India's Himalaya dams. Science, 339:36-37.
3. Manahan, S. E. 2000. Environmental Chemistry 7thEdn. Lewis Publishers. Stumm, W. and Morgan, J.J. 2012. Aquatic Chemistry: Chemical Equilibria and Rates in Natural Waters, John Wiley & Sons.
4. Williams, I. 2001. Environmental Chemistry –a modular approach, Willey John & Sons.

Unit-1: Fundamentals of Environmental Chemistry10 hours **Definition of various terms: standard solution preparation and various concentration terms, stoichiometry, Gibbs energy, fundamentals of chemical thermodynamics and solution formation; basic organic chemistry and biochemistry, solubility product, solubility of gases in water, the carbonate system, unsaturated and saturated hydrocarbons, radionuclides.**

Unit-2: Geochemistry 8 hours

Structure and chemistry of silicate and ore minerals; bulk composition of the earth, crust, & oceans; rock weathering, clay minerals and soil formation; cycling of chemical elements in the earth system, Physico-chemical characteristics of soil, soil humus, mineralization, acidic and alkaline soils, micro and macro nutrients of soil and nitrogen, phosphorus and potassium pathways in the soi.l

Unit-3: Atmospheric Chemistry and properties of environmental elements 8 hours

Ions and radicals, thermo and photochemical reactions, physical and chemical properties of water, concept of oxygen demand: BOD, COD, TDS, TSS, hydrologic cycle; concepts of pH, aquatic life and water chemistry; organic and inorganic including radioactive water pollutants and their removal methods.
Atmospheric Chemistry: Physical and chemical properties of atmospheric air and their variation with latitude and altitude; chemical reactions in air and the residence time of CO2 and the greenhouse gases aerosols, their chemistry, sources and transport; organic compounds in air and their sources; physical and health effects of air chemistry changes, global warming and acid rain.

Unit-4: Pollutant chemistry 10 hours

Chemistry of various organic and hydrocarbon decay, environmental effects of surfactants, pesticides and heavy metals on micro and macro organisms, chemical processes for formation of inorganic and organic particulate matter, thermo chemical and photochemical reactions in the atmosphere, toxic chemicals in the environment, Chemistry of waste substances: Nature and types of various wastes such as mining, industrial, agricultural, municipal, medical and nuclear; chemical and biological treatment of wastes before disposal; chemistry of toxic inorganic and organic compounds in the environment and their interactions with living system.

Unit-5: Environmental Instrumentation 10 hours

Spectrometry, UV-Vis and IR spectrophotometer and AAS, flame spectrometry and fluorimetry; Chromatographic techniques: Paper, Thin Layer, Gas and Gas – Liquid Chromatography, HPLC, X-ray fluorescence, x-ray diffraction, Electrophoresis, NMR and MassSpectrometry.

Unit-6: Application of Environmental chemistry 4 hours

Discuss recent advancement in the technologies geochemistry and pollutant chemistry.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Technology, Environment and Sustainability**				
Course Code	**MEV205**				
Prerequisite	**B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry**				
Corequisite	**Organic Chemistry, Bio-chemistry, Analytical Chemistry, Geology**				
Antirequisite					
Theory Lectures:		**L**	**T**	**P**	**C**
54		**4**	**0**	**0**	**4**

Course Objectives: This course gives an overview about environmental sustainability and policies and technologies that define it.

Course Outcomes

CO1	Develop evolutionary perspective on the relationship between and evolution of technology and environment. (K2)
CO2	Develop in-depth understanding on the role and contribution of different types of economic problems of Environment. (K2)
CO3	Generalise social mechanisms in the contemporary societies shaping the structure and function of Environment. (K2)
CO4	Demonstrate the technological changes in the direction of sustainable development, which will help to achieve ecological and social justice.(K3)
CO5	Aware about the new environmental policies K6

Text Book (s):

Reference Book (s):

1. Manahan, S.E. 1997. Environmental Science and Technology. Lewis, New York. Charles, H. 2011. Environment and Society: Human Perspectives on Environmental Issues, 5th Edition Routledge.

2. Agarwal, B. 1986. Cold Hearths and Barren Slopes: The Wood-fuel Crisis in the Third World. London: Zed Books.

3. Elliot, D. 2003. Energy, Society and Environment, Technology for a Sustainable Future, Routledge

Unit-1: Technology for Energy Resources 10 hours   **Bioenergy, ethanol fermentation.Liquid waste treatment; Biofilters, activated sludge systems; membrane bioreactors.Biotechnological approaches for solid waste management, Phytotechnology-terrestrial and aquatic phytosystems, metal phytoremediation, nutrient film techniques, algal treatment systems.**
Unit-2: Sustainable Development and its different constituents 12 hours   Concept of Sustainability, Sustainable Development and its different constituents. Growth and Development, Technology, Affluence and the Environmental Kuznets' Curve. Principles of Ecological and Environmental Economics, their scope and usefulness.Basic Market process, Market

Failure and Externality, case of environmental problems. Solutions to Environmental Problems: Command and Control, Economic solutions.
Unit-3: Environmental policy and its environmental costs 14 hours   Technology transitions and environmental technology innovations for ecological and socialjustice; Policy tools for integrated technologies and technology innovations for sustainable development. Impacts of social movements on ecological and social justice in India; Corporate responsibility movement; Appropriate technology movement, industrialization, urbanization, and globalization, Estimation of Environmental Costs and Benefits, Cost Benefit Analysis. Valuation of ecosystem services and impact of intervention (malign and benign). Best practices in ecosystem services and sustainability of society.
Unit-4: Environmental Sustainability 14 hours   **Sustainability, issues of development and environmental protection and conflicts over resources discussed in context of Environmental Movements by taking up well known Indian and international case Studies . Inter-connection and linkages of environment destruction on a global scale. Select topics (Impacts of development and habitat destruction on pollution, biodiversity, human health, etc).**
Unit-5 Recent advancement in the environmental policies 4 hours
Discuss new environmental policies

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Environmental Science-II Lab**				
Course Code	**MEV 231**				
Prerequisite	**B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry**				
Corequisite	**Environmental Science, Analytical Chemistry**				
Antirequisite					
Practical Lectures:		**L**	**T**	**P**	**C**
17		**0**	**0**	**4**	**2**

Course Objective:

1. **Analysis of different properties of a given sample of soil.**
2. **Employ the volumetric titrations techniques used in Environmental Science Laboratory for analysis**
3. **Estimate the percentage of NPK in a given soil sample with the help of Flame Photometer.**
4. **Identify basic techniques used in Environmental Science Laboratory for preparation and identification.**

Course Outcomes

Reference Book (s)
2. Lab Manual Quantitative Analytical Method By: Deepak Pant Bookrix edition.

CO1	**Analyze the Physico-chemical properties of soil**
CO2	Estimate the Nitrite content of the soil
CO3	**Estimate the acidity, alkalinity and Porosity of soil**
CO4	**Analyze the NPK of soil by flame photometer**
CO5	**Plan to visit various ecosystems to study the ecological variations**

Text Book (s)

1. V.P. Kudesia. 1997. Air Pollution. Pragati Prakashan.

2. M.H. Rao and H.V.H. Rao. 1998. Air Pollution. Tata McGraw Hill Publication.

3. B.R. Gurjar, L. T. Molina and C. S. P. Ojha. 2010. Air Pollution. CRC Press. Preparation of coordination compounds

1. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.

Unit-1	**3 hours**
To determine the soil pH of a given Soil Sample **To determine the Organic matter in a given sample of soil.** To estimate the humidity/moisture content of a given Soil Sample.	
Unit-2	**2 hours**
To determine the Nitrate and phosphate content in a given sample of soil.	
Unit-3	**3 hours**
To determine the Porosity of a given sample of soil. To determine the soil acidity and alkalinity of a given sample of soil.	
Unit-4	**2 hours**
To estimate the NPK percentage in soil using flame photometer.	
Unit-5	**7 hours**
To study and enlist various biotic and abiotic components of forest Ecosystem. **To study and enlist various biotic and abiotic components of Desert Ecosystem.** **To study and enlist various biotic and abiotic components of Grassland Ecosystem** **To study and enlist various biotic and abiotic components of Aquatic Ecosystem** **To study ecology of some major invasive weeds**	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
50	-	50	100

Name of The Course	**Research Methodology**				
Course Code	**MBS28T2111**				
Prerequisite	**B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry**				
Corequisite					
Antirequisite					
Theory Lectures:		**L**	**T**	**P**	**C**
46		**3**	**0**	**0**	**3**

Course Objectives:

1. **To provide the advance knowledge in the field of Physics.**
2. **To enhance the capability and grasp the concepts of Mathematics more clearly involving specific examples and in-depth knowledge.**

Course Outcomes

CO1	Understand the Principles of Scientific Research and different steps involved in doing research.
CO2	Know how to design research and frame up different steps in design.
CO3	**Appraise the application of sampling through statistics.**
CO4	**Build up the method for data collection and analyse the data.**
CO5	Develop the Concept of hypothesis preparation.
CO6	Develop the statistical analysis indulges in modern research for drug designing.

Text Book (s):

5. **K. Ramakant; Elementary Statistics in a world of applications, Goodyear California Pub. Co.,1979.**
6. **K. D. Broota, Experimental designs in psychological research, Wiley eastern, New York, 1992.**
7. **Guilford, Statistics in Psychology and Education, McGraw hill, New York, 1986.**
8. **Katz and Kahn, Research in Behavioural Sciences, Methuen, USA, 1979.**

Reference Book (s):

1. **Kerlinger, F., Foundations of Behavioural Research, Surjeet Publications, Delhi, 1983.**
2. **Rajamanickam, M., Statistical Methods in Psychological and Educational Research, Concept Publishing Co. New Delhi, India, 1983.**
3. **Smith, Jonathan, A. (Ed.), Qualitative Psychology: A Practical Guide to Research Methods, Sage Publications, 2003.**
4. **Woodworth and Schlosberg, Experimental Psychology, Methuen and co. ltd, London, 1971.**

Refrerneces: for unit 6

5. Leo, A., &Hoekman, D. H. (1995). *Exploring QSAR*. American Chemical Society.
6. ChaninNantasenamat, ChartchalermIsarankura-Na-Ayudhya, ThanakornNaenna, VirapongPrachayasittikul, A Practical Overview of Quantitative Structure- Activity Relationship. EXCLI Journal 2009;8:74-88.
7.
8. WiktorPronobis, AlexandreTkatchenko, and Klaus-Robert Muller, J. Chem. Theory Comput. 2018, 14, 2991−3003

Unit-I:Principles of Scientific Research	**8 hours**

Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Procedures in research, Identification of the problem - Literature survey - Reference collection - Familiarity with ideas and concept of investigation - Qualitative and Quantitative analysis - Results - Synopsis writing - Art of writing a Research paper and Thesis.
Unit-II:Research Design, Sampling & Probability **10 hours** **Research Design: Need for Research Design, Features of a Good Design, Different Research Designs, Sampling: Principles, methods, types of sampling, rationale for using a particular sampling procedure, Probability: Classical definition of Probability, Basic terms - Events, Trials, Mutually exclusive events, Favourable events, Exhaustive events etc.**
Unit-III: Data collection & analysis **8 hours** **Types of data, Collection of Data, double blind procedures, incidence and prevalence studies, Data Analysis: Measures of Central Tendency, Measures of Dispersion, Measures of Asymmetry**
Unit-IV: Correlation and Regression **8 hours** **Methods of correlation, Types of correlation (Pearson r& Rho); Regression analysis, linear regression, Non-linear regression.**
Unit-V: Hypothesis and Statistics **8 hours** **Hypothesis Testing: Problems and hypothesis, variables and type of variables, Parametric and nonparametric statistics; level of significance, the various nonparametric tests with one sample, two samples and k-samples, chi square analysis, Analysis of Variance (ANOVA).**
Unit 6: Recent research advances **4 hours**
Descriptors, Quantitative structure-activity relationship (QSAR) , Quantitative structure-property relationship(QSPR), Drug designing.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

SEMESTER-III

Name of The Course	Minor Project/Summer Training				
Course Code	MEV341				
Prerequisite	B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry				
Corequisite					
Antirequisite					
		L	T	P	C
		0	0	0	2

Course Objectives: The minor project is aimed at training students in field areas and to prepare them for their major project in the upcoming semester.

Course Outcomes

At the end of the course, the student will be able to:

6. Review the literature for the topic of theproject.(K2)
7. Operate instruments neatly for analysis and discuss their experimentalresults.(K3)
8. Validate the specification of instrumental techniques and interpretation ofdata.(K5)
9. Used ICT tools to prepare project reports and present it using Powerpointpresentation.(K6)
10. Develop the skills to work within a small team to achieve a common researchgoal.(K6)

Continuous Assessment Pattern

Internal Viva (IA)	Mid Term Test (MTE)	External Exam (ETE)	Total Marks
50	-	50	100

Name of The Course	**MAJOR PROJECT**				
Course Code	**MBS26P2998**				
Prerequisite	**B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry**				
Corequisite	**Knowledge of research methodology**				
Antirequisite					
		L	**T**	**P**	**C**
		0	**0**	**0**	**6**

Course Objectives:

The major project will help the students to have a hand on experience and practical knowledge of the theory papers studied so far. It will enable them to tackle practical problems and expose them to industrial experience.

Course Outcomes

CO1	Survey literature for the topic of the project.**(K4)**
CO2	Correctly interpret the literature review before starting any individual experiment **(K3)**
CO3	Propose novel methods and pathways to understand the environmental issues **(K6)**
CO4	Interpret the results and data obtained from any experiment clearly, interpret the results and data obtained;records experiments orderly for future reference and draw clear and logical conclusions&assemblein presentations and reports.**(K4)**
CO5	**Demonstrate leadership skills and effective teamwork while working and prepare themselves for their future career in environmental ares, industries or academics (K6)**

SEMESTER-IV

Name of The Course	**Environmental Biotechnology**				
Course Code	**MEV401**				
Prerequisite	**B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry**				
Corequisite	**Organic Chemistry, Bio-chemistry, Analytical Chemistry, Geology**				
Antirequisite					
Theory Lectures:		**L**	**T**	**P**	**C**
54		**4**	**0**	**0**	**4**

Course Objectives: The course is aimed at providing comprehensive training in investigating the natural environment and to develop potential solutions to remedy its damage using chemical, biochemical and molecular technologies.

Course Outcomes

CO1	**Determine the nature of genetic information and gene expression.(K4)**
CO2	**Analyse the recombinant DNA technology.(K4)**
CO3	**Determine the various processes of waste water treatment.(K4)**
CO4	**Illustrate the different methods of solid waste treatment. (K3)**
CO5	**Discuss various bioremedial methods of degraded ecosystems. (K2)**
CO6	**Choose the advance technique to solve the environmental issues. K6**

Text Book (s):

1. Gardner, E.J., Simmons, M.J. and Snustad, D.P. 2006. Principles of Genetics. John Wiley, 8th Edition.
2. Mohapatra, P. K. 2006. Text Book of Environmental Biotechnology. I K International.

Reference Book (s):

1. Olguin, E., Sanchez, G. and Hernandez, E. 1999. Environmental Biotechnology and Cleaner Bioprocesses, Taylor & Francis, London.
2. Rittman, B. E., and McCarty, P. L. 2001. Environmental Biotechnology. Principles and applications. McGraw-Hill, New York.
3. Scragg, A. H. 2005. Environmental Biotechnology. Oxford University of Press.
4. Wainwright, M. 1999. An introduction to environmental biotechnology. Springer Verlag, New York.

Unit-1: Structure and perpetuation of nucleic acids	**12 hours**
Pioneering experiments leading to development of molecular genetics, Fine structure of gene. DNA replication models, mechanism of replication, enzymes involved in replication. Introduction to nature of genetic information and gene expression: Transcription of DNA; RNA polymerase, initiation, chain elongation, termination, post-transcriptional modifications. The genetic code; protein synthesis: tRNA as adaptor molecule, ribosome structure, ribosomal	

Metal collector bacteria and its applications, Bacteria engineered to protect bees from pests and pathogens, Synthetic phages with programmable specificity, Genetically engineered plasmid can be used to fight antimicrobial resistance.

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genes, initiation, elongation and termination of protein synthesis. Inhibition of protein synthesis.

Unit-2: Recombinant DNA technology 10 hours

Recombinant DNA technology: Early discoveries, restriction endonucleases, ligases modification enzymes, DNA and RNA markers, cloning and expression vectors (plasmids, bacteriophage, phagmids, cosmids, artificial chromosomes), selection of recombinant clones, DNA sequencing, gene probes. CDNA synthesis and cloning (mRNA enrichment, reverse transcription, DNA promers, linkers, adaptors and their chemical synthesis, library construction and screening). Nucleic acid microarrays.

Unit-3: Wastewater Treatment 10 hours

Water as a scarce natural resource, Measurement of water pollution, sources of water pollution. Wastewater treatment: anaerobic, aerobic process, methanogenesis, bioreactors, cell and protein (enzyme) immobilization techniques. Treatment schemes for waste water, dairy, distillery, tannery, sugar, antibiotic industries.

Unit-4: Solid Waste Treatment 8 hours

Sources and management (composting, wormiculture and methane production, landfill. Hazardous waste treatment, bio-fuels.

Unit-5: Bioremediation 10 hours

Remediation of degraded ecosystems, degradation of xenobiotics in environment, decay behaviour& degradative plasmids, hydrocarbons, substituted hydrocarbons, oil pollution, surfactants, pesticides, heavy metals degradative pathways.

Unit 6 Unit-6: Recent advancement in Environmental Biotechnology 4 hours

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Green Technology**				
Course Code	**MEV402**				
Prerequisite	**B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry**				
Corequisite	**Organic Chemistry, Bio-chemistry, Analytical Chemistry, Geology**				
Antirequisite					
Theory Lectures:		**L**	**T**	**P**	**C**
54		**4**	**0**	**0**	**4**

Course Objective: This course aims at teaching students the basic concepts of Green Chemistry and Technology. Students will be able to understand the importance of Green resources, methodologies and applications of Green Technology and appreciate how Green is better than the conventional methods

CO1	**Demonstrate the fundamental concepts of Green Chemistry and Sustainable Development (K2)**
CO2	**Examine the different Renewable energy resources and systems (K4)**
CO3	**Demonstrate methods for converting different wastes into energy (K2)**
CO4	**Apply the concept of Nanotechnology in Green Technology (K3)**
CO5	**Demonstrate different applications of Green Technology (K2)**
CO6	Adapt new green methods to conserve environment. (K6)

ReferenceBooks:

1. The Sustainability Revolution: Portrait of a Paradigm Shift by Edwards, Andres R.,New Society Publishers, 2005.
2. Sustainable development in India: Stocktaking in the run up to Rio+20: Report prepared by TERI for MoEF,2011.
3. Report of the Department for Policy Coordination and Sustainable Development (DPCSD), United Nations Division for Sustainable Development.
4. Environmental Studies, Anubha Kaushik, C P Kaushik, New Age International Publishers, 2008, ISBN:978-81-224-2159-0
5. M. H. Fulekar (2010) Nanotechnology Importance and applications, I K international publishing house Pvt.Ltd.

Unit-1: Fundamentals of Green Chemistry and Sustainable Development	**10 hours**

Green Chemistry: Concept of Green Chemistry, Atom Economy, Twelve basic Principles of Green Chemistry and their discussions, Tools of Green Chemistry; Sustainable Development: Principles of Sustainable Development, History and emergence of Sustainable development, Socio-economic policies for sustainable development, Strategies for implementing eco-development programmes, International agreements/conventions on energy and sustainability - United Nations Framework Convention on Climate Change (UNFCC)
Unit-2: Renewable Energy Resources and Systems 10 hours **Current energy requirements, growth in future energy requirements, *Solar Energy:*Solar radiation: measurements and prediction, solar heating of buildings, solar water heaters, Solar Photovoltaic: Principle of photovoltaic conversion of solar energy, types of solar cells and fabrication. Photovoltaic applications : battery charger, domestic lighting, street lighting, water pumping, power generation schemes, *Wind Energy:*Atmospheric circulations, classification, factors influencing wind, turbulence, wind speed monitoring, applications, *Ocean Energy:*Ocean energy resources-ocean energy routes - Principles of ocean thermal energy conversion systems- ocean thermal power plants- Principles of ocean wave energy conversion and tidal energy conversion, Hydropower and Geothermal energy**
Unit-3: Waste to Energy Conversion 10 hours ***Introduction to Waste & Waste processing:* Definitions, sources, types and composition of various types of wastes; characterisation of Municipal Solid Waste (MSW) , Industrial waste and Biomedical Waste (BMW); *Energy from waste-thermo chemical conversion:*Sources of energy generation, incineration, pyrolysis,gasification of waste using gasifiers, briquetting, environmental and health impacts of incineration and methods to mitigate them; *Energy from waste- Bio-chemical Conversion:* Anaerobic digestion of sewage and municipal wastes, direct combustion of MSW-refuse derived solid fuel, industrial waste, agro residues, anaerobic digestion biogas production, land fill gas generation and utilization, present status of technologies for conversion of waste into energy, design of waste to energy plants for cities, small townships and villages**
Unit-4: Green Nanotechnology 10 hours ***Nanomaterials for "Green" Systems:*Green materials, including biomaterials, biopolymers,**

and bioplastics, for Truly Sustainable Construction: Windows, Skylights, and Lighting. Paints, Roofs, Walls, and Cooling. Multifunctional Gas Sensors; *Nanomaterials for Alternative Energy:*Nanomaterials for Fuel Cells and Hydrogen Generation and storage, Nanostrcutures for efficient solar hydrogen production, *Nanomedical applications of green Nanotechnologies:* use of nanotechnologies and materials impact on biodiversity, resource conservation, ecosystems and human.
UNIT-5 Green Technology Application 10 hours
Biocatalysis, green chemistry in industries, fuel cell and electric vehicles, solar energy and hydrogen production, energy from alternate sources; Solar photovoltaic technology, Biofuel production (bio-ethanol and biodiesel), Biomass, prevention/minimization of hazardous/toxic products. Agricultural related practices and food processing, Production of biodegradable materials, concept of green building, Pollution free engineering processes.
Unit-6 Recent advancement in green technology 4 hours
Discuss the new advance methods and green synthesis to conserve environment.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Environmental Science Lab-III**				
Course Code	**MEV431**				
Prerequisite	**B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry**				
Corequisite	**Environmental Science, Analytical Chemistry, Botany**				
Antirequisite					
Practical Lectures:		**L**	**T**	**P**	**C**
17		**0**	**0**	**4**	**2**

Course Objectives: The course aims at studying different eco-systems and biodiversity present in the environment and also deals with an in-depth study of waste water treatment.

Course Outcomes

CO1	**Demonstrate index of diversity and dominance of species (K2)**
CO2	**Demonstrate biotic and abiotic components of ecosystems (K2)**
CO3	**Estimate chlorophyll, carbohydrate & protein content in plant samples (K5)**
CO4	**Analyze hardness, chloride content, TSS, BOD ,COD and TDS of water sample (K4)**
CO5	Calculate Na and K metals in water by flame photometer (K4)

Text Book (s):

1. Anjaneyalu, Y. 2004. Introduction to Environmental Science. BS Publications, Hyderabad, A.P. India.
2. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.

Unit-1: **1.To study ecology of some more exotic invasive weeds.**	**2 hours**
Unit-2: **1.To study and enlist various biotic and abiotic components of pond and forest ecosystem.**	**2 hours**
Unit-3: **1. To estimate carbohydrate content in given plant sample.** **2. To estimate protein content in the given sample.**	**3 hours**
Unit-4: **1. Determination of chloride of a given water sample. (Precipitation titration)** **2. Determination of TS, TSS and TDS of a given water sample by alternative method.** **3. Determination of turbidity of different drinking water samples** **4. Potentiometric determination of pH of water/wastewater samples.** **5. Determination of BOD of a wastewater sample**	**8 hours**
Unit-5: **1.Determination of pH and electrical conductivity of different drinking water samples.**	**2 hours**

Continuous Assessment Pattern

Internal Viva (IA)	Mid Term Test (MTE)	External Exam (ETE)	Total Marks
50	-	50	100

SEMESTER-IV/List of ELECTIVES

Name of The Course	**System Analysis and Modelling**				
Course Code	**MBS26T5101**				
Prerequisite	**B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry**				
Corequisite	**Environmental Science, Mathematics, Physics and Computer Science**				
Antirequisite					
Theory Lectures:		**L**	**T**	**P**	**C**
52		**3**	**0**	**0**	**3**

Course Objectives:

The paper introduces the student to the concept of systems and sub-systems, and modelling and simulations as well as computational techniques. These concepts are used to model various environmental systems, particularly those dealing with ecology and ecosystems and study of environmental pollution in modelling air and water quality.

Course Outcomes

CO1	Develop the concept of systems and sub-systems, and modelling and simulations as well as computational techniques. (K6)

CO2	Create various environmental systems, particularly those dealing with ecology and ecosystems and study of environmental pollution in modelling air and water quality. (K6)
CO3	Collect major approaches towards natural resource issues and enables to think creatively about conflict and concord in general, with special emphasis on the roles of ideas and institutions in environmental politics. (K6)
CO4	**Formulate on the simulation models to analyze environmental processes. (K6)**
CO5	Analyse computational techniques for environmental processes (K4).
CO6	Choose the advance techniques for system analysis and modelling. (K6)

Text Book (s)

1. Bennett, J. and Blamey, R. (eds). 2001. The choice modelling approach to environmental valuation. Edward Elgar Publishing.
2. Beven, K. 2007. Environmental Modelling: An Uncertain Future? CRC press.
3. Fotheringham, S. and Rogerson, P. (eds). 2014. Spatial analysis and GIS. CRC Press.

Reference Book (s)

1. Gallager R. 1996. Discrete Stochastic Processes, Kluwer Academic Publishers.
2. Grant, W.E., Pederson, E.K. and Sendra, L.M., 1997, Ecology and Natural Resource Management: Systems Analysis and Simulation, John Wiley, New York.
3. Illian, J., Penttinen, A., Stoyan, H. and Stoyan, D. 2008. Statistical Analysis and Modelling of Spatial Point Patterns (Vol. 70). John Wiley & Sons.
4. Recknagal, F., (Ed.), 2003, Ecological Informatics, chapters I, II, III and IV. Springer, Germany.
5. Refsgaard, J.C., van der Sluijs, J.P., Højberg, A.L. and Vanrolleghem, P.A. 2007. Uncertainty in the environmental modelling process–a framework and guidance. Environmental Modelling &Software, 22:1543-1556.
6. Wainwright, J., Mulligan, M. (Eds). 2004. Environmental Modelling: Finding Simplicity in Complexity. John Wiley, New York
7. Zannetti, P. 1990. Air pollution modeling, theories computational methods and available softwares. Van NostrandRheinhold, New York.

Unit-1 Introduction	**12 hours**
Definitions and concepts of system, sub-system, variables and parameters, systems analysis, modelling and simulation. Linear vs. non-linear models; Non-linear forecasting. Prey-predator systems, Environmental systems. Time series analysis.	
Unit-2Types of Systems	**10 hours**
Open and cybernetic systems; feedback; Ecosystem as a cybernetic system; Critical points of a system; stability of critical points. Limitations of modelling.	
Unit-3 Models in Ecology	**10 hours**
Stochastic and Deterministic model; Development of Ecological models. Fundamental interactions in ecology: predator-prey, competition, mutualism and interference.	
Unit-4 Models in Ecosystem	**10 hours**
Analysis, Synthesis and forecasting: statistical regression approach, differential equation approach and computational approaches, Lotka-Voltera model. Air and water quality modelling.	
Unit-5 Introduction to computational technology	**10 hours**
Fuzzy logic; artificial neural networks; Genetic algorithms; Evolutionary algorithm, Natural Distribution functions.	
Unit-6 Recent advancement in system analysis and modeling	**4hours**
Application of advanced techniques for system analysis and modelling.	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Remote Sensing and GIS**				
Course Code	**MBS26T5102**				
Prerequisite	**B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry**				
Corequisite	**Environmental Science, Mathematics, Physics and Computer Science**				
Antirequisite					
Theory Lectures:		**L**	**T**	**P**	**C**
48		**3**	**0**	**0**	**3**

Course outcome

CO1	**CO1: Demonstrate different mechanism and characteristics of Remote Sensing process**
CO2	**CO2: Analyze different aspects of Remote Sensing Data**
CO3	**CO3: Demonstrate the different applications of Remote Sensing data**
CO4	**CO4: Analyze the different concepts and applications of GIS**
CO5	Adapt new techniques for remote sensing

Text Books and References:

1. Burough, P.A. and McDonnel, R. 1998. Principles of Geographical Information Systems. Oxford University Press, NY.

2. Campbell, J.B. (2nd Ed), 1996. Introduction to Remote Sensing. Taylor and Francis.

3. Christopher, J. 1997. Geographical Information Systems and Computer Cartography. Longman.

4. Reeves, Robert G. 1999. Manual of Remote Sensing, (Vols. I & II). American Society of Photogrammetry and Remote Sensing, USA.

5. Rencz, A.N. (3rd Ed.) Remote Sensing for the Earth Sciences: Manual of Remote Sensing. John Wiley & Sons, Inc., New York.

6. Sabins, F. F. Jr. (2nd Ed). 1986. Remote Sensing: Principles and Interpretation. W.H. Freeman & Co.

UNIT-1:	**10 hours**

Electromagnetic Radiation as Remote Sensing Medium; General Mechanism of Remote Sensing Data Recording; General Characteristics of Remote Sensing Platforms; General Characteristics of Remote Sensing Sensors; Indian Remote Sensing Satellites and Sensors.	
Unit-2	**10 hours**
Spectral Characteristics of Common Natural Objects; Atmospheric Effects on Remote Sensing Data; Spectral Signatures and Spectral Response Patterns; Resolution of Remote Sensing Data; Characteristics of Raw Remote Sensing Data	
Unit -3	**10 hours**
Nature of Qualitative Information and Sequence in Interpretation; Elements of Image Patterns-Landforms, Drainage, Erosion Details; Applications of Remote Sensing; Remote Sensing Applications in Environmental Studies; Digital Image enhancement and classification methods; Principles of Microwave Remote Sensing; Characteristics of Microwave remote sensing Data; Radar and Lidar: Applications of Microwave Remote Sensing Data.	
Unit-4	**10 hours**
Geograpical Data and GIS; Coordinate Systems and Datums; Digital representation of geographical data-Raster and Vector models; GIS Data Standards-Concepts and Components; Conceptual and Logical Data Modeling; Applications of GIS	
Unit-5 Recent advancement in remote sensing and GIS	**8 hours**
Application of advanced techniques for remote sensing and GIS	

Internal Assessment (IA)	**Mid Term Test (MTE)**	**End Term Test (ETE)**	**Total Marks**
30	**20**	**50**	**100**

Name of The Course	**Methodolgy Lab I - Practical on System Analysis and Modelling**				
Course Code	**MBS26T5103**				
Prerequisite	**B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry**				
Corequisite	**Environmental Science, Mathematics, Physics and Computer Science**				
Antirequisite					
Practical Lectures:		**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**

Course outcome

CO1	**Generate the random numbers**
CO2	**Analyse the random numbers generators**
CO3	**Build Chi-square goodness-of-fit test**
CO4	**Classify Simulation of single/two server queuing system**

List of experiment

1. Generation of Random Numbers
2. Testing for Random Number Generators and Standard Normal Distribution
3. Chi-square goodness-of-fit test
4. Monte-Carlo Simulation

5. Simulation of single/two server queuing system

Reference Books:

1. Illian, J., Penttinen, A., Stoyan, H. and Stoyan, D. 2008. Statistical Analysis and Modelling of Spatial Point Patterns (Vol. 70). John Wiley & Sons.
2. Wainwright, J., Mulligan, M. (Eds). 2004. Environmental Modelling: Finding Simplicity in Complexity. John Wiley, New York

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
50		50	100

Name of The Course	Methodology Lab II - Practical on Remote Sensisng and GIS			
Course Code	MBS26T5104			
Prerequisite	B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry			
Corequisite	Environmental Science, Mathematics, Physics and Computer Science			
Antirequisite				
Theory Lectures:	L	T	P	C
	0	0	2	1

Course Outcomes

CO1	Classify aerial photos and satellite image
CO2	Explain the remote sensing data
CO3	Analyzethe spectral response pattern of different landforms
CO4	AnalyseGPS & GIS data integration and output preparation

1. Fundamentals of aerial photos and satellite image interpretation
2. Techniques of Visual interpretation; Generations of Thematic maps
3. Features extractions from remote sensing data
4. Image interpretation and Analysis of spectral response pattern of different landforms
5. Familiarization with digital image processing & image processing software
6. Importing raw data, Displaying image data, Image Rectification & Registration, Image Enhancement & Transformation.
7. GPS & GIS data integration and output preparation

Reference Books:

1. Integrating GIS and the Global Positioning System Karen Steede-Terry

2. Remote Sensing and Image Interpretation Thomas M. Lillesand &Palph W. Kiefer
3. Elements of Photogrammetry with application in GIS Paul R. Wolf & Bon A. Dewitt
4. Remote Sensing Geology Ravi P. Gupta

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
50		50	100

Name of The Course	Solid and Hazardous Waste Management			
Course Code	MBS26T5105			
Prerequisite	B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry			
Corequisite	Environmental Science, Mathematics, Physics and Computer Science and Bio-statistics			
Antirequisite				
Theory Lectures:	L	T	P	C
50	3	0	0	3

Course Objective:

1. To provide comprehensive overview of solid, biomedical and hazardous waste management.
2. To provide knowledge on solid waste management design aspects.
3. To learn about the different methods of solid waste management.

Course Outcomes

CO1	Identify different types of solid wastes and methods of collection K3
CO2	Analyze different treatment methods of solid wastes K4
CO3	Identify different techniques for biomedical waste management K3
CO4	Interpret different thermal treatment processes of solid wastes K3
CO5	Adapt new techniques to treat waste K6

Text Books and References:

1. Tchobanoglous G., Theissen H., and EIiassenR.(1991), "Solid Waste Engineering - Principles and Management Issues", McGraw Hill, New York.

2. Pavoni J.L(1973)., "Handbook of Solid Waste Disposal".

3. Peavy, Rowe and Tchobanoglous (1985), "Environmental Engineering", McGraw Hill Co. 4th Edition

4. Mantell C.L., (1975), "Solid Waste Management", John Wiley.

5. CPHEEO, Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organisation, Government of India, New Delhi, 2000.

6. WHO Manual on Solid Waste Management.

7. VesilandA.(2002), "Solid Waste Engineering", Thompson Books.

8. Hazardous waste (management and handling) rules, 2001

9. Biomedical (Handling and Management) Rules 2008

Unit-1 Solid waste	**8 hours**
sources and engineering classification, characterization, generation and quantification. Transport - collection systems, collection equipment, transfer stations, collection route optimization.	
Unit-2 Treatment methods -	**10 hours**
various methods of refuse processing, recovery, recycle and reuse, composting – aerobic and anaerobic, incineration, pyrolysis and energy recovery, Disposal methods – Impacts of open dumping, site selection, sanitary land filling – design criteria and design examples, leachate and gas collection systems, leachate treatment.	
Unit-3 Biomedical Waste management	**10 hours**
sources, treatment and disposal Hazardous Waste Management- Introduction, Sources, Classification, Physico-chemical, Chemical and Biological Treatment of hazardous waste, regulations	
Unit-4 Thermal treatment	**10 hours**
Incineration and pyrolysis. Soil contamination and site remediation – bioremediation processes, monitoring of disposal sites.	
Unit-5 Recent Advancement in Waste Management and treatment	**6 hours**
Discuss the new techniques to treat variety of waste.	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Waste Water Management**				
Course Code	**MBS26T5106**				
Prerequisite	**B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry**				
Corequisite	**Environmental Science, Mathematics, Physics and Computer Science and Bio-statistics**				
Antirequisite					
Theory Lectures:		**L**	**T**	**P**	**C**
50		**3**	**0**	**0**	**3**

Course Objectives:

1. To learn about the methods used for the treatment of wastewater biologically.
2. To make the students understand modeling and design aspects of biological techniques available.

CO1	**CO1: Analyze the objectives of Waste Water treatment (K4)**

CO2	**Interpret the kinetics of biological treatment systems (K2)**
CO3	**Organize the theoretical principles and design of Water treatment process (K3)**
CO4	**Identify different advanced Water treatment processes (K3)**
CO5	**Adapt new methods to treat waste water K6**

Text Books and References:

1. **Peavy, H.S., Rowe and Tchobonoglous,G., (1985), "Environmental Engineering", McGraw Hill**
2. **Metcalf and Eddy Inc., (2003), "Wastewater Engineering - Treatment and Reuse", 4th Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi.**
3. **Benefield R.D.,and Randal C.W., (1980), "Biological Process Design for Wastewater Treatment", Prentice Hall, Englewood Chiffs, New Jersey.**
4. **Karia G.L., and Christian R.A., (2001), "Wastewater Treatment Concepts and Design Approach", Prentice Hall of India Pvt. Ltd., New Delhi.**
5. **Lee C.C., and Lin S.D., (1999), "Handbook of Environmental Engineering Calculations", McGraw Hill, New York.**

Unit-1	**12 hours**
Objectives of wastewater treatment: flow variations , characteristics, analysis of BOD, COD, solids and volatile solids & their significance, BOD progression & its formulation, types of reactors and reactors analysis. Study of Wastewater Treatment, Flow Diagrams and Hydraulic Profile. Theoretical principles and design - screens, equalization basin, grit chamber, primary and secondary settling tanks.	
Unit-2	**10 hours**
Kinetics of biological treatment systems: bio-kinetic constants and their determination, batch and continuous systems.	
Unit-3	**10 hours**
Theoretical principles and design: Suspended growth system - conventional activated sludge process and its modifications. Theoretical principles and design – attached growth system – trickling filter, bio-towers and rotating biological contactors. Principles and design of stabilization ponds	
Unit-4	**10 hours**
Sludge Processing: Separation, sludge thickeners, volume reduction, conditioning and digestion – aerobic and anaerobic. Advanced Wastewater Treatment – Need and technologies used. Nitrification and Denitrification Processes, Phosphorous removal, Wastewater disinfection.	
Unit-5	**8 hours**
Discuss the new techniques to treat waste water.	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks

30	**20**	**50**	**100**

Name of The Course	**Waste management Lab I - Practicals on Solid Waste**				
Course Code	**MBS26T5107**				
Prerequisite	**B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry**				
Corequisite	**Environmental Science, Mathematics, Physics and Computer Science and Bio-statistics**				
Antirequisite					
Theory Lectures:		**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**

Course Outcomes

CO1	**Determine the pH of MSW and total solids**
CO2	Analyze the nutrient value (NPK) .
CO3	**Illustrate vermicomposting in lab.**
CO4	**Survey report of disposal site and handling of hazardous materials.**
CO5	**Illustrate the working of incinerators**

Reference Books:

1. J. Glynn Henry and Gary. W. Heinke, "Environmental Science and Engineering", Pretice Hall of India, 2004.
2. A. D.Bhide and B.B.Sundaresan, "Solid Waste Management – Collection, Processing and disposal" Mudrashilpa Offset Printers, Nagpur, 2001.
3. Biomedical waste (Management and Handling) Rules, 1998.

List of experiments

1. Determination of pH of MSW
2. Determination of Total Solids, fixed solids and volatile solids
3. Determination of nutrient value (NPK)
4. Lab scale study on vermin-composting
5. Lab scale study of aerobic and anaerobic digesting of solid wastes (Both industrial & Municipal)
6. A Visit to the Hazardous waste Generation or disposal site.
7. Practical knowledge and working of incinerators
8. Visit to Industrial area, study the handling of Hazardous materials

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
50		**50**	**100**

Name of The Course	Waste Management Lab II - Practicals on Waste Water Treatment			
Course Code	MBS26T5108			
Prerequisite	B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry			
Corequisite	Environmental Science, Mathematics, Physics and Computer Science and Bio-statistics			
Antirequisite				
Practical Lectures:	L	T	P	C
	0	0	2	1

Course Outcomes

CO1	Differentiate bacteria and fungi.
CO2	Test for Gram staining, capsule staining, differential staining and motility and microbes in lab .
CO3	Summarize the preservation of culture and Batch and Fed culture i.
CO4	Determine DO,BOD and COD in lab.
CO5	Analyse Fats, oils, greases in lab.

Reference Books:

1. Prescott and Dunn, "Industrial Microbiology", Macmillian.

2. Dany Spencer Adams, "Lab Methodologies", IK Intl.Pub house.

3. L.M. Prescott, Harley, Klein, (2002), "Microbiology" 5th edition, McGraw-Hill Higher Education.

4.Chemistry for Environment Engineering. Sawyer and Mc Carty.

List of experiments

1. Isolation of bacteria and fungi from wastewater.
2. Gram staining, capsule staining, differential staining and motility test.
3. Biochemical Tests for characterization of microbes.
4. Preservation of cultures.
5. Batch and Fed batch culture studies.
6. Determination of Solids in wastewater: Total Solids, Suspended Solids, Dissolved Solids, Volatile Solids, Fixed Solids, Settleable Solids.
7. Determination of DO, BOD and COD
8. Determination of Fats, oils and greases.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
50		50	100

Name of The Course	Rural Society and Development
Course Code	MBS26T5109

Prerequisite	**B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry**				
Corequisite	**Environmental Science, Mathematics, Physics and Computer Science and Bio-statistics**				
Antirequisite					
Theory Lectures:		**L**	**T**	**P**	**C**
50		**3**	**0**	**0**	**3**

Course Objectives:

a) To make the students to understand some basic concepts and theoretical approaches related towards Rural Social Structure.

b) To expose the students to the critical / analysis and evaluation of those programmes aiming to bring desired change in Indian Society.

c) To make the students aware of changed prospective of Rural Society in India.

d) To create practical approach among the students.

CO1	**Identify the components of Rural Society and the different institutions associated with it**
CO2	**Interpret the different concept and theories of Rural Social Change**
CO3	**Analyze methods of agricultural development**
CO4	**Identify the various sources of Rural Employment**
CO5	**Adapt new processes for development of rural society.**

Text Books and References:

1. Vasant Desai: A Study of rural economics; Himalaya Publishing Company; New Delhi.

2. Sharma K.C. (1997): Rural Sociology in India; Rural Publication; New Delhi.

3. Jain S.C: Rural Development; Concept Publishing.

4. S.R.Mehta: Sociology of Rural Development; Sage. Publications; New Delhi.

5. Sreenivas M. N.: Social Change in Modern India; Orient Black Swan.

6. A. R. Desai: Rural Sociology; Popular Prakashan.

Unit-1 : Rural Society and Institutions 10 hours
Indian Rural society – Nature and Characteristics, Factors of Indian Society- Tribal- Rural-Urban- Rural Urban continuum, Problems of Weaker Sections- Schedule Casts, Schedule Tribes and, Women, Caste and Class, Caste and Economic Inequalities

Institutions: Religious- Concept, Nature, Function and its Changing Structure, Education-Objectives, Functions and Importance, Co-operation- Concept, Nature, Scope, Role and Significance in Rural Development.	
Unit-2 Rural Social Change	**10 hours**
Concept of Social Change; Factors of Social Change: Cyclical Theories; Linear Theories; Conflict Theories, Sanskritization, Westernization, Modernization, Diffusion of Innovation; Resistance to Change; Socio-Cultural Barriers for Rural Development, Role of Leadership in Promoting Social Change.	
Unit-3 Development of Agriculture	**12 hours**
National Agricultural Policy 2000 and Food Security, Irrigation and Water Management, Methods of Irrigation, Conventionaland Modern Methods, Role of Agricultural Universities and Krishi Vigyan Kendra- Needs andEstablishment	
Unit-4 Sources of Rural Employment	**10 hours**
Self Help Group- Concept, Characteristics and Functions, Swarnajayanti Gram Swarojgar Yojana (SGSY)- Salient features of SGSY, Nature and Scope, Agro Based Industries- Concept, Types, Functions and Importance in Rural Employment Generation	
Unit-5 Recent development in rural society	**8 hours**
Discuss the new development in rural society, agriculture tech. and employment.	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Urban Ecosystem**				
Course Code	**MBS26T5110**				
Prerequisite	**B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry**				
Corequisite	**Environmental Science, Mathematics, Physics and Computer Science and Bio-statistics**				
Antirequisite					
Theory Lectures:		**L**	**T**	**P**	**C**
50		**3**	**0**	**0**	**3**

Course Outcomes

CO1	**Describe the concept of urbanization; urban sprawl and associated environmental issues.**

CO2	Generalize emerging importance of the urban setting as the locus of environmental conflict and governance.
CO3	**Relate and examine town planning, acts and their environmental aspects presence of slums as a specific environmental issue in urban contexts.**
CO4	**Determine the major forms of urban pollution - air, water, noise and land are explored.**
CO5	**Adapt new processes for sustainable development in urban areas**

Course Objectives:
This paper introduces the students to the concept of urbanization, urban sprawl and environmental issues.

Text Books/References

- Berkowitz, A.R., Nilon, C.H. and Hollweg, K.S. (eds.). 2003. *Understanding urban ecosystems: a new frontier for science and education*. Springer Science & Business Media.
- D'Monte D. 1985. Industry versus Environment Temples or Tombs. Three Controversies, Delhi, CSE.
- Douglas, I. 2012. Peri-urban ecosystems and societies: transitional zones and contrasting values. In The Peri-urban Interface (pp. 41-52). Routledge.
- Kopecká, M., Nagendra, H. and Millington, A. 2018. Urban Land Systems: An Ecosystems Perspective.
- Kumar, P. 2009. Assessment of economic drivers of land use change in urban ecosystems of Delhi, India. AMBIO:A Journal of the Human Environment, **38**: 35-39.
- Nagendra, H., Sudhira, H.S., Katti, M., Tengö, M. and Schewenius, M. 2014. Urbanization and its impacts on land use, biodiversity and ecosystems in India. INTERdisciplina, 2.
- Pelling, M. and S. Blackburn (eds.). 2003. Megacities and the Coast: Risk, Resilience and Transformation, Abington: Routledge.
- Singh, V.S., Pandey, D.N. and Chaudhry, P. 2010. Urban forests and open green spaces: lessons for Jaipur, Rajasthan India. Jaipur: Rajasthan State Pollution Control Board.
- Oldenburg, V.T. 2014. The Making Of Colonial Lucknow, 1856-1877. Princeton University Press.
- Verma, G.D. 2002. Slumming India: A Chronicle Of Slums And Their Saviours. Penguin Books, New Delhi.

Unit-1Environment in an urban setting-City, region and modernity 10 hours
Urban ecosystem, meaning and concept, introduction to urbanization; Man as the driver of urban ecosystem, increasing challenges posed by modernity for the environment. Nature in the city: Parks, Gardens and Public spaces. Examines the principles and techniques through which green spaces are organized in the city to produce 'controlled nature' **Infrastructure: A variety of infrastructure from sewage and water to transport and communication are studied from an environmental perspective.**
Unit-2 Urban Planning and environment 12 hours
Town planning Acts and their environmental aspects are studied across a range of Indian cities. Historical and contemporary developments in urban planning and environmental management are addressed. Slums and neighborhoods: Examines the housing scenario across large-medium-small cities and the presence of slums as a specific environmental issue in urban contexts.

Unit-3 Occupational environment of Urban Areas 12 hours
Environmental aspects of a variety of informal and formal work spaces are examined. Pollution and waste, Major forms of urban pollution - air, water, noise and land - are explored historically and across various urban sites. Spatial dimensions of waste circulation are explored.
Unit-4 Consuming nature and environmental impacts 12hours
Introduce the issue of consumption from a variety of perspectives - materials, symbolic and aesthetic. Energy and environment Examines the major techniques for providing energy in urban contexts - generation, transportation, usage, alternatives and environmental impacts. Insight into some key challenges facing urban sustainability in the 21st century; Urban futures.
Unit-5 Recent advancement in urban ecosystem 4 hours
Discuss about the new processes applicable for sustainable development of urban ecosystem

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**E&S Lab I - Field Work on Rural Development**				
Course Code	**MBS26T5111**				
Prerequisite	**B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry**				
Corequisite	**Environmental Science, Mathematics, Physics and Computer Science and Bio-statistics**				
Antirequisite					
Lectures:		**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**

Course objective

Students will get exposure the rural societies understand their development issues.

Course Outcomes:

CO1	**Identify rural societies in an area and plan visits to study about them (K3)**
CO2	Analyze structure, agriculture and recent developments in rural societies (K4)
CO3	**Organizing visits in the sector in which students choose to develop policy concentration and specialization (K3)**
CO4	**Compile data collected from field work for report writing (K6)**

List:

1. Understanding Rural Societies and Development in Rural Areas (understanding of rural society, structure, agriculture etc.)

2. Policy Area Concentration Aligned Experiential Learning (acquiring practical, political and administrative experience in the sector in which students choose to develop policy concentration/specialisation)

3. Primary data collection from the field work carried out and report writing on the same.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
50		50	100

Name of The Course	E&S Lab II - Field Work on Urban Ecosystem				
Course Code	MBS26T5112				
Prerequisite	B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry				
Corequisite	Environmental Science, Mathematics, Physics and Computer Science and Bio-statistics				
Antirequisite					
Lectures:		L	T	P	C
		0	0	2	1

Course Outcomes

CO1	Illustrate formation and Community Planning exercise
CO2	Identify the problems of special area **(slum / new town / rural area)**
CO3	Simplify the interaction studies of a small urban area and its environment.
CO4	Illustrate the Heritage and the roots of our modern concepts in urban design.
CO5	Analyse theories and principles of urban development plan and preparation for survey and data collection.

Course objective

Students develop the skill to solve the issues related to urbanization.

Reference Books:

1. Urban Design: The architecture of towns & cities / SPREIREGEN, PAUL. D.

2. The urban pattern: city planning and design / GALLION, A B.

3. Water supply, waste disposal & Environmental Engineering / CHATTERJEE, AK

List of experiments:

1. Skill formation and Community Planning exercise.

2. Housing cluster and residential sector studies – layout, density, utility net-work and community facilities locations

3. Introduction to special area problems (slum / new town / rural area) and preparation of their plan program.

4. Land use interaction studies of a small urban area and its environment.

5. Early examples of Urban Design in classical and pre-industrial cities – Heritage and the roots of our modern concepts in urban design.

6. Objectives and scope of urban design, Basic functions, principles and techniques, Value enhancement, aesthetics and conservation aspects.

7. Theories and principles of urban development plan and preparation for survey and data collection.

8. Field survey of the study area and Analysis of data and information

9. Planning for urban area and its region (structure plan / Development plan) with emphasis on:

- **Land use and transportation network**
- **Infrastructure plan**
- **Action area programs and urban renewal plan**
- **Capital budget and financing**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
50		50	100

GALGOTIAS UNIVERSITY

(Established under Galgotias University Uttar Pradesh Act No. 14 of 2011)

School of Basic and Applied Sciences
Department of Life Sciences
Division of Biochemistry

Program **:M.Sc. Biochemistry**

Scheme effective from: 2020 – 2022

Date of BoS: 22.04.2020

Vision

"To be known globally for value-based education, research, creativity and innovation"

Mission

1. **Establish state-of-the-art facilities for world class education and research.**
2. **Collaborate with industry and society to align the curriculum,**
3. **Involve in societal outreach programs to identify concerns and provide sustainable ethical solutions.**
4. **Encourage life-long learning and team-based problem solving through an enabling environment.**

School of Basic and Applied Sciences

Vision:

To be recognized globally as a center of excellence in imparting value-based education in Basic and Applied Sciences by creating innovation in fundamental and multidisciplinary research.

Mission

M1. **To excel in imparting contemporary knowledge and skills by developing an educational ecosystem with diverse interests and talents.**

M2. **To perform cutting edge research leading to innovation in sciences through national and international collaborations.**

M3. **To develop solutions for the emerging challenges in Basic and Applied Science to cater the needs of society.**

M4. **To attract best quality faculty to facilitate knowledge and develop confidence in our graduates to succeed in the world.**

Salient features

Biochemistry is a central basic discipline to all branches of Biology/ Life Sciences. It deals with the chemical nature, function, structure, energetic and pathways of synthesis and degradation of simple to complex biological and/or cellular molecules to understand the various aspects of cellular and molecular functions in development, health and disease with applications in Biotechnology and Medicine. The Postgraduate course in Biochemistry made under credit system at the Division of Biochemistry, School of Basic and Applied Sciences, Galgotias University is effective from the academic year 2015-16.

The aim of the course is to develop a scientific aptitude in the students and to motivate them for research in Biochemistry. Two years of intense training gives them a sound knowledge of the fundamentals of the subject and a fairly good idea about the recent developments in Biochemistry and allied areas. By the end

of their second year, students gain expertise in the latest biochemical techniques and learn to appreciate the applications of the basic science to the field of modern medicine.

Eligibility

Graduation in Botany/ Zoology/ Biochemistry/ Biotechnology/ Microbiology/ Biomedical Sciences/ Genetics/ Medicine/ Agriculture/ Life Sciences/ Chemistry/ Pharmacy from any recognized university or equivalent examination with a minimum of 50 % marks in aggregate.

Scope of the Proposed Programme

The M.Sc., programme of two years is designed to help all the students to get good quality education in the field of Biochemistry so that they can find employment after their Post Graduation. The ultimate aim is to enable the students to develop an integrated approach for understanding the various life science problems at the molecular level. In addition, the present curriculum gives scope for vertical and horizontal mobility in the education system so that the students can enter different modules to update their knowledge depending upon the employment opportunities in each area. Various practical courses have been designed not only to enable the students to appreciate scientific basis of various life processes but also to train them for self-employment. The practical training will develop their reasoning ability to critically evaluate the results obtained from the projects. There is a greater demand globally for trained manpower in the area of Biochemistry for Research and Development, in Multinational Companies, Public Sectors, Quality Control Labs, Biopharmaceuticals companies, Food industries as well as in Universities and the present curriculum will cater to that needs.

The course will provide solid foundation for all the students regardless of background and will gain a comprehensive understanding of the principles of Biochemistry to an advanced level, including clinical and research aspects and with the special attention to current development in the discipline.

Programme Outcome

PO1	**Apply knowledge of basic and applied sciences to the solution of complex biochemical conditions.**
PO2	**Conduct experiments and researches, perform analysis and interpret data for complex biochemical conditions.**
PO3	**Identify, investigate, analyse and generate solutions for biochemical processes.**
PO4	**Use research-based knowledge together with design of experiments, analysis and interpretation of data, to provide valid conclusions with an understanding of their limitations.**
PO5	**Create, select and apply appropriate techniques, resources and modern science and research tools within a defined specification that meet specified needs with appropriate consideration for public health and safety.**

PO6	**Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal issues and the consequent responsibilities relevant to the professional biochemist.**
PO7	**Understand the impact of professional life sciences solutions in communal and environmental contexts and demonstrate knowledge and need for sustainable development.**
PO8	**Execute responsibility professionally and ethically.**
PO9	**Function effectively as an individual, and as a member or leader in diverse resource teams.**
PO10	**Articulate ideas, comprehend and write effective reports, documentation and to communicate effectively with the basic and applied sciences community and with society at large.**
PO11	**Demonstrate knowledge and understanding of science and technical principles to manage projects in multidisciplinary research areas.**
PO12	**Seeking stimulation and to exploring numerous opportunities to engage in independent and life-long learning in the broadest context of technological change.**

Programme Educational Objective of M.Sc Biochemistry

PEO1	**The graduated young minds will be ignited to understand the world of biochemical concepts through application based learning.**
PEO2	**The graduates will be emphasized on applied aspects of advance biochemical techniques by hands-on training and to inculcate ethics and professional attitude.**
PEO3	**The graduates of Biochemistry will be trained for self-directed learning, recognizing, continuing educational needs in occupying positions in research, industries and related organization.**

Program Specific Outcomes (PSOs) for M.Sc. Biochemistry are defined as:

PSO1	Developing deeper understanding of key concepts of biochemistry and allied branches of biological sciences such as molecular cell biology, microbiology, biotechnology, clinical and industrial biochemistry.
PSO2	Equip students with analytical and technical skills through application based learning such as use of audio visual aids,,problem/project based learning, guest lectures, visits to industrialand academicorganizations and to practice evidence based biochemistry.

Programme Structure: M.Sc. Biochemistry (2020-2022)

First Semester									
Sl. No.	Course Code	Course Title	L	T	P	C	Assessment Pattern		
							IA	MTE	ETE
1	MSDB5013	Cell Biology	3	1	0	3	30	20	50
2	MSDB5002	Molecular Biology	4	0	0	4	30	20	50
3	MSDB5003	Biomolecules	4	0	0	4	30	20	50
4	MSBC5004	Enzymology	4	0	0	4	30	20	50
5	MSBC5005	Advanced Biochemistry Lab - I			4	2	50		50
6	XXXX	Soft Skills				0			
7	XXXX	Computer awareness				0			
Total Credits						17			

Second Semester									
Sl. No.	Course code	Course Title	L	T	P	C	Assessment Pattern		
							IA	MTE	ETE
1	MSDB5006	Immunology	4	0	0	4	30	20	50
2	MSDB5007	Bioanalytical and Microbial Techniques	4	0	0	4	30	20	50
3	MSDB5008	Biotechnology And Genetic Engineering	4	0	0	4	30	20	50
4	MSDB5010	Microbiology	4	0	0	4	30	20	50
5	MSBC5014	Bioenergetics and Intermediary Metabolism	3	1	0	3	30	20	50
6	MSBC5012	Advanced Biochemistry Lab - II	0	0	4	2	50	-	50
7	XXXX	BEC (B1)				3			
8	MBS28T2111	Research Methodology	2	0	0	2	30	20	50
9	XXXX	IPR				1			
Total Credits						27			

Third Semester									
Sl. No.	Course Code	Course Title	L	T	P	C	Assessment Pattern		
							IA	MTE	ETE
1	MSDB6001	Genetics	4	0	0	4	30	20	50
2	MSBC6003	Summer Training	0	0	0	2	50	-	50
3	MSBC6004	Protein, Lipid and Nucleotide Metabolism	4	0	0	4	30	20	50

4	MSBC6005	Clinical And Nutritional Biochemistry	4	0	0	4	30	20	50
5	MSBC6006	Advanced Biochemistry	4	0	0	4	30	20	50
6	MSDB#	Elective#	3	0	0	3	30	20	50
7	MSBC6007	Advanced Biochemistry Lab - III	0	0	4	2	50	-	50
8	XXXX	Campus to Corporate	0	0	2	1	50	-	50
Total Credits						24			

Fourth Semester									
Sl. No.	Course Code	Course Title	L	T	P	C	Assessment Pattern		
							IA	MTE	ETE
1	MSBC9997	Dissertation	0	0	0	12	50	-	50
Total Credits						12			

List of Electives									
							Assessment Pattern		
Sl. No.		Course Title	L	T	P	C	IA	MTE	ETE
1	MSDB6019	Computational Biology	3	0	0	3	30	20	50
2	MSDB6020	Bioethics, Bio-safety and IPR	3	0	0	3	30	20	50
3	MSDB6021	Toxicology	3	0	0	3	30	20	50
4	MSDB6022	Industrial Biochemistry	3	0	0	3	30	20	50
5	MSDB6023	Advanced Microbiology	3	0	0	3	30	20	50
6	MSDB6024	Plant –Pathogen interaction	3	0	0	3	30	20	50

***Summer training will be done in II Semester; credit will be evaluated in III Semester**

Detailed Syllabus

Name of The Course	**Cell biology**				
Course Code	**MSDB5013**				
Prerequisite	**Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.**				
Corequisite	**Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.**				
Antirequisite					
		L	**T**	**P**	**C**
		3	**1**	**0**	**3**

Course Objectives:

1. Students will understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles.

2. These can include responses to environmental or physiological changes, or alterations of cell function brought about by mutation.

Course Outcomes

CO1	**Identify cell types, structure, functions and cell division.**
CO2	**Demonstrate the function and structure of various cell organelles**
CO3	**Interpret the models of biological membrane and illustrate membrane biochemistry**
CO4	**Interpret the membrane biochemistry and transport of ions across the membrane.**
CO5	**Elucidate the knowledge in the area of cell aging and death**
CO6	**Analyze the recent advancement in cell biology**

Text Book (s)

- The Cell: A Molecular Approach (2009) 5th ed., Cooper, G.M. and Hausman, R.E., ASM Press & Sunderland (Washington DC), Sinauer Associates, MA, ISBN:978-0-87893-300-6.
- Molecular Cell Biology (2012) 7th ed., Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell. J., W.H. Freeman & Company (New York), ISBN:13:978-1- 4641-0981-2 / ISBN: 10: 1-4641-0981-8.
- Molecular Biology of the Cell (2008) 5th ed., Alberts, B., Johnson,A., Lewis, J., and Enlarge, M., Garland Science (Princeton), ISBN:0-8153-1619-4.

Reference Book (s)

- Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13: 978-1-4641-0962-1 / ISBN:10:1-4292-3414- 8.
- Molecular Biology of the Cell (2008) 5th ed., Alberts, B., Johnson,A., Lewis, J., and Enlarge, M., Garland Science (Princeton), ISBN:0-8153-1619-4.

Unit-1 Introduction to cell biology (8 hours) **Introduction to the cell, its chemical composition, Cell types - organization of prokaryotic and eukaryotic cells, Plant and animal cells: variation in structure and function, cell theory, cell cycle - phases of cell cycle; cell division - mitosis and meiosis**
Unit-2 structure and function of different cell organelles (10 lectures)

Cell organelles; structure and function of endoplasmic reticulum, Golgi body, endosome, lysosome, vacuole, peroxisome, ribosome, mitochondria, chloroplast, nucleus, cytoskeleton, cell wall; subcellular fractionation; cytoplasm and cytosol, Structure of nuclear envelope, nuclear pore complex.
Unit-3 Membrane biochemistry(10 lectures) Membrane: chemical composition and its structural plan; membrane lipids; Overview of membrane protein - peripheral and integral; molecular model of cell membrane - fluid mosaic model and membrane fluidity; factors affecting the membrane fluidity.
Unit-4 Cellular communication and transport (10 lectures) Microvilli, tight junctions, epithelia, Bell and sqot desmosomes, Types of Cell Junctions; membrane transport; small molecules - passive transport, active transport by ATP powered pumps, Overview of types of transport systems and macromolecule transport: Exocytosis; Endocytosis; Pinocytosis and phagocytosis.
Unit-5 Cell cycle and cell death (08 lectures) Cell cycle regulation, Cell aging: Mechanism Cell death: necrosis and Its mechanism, Apoptosis : Definition, mode of programmed cell death, Role of mitochondria in apoptosis
Unit-6 Recent Advancement in cell biology (04 lectures) Research article/ Review paper/ MOOC

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Molecular Biology				
Course Code	MSDB5002				
Prerequisite	Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.				
Corequisite	Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.				
Antirequisite					
		L	T	P	C
		4	0	0	4

Course Objectives:
Molecular biology deals with nucleic acids and proteins and how these molecules interact within the cell to promote proper growth, division, and development. It is a large and ever-changing discipline. This course will emphasize the molecular mechanisms of DNA replication, repair, protein synthesis etc.

Course Outcomes

CO1	Generalize the prokaryotic and eukaryotic mechanism of transcription.

CO2	**Illustrate of genetic code and the process of translation.**
CO3	**Interpret of protein targeting and degradation mechanism.**
CO4	**Determine the regulation of gene expression in prokaryotes and eukaryotes.**
CO5	**Evaluate the procedure of recombinant DNA technology**
CO6	**Analyze the recent advancement in molecular biology.**

Text Book (s)

- Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13: 978-1-4641-0962-1 / ISBN:10:1-4292-3414- 8.
- Molecular biology of the gene, (4^{th}ed)J D Watson, Benjamin/Cummings publ. Co Inc.
- Molecular Cell Biology (2012) 7th ed., Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell. J., W.H. Freeman & Company (New York), ISBN:13:978-1- 4641-0981-2 / ISBN:10: 1-4641-0981-8.
- Molecular Biology of the Cell (2008) 5th ed., Alberts, B., Johnson,A., Lewis, J., and Enlarge, M., Garland Science (Princeton), ISBN:0-8153-1619-4 / ISBN:0-8153-1620-8.

Reference Book (s)

- **Alberts B, Bray D, Johnson A et al. (1997) Essential Cell Biology. London: Garland Publishing.**
- **Darwin C (1859) On the Origin of Species. London: Murray.**
- **Graur D & Li W-H (1999) Fundamentals of Molecular Evolution, 2nd edn. Sunderland, MA: Sinauer Associates.**

Unit-1 Nucleic acid structure and function (10 lectures) **Historical account of DNA discovery; Overview of flow of genetic information; DNA and RNA as genetic material; Unnatural structures of DNA; DNA topology and supercoiling. Nucleosome structure and packaging of DNA into higher order structures; Organelle genomes; chromosome diversity; Clusters and tandem repeats, Microsatellite Repeat Sequences and transposons.**
Unit-2 DNA replication, mutagenesis, DNA damage and repair mechanisms (12 lectures) **The Origin of Replication; Unwinding of DNA; Formation of the Replication Fork; The DNA Polymerase Complex; Initiation & Elongation of DNA Synthesis; Replication Exhibits Polarity; Formation of Replication Bubbles; Reconstitution of Chromatin Structure; DNA Synthesis Occurs During the S Phase of the Cell Cycle. Mutagenesis and replication fidelity; Types of Damage to DNA; DNA repair mechanisms - Mismatch repair of DNA, Base Excision-Repair, Nucleotide Excision-Repair, Double-Strand Break Repair**
Unit-3 Transcription (10 lectures) **Prokaryotic transcription- promoters, properties of bacterial RNA polymerase, steps: initiation, elongation and termination; Eukaryotic transcription- promoters, enhancer factors and properties of RNA polymerase I, II and III; Reverse transcription; Inhibitors of transcription. RNA processing, splicing, capping and polyadenylation, rRNA and tRNA processing.**
Unit-4 Genetic code, protein translation, targeting and degradation (10 lectures) **Genetic code - definition, deciphering of the genetic code, salient features of genetic code; Protein biosynthesis - initiation, elongation and termination; post-translational modifications; Inhibitors of protein synthesis. Intracellular protein targeting; Signal hypothesis, signal sequences, glycosylation,**

Targeting of protein to mitochondria, lysosomes, ER, plasma membrane, peroxisomes, chloroplast; Destruction of proteins; Protein folding.
Unit-5 Regulation of gene expression (12 lectures) **Positive and negative control; Repressor & Inducer; concept of operon- lac, ara, trp operons; attenuation, catabolite repression, autogenous regulation, lytic cycle of bacteriophage; stringent response of rRNA synthesis. Hormonal control, transcription factors, steroid receptors. DNA binding motifs in pro- and eukaryotes – Helix-turn-helix, zinc fingers, leucine zippers, helix loop helix motifs.**
Unit-6 Recent Advancement in molecular biology (04 lectures) **Research article/ Review paper/ MOOC**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Biomolecules**				
Course Code	**MSDB5003**				
Prerequisite	**Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.**				
Corequisite	**Students should have understanding of general biology, including a basic knowledge of the , structure/functionof biological molecules**				
Antirequisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives:The course objectives are as following -

- **Demonstrate knowledge and understanding of the molecular machinery of living cells;**
- **Demonstrate knowledge and understanding of the principles that govern the structures of macromolecules and their participation in molecular recognition;**

Course Outcomes

CO1	**Illustrate the effect of water, electrolyte and acid-base balance in the physiological system.**
CO2	**Describe the different classes of carbohydrates and their functions.**
CO3	**Explain the structure and functions of lipids in the living system**
CO4	**Summarize the different classes of aminoacids and proteins and their functions**
CO5	**Demonstrate the types of nucleic acids and its sequencing**
CO6	**Analyze the recent advancement in basic biochemistry**

Text Book (s)

- Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13: 978-1-4641-0962-1 / ISBN:10:1-4292-3414- 8.
- Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New York), ISBN:978-0-470-28173-4.
- Biochemistry (2011) 4th ed., Donald, V. and Judith G.V., John Wiley & Sons Asia Pvt. Ltd. (New Jersey), ISBN:978-1180-25024.

Reference Book (s)

- Berg, J. M., Tymoczko, J. L. and Stryer, L. Biochemistry. Freeman, 7th edition, 2011.

- Mathews, C. K. & Van Holde, K. E. & Ahern, K. G. Biochemistry. Addison Wesley, 4th edition, 2012.
- Wilson, K. & Walker, J. Principles and Techniques of Biochemistry and Molecular Biology. CUP, 7th edition.

Unit-1 UNIT -I: WATER, ELECTROLYTES AND BUFFERS (10 hours) **Ionization of Water, Weak Acids, and Weak Bases, Buffer, Handerson-Hassel back equation, Buffering against pH Changes in Biological Systems, disorders of acid-base balance. Water as a Reactant, weak interactions in aqueous solution, Electrolytes – distribution and balance, sodium, potassium chloride and bicarbonate;**
Unit-2 CARBOHYDRATES (10 hours) **Nomenclature and classification of carbohydrates; Isomerism; Structure and classification of monosaccharides, Reactions of monosaccharides; Sugar derivatives – amino sugars and deoxy sugars; Structure and functions of disaccharides and polysaccharides; Glycosaminoglycans and glycoconjugates.**
Unit- 3 LIPIDS (10 hours) **Classification of lipids; Reactions of lipids; Structure and biological role of the following: fatty acids, acyl glycerols, phospholipids, plasmalogens, sphingolipids, glycolipids, Eicosanoids – prostaglandins, thromboxanes& leukotrienes, leptin and visfatin; Lipoproteins.**
Unit- 4 AMINO ACIDS AND PROTEINS (10 hours) **Classification, structure and properties of aminoacids; general reactions of aminoacids; Peptide bond; Primary, secondary, tertiary and quaternary structures of proteins; Sequence analysis; Structure and functions of myoglobin and hemoglobin.**
Unit-5 NUCLEIC ACIDS (10 hours) **Purines and pyrimidines; Structure and properties of DNA;A, B and Z forms of DNA;Classes and structure of RNA – mRNA, tRNA and rRNA; Nucleic acid sequencing – Maxam and Gilbert and Sangers method.** .
Unit-6 Recent Advancement in basic biochemistry (04 lectures) **Research article/ Review paper/ MOOC**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Enzymology**
Course Code	**MSBC5004**
Prerequisite	**Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.**
Corequisite	**Students should have understanding of general biology, including a basic knowledge of the protein biology.**
Antirequisite	

	L	T	P	C
	4	0	0	4

Course Objectives:

Students are able to describe the kinetics, structure and regulation of enzymes.

Course Outcomes

CO1	**Describe the concepts of ecology.**
CO2	**Explain the different components of Ecosystem.**
CO3	**Describe the fundamentals of population ecology**
CO4	**Discuss about community and Ecosystem Ecology**
CO5	**Explain the different type of bioremediation process.**
CO6	**Analyze the recent advancement in enzymology.**

Text Book (s)

- Colinvaux, P. A. (1993). Ecology. II Edition. Wiley, John and Sons, Inc.
- Krebs, C. J. (2001). Ecology. VI Edition. Benjamin Cummings.
- Odum, E.P., (2008). Fundamentals of Ecology. Indian Edition. Brooks/Cole
- Ricklefs, R.E., (2000). Ecology. V. Edition. Chiron Press.

Reference Book (s)

- Basic Ecology: E. P. Odum, Indian Edition. Brooks/Cole
- P. D. Sharma Ecology and Environment, Rastogi publications, india.
- R. H. Whittaker, Communities and Ecosystems, New York and London: Macmillan Publishing Co. Inc., 1975. Second edition. Octavo, pp xx, 385.

Unit-1 ENZYMES – INTRODUCTION AND CLASSIFICATION (10 hours) **Enzymes as biological catalysts: characteristics, nomenclature and classification; enzyme assay and enzyme activity; enzyme units; coenzymes: structure and function; factors affecting enzyme activity; Active site – Fisher and Koshland models, multifunctional enzymes; isoenzymes; ribozymes; abzyme and synzymes.**
Unit-2: ENZYME KINETICS AND ENZYME INHIBITION (10 hours) **Kinetics of enzyme catalyzed reactions; steady-state hypothesis and derivation of Michaelis- Menten equation; significance of K_m and V_{max} and their determination using different plots; double reciprocal plot; enzyme inhibition: competitive, noncompetitive, and uncompetitive inhibition; excess substrate inhibition; Suicide inhibitor; enzyme kinetics in the presence of inhibitors; determination of Ki; enzyme catalyzed reactions involving two substrates.** **as limiting factors, soil types and soil erosion.**
Unit-3 CATALYTIC MECHANISMS (10 hours) **Catalytic efficiency and factors associated with catalytic efficiency: proximity, orientation, distortion and strain; catalytic mechanisms: acid-base, covalent, metal ion and electrostatic catalysis; active site mapping of enzymes; experimental approaches to the determination of enzyme mechanisms; mechanism of action of lysozyme**
Unit-4REGULATION OF ENZYME ACTIVITY AND IMMOBILIZED ENZYMES (12 hours) **Mechanisms to control the enzyme activity; product inhibition; allosteric enzymes and their kinetics; models of allosteric regulation; Reversible and irreversible covalent modification of enzymes,Feedback inhibition; Proteolytic activation. Concepts of Convergent and Divergent evolution of enzymes; enzyme immobilization: methods, applications**

Unit-:5 INDUSTRIAL USES OF ENZYMES (08 hours) **Industrial uses of enzymes - sources of industrial enzymes; thermophilic enzymes; Textile industry application and in Laundry detergents; cheesed production.**
Unit-6 Recent Advancement in enzymology (04 lectures) **Research article/ Review paper/ MOOC**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Advanced Biochemistry Lab – I**				
Course Code	**MSBC5005**				
Prerequisite	**Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.**				
Corequisite	**Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.**				
Antirequisite					
		L	**T**	**P**	**C**
		0	**0**	**4**	**2**

Course Objectives:

- Supporting or strengthening theoretical knowledge.
- Experiencing the pleasure of discovery and development of their psycho-motor skills.
- Teaching how scientific knowledge may be used in daily life.
- Increasing creative thinking skills.
- Gains in scientific working methods and higher order thinking skills.
- Developing manual dexterity by using tools and equipment and allowing students to apply skills instead of memorizing.

Course Outcomes

CO1	**Display the various GLP with basic concentration problems**
CO2	**Construct various buffer solutions.**
CO3	**Handle extraction of enzymes using different sources**
CO4	**Measures the various factors affecting enzyme activity.**
CO5	**Perform the analysis of carbohydrates, Lipids and protein**

Text Book (s)

- Myer's and Koshi's Manual of Diagnostic Procedures in Medical Microbiology and Immunology / Serology. Published by Department of Clinical Microbiology, CMC and Hospital, Vellore, Tamil Nadu. 2001.
- Kalaichelvan PT. Microbiology and Biotechnology – A Laboratory Manual 1st Edition, MJP Publishers, A Unit of Tamil Nadu Book House, Chennai. 2005.

Reference Book (s)

- Chellam Rajamanicam – Experiments Protocols in Basic Molecularbiology. Osho Scientific Publications, Madurai.

- Teresa Thiel, Shirley Bissen & Eilence M Lyons. Biotechnology – DNA & Protein – A laboratory project in Molecularbiology. International edition, published by Tata Mc. Graw – Hill publishing company, 2002.

S.N.	Name of Practicals
1.	Introduction to Biological science Laboratory
2.	Brief review of analytical chemistry
3.	Hydrogen ion concentration and preparation of Buffer
4.	Diffusion and Osmosis
5.	General Tests for Carbohydrates
6.	General Tests for Lipids
7.	General Tests for Proteins
8.	Salivary amylase activity
9.	Isolation of enzyme
10.	Effect of pH on enzyme activity
11.	Effect of temperature on enzyme activity

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
50	0	50	100

Semester-II

Name of The Course	Immunology				
Course Code	MSDB5006				
Prerequisite	Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.				
Corequisite	Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.				
Antirequisite					
		L	T	P	C
		4	0	0	4

Course Objectives:

- The students will be able to identify the cellular and molecular basis of immune responsiveness.
- The students will be able to describe the roles of the immune system in both maintaining health and contributing to disease.
- The students will be able to describe immunological response and how it is triggered and regulated.

Course Outcomes

CO1	Explain the basic concepts of Immunology.
CO2	Describe the working of adaptive immune response.
CO3	Demonstrate the types of vaccines and different immunological techniques.
CO4	Illustrate the genetic basis of immunology, transplant and tumor immunology.
CO5	Discuss the various types of immune system disorder
CO6	Analyze the recent advancement in Immunology

Text Book (s)

- Immunology, 6th edition, (2006), J. Kuby et al, W.H. Freeman and Company, New York. ISBN-13: 978-1429202114.
- Roitt"s Essential Immunology, 12th edition, (2011), Wiley-Blackwell Science. ISBN-13: 978-1405196833.
- Cellular and Molecular Immunology, 7th edition, (2011). Abul K. Abbas, Andrew H. Lichtman, Shiv Pillai. Saunders. ISBN-13: 978-1437715286.

Reference Book (s)

- Immunology, 6th edition, (2006), J. Kuby et al, W.H. Freeman and Company, New York. ISBN-13: 978-1429202114.
- Cellular and Molecular Immunology, 7th edition, (2011). Abul K. Abbas, Andrew H. Lichtman, Shiv Pillai. Saunders. ISBN-13: 978-1437715286.

Unit-1 Basic concepts of immunology (08 lectures) **Types of immunity; organs and cells involved in immune system; Antigen, haptens, adjuvants, antigenicity, antigenic determinants and epitopes;Antibodystructure and functions; Theories of antibody formation; Antibody diversity.**
Unit-2 Complement system and adaptive immune response (10 lectures) **Complement system - components, nomenclature, activation of complement, complement receptors and alternate pathway; Antigen recognition - T cell and B cell receptor complexes, antigen processing and presentation; Interaction of T and B cells; Cytokines; Immunological memory; Cytotoxicity - immunotolerance, immunosuppression; Basic concepts of abzymes, immunotoxin, chimera, hybrid antibodies, antigen-antibody interactions**
Unit-3 Vaccines and immunological techniques (10 lectures) **Vaccines - Types and their characteristics; Immunization practices-immunoprophylaxis and immunotherapy. Immunological techniques - Affinity and avidity, cross reactivity, precipitation, agglutination, immunodiffusion, immunoelectrophoresis, ELISA (indirect, sandwich, competitive, chemiluminescence, and ELISPOT assay), immunofluorescence, flow cytometry and fluorescence, and immunoelectron microscopy.**
Unit-4 Genetic basis of immunology, transplantation and tumor immunology **(10 lectures)** **Major Histocompatibility Complex - Organization of MHC and inheritance in humans, concepts of polygeny and polymorphism with respect to MHC; Histocompatibility testing; Transplantation - types, genetics of transplantation, graft versus host reactions; Tissue matching and immuno suppressive agents; Tumor immunology - immune surveillance, tumor antigens, immune response to tumors, immunotherapy of tumors.**
Unit-5 Dysfunctions of the immune system (10 lectures) **Hypersensitivity - definition and classification, mechanism involved, diagnosis and treatment; Autoimmunity and autoimmune diseases - mechanism of development, diagnosis and treatment; Immunodeficiency disorders-B cell deficiencies, T cell deficiencies, secondary immunodeficiency diseases-pathogenesis, diagnosis and treatment of AIDS.**
Unit-6 Recent Advancement in Immunology (04 lectures) **Research article/ Review paper/ MOOC**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Bioanalytical and Microbial Techniques**				
Course Code	**MSDB 5007**				
Prerequisite	**Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.**				
Corequisite	**Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.**				
Antirequisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives:

- To provide the knowledge of the scientific instruments in life sciences and biotechnology along with the applications.
- This will enable the students to understand all the subjects of biological sciences as these tools and techniques will be used therein.
- Also acquire the basic knowledge of the microbiological techniques to be applied in the laboratory.
- To know the general microbiological techniques for isolation of pure cultures of microorganisms.

Course Outcomes

CO1	**Demonstrate the basic principles, working and applications of different microscopic techniques.**
CO2	**Demonstrate the principle and applications of centrifugation technique.**
CO3	**Illustrate the principle and functioning of electrophoresis and chromatography.**
CO4	**Evaluate the different types of spectroscopic techniques**
CO5	**Deduce fundamental concept of radioactivity and radioisotopic techniques**
CO6	**Analyze the recent advancement in Biochemical Technique.**

Text Book (s)

- Physical Biochemistry: Principles and Applications (2010) 2nd ed., Sheehan, D., Wiley Blackwell (West Sussex), ISBN:978-0-470-85602-4 / ISBN:978-0-470-85603-1.
- Physical Biochemistry: Applications to Biochemistry and Molecular Biology (1982) 2nd ed., Freifelder, D., W.H. Freeman and Company (New York), ISBN:0-7167-1315-2 / ISBN:0-7167-1444-2.
- An Introduction to Practical Biochemistry (1998) 3rd ed., Plummer D. T., Tata McGraw Hill Education Pvt. Ltd. (New Delhi), ISBN:13: 978-0-07-099487-4 / ISBN:10: 0-07-099487-0.

Reference Book (s)

- Principles and techniques of biochemistry and molecular biology. 6th ed. Wilson, Keith, Walker, John M Cambridge; New York : Cambridge. ISBN-10: 9780521178747.
- An Introduction to Practical Biochemistry (1998) 3rd ed., Plummer D. T., Tata McGraw Hill Education Pvt. Ltd. (New Delhi), ISBN:13: 978-0-07-099487-4 / ISBN:10: 0-07-099487-0

Unit-1 Microscopy	**(08 lectures)**

Light, electron (scanning and transmission), phase contrast, fluorescence microscopy, freeze-fracture technique, specific staining of organelles or marker enzymes.
Unit-2 Viscosity and centrifugation (10 lectures) **Viscosity – Viscosity of macromolecules, relationship with conformational changes; Centrifugation – Principles of centrifugation, concepts of RCF, different types of instruments and rotors, preparative, differential and density gradient centrifugation, analytical ultra-centrifugation, determination of molecular weights and other applications, subcellular fractionation.**
Unit-3 : Electrophoresis and chromatography (08 lectures) **Electrophoresis - Moving boundary and zonal electrophoresis, paper and gel electrophoresis, isoelectric focusing; Chromatography -Principles of partition chromatography, paper, thin layer, ion exchange and affinity chromatography, gel permeation chromatography, HPLC and FPLC.**
Unit-4 Spectroscopy (08 lectures) **Spectroscopy - Concepts of spectroscopy, Visible and UV spectroscopy, Laws of photometry. Beer-Lambert's law, Principles and applications of colorimetry; Basic concepts and applications of MS, ORD, CD, X-ray diffraction, X-ray absorption, NMR.**
Unit-5 Radioisotopic techniques (08 lectures) **Nature of radioactivity, properties of α-, β-, and γ-rays; measurement of radioactivity, use of radioisotopes in research. In vivo and in vitro labeling techniques, double labeling, quenching, internal standard, channel ratio, external standard ratio, emulsion counting, radioactive decay, autoradiography.**
Unit-6 Recent Advancement in Biochemical Techniques (04 lectures) **Research article/ Review paper/ MOOC**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Biotechnology and Genetic Engineering**				
Course Code	**MSDB 5008**				
Prerequisite	**Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.**				
Corequisite	**Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.**				
Antirequisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives:

The objective of the course is to familiarize the students with the basic concepts in genetic engineering; to acquaint the students to versatile tools and techniques employed in genetic engineering and recombinant DNA technology; and to appraise them about applications genetic engineering.

Course Outcomes

CO1	**Interpret the basic concept of animal and plant biotechnology using animal and of plant cell culture.**
CO2	**Demonstrate the isolation, purification of nucleic acid Construction DNA library and DNA sequencing.**
CO3	**Illustrate the various Gene transfer techniques.**
CO4	**Evaluate the concept of plant genetic Engineering, PCR and application of transgenic science in plant and animal improvement.**
CO5	**Analysis of gene therapy and stem cell therapy.**
CO6	**Analyze the recent advancement in Biotechnology and Genetic Engineering**

Text Book (s)

- Principles of Gene Manipulations 1994 by Old and Primrose Blackwell Scientific Publications.
- DNA Cloning: A Practical Approach by D.M. Glower and B.D. Hames, IRL Press, Oxford. 1995.
- Molecular Biotechnology 2nd Edition by S.B. Primrose. Blackwell Scientific Publishers, Oxford. 1994.
- Genetic Engineering and Introduction to Gene Analysis and Exploitation in Eukaryotes by S.M. Kingsman and A.J. Kingsman, Blackwell Scientific Publications, Oxford 1998.

Reference Book (s)

- PCR Technology - Principles and Applications for DNA Amplification by Henry A. Erlich (Ed.) Stockton Press. 1989.
- Biotechnology: A Guide to Genetic Engineering by Peters.
- Genetic Engineering – 2000 by Nicholl.
- Recombinant DNA and Biotechnology: Guide for Teachers. 2nd Edition by Helen Kreuz. 2001. ASM Publications.
- Molecular Biotechnology: Principles and Applications of Recombinant DNA. 2 nd Edition. 1998 by Bernard R. Glick and Jack J. Pastemak, ASM Publications.
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Unit-1 Introduction to animal and plant biotechnology (08 lectures) **Basic introduction to animal and plant biotechnology; types of plant tissue culture, germplasm conservation, Animal Biotechnology - organ culture; cell culture and initiation of cell culture; evolution of continuous cell lines.**
Unit-2 Construction of DNA libraries (08 lectures) **Isolation and purification of nucleic acid (genomic/plasmid DNA and RNA), Quantification and storage of nucleic acids, Construction ofcDNA library, Construction of Genomic library, Screening and preservation of DNA libraries, DNA Sequencing and cloning strategies.**
Unit-3 Gene transfer techniques (06 lectures) **Gene transfer techniques: biological methods; chemical methods; physical or mechanical methods.**
Unit-4 Transgenics (10 lectures)

Plant Genetic Engineering: Restriction enzymes; Transformation of plant cells; different type of vectors including viral vectors and their benefits; Screening and selection of transformants, PCR and hybridization methods; Transgene selection and silencing; Generation and maintenance of transgenic plants, Bt cotton, golden rice and some others as examples; Application of transgenic science in plant and animal improvement.
Unit-5 Gene therapy and stem cell (08 lectures) **Gene therapy: Introduction and Methods, Gene targeting and silencing, Gene therapy in the treatment of diseases, Challenges, future and ethical considerations in human gene therapy. Stem cells: Culture, identification, maintenance, characterization and proliferation heterogeneity.**
Unit-6 Recent Advancement in Biotechnology and Genetic Engineering (04 lectures) **Research article/ Review paper/ MOOC**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Microbiology**				
Course Code	**MSDB5010**				
Prerequisite	**Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.**				
Corequisite	**Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.**				
Antirequisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives:

- Knowledge on Landmark discoveries in Microbiology and different domains classification of living organisms.
- Familiarity with general characters of prokaryotic and Eukaryotic microorganisms for conventional and molecular characterization using modern methods.
- Knowledge of cellular organization, life cycle and economic importance of prokaryotic (Eubacteria, Archaea, Cyanobacteria) and Eukaryotic (Algae, Fungi and protozoans).

Course Outcomes

CO1	**Discuss about history, diversity and scope of microbiology.**
CO2	**Explain microbial nutrition, growth and control of microorganism.**
CO3	**Describe microbial molecular biology and genetics.**
CO4	**Demonstrate viruses and microbial pathogenicity.**
CO5	**Interpret various applications of food and industrial microbiology.**
CO6	**Analyze the recent advancement of microbiology.**

Text Book (s)

- Prescott & Dunn's Industrial Microbiology. Ed. E.G. Reed (1987). CBS Publishers, New Delhi.
- Biotechnology: A Text book of Induxctrial Microbiology 2nd Edition. Crueger, W. and Cruger, A. (2000) Panima Publishing Corporation, New Delhi.
- Manual of Industrial Microbiology and Biotechnology 2nd Edition. Ed. Arnold L. Demain and Julian E. Davies (1999) ASM Press Washington D.C.
- Microbiology, Pelczar Jr. M.J.: Chan E.C.S. and Krieg, N. R. (1993) Tata Mc. Graw Hill, New Delhi.

Reference Book (s)

- Prescott & Dunn's Industrial Microbiology. Ed. E.G. Reed (1987). CBS Publishers, New Delhi.
- Biotechnology: A Text book of Induxctrial Microbiology 2nd Edition. Crueger, W. and Cruger, A. (2000) Panima Publishing Corporation, New Delhi.

Unit-1 History, diversity and scope of microbiology (10 lectures) **Discovery of microorganisms, spontaneous generation, germ theory of disease, members of the microbial world, scope and relevance of microbiology, Microbial taxonomy and phylogeny, Archaea, Bacteria, fungi, slime molds, water molds, algae, protozoa, helminths, the future of microbiology.**
Unit-2 : Microbial nutrition, growth and control (12 lectures) **Microbial nutrition; culture media; isolation and cultivation of pure cultures, bacterial growth curve and measurement of growth; staining techniques, differences between Gram-positive and Gram-negative bacteria, Control of microorganism by physical and chemical agents. antimicrobial agents: structure and mechanisms.**
Unit-3 Microbial molecular biology and genetics (12 lectures) **Structure and function of the genetic material, identification and isolation of bacterial mutants; bacterial and phage genetics; DNA repair, microbial recombination and bacterial plasmids, transposable elements, gene transfer in bacteria: conjugation, transformation and transduction.**
Unit-4 Viruses and microbial pathogenicity (08 lectures) **The Viruses: Introduction and general characteristics, the bacteriophages, viruses of eukaryotes. Pathogenicity of microorganisms, diseases caused by viruses, bacteria, fungi and protozoa.**
Unit-5 Food and industrial microbiology (08 lectures) **Microbiology of food, food processing and preservation, probiotic and prebiotic, applied and industrial microbiology: major products of industrial microbiology.**
Unit-6 Recent Advancement in Microbiology (04 lectures) **Research article/ Review paper/ MOOC**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Bioenergetics and Intermediary Metabolism**				
Course Code	**MSBC5014**				
Prerequisite	**Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.**				
Corequisite	**Students should have understanding of general biology, including a basic knowledge of the biological molecules.**				
Antirequisite					
		L	**T**	**P**	**C**
		3	**1**	**0**	**3**

Course Objectives:

- The major aims of this course are to provide students with a basic understanding of the fundamental processes and mechanisms that serve and control the various metabolic pathways.

Course Outcomes

CO1	**Analyze the concept of energy production in the living cell.**
CO2	**Interpret the fundamentals of intermediary metabolism and their significance.**
CO3	**Illustrate the sequential process of oxidative phosphorylation electron transport in the living cell.**
CO4	**Demonstrate the process of photosynthesis.**
CO5	**Explain the fundamentals of carbohydrate metabolism.**

Text Book (s)

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13: 978-1-4641-0962-1 / ISBN:10:1-4292-3414- 8.

Reference Book (s)

1. Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New York), ISBN:978-0-470-28173-4

Unit-1 : BIOENERGETICS (08 hours) **Laws of thermodynamics, free energy, exergonic and endergonic reactions, coupled reactions. High energy compounds - ATP, synthesis of ATP, ATP-ADP cycle, storage of high energy phosphates. Chemical basis of high standard energy of hydrolysis of ATP, PEP, 1,3-BPG and thioesters. Redox reactions, standard redox potentials and Nernst equation.**
Unit- 2 INTERMEDIARY METABOLISM (10 hours) **Formation and fate of Acetyl CoA; Citric acid cycle - reactions, Significance of TCA cycle, Amphibolic role, Regulation, Glyoxalte pathway, Integration of metabolism.Mitochondrial shuttles – ATP-ADP transporter; Glycerol-phosphate shuttle, malate-aspartate shuttle, creatine phosphate shuttle**
Unit-3 ELECTRON TRANSPORT CHAIN AND OXIDATIVE PHOSPHORYLATION (10 hours) **Electron transport chain - Components, organization and inhibitors of electron transport chain; Oxidative phosphorylation – mechanism, Chemi-osmotic theory, ATP synthase, Inhibitors of oxidative phosphorylation.**
Unit- 4 PHOTOSYNTHESIS (12 hours)

Pigments of photosynthesis; Role of carotenoids; Photosystems I and II; Hill reaction; Photosynthetic electron transport and generation of NADPH & ATP; Cyclic and non-cyclic photophosphorylations; Complexes associated with thylakoid membranes; Light harvesting complexes; Path of carbon in photosynthesis – C3 and C4 pathway of carbon reduction and its regulation; Photorespiration.
Unit-5 CARBOHYDRATES METABOLISM (10 hours) **Major pathways of carbohydrate metabolism – Glycolysis, Gluconeogenesis, Pentose phosphate pathway, Glycogen metabolism; Minor pathways of carbohydrate metabolism – uronic acid pathway, metabolism of fructose and galactose, polyol pathway**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Research Methodology**				
Course Code	**MBS28T2111**				
Prerequisite					
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		2			**2**

Course Objectives:

Course Outcomes

CO1	1. Understand the Principles of Scientific Research and different steps involved in doing research.
CO2	2. Know how to design research and frame up different steps in design.
CO3	3. Appraise the application of sampling through statistics.
CO4	4. Build up the method for data collection and analyse the data.
CO5	5. Develop the Concept of hypothesis preparation.
CO6	6. Developthe statistical analysis indulges in modern research for drug designing.

Text Books:

9. **K. Ramakant; Elementary Statistics in a world of applications, Goodyear California Pub. Co.,1979.**
10. **K. D. Broota, Experimental designs in psychological research, Wiley eastern, New York, 1992.**
11. **Guilford, Statistics in Psychology and Education, McGraw hill, New York, 1986.**
12. **Katz and Kahn, Research in Behavioural Sciences, Methuen, USA, 1979.**

Reference Books:

5. **Kerlinger, F., Foundations of Behavioural Research, Surjeet Publications, Delhi, 1983.**
6. **Rajamanickam, M., Statistical Methods in Psychological and Educational Research, Concept Publishing Co. New Delhi, India, 1983.**

7. Smith, Jonathan, A. (Ed.), Qualitative Psychology: A Practical Guide to Research Methods, Sage Publications, 2003.
8. Woodworth and Schlosberg, Experimental Psychology, Methuen and co. ltd, London, 1971.

5.Chanin Nantasenamat, Chartchalerm Isarankura-Na-Ayudhya, Thanakorn Naenna, Virapong Prachayasittikul, A Practical Overview of Quantitative Structure- Activity Relationship.EXCLI Journal 2009;8:74-88.

9. Wiktor Pronobis,Alexandre Tkatchenko,and Klaus-Robert Muller, J. Chem. Theory Comput. 2018, 14, 2991−3003
10. Leo, A., & Hoekman, D. H. (1995). *Exploring QSAR*. American Chemical Society.

Unit – 1: Principles of Scientific Research 6 Lectures

Research and research methodology, Procedures in research, Identification of the problem - Literature survey - Reference collection - Familiarity with ideas and concept of investigation - Qualitative and Quantitative analysis - Results - Synopsis writing - Art of writing a Research paper and Thesis.

Unit – 2: Research Design, Sampling & Probability 5-Lectures

Research Design: Features of a Good Design, Different Research Designs, Sampling: Principles, methods, types of sampling, rationale for using a particular sampling procedure, Probability: Classical definition of Probability.

Unit – 3: Data collection & analysis 6- Lectures

Types of Data, Collection of Data, double blind procedures, incidence and prevalence studies, Data Analysis: Measures of Central Tendency, Measures of Dispersion, Measures of Asymmetry,

Unit-4: Correlation and Regression 5-Lectures

Methods of correlation, Types of correlation (Pearson r& Rho); Regression analysis, linear regression, Non-linear regression.

Unit – 5: Hypothesis and Statistics 5-Lectures

Hypothesis Testing: Problems and hypothesis, variables and type of variables, Parametric and nonparametric statistics; level of significance, the various nonparametric tests with sample.

Module 6: Recent research advances

Descriptors, Quantitative structure-activity relationship (QSAR), Quantitative structure-property relationship(QSPR), Drug designing.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Advanced Biochemistry Lab – II
Course Code	MSBC5012
Prerequisite	Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.
Corequisite	Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics,

	regulation, structure/function, interaction with the environment, and evolution.				
Antirequisite					
		L	**T**	**P**	**C**
		0	**0**	**4**	**2**

Course Objectives:

- This will enable the students to understand all the subjects of biological sciences as these tools and techniques will be used therein.
- Also acquire the basic knowledge of the microbiological techniques to be applied in the laboratory.
- To know the general microbiological techniques for isolation of pure cultures of microorganisms.

Course Outcomes

CO1	**Display the various methods of sterilization.**
CO2	**Construct various culture media.**
CO3	**Handle pure culture techniques.**
CO4	**Perform the isolation and estimation of DNA, RNA.**
CO5	**Perform the blood grouping, agglutination inhibition Assay.**
CO6	**Demonstrate the knowledge of laboratory practices in molecular biology,immunology and microbiology.**

Text Book (s)

- Aneja KR. Experiments in Microbiology, Plant pathology and Biotechnology. 4th Edition, New Age International Publishers, Chennai. 2005.
- Horold J Benson. Microbiological Applications. Laboratory Manual in General Microbiology. 7th International Edition, WCB McGraw – Hill, Boston. 1998 .
- James G Cappuccino& Natalie Sherman Microbiology: A Laboratory manual. 6th Edition, Published by Pearson Education. 2004 .
- Dubey RC and Maheswari DK. Practical Microbiology 1st Edition, S. Chand & Company Ltd., New Delhi. 2004

Reference Book (s)

- James G Cappuccino & Natalie Sherman Microbiology: A Laboratory manual. 6th Edition, Published by Pearson Education. 2004 .
- Dubey RC and Maheswari DK. Practical Microbiology 1st Edition, S. Chand & Company Ltd., New Delhi. 2004

S.N.	**Name of Practicals**
1.	**To study different methods of sterilization.**
2.	**To preparation different types of culture media liquid, solid, slant and plate.**
3.	**Bacterial culture: establishing a pure culture; Spread plate, streak plate; Pour Plate.**
4.	**To perform Gram staining for identification of bacteria.**
5.	**To estimate the concentration of protein in given sample.**
6.	**To perform immuno-diffusion by Ouchterlony/ Mancini method.**
7.	**To perform ELISA experiment for elucidating antigen-antibody interaction.**
8.	**To determine the effect of exercise on heart rate in human.**

9.	**To determine the effect of physical exercise on the circulation**
10.	**To study the effect of cold (vasoconstriction) on blood pressure.**
11.	**To demonstrate knee-jerk reflex.**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
50	00	50	100

SEMESTER-III

Name of The Course	**Genetics**				
Course Code	**MSDB6001**				
Prerequisite	**Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.**				
Corequisite	**Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.**				
Antirequisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives:

The objective of the course is to familiarize the students with the basic concepts in genetic engineering; to acquaint the students to versatile tools and techniques employed in genetic engineering and recombinant DNA technology; and to appraise them about applications genetic engineering.

Course Outcomes

CO1	**Describe the basic concept of "Mendelian Genetics"**
CO2	**Evaluate the mechanism of co-dominance, epistasis**
CO3	**Illustrate the process of Linkage and crossing over.**
CO4	**Explain different types of genetic disorders**
CO5	**Analyse the effect of natural selection on population genetics.**
CO6	**Analyze the recent advancement in genetics.**

Text Book (s)

- Benjamin A. Pierce. 2003. Genetics: A Conceptual Approach. W.H, Freeman and Company, New York.
- NY. Gardner E.J., Simmons, M.J., and Snustad, D.P. 1991. Principles of Genetics, (8th edition) John Wiley & Sons Inc., New York.
- Griffith A.F. J., Miller, J.H, Suzuki, D.T., Lewontin, R.C., Geibart. W.M, 1993. An Introduction to Genetic analysis (7th edition). W.H Freeman & Company, New York.

Reference Book (s)

- 1. NY. Gardner E.J., Simmons, M.J., and Snustad, D.P. 1991. Principles of Genetics, (8th edition) John Wiley & Sons Inc., New York.
- Griffith A.F. J., Miller, J.H, Suzuki, D.T., Lewontin, R.C., Geibart. W.M, 1993. An Introduction to Genetic analysis (7th edition). W.H Freeman & Company, New York.

Unit-1 1 Introduction to Mendelian Genetics (08 lectures) **Genetic terminology: Definition of genetics, Gene, Alleles, Homozygous and Heterozygous, Genotype and Phenotype, Dominant and recessive, Mendelian Laws of inheritance: Law of Dominance, Law of segregation, Law of independent Assortment. Results of Genetic crosses by various methods including Test cross and Back cross, Difference between complementary gene and duplicate gene.**	
Unit-2 Deviations from Mendelian Genetics (12 lectures) **Codominance, incomplete dominance, gene interactions: Epistasis, Dominant epistasis and recessive Epistasis or supplementary gene, Multiple alleles, Lethal alleles, Cytoplasmic inheritance, Genomic imprinting in mice, human disorders related to imprinting, Prader Willi and Angelmen syndrome, Molecular basis of Epigenetic regulation in H19 and Igf2 region, histone modification marks, Position effect variegation., penetrance and expressivity, probability.**	
Unit-3 Linkage and crossing over (10 lectures) **Genetic linkage and gene mapping, Linkage group, Recombination, Crossing over, Determination of frequency of crossing over, calculation of Map distance, Chromosomal basis of Sex determination, Genetic balance theory of Sex determination, sex linked inheritance, Sex Influenced inheritance, Sex limited inheritance, Pleiotropy, Phylogentic tree**	
Unit-4 Chromosomal Aberration (10 lectures) **Chromosomal anomalies including autosomal and sex chromosomal, genetic disorders; Albinism, phenylketonuria, alkaptonuria, Types of mutations i.e. point mutations, deletions, rearrangements, insertions, dynamic mutations (repeat expansions) with appropriate examples.**	
Unit-5 Population Genetics (10 lectures) **Definition, aim and scope of population genetics, population structure, factors maintaining population boundaries, effective breeding size, gene pool, Hardy-Weinberg equilibrium, Deviation of the Hardy-Weinberg Law, Human polymorphism (transient and balanced), relationship between sickle cell polymorphism and malaria, other ploymorphisms that may be an adaptation to malaria eg: G6PD deficiency. Duffy blood groups, thalassemia and haptoglobins. X linked polymorphism (G6PD and colour blindness).**	
Unit-6 Recent Advancement in Genetics (04 lectures) **Research article/ Review paper/ MOOC**	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Summer Training**
Course Code	**MSBC6003**
Prerequisite	**Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.**

Corequisite	**Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.**				
Antirequisite					
		L	**T**	**P**	**C**
		0	**0**	**0**	**2**

Course Objectives:

- By taking summer internships students will be able to:
- Get hands-on experience about real world problems in a field relevant to their major of studies.
- Acquire confidence for employment after graduation.
- Acquire skills important for time management, discipline, self-learning, effective communication and so on.
- Learn practically about team-work, collaboration, and leadership.

Course Outcomes

CO1	**Demonstrate the use ofknowledge of basic and applied sciences in project based learning.**
CO2	**Organizes experiments and researches, perform analysis and interpret data for the designed project.**
CO3	**Cooperateeffectively as an individual and as a member in the research team.**
CO4	**Systematize the articulated ideas, comprehend and write effective reports, documentation and to communicate effectively.**
CO5	**Demonstrate knowledge and understanding of research problems and related principles to manage projects in multidisciplinary research areas.**

COURSE CONTENTS:

Summer Training is considered as a special course involving application of knowledge in solving / analysing /exploring a real life situation / difficult problem. Summer training work may be given in lieu of a discipline specific elective paper/Biochemistry.This should be done in consultation with the faculty supervisor and agency supervisor under whom he / she is getting trained. The project report should be around 40 pages and chaptered as follows:

Chapter I: Introduction
Chapter II: Review of Literature
Chapter III: Methodology
Chapter IV: Results
Chapter V: Discussion
Chapter VI: Summary and Conclusion

The following weightage is assigned at each stage of Student Project evaluation.

Activity	**Remarks**
Zeroth Review	**Project scopes and Proposal**
1st Review	**Methods of project Implementation**
2nd Review	**Technical Achievement**
3rd Review (Final)	**Innovation and contribution**
Submission of Project Report to the Department	**Two weeks before the viva-voce exam**

Continuous Assessment Pattern

Internal Assessment (IA)	**Mid Term Test (MTE)**	**End Term Test (ETE)**	**Total Marks**

50		50	100

Name of The Course	**Protein, Lipid and Nucleotide Metabolism**				
Course Code	**MSBC6004**				
Prerequisite	**Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.**				
Corequisite	**Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment,**				
Antirequisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives:

It will enhance the knowledge of Biochemistry within the living organisms. The course will emphasize brief description about hormones biology and on the metabolism of carbohydrates, lipids, proteins and nucleotides.

Course Outcomes

CO1	**Illustrate the basic concepts of hormones and their mechanism of action.**
CO2	**Explain the process of synthesis and degradation of lipids.**
CO3	**Discuss about the metabolism of essential and non-essential aminoacids.**
CO4	**Explain the metabolism of nucleotides.**
CO5	**Describe the synthesis of heme and its degradation.**
CO6	**Analyze the recent advancement in basic metabolic pathways.**

Text Book (s)

- Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN: 13: 978-1-4641-0962-1 / ISBN:10:1-4292-3414- 8.
- Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New York), ISBN:978-0-470-28173-4.
- 2. Biochemistry (2011) 4th ed., Donald, V. and Judith G.V., John Wiley & Sons Asia Pvt. Ltd. (New Jersey), ISBN:978-1180-25024.

Reference Book (s)

- Berg, J. M., Tymoczko, J. L. and Stryer, L. Biochemistry. Freeman, 7th edition, 2011.
- Mathews, C. K. & Van Holde, K. E. & Ahern, K. G. Biochemistry. Addison Wesley, 4th edition, 2012.
- Wilson, K. & Walker, J. Principles and Techniques of Biochemistry and Molecular Biology. CUP, 7th edition.

Unit-1 Hormones (08 hours) **Chemistry, functions and abnormalities of hypothalamus, pituitary, steroid and thyroidhormones; Mechanism of action of hormones - G proteins, Cyclic AMP, Protein kinases, Phosphatidyl inositol biphosphate, Inositol triphosphate, Diacyl glycerol, Cyclic GMP, Steroid receptors.**
Unit-2Lipid Metabolism (10 hours) **Synthesis and degradation of triacylglycerols, phospholipids, glycolipids, eicosanoids; Biosynthesis of fatty acids; Oxidation of fatty acids; Ketone bodies; Metabolism of cholesterol - biosynthesis, catabolism and regulation; general metabolism of lipoproteins.**
Unit-3: Amino Acid Metabolism (12 hours)

Biosynthesis and regulation of essential and non-essential aminoacids; Catabolism of individual aminoacids; Conversion of aminoacids to specialized products. Formation and detoxification of ammonia; Urea cycle– steps, regulation and disorders; Biosynthesis of polyamines– putrescine, spermidine and spermine.
Unit-4Nucleotide Metabolism (10 hours) **Purine metabolism – biosynthesis (de novo and salvage pathways), degradation, regulation and disorders of purine metabolism; Pyrimidine metabolism - biosynthesis (de novo and salvage pathways), degradation, regulation and disorders of pyrimidine metabolism.**
Unit-5Heme Synthesis and Degradation (08 hours) **Porphyrins – structure and functions; Biosynthesis of heme – steps and regulation; Porphyrias – hepatic and erythropoieticporphyrias; degradation of heme – bilirubin metabolism and its disorders.**
Unit-6 Recent Advancement in basic metabolism pathways (04 lectures) **Research article/ Review paper/ MOOC**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Clinical and Nutritional Biochemistry**				
Course Code	**MSBC6005**				
Prerequisite	**Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.**				
Corequisite	**Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment,**				
Antirequisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives:

- The course is an introduction to clinical and nutritional biochemistry.
- The students will learn how basic biochemistry and analytical chemistry can be applied to medical diagnosis, treatmentand management. It will use examples within human system to demonstrate clinical disorders,the biochemical consequences of particular disease process and the response to therapy.
- The students will also learn how nutrients effect biochemical processes and signal transduction pathways, and how this can lead to development of nutritionally related diseases.

Course Outcomes:

CO1	**Illustrate the various clinical laboratory practices**
CO2	**Interpret the disorders of biomolecules metabolism.**
CO3	**Discuss the structure and functions of vitamins and minerals.**
CO4	**Evaluate the energy metabolism and malnutrition.**

CO5	**Analysis the food-drug interactions and nutraceuticals**
CO6	**Analyze the recent Advancement in Clinical and Nutritional Biochemistry**

Text Book (s)

1. Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New York), ISBN:978-0-470-28173-4.
2. Textbook of Biochemistry for Medical Students. D.M. Vasudevan, Sreekumari. S, Kannan Vaidyanathan. JPB.
3. Textbook of Medical Biochemistry. M.N. Chatterjea, Rana Shinde. JPB.

Reference Book (s)

1. Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New York), ISBN:978-0-470-28173-4.

2. Harper's Illustrated Biochemistry, 31e, Victor W. Rodwell, David A. Bender, Kathleen M. Botham, Peter J. Kennelly, P. Anthony Weil. **ISBN-**10: 1259837939

Unit -1: Clinical Laboratory Principles (08 hours) **Introduction to laboratory principles and instrumentation in Clinical Biochemistry;Role of diet and nutrition in prevention and treatment of diseases; Biochemical tests in clinical medicine – uses, criteria for selecting a method for biochemical analysis; Quality Assurance.**
Unit -2: Disorders Of Metabolism (12 hours) **Disorders of Carbohydrate Metabolism; Lipids, Lipoproteins and Apolipoproteins; Inborn Errors of Metabolism; Disorders of Electrolytes, Blood Gases and Acid Base Balance; Disorders of Mineral Metabolism; Hormonal Disorders - Adrenocortical steroids, Reproductive endocrinology, Thyroid function; Biochemical Aspects of Hematology - Disorders of erythrocyte metabolism, hemoglobinopathies, thalassemias, and anaemias.**
Unit -3: Vitamins and Minerals (12 hours) **Classification and nutritional aspects of the vitamins and minerals, dietary standards: EAR, RDA, ADI, DRV, DRI, TUL; Anti-nutrients: Naturally occurring food-borne toxicants: Protease inhibitors, Hemagglutinins, Hepatotoxins, Allergens, Oxalates, Toxins from mushrooms, animal food stuffs and sea food.**
Unit -4: Nutrition and Energy Metabolism (10 hours) **Calorific value and respiratory quotient; Basal metabolic rate; Specific dynamic action; Nutritional importance of carbohydrates, lipids and proteins; Nitrogen balance; Protein energy malnutrition; Obesity; Glycemic index.**
Unit -5: Food and Drug Interactions and Nutriceuticals (08 hours) **Nutrient interactions affecting ADME of drugs, Alcohol and nutrient deficiency, Antidepressants, psychoactive drugs and nutrient interactions, Appetite changes with drug intakes and malnutrition. Food as medicine.**
Unit-6 Recent Advancement in Clinical and Nutritional Biochemistry (04 lectures) **Research article/ Review paper/ MOOC**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Advanced Biochemistry**				
Course Code	**MSBC6006**				
Prerequisite	**Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.**				
Corequisite	**Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function.**				
Antirequisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives:

- To introduce key features of xenobiotic metabolism and understand the molecular basis of cellular regulations mechanisms,
- To understand the fundamentals of genomics and proteomics, cancer biochemistry and molecular diagnostics.

Course Outcomes

CO1	**Illustrate the metabolism of Xenobiotic.**
CO2	**Demonstrate the molecular mechanism of signal transduction.**
CO3	**Interpret the fundamentals of genomics and proteomics**
CO4	**Evaluate of the biochemistry of cancer**
CO5	**Analysis the various molecular diagnostic techniques**

Text Book (s)

1. Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New York), ISBN:978-0-470-28173-4.
2. Textbook of Biochemistry for Medical Students. D.M. Vasudevan, Sreekumari. S, KannanVaidyanathan. JPB.
3. Harpers Illustrated Biochemistry 29th Edition. Robert K. Murray, Daryl K. Granner, Peter A. Mayes, Victor W. Rodwell. McGraw Hill Education.

Reference Book (s)

1. Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New York), ISBN:978-0-470-28173-4.

2. Harper's Illustrated Biochemistry, 31e, Victor W. Rodwell, David A. Bender, Kathleen M. Botham, Peter J. Kennelly, P. Anthony Weil. **ISBN-**10: 1259837939

Unit-1 Metabolism of Xenobiotics (08hours) **Metabolism of xenobiotics – Phase I (oxidation, reduction and hydrolysis) and II (conjugation, acetylation and methylation) reactions; Free radical and anti-oxidants – generation of free radicals, free radical scavenger system, lipid peroxidation, anti-oxidants.** **.**
Unit-2Molecular Mechanisms of Signal Transduction(08hours)

General features of signal transduction; G Protein-coupled receptors and second messengers; Receptors - tyrosine kinases, guanylylcyclases, cGMP and protein kinase G; Multivalent adaptor proteins and membrane rafts; gated-ion channels; integrins; regulation of transcription by steroid hormones.
Unit-3Genomics and Proteomics (12 hours) **Introduction to Genome Projects, organization and goals of human genome project ,Microarray ,DNA methylation, changes in histone, Riboswitches, Gene clusters, Diversity in size and organization of genes, Pseudogenes, Introduction to Proteomics,2D electrophoresis, Proteomics applications. Protein biomarker,surfaceplasmon resonance (SPR), protein microarraysdual polarisation interferometry, microscalethermophoresis**
Unit-4Biochemistry of Cancer (10hours) **Etiology - Chemical carcinogens, Oncogenic viruses;Molecular basis of cancer - Oncogenes, Antioncogenes, Oncosuppressor genes, Apoptosis, Growth factors;Tumour kinetics - Doubling time, Contact inhibition, Anchorage dependence;Oncofetal antigens; Tumor markers; Cancer therapy - Anticancer drugs, Drug resistance.**
Unit-5Molecular Diagnostics (12 hours) **Hybridization and blotting techniques; DNA finger printing; Restriction fragment length polymorphism (RFLP); Polymerase chain reaction (PCR);Hybridomatechnology;Transgenesis; DNA sequencing; Mutation detection techniques – single strand conformation polymorphism, heteroduplex analysis, conformation sensitive gel electrophoresis, protein truncation test, denaturation high performance liquid chromatography.**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Advanced Biochemistry Lab – III**				
Course Code	**MSBS6007**				
Prerequisite	**Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.**				
Corequisite	**Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.**				
Antirequisite					
		L	**T**	**P**	**C**
		0	**0**	**4**	**2**

- **Course Objectives:**This will enable the students to understand all the subjects of Biochemistry as these tools and techniques will be used therein.
- Acquire the basic knowledge of the techniques to be applied in the laboratory for studying cell physiology and food sample analysis
- To know the general molecular biology and protein analysis technique

Course Outcomes

CO1	**Display the normal and abnormal constituents of urine**
CO2	**Measure the markers for kidney function.**
CO3	**Perform Analysis of food adulteration**
CO4	**Perform Gel electrophoresis for separation of biomolecules**
CO5	**Identify and separate different types of aminoacids and carbohydrates**
CO6	**Determination of protein concentration by spectroscopy**

Text Book (s)

- Singh S.K. and Sahaney S K Introductory Practical Biochemsitry (Eds) Narosa Publisher
- An Introduction to practical biochemistry (2nd edition): By David T. Plummer. pp. 362 McGraw-Hill Book Company (U.K.) Ltd., London 1978

Reference Book (s)

- Singh S.K. and Sahaney S K Introductory Practical Biochemsitry (Eds) Narosa Publisher
- An Introduction to practical biochemistry (2nd edition): By David T. Plummer. pp. 362 McGraw-Hill Book Company (U.K.) Ltd., London 1978

S.N.	**Name of Practicals**
1.	**Detect the presence of albumin protein and bile salt in urine**
2.	**Detect the presence of creatinin in the given sample of blood**
3.	**Detect the presence of bile salt in urine**
4.	**Determination of cholesterol in urine**
5.	**Estimation of Sugar level in urine.**
6.	**Separation and identification of protein molecule by using SDS-PAGE**
7.	**Identification of different amino acid by paper chromatography.**
8.	**Identification of different carbohydrates by thin layer chromatography**
9.	**Demonstration of principle of PCR**
10.	**Separation of DNA molecule by using agarose gel electrophoresis.**
11.	**Determination of protein concentration by Beer Lambert's Law.**
12.	**Perform experiment to detect adulteration in food material**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
50	00	50	100

SEMESTER IV

Name of The Course	**Project Work / Dissertation**				
Course Code	**MSBC9997**				
Prerequisite	**Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.**				
Corequisite	**Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.**				
Antirequisite					
		L	**T**	**P**	**C**
		0	**0**	**0**	**12**

Course Objectives:

The aim is to develop an understanding of the processes and skills required to undertake a supervised research project at masters level of study. The objectives are

- **To develop research skills commensurate with the accomplishment of a masters degree.**
- **To develop skills in independent inquiry.**
- **To produce a coherent and logically argued piece of writing that demonstrates competence in research and the ability to operate independently.**
- **To address issues of research design, methodology, ethics and theoretical arguments, and apply these to your own research.**

Course Outcomes

CO1	**Demonstrate the use of knowledge of basic and applied sciences in project based learning.**
CO2	**Organizes experiments and researches, perform analysis and interpret data for the designed project.**
CO3	**Cooperate effectively as an individual and as a member in the research team.**
CO4	**Systematize the articulated ideas, comprehend and write effective reports, documentation and to communicate effectively.**
CO5	**Demonstrate knowledge and understanding of research problems and related principles to manage projects in multidisciplinary research areas.**

Project work/Dissertation is considered as a special course involving application of knowledge in solving / analyzing /exploring a real life situation / difficult problem. A Project/Dissertation work may be given in lieu of a discipline specific elective paper/Biochemistry.This should be done in consultation with the faculty supervisor and agency supervisor under whom he / she is getting trained. The project report should be around 100 pages and chaptered as follows:

Chapter I: Introduction
Chapter II: Review of Literature

Chapter III: Methodology
Chapter IV: Results
Chapter V: Discussion
Chapter VI: Summary and Conclusion

The research should be original and should be action oriented in that the results should be able to throw light on some of the important unexplored areas that would be of practical use to the forensic experts.

Students are expected to decide on the specific project area and title, and carry out substantial portion of the literature survey during the end of their 3rd semester.After the end of their 3rdsemester ETEs, each student will be asked to make presentation about the project including literature available, objective sought and work plan including methodologiesto the Student Project Monitoring Committee constituted by the Division Chair. The Project Work may be a work based on theoretical analysis, modelling & simulation, experimentation & analysis, prototype design, fabrication of new equipment, correlation and analysis of data, etc. or a combination of these. The final project report will be evaluated by a panel of examiners consisting of Dean,DC, PC,supervisor and Co-supervisor (wherever applicable) and an External Examiner. Viva-voce examination for the same will be conducted.
The following weightage is assigned at each stage of Student Project evaluation.

Activity	Remarks
Zeroth Review	Project scopes and Proposal
1st Review	Methods of project Implementation
2nd Review	Technical Achievement
3rd Review (Final)	Innovation and contribution
Submission of Project Report to the Department	Two weeks before the viva-voce exam

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
50	00	50	100

Programme Electives

Name of The Course	Computational Biology				
Course Code	MSDB6019				
Prerequisite	Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.				
Corequisite	Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.				
Antirequisite					
		L	T	P	C
		3	0	0	3

Course Objectives:

High-throughput technologies produce massive amounts of data, much too large to analyze by hand. The goal of this course is to learn how to analyze DNA, RNA, and protein sequences using computers. The objectives are -

- To know about the properties of DNA, RNA, and proteins, the relationships among these molecules, and some biological questions that have puzzled researchers.
- To know how to convert a biological question into a computational problem that can be solved using computers.
- To know how to read and understand solutions to computational problems, which will be formalized as a series of tasks (an algorithm).
- To learn about general approaches for solving computational problems, and you will be able to apply these approaches to new problems you encounter.
- To know how implement the algorithms by writing computer programs in Python, which can be run and understood by others.

Course Outcomes

CO1	**Illustration of the computational biology and bioinformatics**
CO2	**Interpretation Biological databases and genome browsers**
CO3	**Evaluation of the Sequence alignment and visualization**
CO4	**Evaluation of the Phylogenetic analysis**
CO5	**Analysis of the Microarray analysis and Drug discovery pipeline**
CO6	**Analyze the recent advancement in computational biology.**

Text Book (s)

- Introduction to Computational Biology: An Evolutionary Approach by Haubold, Wiele. 1st edition. Springer International. 2006.
- Introduction to Bioinformatics by A. Lesk. 3rd edition. OUP India. 2009.
- Statistical methods in Bioinformatics: An introduction by W. Ewens, G.R. Grant. 2nd Edition. Springer-Verlag. 2006.
- Bioinformatics: Sequence and genome analysis by D. Mount. 2nd edition. Cold Spring Harbor Lab Press. 2004.
- Bioinformatics: A practical guide to the analysis of genes & proteins. Edited by Baxevanis, Outlette. 2nd edition. John Wiley and Sons. 2001.
- An Introduction to Protein Informatics by K-H Zimmermann. 1st edition, Springer International. 2007.

Reference Book (s)

- Fundamental Concepts of Bioinformatics by Krane. 1st edition. Pearson Education. 2003.
- Discovering Genomics, Proteomics and Bioinformatics by Campbell. 2nd edition. Campbell Pearson Education. 2007.
- Structural bioinformatics: an algorithmic approach by F. J. Burkowski. 1st edition, Chapman & Hall/CRC. 2009.
- Structural Bioinformatics edited by J. Gu, P.E. Bourne. 2nd Edition. Wiley-Blackwell. 2009.

Unit-1 Introduction to computers (10 hours)

Units of computers, Block Diagram, Generation of Computers, Characteristics of Computers, Phases of Computers, Different types of Memory, Input and Output Devices.
Logic Development and Program Development Tools: Data Representation, Flowcharts, Problem Analysis, Decision Trees/Tables, Pseudo Code and Algorithms, Program Debugging, Compilation and Execution.
Fundamentals: Character Set, Identifiers and Key Words, Data Types, Constants, Variables, Expressions, Statements, Symbolic Constants.
Operations and Expressions: Arithmetic Operators, Unary Operators, Relational Operators, Logical Operators, Assignment and Conditional Operators, Library functions.

Unit-2Procedural Concept (08 hours) Structured Programming – Built-in library function – User defined functions – Pointer introduction – Passing pointer in a function – Structure – Union – File handle: Read and Write character from a file
Unit-3Programming in C: C language (10 hours) Introduction – Tokens – Keywords, Identifier, Variables, Constants, Operators – Expression – Data types –Operator precedence - Statement: Input statement, Output statement, Conditional and Unconditional Control Statement – Looping Statement: while, do-while, for – nested loop – Arrays.
Unit-44 Object Oriented Programming: Programming in C++ (10 hours) **C++ programming – Object Oriented Concept: Encapsulation, Inheritance, Polymorphism – Different forms of Constructor – Destructor – Abstract class – Virtual function**
Unit-55 PERL (10 hours) Basic Perl Data Types, References, Matrices, Complex/Nested Data Structures, Scope: my, local, our – Function/Subroutines, System and User Function, File handle and File Tests – stat and lstat Functions – Perl
Unit-6 Recent Advancement in computational biology (04 lectures) **Research article/ Review paper/ MOOC**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Bioethics, Bio-safety and IPR**				
Course Code	**MSDB6020**				
Prerequisite	**Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.**				
Corequisite	**Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.**				
Antirequisite					
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

- To gain awareness about *Intellectual Property Rights* (*IPRs*) to take measure for the protecting their ideas and to devise business strategies by taking account of *IPRs.*
- To assists in technology upgradation and enhancing competitiveness
- To introduce basic concepts of ethics and safety that are essential for different disciplines of science and procedures involved and protection of intellectual property and related rights.
- To understand balanced integration of scientific and social knowledge in sustainable development.

Course Outcomes

CO1	**Understanding on basic principles of bioethics.**
CO2	**Evaluation of the process of biosafety levels**
CO3	**Evaluation of the process of IPR**
CO4	**Illustration of patent and licensing process**
CO5	**Illustration of regulatory aspects of QC, QA, and QM**
CO6	**Analyze the recent advancement in bioethics, bio-safety and IPR**

Text Book (s)

- Fleming, D.A., Hunt, D.L., (2000). Biotechnology and Safety Assessment (3rd Ed) Academic press.ISBN-1555811804,9781555811808.
- Thomas, J.A., Fuch, R.L. (1999). Biotechnology and safety assessment (3rd Ed). CRC press, Washington. ISBN: 1560327219, 9781560327219
- Law and Strategy of biotechnological patents by Sibley. Butterworth publication.(2007) ISBN: 075069440, 9780750694445.
- Intellectual property rights- Ganguli-Tat McGrawhill. (2001) ISBN-10: 0074638602,

Reference Book (s)

- Biotechnology - A comprehensive treatise (Vol. 12). Legal economic and ethical dimensions VCH. (2nd ed) ISBN-10 3527304320.
- Encyclopedia of Bioethics 5 vol set, (2003) ISBN-10: 0028657748.
- Thomas, J.A., Fuch, R.L. (2002). Biotechnology and safety Assessment (3rd Ed) Academic press.

Unit-1 INTRODUCTION AND PRINCIPLE OF BIOETHICS (10 hours)

Biotechnology and social responsibility, public acceptance issues in biotechnology, issues of access, ownership, monopoly, traditional knowledge, biodiversity, benefit sharing, environmental sustainability, public viz; private funding, biotechnology in international relations, globalization and development divide. Introduction to bioethics: Social and ethical issues in biotechnology. Principles of bioethics. Ethical conflicts in biotechnology- interference with nature, unequal distribution of risk and benefits of biotechnology, bioethics viz; business ethics.

Unit-2 BIOSAFETY (10 hours)

Biosafety: Definition of bio-safety, Biotechnology and bio-safety concerns at the level of individuals, institutions, society, region, country and world with special emphasis on Indian concerns. Biosafety in laboratory institution: laboratory associated infection and other hazards, assessment of biological hazards and level of biosafety. Bio safety regulation: handling of recombinant DNA products and process in industry and in institutions (Indian context).

Unit-3INTELLECTUAL PROPERTY PROTECTION (08 hours)

Introduction to IPR: IPR, forms of IPR and Intellectual property protection. Concept of property with respect to intellectual creativity, Tangible and Intangible property. WTO: agency controlling trade among nations, WTO with reference to biotechnological affairs, TRIPs. WIPO, EPO.

Unit-4 PATENT AND LICENCING (10 hours)

Concept related to patents novelty, non-obviousness, utility, anticipation, prior art etc. Type of patents. Indian patent act and foreign patents. Patentability, Patent application, Revocation of

patent, Infringement and Litigation with case studies on patent, Commercialization and Licensing.
Unit-5QUALITY ASSURANCE AND VALIDATION (12 hours) **Regulatory aspects of QC, QA, and QM. GMP, GLP and CMP in Pharma Industry. ISO, WHO, USFDA certification. Microbial Limit test of Pharma products. Sterility testing, pyrogen testing and LAL test of Sterile Pharma products. Sterilization- heat, D- value, Z-value and survival curve, radioactive, gaseous and filtration. Chemical and biological indicators. Designing layout for microbiology laboratory.**
Unit-6 Recent Advancement in Bioethics, Bio-safety and IPR (04 lectures) **Research article/ Review paper/ MOOC**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Toxicology**				
Course Code	**MSCB5021**				
Prerequisite	**Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.**				
Corequisite	**Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.**				
Antirequisite					
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

- **Understand toxicology and associated terms and learn about everyday toxic substances**
- **Interpret a dose-response curve and acquire information about biological variation.**
- **Define exposure types and familiarity with toxicity episode phases.**
- **Basic understanding of risk assessment**

Course Outcomes

CO1	Discuss the various routes of toxic exposure and response.
CO2	Evaluate the process of evaluation of toxicity.
CO3	Explain the fate of xenobiotics in the physiological system.
CO4	Summarize the various toxic agents.
CO5	Discuss the different eco-toxicological effects.
CO6	Analyze the recent advancement in toxicology.

Text Book (s)

- Cassarett and Doull‟s Toxicology "The Basic Science of The Poisons" 7th edition (2008), Curtis D. Klaassen Editor, McGrawHill Medical. ISBN: 9780071470513.

- Cassarett and Doull‟s "Essentials of Toxicology" 2nd edition (2010), Klaassen and Whatkins, McGraw Hill Publisher. ISBN-13: 978-0071622400.
- Introduction to Toxicology, 3rd edition (2001), John Timbrell, Taylor and Francis Publishers. ISBN 13: 9780415247627.
- Principles of Toxicology, 2nd edition (2006), Stine Karen and Thomas M Brown, CRC press. ISBN-13: 978-0849328565.

Reference Book (s)

- Introduction to Toxicology, 3rd edition (2001), John Timbrell, Taylor and Francis Publishers. ISBN 13: 9780415247627.
- Principles of Toxicology, 2nd edition (2006), Stine Karen and Thomas M Brown, CRC press. ISBN-13: 978-0849328565.
- Lu‟s basic toxicology: Fundamentals target organ and risk assessment, 5th edition (2009), Frank C Lu and Sam Kacow, Informa Health care. ISBN: 9781420093117.

Unit-1Toxic exposure and response (10 hours) **Different areas of modern toxicology, classification of toxic substances, various definitions of toxicological significance. Effect of duration, frequency, route and site of exposure of xenobiotics on its toxicity. Characteristic and types of toxic response. Types of interactions between two and more xenobiotics exposure in humans. Tolerance and addiction.**
Unit-2Evaluation and mechanism of toxicity (08 hours) **Various types of dose response relationships, assumptions in deriving dose response, LD50, LC50, TD50 and therapeutic index. Delivery of the toxicant, mechanisms involved in formation of ultimate toxicant, detoxification of ultimate toxicant.**
Unit-3Fate of xenobiotics in human body (08 hours) **Absorption, Distribution, Excretion and Metabolism of xenobiotics (biotransformation, Phase-I reactions including oxidations, hydrolysis, reductions and phase II conjugation reactions).Toxic insult to liver, its susceptibility to toxicants with reference to any two hepatotoxicants.**
Unit-4Toxic agents (10 hours) **Human exposure, mechanism of action and resultant toxicities of the following xenobiotics: Metals: lead, arsenic, Pesticides: organophosphates, carbamates, organochlorine, bipyridyl compounds and anticoagulant pesticides.**
Unit-5 Eco-toxicology (10 hours) **Brief introduction to avian and aquatic toxicology, movement and effect of toxic compounds in food chain (DDT, mercury), bioaccumulation, biomagnification, acid rain and its effect on ecosystems, concept of BOD and COD.**
Unit-6 Recent Advancement in Toxicology (04 lectures) **Research article/ Review paper/ MOOC**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Industrial Biochemistry**				
Course Code	**MSDB6022**				
Prerequisite	**Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.**				
Corequisite	**Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.**				
Antirequisite					
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

The course aims to integrate the knowledge of biochemistry and molecular biology with those of microbiology and biochemical engineering, with emphasis on their application to the biotechnological processes.

Course Outcomes

CO1	**Demonstrate the industrial bioprocesses technology, downstream processing.**
CO2	**Describe the process of fermentation.**
CO3	**Demonstrate the various ways of food processing.**
CO4	**Describe the process of BIOSAFETY, IPR**
CO5	**Discuss the general principles of Quality Control and Good Manufacturing practices in food industry.**
CO6	**Analyze the recent advancement in industrial Biochemistry**

Text Book (s)

- DobleMukesh and Kumar Anil, Biotreatment of industrial effluents.
- Wackett, L.P. and Hershberger, C.D. Biocatalysis and Biodegradation, Microbial Transformation of Organic Compounds, 2001 P.-171-190. ISBN 1-55581-179-5. ASM Press Washington D.C.
- WulfCrueger and Anneliese Crueger, Biotechnology, Panima Publishing company New Delhi.
- Rainbow C. and Rose A.H., A.P., Biochemistry of Industrial micro-organisms.
- P. F. Stanbury, A. Whitaker and S. Hall, Principles of Fermentation Technology.

Reference Book (s)

- Bioethics and Biosafety, 1st edition (2008), M. K Sateesh, I K International Pvt Ltd, ISBN-13: 978-8190675703.
- Biosafety and Bioethics, 1st edition (2006), Rajmohan Joshi; Isha Books ISBN-13: 978-8182053779.
- Bioethics and biosafety in biotechnology, 1st edition (2007), V. Sreekrishna; New Age International (P) Ltd., ISBN-13: 978-8122420852.
- P. F. Stanbury, A. Whitaker and S. Hall, Principles of Fermentation Technology.
-

Unit-1Introduction to industrial bioprocessestechnology(10 hours) **Definition and scope of Industrial Biochemistry,A historical overview of Industrial fermentation processes- traditional and modern biotechnology, Organism, processes and products related to modern biotechnology, Types of Bioreactors, Parameters for Bio process, bioprocess monitoring, downstream processing.**
Unit-2Basics of fermentation(08 hours)

Biochemical Basis and Development of Industrial Fermentation process: screening and selection of the organisms for the production of biologically important compounds, Strain improvements, Detection and production of fermentation products, Fermentation media, Scale up of fermentations
Unit-3Food biochemistry (12 hours) **Introduction to different categories of food; constituents of food products and their functional properties; introduction to food processing; intermediate moisture food; food spoilage; intrinsic and extrinsic factors affecting the quality and life of food material; food storage and preservation techniques; food poisoning and intoxication; by-product utilization and scale up; molasses and alcohol production.**
Unit-4Biosafety, IPR(10 hours) **Historical background, introduction to biological safety cabinets, primary containment for biohazards, biosafety levels of specific microorganisms, recommended biosafety levels for infectious agents and infected animals. Intellectual property rights (IPR)**
Unit-5QC and GMP (10 hours) **General principles of Quality Control and Good Manufacturing practices in food industry, Determination of shelf – life of food products, Food Adulteration – Common food adulterants, their harmful effects and physical and chemical methods for their detection, Role of ISI Agmark and FDA in food industry.**
Unit-6 Recent Advancement in Industrial Biochemistry (04 lectures) **Research article/ Review paper/ MOOC**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Advanced Microbiology**				
Course Code	**MSDB6023**				
Prerequisite	**Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.**				
Corequisite	**Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.**				
Antirequisite					
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

- To understand the impact and the importance of the activity of microorganisms on health and on other living organisms.
- To appreciate the intimate connection between the knowledge of molecular mechanisms underlying the interaction between microorganisms and the capacity to develop new biotechnologies.
- To improve the general skills in the laboratory using modern molecular techniques.

- To contribute to one of the great initiatives of modern times: Wikipedia, with new knowledge in the field of microbiology.
- To develop team working skills while reviewing a cutting edge topic in microbiology

Course Outcomes

CO1	**Acquire knowledge on microbial proteomics**
CO2	**Understand the fundamentals of nanotechnology**
CO3	**Illustration of the applications of nanobiotechnology**
CO4	**Application of knowledge on grant of patent and patenting authorities**
CO5	**Evaluation of advanced approach in microbiology**
CO6	**Analyze the recent advancement in advanced microbiology**

Text Book (s)

- Bare Act, 2007.Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., New Delhi.
- Kankanala C (2007). Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution Pvt. Ltd. New Delhi.
- Nanobiotechnology: Concepts,Applications and Perspectives (2004), Christof M.Niemeyer (Editor), Chad A. Mirkin (Editor), Wiley VCH.
- Nanobiotechnology - II more concepts and applications. (2007) - Chad A Mirkin and Christof M. Niemeyer (Eds), Wiley VCH.

Reference Book (s)

- Pradeep T., “A Textbook of Nanoscience and Nanotechnology”, Tata McGraw Hill Education Pvt. Ltd., 2012.
- Singh K K (2015). Biotechnology and Intelectual Property Rights: Legal and Social
- Impliocations, Springer India.
- Goel D &Prashar S (2013). IPR, Biosafety and Bioethics. Pearson

Unit-1 Microbial proteomics (12 hours) **Introduction to Proteomics, 2D electrophoresis, Proteomics applications. Protein biomarker,surfaceplasmon resonance (SPR), protein microarraysdual polarisation interferometry, microscalethermophoresis Microbial pathogenesis at the proteome level. Proteomics of *Saccharomyces cerevisiae*-cell wall & transport, differential expression in stress. Proteomics of probiotic lactobacilli-intestinal epithelial cells interactions, Lantibiotics and Immunomodulators. Proteomic Identification of *Mycobacterium tuberculosis***
Unit-2Introduction to nanotechnology (10 hours) **Historical perspectives, Existence of nanostructures in nature, Nanoscale Properties (Electrical, Optical, Chemical) Nanomaterials - Quantum Dots,Wells and Wires, nanotubes, graphene, nanogold, nanosilver and metal oxides, Nanopolymers. Synthesis using Microorganisms, Synthesis using Biological templates, synthesis using plants and plant extracts.**
Unit-3Applications of nanobiotechnology (08 hours) **Nanobiosensors, molecular imaging using nanoparticles, targeted drug delivery. Applications in health and disease - infectious and chronic. Nanobiotechnological applications in Environment and food - detection and mitigation.**
Unit-4Grant of patent, agreements and treaties (12 hours)

Grant of Patent and Patenting Authorities: Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; An introduction to Patent Filing Procedures; Patent licensing and agreement; Patent infringement- meaning, scope, litigation, case studies, Rights and Duties of patent owner. Agreements and Treaties: GATT, TRIPS, WIPO, Budapest Treaty on international recognition of the deposit of microorganisms etc.
Unit-5Advance approach in microbiology (12 hours) **Novel approaches for anti-influenza virus therapy. Use of bacteria in cancer therapy, Protein secretion: from mechanism to exploitation, microbicides, Biofilm-related infections, Fungal infections: novel diagnostic tools and antifungal agents, Epidemiology of respiratory viruses, Tumor-associated viruses, Virus (HIV) entry as therapeutic target, Applications of CRISPR genome editing to microbiology.**
Unit-6 Recent Advancement in Advanced Microbiology (04 lectures) **Research article/ Review paper/ MOOC**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Plant – pathogen interaction**				
Course Code	**MSDB6024**				
Prerequisite	**Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.**				
Corequisite	**Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.**				
Antirequisite					
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

- To gain a deeper knowledge of host-pathogen interactions at the molecular to organismal level, with emphasis on several model pathosystems and phenomena whose elucidation will have the most power in explaining disease.
- To gain an understanding of the virulence mechanisms and pathogenic lifestyles of necrotrophic and biotrophic plant pathogens and of the defenses of plants against these pathogens.
- To understand research tools and their limitations and how technology and knowledge have grown together in the history of our discipline.
- To use knowledge of molecular interactions to understand the basis for current disease controls and identify potential new targets for control.

Course Outcomes

CO1	**Understanding on microbial infections on plant physiology**
CO2	**Evaluation of important plant diseases and etiology**
CO3	**Evaluation of genetics of diseases**
CO4	**Illustration of plant disease control**

CO5	**Illustration of diseases forecasting and its relevance**
CO6	**Analyse the recent advancement in parasitology**

Text Book (s)

- Plant pathology by George N. Agrios: 4th ed., Academic press, New York, 1969.
- Plant pathology by R.S. Mehrotra: Tata McGraw –Hill publishing company limited. New Delhi.
- Bacterial plant pathology, cell and molecular aspects by David C. Sigee, Cambridge University Press, 1993.
- Molecular plant pathology by M. Dickinson: BIOS Scientific Publishers, London, 2003.

Reference Book (s)

- The essentials of Viruses, Vectors and Plant diseases by A.N. Basu & B.K. Giri: Wiley Eastern Limited, 1993.
- Biocontrol of Plant Diseases (Vol. I) by K.G. Mukerji & K.L. Garg: CRC Press, Inc., Boca Raton, Florida, 1988.
- Molecular Biology of Filamentous Fungi by U. Stahl & P. Tudzyski: VCH Verlagsgesellschaft mbH, D-6940 Weinheim (Federal Republic of Germany), 1992

Unit-1 Concepts and physiology of plant diseases (08 hours) **What is a disease and what causes disease, pathogenesis, pathogenesis in relation to environment, effect of microbial infections on plant physiology, photosynthesis, respiration, transpiration, translocation. Enzymes and toxins in plant diseases, phytoalexins.**
Unit-2Some important plant diseases and their etiological studies (10 hours) **Crown gall, symptoms of viral diseases and their control, diseases of some important cereals, vegetables and crops. Diseases caused by fungi: *Sclerotium rolfsii* and *Macrophomina phaseolina* (collar rot disease, charcoal rot), bacteria: *Xanthomonas campestris* (black rot), actinomycetes: *Streptomyces scabies* (common scab).**
Unit-3Genetical basis of plant diseases (08 hours) **Genetics of host-pathogen interactions, resistance genes, resistance mechanism in plants. Molecular diagnosis, transgenic approach for plant protection, futuristic vision of molecular diagnosis, applications and constraints.**
Unit-4 : Disease control (10 hours) **Principles of plant disease control, physical and chemical methods of disease control, biocontrol, biocontrol agents - concepts and practices, fungal agents, *Trichoderma* as biocontrol agent, biocontrol agents – uses and practical constraints**
Unit-5Disease forecasting (10 hours) **History and important milestones in disease control, disease forecasting and its relevance in Indian farming.**
Unit-6 Recent Advancement in parasitology (04 lectures) **Research article/ Review paper/ MOOC**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

(Established under Galgotias University Uttar Pradesh Act No. 14 of 2011)

School of Basic and Applied Sciences
Department of Life Sciences
Division of Microbiology

Program: M. Sc. Microbiology

Scheme: 2020 – 2022

Date of BoS: 22.04.2020

Vision

"To be known globally for value-based education, research, creativity and innovation"

Mission

1. Establish state-of-the-art facilities for world class education and research.
2. Collaborate with industry and society to align the curriculum,
3. Involve in societal outreach programs to identify concerns and provide sustainable ethical solutions.
4. Encourage life-long learning and team-based problem solving through an enabling environment.

Vision:
To be recognized globally as a center of excellence in imparting value-based education in Basic and Applied Sciences by creating innovation in fundamental and multidisciplinary research.

Mission
M1. To excel in imparting contemporary knowledge and skills by developing an educational ecosystem with diverse interests and talents.
M2. To perform cutting edge research leading to innovation in sciences through national and international collaborations.
M3. To develop solutions for the emerging challenges in Basic and Applied Science to cater the needs of society.
M4. To attract best quality faculty to facilitate knowledge and develop confidence in our graduates to succeed in the world.

Preamble of Programme:
M.Sc. Microbiology is a postgraduate programme. The M.Sc. Microbiology programme is of two years duration and is divided into four semesters. Microbiology is the branch of the science that deals with the detail study of microorganisms such as bacteria, fungi, protozoa and viruses. This programme includes collecting information of diversity and exploration micro-organisms from extreme environments. It also includes about the pathogenicity of the microorganism and etiology of the diseases. The students will also learn the application of bacteria, fungi, protozoa and viruses in traditional (food, dairy, wine, antibiotics, fermentation, etc.), biotechnological industries, agricultural industries and on environmental aspect. Further, the program also focused on Basic Microscopy & Instrumentation, Cell biology, Principles of Immunology, Pharmaceutical Microbiology, Research Methodology, Toxicology, Computational Biology, etc. During programme the student will undergo various industrial visits, training, conferences for research towards higher degrees, or in the field of development of industrial processes.

Scope of the Proposed Programme
The M.Sc., programme of two years is designed to help all the students to get good quality education in the field of Microbiology so that they can pursue Higher education or find employment. After M.Sc. the opportunities for students are responsible positions in technical production, planning and policy making, both in research and industry will open.
The curriculum is designed in such a way, that after their postgraduate studies, students will be able to work directly in the applied field (industry or research institute). After completing this curriculum the students will be able to take up the following responsibilities:

1. Research at national, international level.
2. Higher positions in biotech production units as food microbiologist, environmental microbiologist, medical microbiologist, etc.
3. Planning and policy making for biotechnology.
4. Teaching at undergraduate / postgraduate level courses in Microbiology / Biotechnology.

Eligibility

Graduation in Botany/ Zoology/ Biochemistry/ Biotechnology/ Microbiology/ Biomedical Sciences/ Genetics/ Medicine/ Agriculture/ Life Sciences/ Chemistry/ Pharmacy from any recognized university or equivalent examination with a minimum of 50 % marks in aggregate.

Programme Outcome:

PO1	**Apply knowledge of basic and applied sciences to the solution of complex biochemical conditions.**
PO2	**Perform experiments and researches, perform analysis and interpret data for complex biochemical conditions.**
PO3	**Identify, investigate, analyse and generate solutions for biological processes.**
PO4	**Use research-based knowledge together with design of experiments, analysis and interpretation of data, to provide valid conclusions with an understanding of their limitations.**
PO5	**Create, select and apply appropriate techniques, resources and modern science and research tools within a defined specification that meet specified needs with appropriate consideration for public health and safety.**
PO6	**Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal issues and the consequent responsibilities relevant to the professional biologist.**
PO7	**Understand the impact of professional life sciences solutions in communal and environmental contexts and demonstrate knowledge and need for sustainable development.**
PO8	**Execute responsibility professionally and ethically.**
PO9	**Function effectively as an individual, and as a member or leader in diverse resource teams.**
PO10	**Articulate ideas, comprehend and write effective reports, documentation and to communicate effectively with the basic and applied sciences community and with society at large.**
PO11	**Demonstrate knowledge and understanding of science and technical principles to manage projects in multidisciplinary research areas.**
PO12	**Seeking stimulation and to exploring numerous opportunities to engage in independent and life-long learning in the broadest context of technological change.**

Programme Educational Objectives (PEOs):

PEO1	**The graduated young minds will be ignited to understand the eukaryotic and prokaryotic classification**
PEO2	**The graduates will be emphasized on applied aspects of advanced laboratory training in included to prepare them for careers in the applied research**
PEO3	**The graduates of Microbiology will be trained for skilled scientific manpower with apprehension of research ethics involving microorganisms to contribute to application**

Programme Specific Outcome (PSOs):

PSO1	**At the end of the two year programme the student will understand and be able to explain different branches of Microbiology such as Bacteriology, Virology, Mycology and Phycology. The student will be able to explain about various applications of Microbiology such as Environmental Microbiology, Industrial Microbiology, Food Microbiology, and Microbial Pathogenicity.**
PSO2	**Student will be able to design and execute experiments related to Basic Microbiology, Immunology, Molecular Biology, Recombinant DNA Technology, and Microbial Genetics, and will be able to execute a short research project incorporating techniques of Basic and Advanced Microbiology under supervision. The student will be equipped to take up a suitable position in academia or industry, and to pursue a career in research if so desired.**

Curriculum

Sl. No	Course Code	Name of the Course	L	T	P	C	IA	MTE	ETE
Semester I									
Sl. No	Course Code	Name of the Course					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MSDB5013	Cell Biology	3	1	0	3	30	20	50
2	MSDB5002	Molecular Biology	4	0	0	4	30	20	50
3	MSDB5004	Fundamentals of Biochemistry	4	0	0	4	30	20	50
4	MSMB5003	General Microbiology	4	0	0	4	30	20	50
5	MSMB5005	Advanced Microbiology Lab - I			4	2	50		50
6	XXXX	Soft Skills				0			
7	XXXX	Computer awareness				0			
Total Credits						1			
Semester II									
Sl No	Course Code	Name of the Course					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MSDB5006	Immunology	4	0	0	4	30	20	50
2	MSDB5007	Bioanalytical and Microbial Techniques	4	0	0	4	30	20	50
3	MSDB5008	Biotechnology And Genetic Engineering	4	0	0	4	30	20	50
4	MSMB5010	Microbial Physiology and Metabolism	4	0	0	4	30	20	50
5	MSMB5014	Advanced Virology	3	1	0	3	30	20	50
6	MSBC5012	Advanced Microbiology Lab - II	0	0	4	2	50	-	50
7	XXXX	BEC (B1)				3			
8	MBS28T2111	Research Methodology	2	0	0	2	30	20	50
9	XXXX	IPR				1			
Total Credits						27			
Semester III									
Sl No	Course Code	Name of the Course					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MSDB6002	Medical and Pharmaceutical Microbiology	4	0	0	4	30	20	50
2	MSMB6003	Summer Training*	0	0	0	2	50	-	50
3	MSMB6004	Algal and Fungal Microbiology	4	0	0	4	30	20	50
4	MSMB6005	Microbes in Food and Agriculture	4	0	0	4	30	20	50
5	MSMB6006	Environmental Microbiology	4	0	0	4	30	20	50
6	MSMB6007	Advanced Microbiology Lab- III	0	0	4	2	50	-	50
7	MSDB60##	Electives#	3	0	0	3	30	20	50
8	XXXX	Campus to Corporate	0	0	2	1	50	-	50
Total Credits						24			
Semester IV									
Sl No	Course Code	Name of the Course					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MSMB9997	Dissertation	0	0	0	12	50	-	50
Total Credits						12			
Grand Total						80			

Elective Courses									
Sl. No.	**Course code**	**Course Title**	**L**	**T**	**P**	**C**	**Assessment Pattern**		
							IA	**MTE**	**ETE**
1	MSDB6019	Computational Biology	3	0	0	3	30	20	50
2	MSDB6020	Bioethics, Bio-safety and IPR	3	0	0	3	30	20	50
3	MSDB6021	Toxicology	3	0	0	3	30	20	50
4	MSDB6022	Industrial Biochemistry	3	0	0	3	30	20	50
5	MSDB6023	Advanced Microbiology	3	0	0	3	30	20	50
6	MSDB6024	Plant –Pathogen interaction	3	0	0	3	30	20	50

Name of The Course	**Cell Biology**				
Course Code	**MSDB5013**				
Prerequisite	**Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.**				
Corequisite	**Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.**				
Antirequisite					
		L	**T**	**P**	**C**
		3	**1**	**0**	**3**

Course Objectives:

1. Students will understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles.
2. These can include responses to environmental or physiological changes, or alterations of cell function brought about by mutation.

Course Outcomes

CO1	**Identify cell types, structure, functions and cell division.**
CO2	**Demonstrate the function and structure of various cell organelles**
CO3	**Interpret the models of biological membrane and illustrate membrane biochemistry**
CO4	**Interpret the membrane biochemistry and transport of ions across the membrane.**
CO5	**Elucidate the knowledge in the area of cell aging and death**
CO6	**Analyze the recent advancement in Cell Biology**

Text Book (s)

- The Cell: A Molecular Approach (2009) 5th ed., Cooper, G.M. and Hausman, R.E., ASM Press & Sunderland (Washington DC), Sinauer Associates, MA, ISBN:978-0-87893-300-6.
- Molecular Cell Biology (2012) 7th ed., Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell. J., W.H. Freeman & Company (New York), ISBN:13:978-1- 4641-0981-2 / ISBN: 10: 1-4641-0981-8.
- Molecular Biology of the Cell (2008) 5th ed., Alberts, B., Johnson,A., Lewis, J., and Enlarge, M., Garland Science (Princeton), ISBN:0-8153-1619-4.

Reference Book (s)

- Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13: 978-1-4641-0962-1 / ISBN:10:1-4292-3414- 8.
- Molecular Biology of the Cell (2008) 5th ed., Alberts, B., Johnson,A., Lewis, J., and Enlarge, M., Garland Science (Princeton), ISBN:0-8153-1619-4.

Unit-1 introduction to cell biology (8 lectures) **Introduction to the cell, its chemical composition, Cell types - organization of prokaryotic and eukaryotic cells, Plant and animal cells: variation in structure and function, cell theory, cell cycle - phases of cell cycle; cell division - mitosis and meiosis**
Unit-2 structure and function of different cell organelles (10 lectures)

Cell organelles; structure and function of endoplasmic reticulum, Golgi body, endosome, lysosome, vacuole, peroxisome, ribosome, mitochondria, chloroplast, nucleus, cytoskeleton, cell wall; subcellular fractionation; cytoplasm and cytosol, Structure of nuclear envelope, nuclear pore complex.
Unit-3 Membrane biochemistry (10 lectures) **Membrane: chemical composition and its structural plan; membrane lipids; Overview of membrane protein - peripheral and integral; molecular model of cell membrane - fluid mosaic model and membrane fluidity; factors affecting the membrane fluidity.**
Unit-4 Cellular communication and transport (10 lectures) **Microvilli, tight junctions, epithelia, Bell and sqot desmosomes, Types of Cell Junctions; membrane transport; small molecules - passive transport, active transport by ATP powered pumps, Overview of types of transport systems and macromolecule transport: Exocytosis; Endocytosis; Pinocytosis and phagocytosis.**
Unit-5 Cell cycle and cell death (08 lectures) **Cell cycle regulation, Cell aging and death - necrosis and apoptosis**
Unit-6 Recent advances in Cell Biology (04 lectures) **Research article/ Review paper/ MOOC**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Molecular Biology**				
Course Code	**MSDB5002**				
Prerequisite	**Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.**				
Corequisite	**Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.**				
Antirequisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives:

Molecular biology deals with nucleic acids and proteins and how these molecules interact within the cell to promote proper growth, division, and development. It is a large and ever-changing discipline. This course will emphasize the molecular mechanisms of DNA replication, repair, protein synthesis etc.

Course Outcomes

CO1	**Generalize the prokaryotic and eukaryotic mechanism of transcription.**
CO2	**Illustrate of genetic code and the process of translation.**
CO3	**Interpret of protein targeting and degradation mechanism.**
CO4	**Determine the regulation of gene expression in prokaryotes and eukaryotes.**
CO5	**Evaluate the procedure of recombinant DNA technology**
CO6	**Analyze the recent advancement in molecular biology.**

Text Book (s)

- Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York):10:1-4292-3414- 8.
- Molecular biology of the gene, (4th ed)J D Watson, Benjamin/Cummings publ. Co Inc.
- Molecular Cell Biology (2012) 7th ed., Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell. J., W.H. Freeman & Company (New York), ISBN:13:978-1- 4641-0981-2 / ISBN:10: 1-4641-0981-8.
- Molecular Biology of the Cell (2008) 5th ed., Alberts, B., Johnson,A., Lewis, J., and Enlarge, M., Garland Science (Princeton), ISBN:0-8153-1619-4 / ISBN:0-8153-1620-8.

Reference Book (s)

- Alberts B, Bray D, Johnson A et al. (1997) Essential Cell Biology. London: Garland Publishing.
- Darwin C (1859) On the Origin of Species. London: Murray.
- Graur D & Li W-H (1999) Fundamentals of Molecular Evolution, 2nd edn. Sunderland, MA: Sinauer Associates.

Unit-1 Nucleic acid structure and function (10 lectures) **Historical account of DNA discovery; Overview of flow of genetic information; DNA and RNA as genetic material; Unnatural structures of DNA; DNA topology and supercoiling. Nucleosome structure and packaging of DNA into higher order structures; Organelle genomes; chromosome diversity; Clusters and tandem repeats, Microsatellite Repeat Sequences and transposons.**
Unit-2 DNA replication, mutagenesis, DNA damage and repair mechanisms (12 lectures) **The Origin of Replication; Unwinding of DNA; Formation of the Replication Fork; The DNA Polymerase Complex; Initiation & Elongation of DNA Synthesis; Replication Exhibits Polarity; Formation of Replication Bubbles; Reconstitution of Chromatin Structure; DNA Synthesis Occurs During the S Phase of the Cell Cycle. Mutagenesis and replication fidelity; Types of Damage to DNA; DNA repair mechanisms - Mismatch repair of DNA, Base Excision-Repair, Nucleotide Excision-Repair, Double-Strand Break Repair**
Unit-3 Transcription (10 lectures) **Prokaryotic transcription- promoters, properties of bacterial RNA polymerase, steps: initiation, elongation and termination; Eukaryotic transcription- promoters, enhancer factors and properties of RNA polymerase I, II and III; Reverse transcription; Inhibitors of transcription. RNA processing, splicing, capping and polyadenylation, rRNA and tRNA processing.**

Unit-4 Genetic code, protein translation, targeting and degradation (10 lectures) **Genetic code - definition, deciphering of the genetic code, salient features of genetic code; Protein biosynthesis - initiation, elongation and termination; post-translational modifications; Inhibitors of protein synthesis. Intracellular protein targeting; Signal hypothesis, signal sequences, glycosylation, Targeting of protein to mitochondria, lysosomes, ER, plasma membrane, peroxisomes, chloroplast; Destruction of proteins; Protein folding.**
Unit-5 Regulation of gene expression (12 lectures) **Positive and negative control; Repressor & Inducer; concept of operon- lac, ara, trp operons; attenuation, catabolite repression, autogenous regulation, lytic cycle of bacteriophage; stringent response of rRNA synthesis. Hormonal control, transcription factors, steroid receptors. DNA binding motifs in pro- and eukaryotes – Helix-turn-helix, zinc fingers, leucine zippers, helix loop helix motifs.**
Unit-6 Recent advances in Molecular Biology (04 lectures) **Research article/ Review paper/ MOOC**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Fundamentals of Biochemistry**				
Course Code	**MSDB5004**				
Prerequisite	**Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.**				
Corequisite	**Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.**				
Antirequisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives: The course objectives are as following -

- Demonstrate knowledge and understanding of the molecular machinery of living cells;
- Demonstrate knowledge and understanding of the principles that govern the structures of macromolecules and their participation in molecular recognition;

Course Outcomes

CO1	**Discuss the effect of water, electrolyte, acid-base balance and structure of special microbial biomolecules**
CO2	**Describe the different classes and function of carbohydrates and lipid.**
CO3	**Summarize the different classes of amino acids, proteins and nucleotides and their functions**
CO4	**Knowledge on enzymes and vitamins**
CO5	**Explain the concept of energy production in the living cell.**

CO6	**Analyze the recent advancement in Biochemistry**

Text Book (s)

- Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN: 13: 978-1-4641-0962-1
- Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New York), ISBN:978-0-470-28173-4.
- Biochemistry (2011) 4th ed., Donald, V. and Judith G.V., John Wiley & Sons Asia Pvt. Ltd. (New Jersey), ISBN:978-1180-25024.
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Reference Book (s)

- Berg, J. M., Tymoczko, J. L. and Stryer, L. Biochemistry. Freeman, 7th edition, 2011.
- Mathews, C. K. & Van Holde, K. E. & Ahern, K. G. Biochemistry. Addison Wesley, 4th edition, 2012.
- Wilson, K. & Walker, J. Principles and Techniques of Biochemistry and Molecular Biology. CUP, 7th edition.

Unit-1 Chemistry of life and special microbial molecules (08 lectures) **Bonds: ionic bonding, Ion-dipole, covalent, H-bonds, Van der Wall's interaction, Hydrophobic and hydrophilic interactions Water as a biological solvent and its role in biological processes pH, Henderson-Hasselbalch equation, concept of buffer, strength of buffer, range of buffer, important biological buffers. Structure of Special Microbial Molecules: Peptidoglycan, bacteriorhodopsin, biphytanyl chains and lipids in archaeal cell membranes and their significance in adaptation in extreme conditions.**
Unit-2 Carbohydrates and lipids (10 lectures) **Carbohydrates: Classification, basic chemical structure, monosaccharides, aldoses, and ketoses, cyclic structure of monosaccharides, steroisomerism, anomers and epimers. Sugar derivatives, deoxy sugars, amino sugars, and sugar acids. Lipids classification: Bacterial lipids, prostaglandins, structure, function, Major steroids of biological importance.**
Unit-3 Proteins and nucleic acid (10 lectures) **Proteins and amino acids: Properties of amino acids, structure, confirmation and properties of proteins, metabolism of amino acids, biosynthesis and degradation – an overview. Nucleic acids: Structure and properties of purines, pyrimidine, nucleosides and nucleotides. Metabolism of purines and pyrimidine - Biosynthesis and degradation.**
Unit-4 Enzymes and vitamins (08 lectures) **Enzymes nomenclature, classification methods for determination of enzyme activity. Isolation and purification of enzymes. Enzyme kinetics: Effect of pH, substrate concentration, temperature and inhibitors. Isoenzymes. Competitive and non-competitive inhibition. Methods for increased microbial enzymes production and activity. Vitamins and cofactors: structure, distribution and biological properties.**
Unit-5 Bioenergetics (08 lectures) **Laws of thermodynamics, entropy, enthalpy, free energy, free energy and equilibrium constant, Gibbs free energy equation, determination of free energy of hydrolytic and biological oxidation reduction reactions, under standard and non-standard conditions, high energy compounds, coupled reactions, determination of feasibility of reactions. ATP and other different groups of high energy phosphate compounds.**

Unit-6 Recent advances in Fundamentals of Biochemistry (04 lectures) **Research article/ Review paper/ MOOC**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**GENERAL MICROBIOLOGY**				
Course Code	**MSMB5003**				
Prerequisite	**Graduation life science and applied science from any recognized university or equivalent examination with a minimum of 50 % marks in aggregate.**				
Corequisite	**Students should have understanding of general biology, including a basic knowledge of the microorganism.**				
Antirequisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives:
Student will understand the structure, metabolism, genetics, and ecology of prokaryotic microorganisms, eukaryotic microorganisms, and viruses. Basic principles of physical and chemical methods used in the control of microorganisms and apply this understandingto the prevention and control ofinfectious diseases.

Course Outcomes

CO1	**Knowledge on historical perspective Microbiology and classification of microorganism**
CO2	**Basic knowledge on different structure of microbes**
CO3	**Understanding of identification and classification of bacteria**
CO4	**Knowledge bacterial genetics.**
CO5	**Ideas on different methods of sterilization and preservation and cultivation of bacteria**
CO6	**Analyze the recent advancement in General Microbiology**

Text and Reference Book (s)

- Microbiology; Lansing M Prescott, John P. Harley, Donald A Klein, Sixth edition, McGraw Hill Higher education.
- Brock Biology of Microorganism; M.T, Martinko, J.M. Parker, Prentice-Hall.
- Microbiology; M.J. Pelczar, E.C.S Chan and N.R. Kreig, Tata MacGraw Hill.
- Microbial Genetics, S.R. Molloy, J.E. Jr. Cronan and Frreifelder D Jones, Bartiett Publishers.
- Breed and Buchanan. *Bergey's Manual of Systematic Bacteriology*. 2nd Edition, (Volumes. 1 – 5) (2001 – 2003).
- General Microbiology, R. Y. Stanier, E. A. Adelberg, J. L. Ingraham, 4th edition, Mac Millan Press, London.

Unit-1 INTRODUCTION TO MICROBIOLOGY 10 lectures
Scope of microbiology - Ancient Microbiology - Refutation of a biogenesis: discovery of penicillin: discovery of vaccination: proposal of one gene one enzyme hypothesis - Major

contribution of scientists– Leeuwenhoek, Edward Jenner, Alexander - Flemming, Joshep Lister, Robert Koch, Louis Pasteur, Hargobind Khorana. Modern Microbiology - Landmark achievements in 20th century - Microbial Taxonomy - Definition and systematics, Nomenclatural rules and identification. Haeckel's three kingdom classification, Whittaker's five kingdom approach - Woese domain system. Major characteristics used in taxonomy – morphological, physiological and metabolic, genetic and molecular taxonomy. Bergey's Classification of bacteria.
Unit-2 BIOLOGY OF MICROORGANISMS 12 lectures
Differences between prokaryotic and eukaryotic cell. Biology of bacteria - cell structure, size, shape, arrangement membrane, cell wall, cytoplasmic inclusions (polyhydroxy butyrate, polyphosphate granules, oil droplets, cyanophycin granules), mesosomes, flagella and motility, slime, capsule, pili, chemotaxis and phototaxis structure, endospore-structure, formation and germination, Protoplast and spheroplast formation and L-form - biology of fungi, structure, physiology and classification – biology of yeast – reproduction - virus (bacteriophages) structure, life cycle (lytic and lysogenic) – biology of algae – Mycoplasma – prions.
Unit-3 TAXONOMY OF BACTERIA 10 lectures
Identification methods and classification of bacteria: Microscopic identification characteristics, staining methods. Ecological identification methods, Nutritional (cultural) identification characters, biochemical identification methods, immunological characteristics, Molecular and genetic characteristics identification (16s rRNA). Principles of bacterial taxonomy and classification: - Numerical taxonomy, Microbial nutrition and metabolism: autotrophy – Photoautotrophy and bacterial photosynthesis Chemoautotrophy and heterotrophic metabolism
Unit-4 BACTERIAL GENETICS 10 lectures
Horizontal and vertical gene transfer. Transformation: Competence, DNA uptake in Gram positive and Gram negative bacteria, transfection. Transduction: Generalized and specialized transduction. Conjugation: Role of sex factor, transfer of genes during F + xF - , Hfr x F - and sexduction
Unit-5 CULTIVATION AND CONTROL OF MICROBES 8 lectures
Methods of sterilization and disinfection: Physical methods and chemical methods. Microbiological media - Autotrophic media, defined synthetic mineral media, heterotrophic media. Staining methods: fixation, types of dyes, simple staining, differential staining (Gram and Acid-fast staining), staining of specific structures (capsule, flagella and spore staining).The concept of prototrophs and auxotrophs, prototrophic (minimal media) complex media (undefined media). Cultivation of Bacteria, Fungi and Algae: Routine and special culture methods. Isolation of pure cultures. Preservation and Maintenance of Microbial Cultures: Routine methods and Liquid nitrogen preservation, freeze-drying (lyophilization), etc.
Unit-6 Recent advances in Microbiology 04 lectures **Research article/ Review paper/ MOOC**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**ADVANCED MICROBIOLOGY LAB - I**
Course Code	**MSMB5005**

Prerequisite	**Graduation life science and applied science from any recognized university or equivalent examination with a minimum of 50 % marks in aggregate.**				
Corequisite	**MSDB5001, MSDB5002, MSDB5004 and MSMB5003**				
Antirequisite					
		L	**T**	**P**	**C**
		-	**-**	**4**	**2**

Course Objectives:
Student will understand the basic fundamental knowledge microbiological instruments used in laboratory, biochemical analysis of bio-molecules. It will also emphasize of the different stages of cell division and enzyme activity. It also extends the knowledge of extraction of nucleic acids.

Course Outcomes

CO1	**Demonstrate the basic principle and applications of important instruments**
CO2	**Construct various buffer solutions.**
CO3	**Handle extraction of enzymes using different sources**
CO4	**Measures the various factors affecting enzyme activity.**
CO5	**Perform the analysis of carbohydrates, Lipids and protein**

Text Book (s)

1. The HiMediaManual.For Microbiology and Cell Culture Laboratory Practice. Published by HiMedia Laboratories Pvt. Ltd., Mumbai. 2003.
2. Aneja KR. Experiments in Microbiology, Plant pathology and Biotechnology. 4th Edition, New Age International Publishers, Chennai. 2005
3. Horold J Benson. Microbiological Applications. Laboratory Manual in General Microbiology. 7th International Edition, WCB McGraw – Hill, Boston. 1998
4. James G Cappuccino & Natalie Sherman Microbiology : A Laboratory manual. 6th Edition, Published by Pearson Education. 2004
5. Dubey RC and Maheswari DK. Practical Microbiology 1st Edition, S. Chand & Company Ltd., New Delhi. 2004
6. Myer's and Koshi's Manual of Diagnostic Procedures in Medical Microbiology and Immunology / Serology. Published by Department of Clinical Microbiology, CMC and Hospital, Vellore, Tamil Nadu. 2001

- **Reference Book (s)**

- Sundararaj T. Microbiology – Laboratory Manual. Revised and Published by AswathySundararaj, No.5. 1st Cross Street, Thirumalai Nagar, Perundgudi, Chennai.
- Kannan N Laboratory Manual in General Microbiology. 1st Edition, Palani Paramount Publications, Palani, Tamilnadu. 1996
- Kannan N. Handbook of Laboratory Culture Media, Reagents, Stains and Buffers. Panima Publishing Corporation, New Delhi. 2003
- 10.Kalaichelvan PT. Microbiology and Biotechnology – A Laboratory Manual 1st Edition, MJP Publishers, A Unit of Tamil Nadu Book House, Chennai. 2005.
- 11.ChellamRajamanicam – Experiments Protocols in Basic Molecularbiology. Osho Scientific Publications, Madurai.

1. **Study of the life history of the following scientists and their contributions with the help of their photographs: Anton von Leeuwenhoek, Edward Jenner, Louis Pasteur, Robert Koch and Alexander Fleming.**

2.	**To study the principle and applications of important instruments (Microscope, biological safety cabinets, autoclave, BOD incubator and hot air oven) used in the microbiology laboratory.**
3.	**Cleaning and preparation of glassware for sterilization.**
4.	**Qualitative analysis of carbohydrates in given solution.**
5.	**Qualitative analysis of lipids in given solution.**
6.	**Qualitative analysis of amino acid and protein present in the given solution.**
7.	**Demonstration of different stages of mitosis.**
8.	**Demonstration the different stages of meosis.**
9.	**Salivary amylase activity**
10.	**Effect of pH on enzyme activity**
11.	**Effect of temperature on enzyme activity**
12.	**Isolation and estimation of DNA.**
13.	**Isolation and estimation of RNA.**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
50		50	100

Semester-II

Name of The Course	**Immunology**				
Course Code	**MSDB5006**				
Prerequisite	**Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.**				
Corequisite	**Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.**				
Antirequisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives:

- The students will be able to identify the cellular and molecular basis of immune responsiveness. The students will be able to describe the roles of the immune system in both maintaining health and contributing to disease. The students will be able to describe immunological response and how it is triggered and regulated.
-

Course Outcomes

CO1	**Explain the basic concepts of Immunology.**
CO2	**Describe the working of adaptive immune response.**
CO3	**Demonstrate the types of vaccines and different immunological techniques.**
CO4	**Illustrate the genetic basis of immunology, transplant and tumor immunology.**
CO5	**Discuss the various types of immune system disorder**
CO6	**Analyze the recent advancement in Immunology**

Text Book (s)

- Immunology, 6th edition, (2006), J. Kuby et al, W.H. Freeman and Company, New York. ISBN-13: 978-1429202114.
- Roitt"s Essential Immunology, 12th edition, (2011), Wiley-Blackwell Science. ISBN-13: 978-1405196833.
- Cellular and Molecular Immunology, 7th edition, (2011). Abul K. Abbas, Andrew H. Lichtman, Shiv Pillai. Saunders. ISBN-13: 978-1437715286.

Reference Book (s)

- Immunology, 6th edition, (2006), J. Kuby et al, W.H. Freeman and Company, New York. ISBN-13: 978-1429202114.
- Cellular and Molecular Immunology, 7th edition, (2011). Abul K. Abbas, Andrew H. Lichtman, Shiv Pillai. Saunders. ISBN-13: 978-1437715286.
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Unit-1 Basic concepts of immunology (08 lectures) **Types of immunity; organs and cells involved in immune system; Antigen, haptens, adjuvants, antigenicity, antigenic determinants and epitopes;Antibodystructure and functions; Theories of antibody formation; Antibody diversity.**
Unit-2 Complement system and adaptive immune response (10 lectures) **Complement system - components, nomenclature, activation of complement, complement receptors and alternate pathway; Antigen recognition - T cell and B cell receptor complexes, antigen processing and presentation; Interaction of T and B cells; Cytokines; Immunological memory; Cytotoxicity - immunotolerance, immunosuppression; Basic concepts of abzymes, immunotoxin, chimera, hybrid antibodies, antigen-antibody interactions**

Unit-3 Vaccines and immunological techniques (10 lectures) **Vaccines - Types and their characteristics; Immunization practices-immunoprophylaxis and immunotherapy. Immunological techniques - Affinity and avidity, cross reactivity, precipitation, agglutination, immunodiffusion, immunoelectrophoresis, ELISA (indirect, sandwich, competitive, chemiluminescence, and ELISPOT assay), immunofluorescence, flow cytometry and fluorescence, and immunoelectron microscopy.**
Unit-4 Genetic basis of immunology, transplantation and tumor immunology (10 lectures) **Major Histocompatibility Complex - Organization of MHC and inheritance in humans, concepts of polygeny and polymorphism with respect to MHC; Histocompatibility testing; Transplantation - types, genetics of transplantation, graft versus host reactions; Tissue matching and immuno suppressive agents; Tumor immunology - immune surveillance, tumor antigens, immune response to tumors, immunotherapy of tumors.**
Unit-5 Dysfunctions of the immune system (10 lectures) **Hypersensitivity - definition and classification, mechanism involved, diagnosis and treatment; Autoimmunity and autoimmune diseases - mechanism of development, diagnosis and treatment; Immunodeficiency disorders-B cell deficiencies, T cell deficiencies, secondary immunodeficiency diseases-pathogenesis, diagnosis and treatment of AIDS.**
Unit-6 Recent advances in Immunology (04 lectures) **Research article/ Review paper/ MOOC**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Bioanalytical and Microbial Techniques**				
Course Code	**MSDB 5007**				
Prerequisite	**Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.**				
Corequisite	**Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.**				
Antirequisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives:

- To provide the knowledge of the scientific instruments in life sciences and biotechnology along with the applications.
- This will enable the students to understand all the subjects of biological sciences as these tools and techniques will be used therein.
- Also acquire the basic knowledge of the microbiological techniques to be applied in the laboratory.
- To know the general microbiological techniques for isolation of pure cultures of microorganisms.

Course Outcomes

CO1	**Demonstrate the basic principles, working and applications of different microscopic techniques.**
CO2	**Demonstrate the principle and applications of centrifugation technique.**
CO3	**Illustrate the principle and functioning of electrophoresis and chromatography.**
CO4	**Evaluate the different types of spectroscopic techniques**
CO5	**Deduce fundamental concept of radioactivity and radioisotopic techniques**
CO6	**Analyze the recent advancement in Bioanalytical Techniques**

Text Book (s)

- Physical Biochemistry: Principles and Applications (2010) 2nd ed., Sheehan, D., Wiley Blackwell (West Sussex), ISBN:978-0-470-85602-4 / ISBN:978-0-470-85603-1.
- Physical Biochemistry: Applications to Biochemistry and Molecular Biology (1982) 2nd ed., Freifelder, D., W.H. Freeman and Company (New York), ISBN:0-7167-1315-2 / ISBN:0-7167-1444-2.
- An Introduction to Practical Biochemistry (1998) 3rd ed., Plummer D. T., Tata McGraw Hill Education Pvt. Ltd. (New Delhi), ISBN:13: 978-0-07-099487-4 / ISBN:10: 0-07-099487-0.
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Reference Book (s)

- Principles and techniques of biochemistry and molecular biology. 6th ed. Wilson, Keith, Walker, John M Cambridge; New York : Cambridge. ISBN-10: 9780521178747.
- An Introduction to Practical Biochemistry (1998) 3rd ed., Plummer D. T., Tata McGraw Hill Education Pvt. Ltd. (New Delhi), ISBN:13: 978-0-07-099487-4 / ISBN:10: 0-07-099487-0

Unit-1 Microscopy (08 lectures) **Light, electron (scanning and transmission), phase contrast, fluorescence microscopy, freeze-fracture technique, specific staining of organelles or marker enzymes.**
Unit-2 Viscosity and centrifugation (10 lectures) **Viscosity – Viscosity of macromolecules, relationship with conformational changes; Centrifugation – Principles of centrifugation, concepts of RCF, different types of instruments and rotors, preparative, differential and density gradient centrifugation, analytical ultra-centrifugation, determination of molecular weights and other applications, subcellular fractionation.**
Unit-3 : Electrophoresis and chromatography (08 lectures) **Electrophoresis - Moving boundary and zonal electrophoresis, paper and gel electrophoresis, isoelectric focusing; Chromatography -Principles of partition chromatography, paper, thin layer, ion exchange and affinity chromatography, gel permeation chromatography, HPLC and FPLC.**
Unit-4 Spectroscopy (08 lectures) **Spectroscopy - Concepts of spectroscopy, Visible and UV spectroscopy, Laws of photometry. Beer-Lambert's law, Principles and applications of colorimetry; Basic concepts and applications of MS, ORD, CD, X-ray diffraction, X-ray absorption, NMR.**
Unit-5 Radioisotopic techniques (08 lectures) **Nature of radioactivity, properties of α-, β-, and γ-rays; measurement of radioactivity, use of radioisotopes in research. In vivo and in vitro labeling techniques, double labeling, quenching, internal standard, channel ratio, external standard ratio, emulsion counting, radioactive decay, autoradiography.**

Unit-6 Recent advances in Bioanalytical and microbial techniques	**(04 lectures)**
Research article/ Review paper/ MOOC	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Biotechnology and Genetic engineering				
Course Code	MSDB 5008				
Prerequisite	Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.				
Corequisite	Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.				
Antirequisite					
		L	T	P	C
		4	0	0	4

Course Objectives:
The objective of the course is to familiarize the students with the basic concepts in genetic engineering; to acquaint the students to versatile tools and techniques employed in genetic engineering and recombinant DNA technology; and to appraise them about applications genetic engineering.

Course Outcomes

CO1	Interpret the basic concept of animal and plant biotechnology using animal and of plant cell culture.
CO2	Demonstrate the isolation, purification of nucleic acid Construction DNA library and DNA sequencing.
CO3	Illustrate the various Gene transfer techniques.
CO4	Evaluate the concept of plant genetic Engineering, PCR and application of transgenic science in plant and animal improvement.
CO5	Analysis of gene therapy and stem cell therapy.
CO6	Analyze the recent advancement in Biotechnology and Genetic Engineering

Text Book (s)

- Principles of Gene Manipulations 1994 by Old and Primrose Blackwell Scientific Publications.
- DNA Cloning: A Practical Approach by D.M. Glower and B.D. Hames, IRL Press, Oxford. 1995.
- Molecular Biotechnology 2nd Edition by S.B. Primrose. Blackwell Scientific Publishers, Oxford. 1994.
- Genetic Engineering and Introduction to Gene Analysis and Exploitation in Eukaryotes by S.M. Kingsman and A.J. Kingsman, Blackwell Scientific Publications, Oxford 1998.

Reference Book (s)

- PCR Technology - Principles and Applications for DNA Amplification by Henry A. Erlich (Ed.) Stockton Press. 1989.
- Biotechnology: A Guide to Genetic Engineering by Peters.
- Genetic Engineering – 2000 by Nicholl.
- Recombinant DNA and Biotechnology: Guide for Teachers. 2nd Edition by Helen Kreuz. 2001. ASM Publications.

- Molecular Biotechnology: Principles and Applications of Recombinant DNA. 2 nd Edition. 1998 by Bernard R. Glick and Jack J. Pastemak, ASM Publications.

Unit-1 Introduction to animal and plant biotechnology (08 lectures) **Basic introduction to animal and plant biotechnology; types of plant tissue culture, germplasm conservation, Animal Biotechnology - organ culture; cell culture and initiation of cell culture; evolution of continuous cell lines.**
Unit-2 Construction of DNA libraries (08 lectures) **Isolation and purification of nucleic acid (genomic/plasmid DNA and RNA), Quantification and storage of nucleic acids, Construction ofcDNA library, Construction of Genomic library, Screening and preservation of DNA libraries, DNA Sequencing and cloning strategies.**
Unit-3 Gene transfer techniques (06 lectures) **Gene transfer techniques: biological methods; chemical methods; physical or mechanical methods.**
Unit-4 Transgenics (10 lectures) **Plant Genetic Engineering: Restriction enzymes; Transformation of plant cells; different type of vectors including viral vectors and their benefits; Screening and selection of transformants, PCR and hybridization methods; Transgene selection and silencing; Generation and maintenance of transgenic plants, Bt cotton, golden rice and some others as examples; Application of transgenic science in plant and animal improvement.**
Unit-5 Gene therapy and stem cell (08 lectures) **Gene therapy: Introduction and Methods, Gene targeting and silencing, Gene therapy in the treatment of diseases, Challenges, future and ethical considerations in human gene therapy. Stem cells: Culture, identification, maintenance, characterization and proliferation heterogeneity.**
Unit-6 Recent advances in biotechnology and genetic engineering (04 lectures) **Research article/ Review paper/ MOOC**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**PHYSIOLOGY AND METABOLISM OF MICROBES**				
Course Code	**MSMB5010**				
Prerequisite	**Graduation life science and applied science from any recognized university or equivalent examination with a minimum of 50 % marks in aggregate.**				
Corequisite	**Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.**				
Antirequisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives:

Students will understand the major features of growth and metabolism of microorganisms. The course will emphasize determination of growth curve of microbial growth and influence of environment and primary and secondary metabolism. It will also enhance the knowledge of microbial metabolism of biomolecules.

Course Outcomes

CO1	**Knowledge on growth of Microbes**
CO2	**Explain the fundamentals of carbohydrate metabolism**
CO3	**Explain the process photosynthesis and of synthesis and degradation of lipids.**
CO4	**Describe the metabolism of essential, non-essential amino acids and nucleotides.**
CO5	**Knowledge on nitrogen metabolism**
CO6	**Analyze the recent advancement in Microbial physiology and metabolism**

Text Book (s)

1. Biochemistry by Geoffrey L. Zubay. Fourth Edition, Addison-Wesley educational publishers Inc., 2008
2. Lehninger Principles of Biochemistry by David L. Nelson and Michael M. Cox. Fifth Edition, W.H. Freeman and Company; 2008.
3. Microbial lipids edited by C. Ratledge and SG Wilkinson, second edition, Academic Press; 1988.
4. Microbial Physiology by Albert G. Moat and John W. Foster. Third edition, John Wiley and Sons; 2002
5. The Physiology and Biochemistry of Prokaryotes by David White. Second Edition, Oxford University Press; 2000.

Reference Book (s)

1. Microbial Physiology by Albert G. Moat and John W. Foster. Third edition, John Wiley and Sons; 2002
2. The Physiology and Biochemistry of Prokaryotes by David White. Second Edition, Oxford University Press; 2000.

Unit-1 Microbial Growth	**10 lectures**
The concept of growth and definition, formation of protoplasm, building of macromolecules from elemental nutrients, supramolecules, orgnelles of cell and cellular components. Cell cycle in microbes and generation time. Growth phases of bacteria – Lag phase, exponential (logarithmic) phase, stationary (ideo) phase, decline and survival of microbial cells. Importance of each growth phase. Synchronous cultures – Methods of synchronous culturing, Continuous culturing methods, factors effecting growth. Methods of growth measurement	
Unit-2 Carbohydrate Metabolism	**10 lectures**
Carbohydrate metabolism: glycolysis and its regulation, Feeder pathway of glycolysis and carbohydrate– homo and hetero lactic fermentation, Glycogenesis, Glycogenolysis and regulation, Gluconeogenesis. Pentose phosphate pathway, ED pathway, Kreb's cycle and glyoxalate pathway. Electron transport system in Mitochondria, Electron careers and multi enzyme complex I to IV.ATP synthesis: substrate level and oxidative phosphorylation and un-couplers, inhibitors of oxidative phosphorylation.	
Unit-3 Lipid Metabolism	**10 lectures**
Lipid biosynthesis: Biosynthesis of lipids and fatty acids, triglycerol and phospholipids and their regulation. Lipid Metabolism: Degradation of Lipids, oxidation of unsaturated, saturated, even and odd chain fatty acids, ketone bodies.	
Unit-4 Photosynthesis And Anaerobic Metabolism	**8 lectures**

Photosynthesis: Oxygenic and an-oxygenic microorganisms, structure of chloroplast, light reaction, photolysis of water and photophosphorylation, C3 and C4 pathway of carbon fixation. Nutritional classification of microorganisms, Energy generation in cyanobacteria, green bacteria, purple sulphur bacteria and chemolithotrops. Anaerobic metabolism: microbiological and biochemical fundamentals, factors influencing anaerobic metabolism.
Unit-5 Nitrogen Metabolism 8 lectures
Nitrification, denitrification, Nitrate and ammonia assimilation pathways, Nitrogen cycle. Diazotrophs and Biochemistry of nitrogen fixation, Structure of nitrogenase complex. Regulation of nitrogenase complex by oxygen and combined nitrogen sources. Nif genes and their regulation.
Unit-6 Recent advances in Microbial physiology and metabolism (04 lectures) **Research article/ Review paper/ MOOC**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**ADVANCED VIROLOGY**				
Course Code	**MSMB5014**				
Prerequisite	**Graduation life science and applied science from any recognized university or equivalent examination with a minimum of 50 % marks in aggregate.**				
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		3	**1**	**0**	**3**

Course Objectives:

Students will understand the classification, basic characteristics and ultra structure of viruses. The course will emphasize on developing an understanding the virus life cycles and their interactions with host cells.

Course Outcomes

CO1	**Knowledge on classification, morphology and ultra structure of viruses.**
CO2	**Knowledge on virus cultivation and assay**
CO3	**Understanding on structure and pathogenicity of plant viruses**
CO4	**Illustration of classification and ultra structure of bacteriophage**
CO5	**Evaluation of viral infection and pathogenesis**
CO6	**Analyze the recent advancement in Virology**

Text Book (s)

1. Principles of Virology: Molecular Biology, Pathogenesis and Control of Animal Viruses by S.J. Flint, L.W. Enquist, V.R. Racaniello, and A.M. Skalka 2nd edition, ASM Press, Washington, DC, 2004.
2. Introduction to Modern Virology EPZ by Nigel Dimmock, Andrew Easton and Keith Leppard, 5th edition, Blackwell Publishing, 2005
3. Virology; Renato Dulbecco and Harold S. Ginsberg, Fourth edition, J.B. Lippincott Company, USA
4. An Introduction to viruses, S. B. Biswas and Amita Biswas. Forth edition, Vikas Publishing House PVT LTD New Delhi.

5. Textbook of Microbiology by Ananthnarayanan and Paniker's, eighth edition, Universities Press .
6. Microbiology; Lansing M Prescott, John P. Harley, Donald A Klein, Sixth edition, McGraw Hill Higher education.
7. Plant Virology by Roger Hull, 4th edition, Academic press, 2002.

Reference Book (s)

1. Principles of Virology: Molecular Biology, Pathogenesis and Control of Animal Viruses by S.J. Flint, L.W. Enquist, V.R. Racaniello, and A.M. Skalka 2nd edition, ASM Press, Washington, DC, 2004.
2. Introduction to Modern Virology EPZ by Nigel Dimmock, Andrew Easton and Keith Leppard, 5th edition, Blackwell Publishing, 2005

Unit-1 CLASSIFICATION AND MORPHOLOGY OF VIRUSES 8 lectures
Brief outline on discovery and origin of viruses. General properties of viruses, morphology and ultra-structure of viruses, capsid and their arrangements, types of envelopes and their composition, measurement of viruses. Viral genome; their types and structure, viral related agents-viroids and prions. Classification and general properties of major families of viruses including detail account of their mode of replication.
Unit-2 CULTIVATION OF VIRUSES 10 lectures
Cultivation of viruses- in embryonated eggs, experimental animals and cell lines; primary and secondary cell lines, diploid cell culture. Assay of viruses: physical and chemical methods, plaque method, pock counting and end point method. Serological methods: hemagglutination, hemagglutination inhibition, neutralization test, complement fixation, ELISA, RIA. Purification of viruses: gradient centrifuge, electrophoresis, and chromatography.
Unit-3 PLANT VIRUSES 8 lectures
Plant viruses: recent advance in classification of plant viruses. Structure and pathogenicity of TMV. Transmission of plant viruses with vector (insect, nematodes and fungi) and without vector (contact, seed and pollens). Biochemical changes induced by virus in plant cell. Animal viruses: nomenclature and classification of animal viruses. General idea about Cyanophage, and Mycophage.
Unit-4 BACTERIOPHAGE 8 lectures
Bacteriophage: classification, morphology and ultra structure. One step growth curve (latent period, eclipse period, and burst of size.) Life cycle: lytic and lysogenic life cycle of bacteriophages. Brief account of M13, Mu, T4, Ø x174 and lambda phage.
Unit-5 PATHOGENESIS OF VIRAL INFECTION 10 lectures
Patterns of some viral diseases- epidemiology, transmission, infection, symptoms, risk, transformation and oncogenesis, emerging viruses. Stages of infection, Anti-viral strategies-prevention and control of viral diseases: Host specific and nonspecific defence mechanisms involved in resistance to and recovery from virus infections. Role of interferon in viral infections. Contributions of various host defence mechanisms in viral infections; Viral Chemotherapy: Nucleoside analogs, reverse transcriptase inhibitors, protease inhibitors, History of vaccines especially smallpox and polio. New methods: subunit vaccines, anti-idiotype and DNA vaccines.
Unit-6 Recent advances in Virology (04 lectures) **Research article/ Review paper/ MOOC**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**ADVANCED MICROBIOLOGY LAB - II**				
Course Code	**MSMB5012**				
Prerequisite	**Graduation life science and applied science from any recognized university or equivalent examination with a minimum of 50 % marks in aggregate.**				
Corequisite	**MSDB5006, MSDB5007, MSDB5008, MSMB5010 and MSMB5011**				
Antirequisite					
		L	**T**	**P**	**C**
		0	**0**	**4**	**2**

Course Objectives:
Student will learnto make the various culture media, isolation and handling of pure culture of microorganism. The course will also help to learn the staining techniques for microorganism. It will also emphasize the immunological experiments.

Course Outcomes

CO1	**Construct various culture media.**
CO2	**Demonstration of handling of microorganism**
CO3	**Isolation pure culture.**
CO4	**Staining of microorganism**
CO5	**Perform the blood grouping, agglutination inhibition Assay.**

Text Book (s)

1. The HiMediaManual.For Microbiology and Cell Culture Laboratory Practice. Published by HiMedia Laboratories Pvt. Ltd., Mumbai. 2003.
2. Aneja KR. Experiments in Microbiology, Plant pathology and Biotechnology. 4th Edition, New Age International Publishers, Chennai. 2005
3. Horold J Benson. Microbiological Applications. Laboratory Manual in General Microbiology. 7th International Edition, WCB McGraw – Hill, Boston. 1998
4. James G Cappuccino & Natalie Sherman Microbiology : A Laboratory manual. 6th Edition, Published by Pearson Education. 2004
5. Dubey RC and Maheswari DK. Practical Microbiology 1st Edition, S. Chand & Company Ltd., New Delhi. 2004
6. Myer's and Koshi's Manual of Diagnostic Procedures in Medical Microbiology and Immunology / Serology. Published by Department of Clinical Microbiology, CMC and Hospital, Vellore, Tamil Nadu. 2001
7. Sundararaj T. Microbiology – Laboratory Manual. Revised and Published by AswathySundararaj, No.5. 1st Cross Street, Thirumalai Nagar, Perundgudi, Chennai.
8. Kannan N Laboratory Manual in General Microbiology. 1st Edition, Palani Paramount Publications, Palani, Tamilnadu. 1996
9. Kannan N. Handbook of Laboratory Culture Media, Reagents, Stains and Buffers. Panima Publishing Corporation, New Delhi. 2003
10.Kalaichelvan PT. Microbiology and Biotechnology – A Laboratory Manual 1st Edition, MJP Publishers, A Unit of Tamil Nadu Book House, Chennai. 2005.
11.ChellamRajamanicam – Experiments Protocols in Basic Molecularbiology. Osho Scientific Publications, Madurai.

1.	**Preparation of nutrient broth for the routine cultivation of bacteria.**
2.	**Preparation of nutrient agar for the routine cultivation of bacteria.**
3.	**Virtual demonstration (as per UGC guidelines) of handling of laboratory microorganism.**
4.	**Isolation of microorganisms by streak plate method.**

5.	**To isolate the microorganisms by spread plate method.**
6.	**To isolate the microorganisms by serial dilution technique (or viable plate count method).**
7.	**To understand the different components of light microscope.**
8.	**To demonstrate the basic principle of centrifuge.**
9.	**Gram staining techniques; identification of bacteria.**
10.	**To perform immuno-diffusion by Ouchterlony/ Mancini method.**
11.	**To perform ELISA experiment.**
12.	**Grouping of blood and Rh typing.**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
50		50	100

Name of The Course	**Research Methodology**				
Course Code	MBS28T2111				
Prerequisite	Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.				
Corequisite	Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.				
Antirequisite					
		L	**T**	**P**	**C**
		2			2

Course Objectives:

The primary objective of this course is to develop a research orientation among the students and scholars and to acquaint them with fundamentals of research methods. Specifically, the course aims at introducing them to the basic concepts used in research and to scientific social research methods and their approach. It includes discussions on sampling techniques, research designs and techniques of analysis.

Course Outcomes

CO1	7. Understand the Principles of Scientific Research and different steps involved in doing research.
CO2	8. Know how to design research and frame up different steps in design.
CO3	9. Appraise the application of sampling through statistics.
CO4	10. Build up the method for data collection and analyse the data.
CO5	11. Develop the Concept of hypothesis preparation.
CO6	12. Developthe statistical analysis indulges in modern research for drug designing.

Text Books:

13. K. Ramakant; Elementary Statistics in a world of applications, Goodyear California Pub. Co.,1979.

14. K. D. Broota, Experimental designs in psychological research, Wiley eastern, New York, 1992.

15. Guilford, Statistics in Psychology and Education, McGraw hill, New York, 1986.

16. Katz and Kahn, Research in Behavioural Sciences, Methuen, USA, 1979.

Reference Books:

11. Kerlinger, F., Foundations of Behavioural Research, Surjeet Publications, Delhi, 1983.

12. Rajamanickam, M., Statistical Methods in Psychological and Educational Research, Concept Publishing Co. New Delhi, India, 1983.

13. Smith, Jonathan, A. (Ed.), Qualitative Psychology: A Practical Guide to Research Methods, Sage Publications, 2003.

14. Woodworth and Schlosberg, Experimental Psychology, Methuen and co. ltd, London, 1971.

5.Chanin Nantasenamat, Chartchalerm Isarankura-Na-Ayudhya, Thanakorn Naenna, Virapong Prachayasittikul, A Practical Overview of Quantitative Structure- Activity Relationship.EXCLI Journal 2009;8:74-88.

15. Wiktor Pronobis,Alexandre Tkatchenko,and Klaus-Robert Muller, J. Chem. Theory Comput. 2018, 14, 2991−3003

16. Leo, A., & Hoekman, D. H. (1995). *Exploring QSAR*. American Chemical Society.

Unit – 1: Principles of Scientific Research 6 Lectures

Research and research methodology, Procedures in research, Identification of the problem - Literature survey - Reference collection - Familiarity with ideas and concept of investigation - Qualitative and Quantitative analysis - Results - Synopsis writing - Art of writing a Research paper and Thesis.

Unit – 2: Research Design, Sampling & Probability 5-Lectures

Research Design: Features of a Good Design, Different Research Designs, Sampling: Principles, methods, types of sampling, rationale for using a particular sampling procedure, Probability: Classical definition of Probability.

Unit – 3: Data collection & analysis 6- Lectures

Types of Data, Collection of Data, double blind procedures, incidence and prevalence studies, Data Analysis: Measures of Central Tendency, Measures of Dispersion, Measures of Asymmetry,

Unit-4: Correlation and Regression 5-Lectures

Methods of correlation, Types of correlation (Pearson r& Rho); Regression analysis, linear regression, Non-linear regression.

Unit – 5: Hypothesis and Statistics 5-Lectures

Hypothesis Testing: Problems and hypothesis, variables and type of variables, Parametric and nonparametric statistics; level of significance, the various nonparametric tests with sample.

Module 6: Recent research advances

Descriptors, Quantitative structure-activity relationship (QSAR), Quantitative structure-property relationship(QSPR), Drug designing.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	**20**	**50**	**100**

SEMESTER-III

Name of The Course	**MEDICAL AND PHARMACEUTICAL MICROBIOLOGY**				
Course Code	**MSDB6002**				
Prerequisite	**Graduation life science and applied science from any recognized university or equivalent examination with a minimum of 50 % marks in aggregate.**				
Corequisite	**Students should have understanding of general pathogens and diseases due to microbes and antibiotics including a basic knowledge of the biological molecules.**				
Antirequisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives:
Student will understand basic principles and various mechanism infections and control of disease. The course will also focus on many etiological agents responsible for global infectious diseases. The course will provide the conceptual basis for understanding pathogenic microorganisms and there pathogenicity. It will also provide the basic concept of role of microorganism in pharma industry.

Course Outcomes

CO1	**Get general information about various mechanisms of infection and control measures of diseases**
CO2	**Evaluation of methods used to identify infectious agents in the clinical microbiology lab**
CO3	**Explain general and specific mechanisms of different bacterial, viral and fungal infection.**
CO4	**Identify the role of microorganism in pharma industry**
CO5	**Ideas on the regulatory aspect, quality assurance and validation in microbiological labs**
CO6	**Analyze the recent advancement in Medical And Pharmaceutical Microbiology**

Text Book (s)

1. Chaechter M. Medoff G. and Eisenstein BC. (1993) Mechanism of Microbial Diseases 2nd edition. Williams and Wilkins, Baltimore.
2. Collee, JG. Duguid JP, Fraser AG, Marimon BP. (1989) Mackie and McCartney Practical Medical Microbiology, 13th Edition. Churchill Livingstone.
3. David Greenwood, Richard CD, Slack, John Forrest Peutherer. (1992) Medical Microbiology. 14th edition. ELBS with Churchill Livingstone.
4. Hugo WB and Russell AD. (1989) Pharmaceutical Microbiology IV edition. Blackwell Scientific Publication, Oxford.
5. Joan Stokes E, Ridgway GL and Wren MWD. (1993). Clinical Microbiology, 7th edition. Edward Arnold. A division of Hodder and Stoughton.

Reference Book (s)

1. Baron EJ, Peterson LR and Finegold SM (1994). Bailey and Scott's – Diagnostic Microbiology. 9th Edition, Mosby Publications.
2. Topley& Wilsons (1995). Principles of Bacteriology, Virology and Immunology, Edward Arnold, London.
3. Morag C 7 MC Timbury (1994). Medical virology. 10th Edition, Churchill Livingstone, London. 4. Patric R Murray (1990). Medical Microbiology. Mosby Publications.

Unit-1 BASICS IN MEDICAL MICROBIOLOGY 8 lectures
Infectious diseases overview. Medically important microbes. Microbial diseases - sources, route of transmission. Pathogenesis, Microbial virulence and virulence factors - Signs and symptoms of microbial diseases. Treatment, Prevention and control of microbial infections. Immunity of microbial diseases.

Unit-2 DIAGNOSIS OF MICROBIAL DISEASE 8 lectures
Collection, transport and preliminary processing of clinical pathogens. Clinical, microbiological, immunological and molecular diagnosis of microbial diseases. Modern methods of microbial diagnosis.
Unit-3 BACTERIOLOGY, VIROLOGY, MYCOLOGY 8 lectures
Characteristics, diagnosis, treatment, prevention and control of diseases caused by Bacteria, DNA, RNA Virus, Human mycotic infections, parasites, Laboratory techniques in parasitology.
Unit-4ANTIBIOTICS, SYNTHETIC ANTIMICROBIAL AGENTS AND ACTION MECHANISM OF ANTIBIOTICS 10 lectures
Antibiotics and synthetic antimicrobial agents, Antifungal antibiotics. Peptide antibiotics, Chloramphenicol, Sulphonamides and Quinolinone antimicrobial agents. Chemical disinfectants, antiseptics and preservatives, Mechanism of action of antibiotics (inhibitors of cell wall synthesis, nucleic acid andprotein synthesis). Bacterial resistance to antibiotics, Penetrating defenses – How the antimicrobial agents reach the targets (cellular permeability barrier, cellular transport system and drug diffusion).
Unit-5REGULATORY PRACTICES, QUALITY ASSURANCE 10 lectures
Financing R&D capital and market outlook. IP, BP, USP., Government regulatory practices and policies, FDA perspective, Application of microbial enzymes in pharmaceuticals, Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) in pharmaceutical industry. Regulatory aspects of quality control. Quality assurance and quality management in pharmaceuticals ISO, WHO and US, Certification, Sterilization control and sterility testing, Safety in microbiology laboratory.
Unit-6 Recent advances in Medical and pharmaceutical microbiology (04 lectures) **Research article/ Review paper/ MOOC**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**SUMMER TRAINING**				
Course Code	**MSBC6003**				
Prerequisite	**Graduation life science and applied science from any recognized university or equivalent examination with a minimum of 50 % marks in aggregate.**				
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		0	**0**	**0**	**3**

Course Objectives:

The course will develop the skill and introduce the students to exciting basic techniques of microbiology, fermentation technology and Biosensors. Student will learn to organize the experiments, collection of results and interpretation of results and analysis. The course will also emphasize on the knowledge and understanding the research process.

Course Outcomes

CO1	**Demonstrate the use of knowledge of basic and applied sciences in project based learning.**
CO2	**Organizes experiments and researches, perform analysis and interpret data for the designed project.**
CO3	**Cooperate effectively as an individual and as a member in the research team.**
CO4	**Systematize the articulated ideas, comprehend and write effective reports, documentation and to communicate effectively.**
CO5	**Demonstrate knowledge and understanding of research problems and related principles to manage projects in multidisciplinary research areas.**

Text Book (s)
Reference Book (s)
COURSE CONTENTS:

Summer Training is considered as a special course involving application of knowledge in solving / analyzing /exploring a real life situation / difficult problem. Summer training work may be given in lieu of a discipline specific elective paper/Biochemistry.This should be done in consultation with the faculty supervisor and agency supervisor under whom he / she is getting trained. The project report should be around 40 pages and chaptered as follows:

Chapter I: Introduction
Chapter II: Review of Literature
Chapter III: Methodology
Chapter IV: Results
Chapter V: Discussion
Chapter VI: Summary and Conclusion

The following weightage is assigned at each stage of Student Project evaluation.

Activity	Remarks
ZerothReveiw	**Project scopes and Proposal**
1st Review	Methods of project Implementation
2nd Review	Technical Achievement
3rd Review (Final)	Innovation and contribution
Submission of Project Report to the Department	Two weeks before the viva-voce exam

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
50	**-**	**50**	**100**

Name of The Course	**ALGAL AND FUNGAL MICROBIOLOGY**				
Course Code	**MSMB6004**				
Prerequisite	**Graduation life science and applied science from any recognized university or equivalent examination with a minimum of 50 % marks in aggregate.**				
Corequisite	**Students should have the basic concept of characteristics and knowledge of biology of algae and fungi.**				
Antirequisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives:
Student will understand classification of algae and fungi based on molecular and phylogenetic relationships. The course will provide phycological and mycological knowledge; learn about the diversity of algae and fungi and their importance in agriculture, industry and environment.

Course Outcomes

CO1	**Express the knowledge in the area of fungal classification, occurrence, somatic structure and life cycles of fungi.**
CO2	**Understands the rules of cellular and physiological development and functioning of fungi**
CO3	**Evaluation of fungal interaction with plant and animals.**
CO4	**Express the knowledge in the area of fungal classification, occurrence, somatic structure and life cycles of algae.**
CO5	**Summarize the applications of Algae in Agriculture, Industry, and Environment.**
CO6	**Analyze the recent advancement in Algal And Fungal Microbiology**

Text Book (s)

1. Alexopolus CJ, Mims CW, Blackwell M (2002). Introductory Mycology, 4th edition, Wiley India Pvt. Ltd, India.
2. Barsanti L, Gualtieri P (2005). Algae, Anatomy, Biochemistry & Biotechnology, CRC press, Taylor & Francis, Florida, USA.
3. Carlile MS, Watkinson SC, and G. Gooday (2001). The Fungi, 2nd edition, Academic Press, New York.
4. Graham LE, Graham JM, Wilcox LW (2009). Algae, 2nd edition, Benjamin Cummings, San Francisco. http://nt.ars-grin.gov/fungaldatabases/
5. Landecker ME (1996). Fundamentals of the fungi, 4th edition, Benjamin Cummings, San Francisco.
6. Moore D, Robson GD, Anthony P, Trinci J (2011). 21st Century Guidebook to Fungi, Cambridge University Press, UK.
7. Sumbali G (2005). The Fungi, 2nd edition, Narosa Publishing India House, India.

Reference Book (s)

1. Alexopolus CJ, Mims CW, Blackwell M (2002). Introductory Mycology, 4th edition, Wiley India Pvt. Ltd, India.
2. Barsanti L, Gualtieri P (2005). Algae, Anatomy, Biochemistry & Biotechnology, CRC press, Taylor & Francis, Florida, USA.
3. Carlile MS, Watkinson SC, and G. Gooday (2001). The Fungi, 2nd edition, Academic Press, New York.
4. Graham LE, Graham JM, Wilcox LW (2009). Algae, 2nd edition, Benjamin Cummings, San Francisco. http://nt.ars-grin.gov/fungaldatabases/

Unit-1 INTRODUCTION TO PHYCOLOGY AND CLASSIFICATION OF ALGAE 8 lectures

Phycology – Distribution of algae, Classification of algae; thallus organization in algae; reproduction in algae; Brief account of Chlorophyta, Bacillariophyta; Phaeophyta; Rhodophyta; Algal ecology.
Unit-2 IMPORTANCE OF ALGAE 10 lectures
Algal phenomenon and their ecological significance: Algal bloom and red tide, bioluminescence, heterotropism, Algal toxin Algal Biotechnology: Aquaculture (micro and macro algae cultivation), recent developments and future of algal biotechnology, bioremediation, Algal biofuels – algal biodiesel, bio-ethanol and biological hydrogen production; Algae in global warming – carbon capture by algae.
Unit-3 MYCOLOGY: CLASSIFICATION OF FUNGI 10 lectures
History and development of mycology, structure and cell differentiation, Criteria for fungal classification: Habitat morphology and reproduction of Slime molds, oomycetes, Zygomycotina, Ascomycotina, Basidiomycotina, Mastigomycotina and Deuteromycotina.
Unit-4 STRUCTURE OF FUNGAL CELL AND REPRODUCTION 10 lectures
Homothallism and Heterothallism, Hetrokaryosis, Sex hormones in fungi physiological specialization in fungi, fungal succession on decomposing litter Mycorrhiza - ectomycorriza, endomycorrhiza and vesicular arbuscularmycorrhiza. Role of Mycorrhiza in agriculture. Lichens
Unit-5 MEDICAL MYCOLOGY 12 lectures
Fungi and animal disease – Dermatophytes and agents of superficial mycoses. Yeasts of medical importance. Mycotoxins, antifungal agents. Dimorphic fungi causing systemic mycoses, Dimatiaceous fungi. Opportunistic hyaline hypomycetes, agents of zygomycosis, Fungi causing eumycoticmycetoma. Study the pathogenesis symptom and control of following diseases: Early and late blight of potato; loose smut of wheat, false smut of paddy, Fusarial wilt, red rot of sugarcane. Mode of actions of antifungal agents.
Unit-6 Recent advances in Algal and fungal microbiology (04 lectures) **Research article/ Review paper/ MOOC**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**MICROBES IN FOOD AND AGRICULTURE**				
Course Code	**MSMB6005**				
Prerequisite	**Graduation life science and applied science from any recognized university or equivalent examination with a minimum of 50 % marks in aggregate.**				
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives:

Student will understand the basic of different foods and its spoilage. Further, it also helps to better understand the mode of food preservation and the quality of different foods can be preserved following the various international guidelines.

Course Outcomes

CO1	**Understand the role of microorganism in food contamination, preservation and spoilage**
CO2	**Explain the role of microorganism in dairy.**
CO3	**Explain the role of microorganism in soil and its role**
CO4	**Evaluation of microbes in agriculture**
CO5	**Illustration of microbial agricultural technology**
CO6	**Analyze the recent advancement in Microbes in food and agriculture**

Text Book (s)

1. TEFrazier and Klesthoff (2004) Food Microbiology
2. James,MJ(2005) Modern Food Microbiology, 4th edition
3. Adams, MR and Moss, MO (2003) Food Microbiology.
4. Microbial Ecology: Organisms, Habitats, and Activities by Stolp, H.
5. Soil Microbiology and Biochemistry by Paul E. and PE Clank
6. Microbial Ecology: Principles, Methods and Applications by Lavin, Seidler, Rogul
7. Biological Nitrogen Fixation by Quispel.

Reference Book (s)

1. Mitchell R. Introduction to Environmental Microbiology. Prentice Hall. Inc. Englewood Cliffs, New Jersy. 1974
2. Atlas RN &BarthaR . Microbial Ecology, 4th Edition, Benjamin Cummings.1998

Unit-1 INTRODUCTION TO FOOD MICROBIOLOGY 10 lectures
Microorganisms important in food microbiology: molds, yeast and bacteria –general characteristics, classification and importance. Principles of food preservation, preservation by use of high temperature, low temperature, drying and dessication. Chemical preservatives and additives. Preservation by radiation. Microbial spoilage of food. Chemical changes caused by the microorganisms during spoilage. Spoilage of fish, meat, poultry, eggs, fruits and vegetables. Detection of spoilage and characterization.
Unit-2DAIRY MICROBIOLOGY 10 lectures
Dairy Microbiology - Types of microorganisms in milk, significance of microorganisms in milk, Microbial products of milk- Acidophilus Milk, Bifidus Milk, Bulgarian milk, Kefir, Kumiss, Microbiology of cheese, butter, yogurt; microbiological examination of milk, control of microbial flora of milk; Probiotics and Prebiotics: Properties and beneficial effects of probiotics and prebiotics; Screening methods of Probiotics; Genetically Modified Probiotics.
Unit-3 FOOD TECHNOLOGY 10 lectures
Microorganisms as source of food: Single Cell Protein (SCP). Mushrooms and food value of mushrooms. Food conversions: Lactic acid conversions, soyabean conversions and Bakery. Microbiological estimation of food: Sample collection, preparation and analysis techniques. Microbial Food poisoning, risks and hazards; Mycotoxins: Groups of mycotoxins, effects on human and animal health, Detoxification Methods (Physical, Chemical and biological) and Mechanism of toxicity; Food preservation methods and food safety issues.
Unit-4 SOIL MICROBIOLOGY AND PLANT PATHOGENS 12 lectures
Microorganisms of soil. Rhizosphere and phyllospheremicroflora. Brief account of Microbial interactions: antagonism, symbiosis, mutualism, commensalisms, synergism and parasitism. Nutrient cycle: Carbon cycle, nitrogen cycle, phosphorous cycle and sulphur cycle. Role of enzymes and toxins in pathogenesis. Fungal diseases of plants: Rusts of wheat, linseeds; late blight of potato; red rot of sugarcane. Bacterial diseases of plants : Citrus canker, blight of rice. Viral diseases of plants: Leaf curl of Papaya, vein clearing of lady's finger
Unit-5 AGRICULTURAL TECHNOLOGY 12 lectures
Physical and chemical control of plant diseases. Bacterial control of insect pests: *Bacillus thuringiensis*as bacterial insecticide. Viral control of insect pests: Nuclear polyhedrosisvisuses (NPV) and cytoplasmic polyhedrosis viruses (CPV). Fungal control of insect pests:

Entomopathogenic fungi. Biofertilizers: Types, production and application. Mycorrhizae : Types and their application in agriculture and forestry. Vermicomposting. Reclamation of waste agricultural land by microorganisms.
Unit-6 Recent advances in Microbes in food and agriculture (04 lectures) **Research article/ Review paper/ MOOC**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**ENVIRONMENTAL MICROBIOLOGY**				
Course Code	**MSMB6006**				
Prerequisite	**Graduation life science and applied science from any recognized university or equivalent examination with a minimum of 50 % marks in aggregate.**				
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives:
Student will understand the role of microorganisms as agents of environmental change. Recognize microorganisms as indicators of alteration of an ecosystem. Understand microbial processes aimed to solve environmental problems such as bioremediation, biodegradation, solid waste management, etc.

Course Outcomes

CO1	**Understand the basics of environmental microbiology**
CO2	**Application of microbes in bioremediation**
CO3	**Application of microbes in biodegradation**
CO4	**Evaluation the role of microbes in biodeterioration**
CO5	**Evaluation the role of microbes in solid waste management treatment**
CO6	**Analyze the recent advancement in Environmental Microbiology**

Text Book (s)

1. Microbial Ecology By Atlas R.M., Bartha R., Benjamin Cummings Publishing Co, Redwood City, CA., 1993.
2. Environmental Microbiology by A.H. Varnam& M.G. Evans, Manson Publishing Ltd., 2000.
3. Manual of Environmental Microbiology by Christon J. Hurst, Ronald L. Crawford, Jay L.Garland, David A. Lipson, Aaron L. Mills, ASM Press, 2007.
4. Environmental Microbiology by W.D. Grant & P.E. Long, Kluwer Academic Publishers, 1981.
5. Microbiology: An environmental Perspective by P. Edmonds, Macmillan, New York, 1978.
6. Lignocellulose Biotechnology: Future Prospects by R.C. Kuhad and A. Singh, I.K. International, 2007.
7. Applied Bioremediation and Phytoremediation by A. Singh and O.P. ward, Springer, 2004.
8. Advances in Applied Bioremediation by A. Singh, R.C. Kuhad and O.P. Ward, Springer, 2009.

Reference Book (s)

1. Microbial and Enzymatic Degradation of Wood and Wood components, by K-E.L. Eriksson, R.A. Blanchettee and P. Ander, Springer, 1990.
2. Encyclopedia of Microbiology, Six-Volume Set, 1-6 by MoselioSchaechter, Academic press, 2009.
3. Environmental Microbiology: Principles And Applications by Patrick K. Jjemba, Science Publishing Inc., 2004.

4. Environmental Microbiology by Raina Maier, Ian Pepper, & Charles Gerba, Academic Press, 2008.

Unit-1 ENVIRONMENTAL PROBLEMS, MONITORING AND DEVELOPMENT OF ENVIRONMENTAL MICROBIOLOGY 10 lectures
Environmental monitoring, Environmental laws and policies in India, Brief history and development of environmental microbiology: History and development of microbial ecology, highlighting significant contributions of microbiologists and emergence of environmental microbiology, and significant applications of microbes in solving environmental pollution problems using bio-indicators, biomarkers, biosensors.
Unit-2 BIOREMEDIATION 8 lectures
Bioremediation principles, Strategies and techniques of bioremediation: in situ and ex situ, Bioremediation of metals, Phytoremediation, GMOs and their impact on bioremediations.
Unit-3 BIODEGRADATION 8 lectures
Principles of biodegradation and mechanism of detoxification, Biodegradation of detergent, pesticide, lignin, hydrocarbon and dyes
Unit-4 BIODETERIORATION 8 lectures
Principles and mechanisms of biodeterioration, Methodology to assess biodeterioration, Prevention and control of biodeterioration, Biodeterioration of selected materials.
Unit-5 SOLID WASTE MANAGEMENT 8 lectures
Solid Waste types & their possible usages, landfill development and composting, Microbes and mineral recovery: Bioleaching of copper, gold and uranium.
Unit-6 Recent advances in Environmental microbiology (04 lectures) **Research article/ Review paper/ MOOC**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**ADVANCED MICROBIOLOGY LAB III**				
Course Code	**MSMB6007**				
Prerequisite	**Graduation life science and applied science from any recognized university or equivalent examination with a minimum of 50 % marks in aggregate.**				
Corequisite	**MSDB6002, MSMB6004, MSMB6005 and MSMB6006**				
Antirequisite					
		L	**T**	**P**	**C**
		0	**0**	**4**	**2**

Course Objectives:

Student will learn to isolate the micro-biota from various sources. The course will also focus on the test of quality of food. Also the student will learn to isolation of various microorganism and understand their role in agriculture.

Course Outcomes

CO1	**Demonstrate micro biota of mouth and food**
CO2	**Identification of food spoilage of food**
CO3	**Handle extraction of enzymes using different sources**
CO4	**Perform the fermentation of food product**
CO5	**Isolation and cultivation of fungi**

Text Book (s)

1. The HiMediaManual.For Microbiology and Cell Culture Laboratory Practice. Published by HiMedia Laboratories Pvt. Ltd., Mumbai. 2003.
2. Aneja KR. Experiments in Microbiology, Plant pathology and Biotechnology. 4th Edition, New Age International Publishers, Chennai. 2005
3. Horold J Benson. Microbiological Applications. Laboratory Manual in General Microbiology. 7th International Edition, WCB McGraw – Hill, Boston. 1998
4. James G Cappuccino & Natalie Sherman Microbiology : A Laboratory manual. 6th Edition, Published by Pearson Education. 2004
5. Dubey RC and Maheswari DK. Practical Microbiology 1st Edition, S. Chand & Company Ltd., New Delhi. 2004
6. Myer's and Koshi's Manual of Diagnostic Procedures in Medical Microbiology and Immunology / Serology. Published by Department of Clinical Microbiology, CMC and Hospital, Vellore, Tamil Nadu. 2001
7. Sundararaj T. Microbiology – Laboratory Manual. Revised and Published by AswathySundararaj, No.5. 1st Cross Street, Thirumalai Nagar, Perundgudi, Chennai.
8. Kannan N Laboratory Manual in General Microbiology. 1st Edition, Palani Paramount Publications, Palani, Tamilnadu. 1996
9. Kannan N. Handbook of Laboratory Culture Media, Reagents, Stains and Buffers. Panima Publishing Corporation, New Delhi. 2003
10. Kalaichelvan PT. Microbiology and Biotechnology – A Laboratory Manual 1st Edition, MJP Publishers, A Unit of Tamil Nadu Book House, Chennai. 2005.
11. ChellamRajamanicam – Experiments Protocols in Basic Molecularbiology. Osho Scientific Publications, Madurai.

Reference Book (s)

1. Demonstration of soil microbial population.
2. Demonstration of microbial flora from skin.
3. Demonstration of microbial flora of mouth and throat.
4. Isolation and identification of fungi from different environmental samples.
5. Isolation and identification of algae from different habitats.
6. To test the quality of milk.
7. To demonstrate production of curd and cheese.
8. Determine the dissolved oxygen of given water sample.
9. Determination of BOD of given water sample
10. Isolation and culturing of *Rhizobium*sp from root nodules and *Azospirillum* from grasses (*Cyanodon*).

Continuous Assessment Pattern

Internal Assessment (IA)	**Mid Term Test (MTE)**	**End Term Test (ETE)**	**Total Marks**
50	**-**	**50**	**100**

SEMESTER IV

Name of The Course	**DISSERTATION**				
Course Code	**MSMB9997**				
Prerequisite	**Graduation life science and applied science from any recognized university or equivalent examination with a minimum of 50 % marks in aggregate.**				
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		0	**0**	**0**	**12**

Course Objectives:
The course will develop the skill and introduce the students to exciting basic techniques of microbiology, fermentation technology and Biosensors. Student will learn to organize the experiments, collection of results and interpretation of results and analysis. The course will also emphasize on the knowledge and understanding the research process.

Course Outcomes

CO1	**Demonstrate the use of knowledge of basic and applied sciences in project based learning.**
CO2	**Organizes experiments and researches, perform analysis and interpret data for the designed project.**
CO3	**Cooperate effectively as an individual and as a member in the research team.**
CO4	**Systematize the articulated ideas, comprehend and write effective reports, documentation and to communicate effectively.**
CO5	**Demonstrate knowledge and understanding of research problems and related principles to manage projects in multidisciplinary research areas.**

Text Book (s)

Reference Book (s)

COURSE CONTENTS:

Project work/Dissertation is considered as a special course involving application of knowledge in solving / analyzing /exploring a real life situation / difficult problem. A Project/Dissertation work may be given in lieu of a discipline specific elective paper/Microbiology. This should be done in consultation with the faculty supervisor and agency supervisor under whom he / she is getting trained. The project report should be around 100 pages and chaptered as follows:

Chapter I: Introduction
Chapter II: Review of Literature
Chapter III: Methodology
Chapter IV: Results
Chapter V: Discussion
Chapter VI: Summary and Conclusion

The research should be original and should be action oriented in that the results should be able to throw light on some of the important unexplored areas that would be of practical use to the forensic experts.

Students are expected to decide on the specific project area and title, and carry out substantial portion of the literature survey during the end of their 3rd semester. After the end of their 3rdsemester ETEs, each student will be asked to make presentation about the project including literature available, objective sought and work plan including methodologiesto the Student Project Monitoring Committee constituted by the Division Chair. The Project Work may be a work based on theoretical analysis, modeling& simulation, experimentation & analysis, prototype design, fabrication of new equipment, correlation and analysis of data, etc. or a combination of these. The final project report will be evaluated by a panel of examiners consisting of Dean, DC, PC, supervisor and Co-

supervisor (wherever applicable) and an External Examiner. Viva-voce examination for the same will be conducted.
The following weightage is assigned at each stage of Student Project evaluation.

Review #	Agenda	Description	Marks weightage	Rubric	PO
Zeroth Review	Project scopes and Proposal		10	R1	
Review I	Methods of project Implementation		10	R2	
Review II	Technical Achievement		15	R3	
Review III	Innovation and contribution		15	R4	
Final Evaluation (External evaluation)	Overall achievement		30	R5	
	Project Report Evaluation		20	R6	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
50	**-**	**50**	**100**

Programme Electives

Name of The Course	**COMPUTATIONAL BIOLOGY**				
Course Code	**MSDB6019**				
Prerequisite	**Graduation life science and applied science from any recognized university or equivalent examination with a minimum of 50 % marks in aggregate.**				
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:
The student will understand the connections between computes and engineering with biology. It is an interdisciplinary course. The students will gain an understanding of the computational challenges (and their solutions) in the analysis of large biological data. Also, they will understand the commonly used bioinformatics tools work and evaluate research articles in the field.

Course Outcomes

CO1	**Understand about the computers, Logic Development and Program Development Tools,Operations and Expressions.**
CO2	**Interpret theapplications of Pointers, Initializing Pointers, Creating the data files.**
CO3	**Express the knowledge in the area of C.**
CO4	**Express the knowledge in the area of C++.**
CO5	**Explain the fundamentals of PERL.**

Text Book (s)

1. P KanetkarYashvant, Let us C, BPB Publications, New Delhi, Seventh Edition.
2. E. Balagurusami, Programming in ANSI C, Tata McGraw Hill, Fourth Edition.
3. Schaum Outline Series,Programming in C.
4. HerbtzSchildt, "C++: The Complete Reference", Fourth Edition, McGrawHill.
5. John R. Hubbard, "Programming with C++", Schaum's Series, 2nd Edition,2000.
6. 1. Programming in ANSI C (4th Ed.) by E. Balagurusamy. Tata McGrawHill Publishing Company Limited. 2007
7. 2. Object Oriented Programming using C++ (4th Ed.) by Lafore, R. Sams Publishers. 2002
8. Beginning PERL for Bioinformatics by James Tisdall. O'Reilly publications.2001.

Reference Book (s)

1. E. Balagurusami, Programming in ANSI C, Tata McGraw Hill, Fourth Edition.
2. Schaum Outline Series,Programming in C.
3. HerbtzSchildt, "C++: The Complete Reference", Fourth Edition, McGrawHill.
4. John R. Hubbard, "Programming with C++", Schaum's Series, 2nd Edition,2000.

Unit-1 INTRODUCTION TO COMPUTERS10 lectures
Units of computers, Block Diagram, Generation of Computers, Characteristics of Computers, Phases of Computers, Different types of Memory, Input and Output Devices.

Logic Development and Program Development Tools: Data Representation, Flowcharts, Problem Analysis, Decision Trees/Tables, Pseudo Code and Algorithms, Program Debugging, Compilation and Execution. **Fundamentals: Character Set, Identifiers and Key Words, Data Types, Constants, Variables, Expressions, Statements, Symbolic Constants.** • **Operations and Expressions: Arithmetic Operators, Unary Operators, Relational Operators, Logical Operators, Assignment and Conditional Operators, Library functions.** •
Unit-2 PROCEDURAL CONCEPT 8 lectures
• **Structured Programming – Built-in library function – User defined functions – Pointer introduction – Passing pointer in a function – Structure – Union – File handle: Read and Write character from a file** •
Unit-3 PROGRAMMING IN C: C LANGUAGE 10 lectures
• **Introduction – Tokens – Keywords, Identifier, Variables, Constants, Operators – Expression – Data types –Operator precedence - Statement: Input statement, Output statement, Conditional and Unconditional Control Statement – Looping Statement: while, do-while, for – nested loop – Arrays.** •
Unit-4 OBJECT ORIENTED PROGRAMMING: PROGRAMMING IN C++ 10 lectures
• **C++ programming – Object Oriented Concept: Encapsulation, Inheritance, Polymorphism – Different forms of Constructor – Destructor – Abstract class – Virtual function** •
Unit-5 PERL 10 lectures
• **Basic Perl Data Types, References, Matrices, Complex/Nested Data Structures, Scope: my, local, our – Function/Subroutines, System and User Function, File handle and File Tests – stat and l stat Functions – Perl** •
•
Unit-6 Recent advances in computational biology (04 lectures) • **Research article/ Review paper/ MOOC**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**BIOETHICS, BIO-SAFETY AND IPR**				
Course Code	**MSDB6020**				
Prerequisite	**Graduation life science and applied science from any recognized university or equivalent examination with a minimum of 50 % marks in aggregate.**				
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:
The student will understand the fundamentals of the ethical theories and principles that apply to bioethical dilemmas. The students will gain the knowledge to identify the potential hazardous biological materials and its risk associated with them. This course will also give the fundamental knowledge of intellectual property right.
Course Outcomes

CO1	**Understanding on basic principles of bioethics.**
CO2	**Evaluation of the process of biosafety levels**
CO3	**Evaluation of the process of IPR**
CO4	**Illustration of patent and licensing process**
CO5	**Illustration of regulatory aspects of QC, QA, and QM**
CO6	**Analyze the recent advancement in bioethics, bio-safety and IPR**

Text Book (s)

- Fleming, D.A., Hunt, D.L., (2000). Biotechnology and Safety Assessment (3rd Ed) Academic press.ISBN-1555811804,9781555811808.
- Thomas, J.A., Fuch, R.L. (1999). Biotechnology and safety assessment (3rd Ed). CRC press, Washington. ISBN: 1560327219, 9781560327219
- Law and Strategy of biotechnological patents by Sibley. Butterworth publication.(2007) ISBN: 075069440, 9780750694445.
- Intellectual property rights- Ganguli-Tat McGrawhill. (2001) ISBN-10: 0074638602,
- Intellectual Property Right- Wattal- Oxford Publicatiopn House.(1997) ISBN:0195905024.
- Biotechnology - A comprehensive treatise (Vol. 12). Legal economic and ethical dimensions VCH. (2nd ed) ISBN-10 3527304320.
- Encyclopedia of Bioethics 5 vol set, (2003) ISBN-10: 0028657748.
- Thomas, J.A., Fuch, R.L. (2002). Biotechnology and safety Assessment (3rd Ed) Academic press.
- B.D. Singh. Biotechnology expanding horizons.
- H.K.Das. Text book of biotechnology 3rd edition.

Reference Book (s)

Unit-1 INTRODUCTION AND PRINCIPLE OF BIOETHICS 10 lectures
Biotechnology and social responsibility, public acceptance issues in biotechnology, issues of access, ownership, monopoly, traditional knowledge, biodiversity, benefit sharing, environmental sustainability, public vs private funding, biotechnology in international relations, globalization and development divide. Introduction to bioethics: Social and ethical issues in biotechnology. Principles of bioethics. Ethical conflicts in biotechnology- interference with nature, unequal distribution of risk and benefits of biotechnology, bioethics vs business ethics.
Unit-2 BIOSAFETY 10 lectures
Biosafety: Definition of bio-safety, Biotechnology and bio-safety concerns at the level of individuals, institutions, society, region, country and world with special emphasis on Indian concerns. Biosafety in laboratory institution: laboratory associated infection and other

hazards, assessment of biological hazards and level of biosafety. Bio safety regulation: handling of recombinant DNA products and process in industry and in institutions (Indian context).
Unit-3 INTELLECTUAL PROPERTY PROTECTION 8 lectures
Introduction to IPR: IPR, forms of IPR and Intellectual property protection. Concept of property with respect to intellectual creativity, Tangible and Intangible property. WTO: agency controlling trade among nations, WTO with reference to biotechnological affairs, TRIPs. WIPO, EPO.
Unit-4 PATENT AND LICENCING 10 lectures
Concept related to patents novelty, non-obviousness, utility, anticipation, prior art etc. Type of patents. Indian patent act and foreign patents. Patentability, Patent application, Revocation of patent, Infringement and Litigation with case studies on patent, Commercialization and Licensing.
Unit-5 QUALITY ASSURANCE AND VALIDATION 12 lectures
Regulatory aspects of QC, QA, and QM. GMP, GLP and CMP in Pharma Industry. ISO, WHO, USFDA certification. Microbial Limit test of Pharma products. Sterility testing, pyrogen testing and LAL test of Sterile Pharma products. Sterilization- heat, D- value, Z-value and survival curve, radioactive, gaseous and filtration. Chemical and biological indicators. Designing layout for microbiology laboratory.
Unit-6 Recent advances in bioethics, bio-safety and IPR (04 lectures) **Research article/ Review paper/ MOOC**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**TOXICOLOGY**				
Course Code	**MSDB6021**				
Prerequisite	**Graduation life science and applied science from any recognized university or equivalent examination with a minimum of 50 % marks in aggregate.**				
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

The students will learn to apply their knowledge of basic toxicokinetic principles and metabolic systems to elucidate mechanisms of toxicity induced by xenobiotic compounds. In addition, they will learn basic principles of omics-based approaches and methodologies, and how such data can be integrated to assess and predict adverse effects of chemical exposures across multiple levels of biological complexity.

Course Outcomes

CO1	**Discuss the various routes of toxic exposure and response.**
CO2	**Evaluate the process of evaluation of toxicity.**
CO3	**Explain the fate of xenobiotics in the physiological system.**
CO4	**Summarize the various toxic agents.**
CO5	**Discuss the different eco-toxicological effects.**
CO6	**Analyze the recent advancement in toxicology.**

Text Book (s)

- Cassarett and Doull"s Toxicology "The Basic Science of The Poisons" 7th edition (2008), Curtis D. Klaassen Editor, McGrawHill Medical. ISBN: 9780071470513.
- Cassarett and Doull"s "Essentials of Toxicology" 2nd edition (2010), Klaassen and Whatkins, McGraw Hill Publisher. ISBN-13: 978-0071622400.
- Introduction to Toxicology, 3rd edition (2001), John Timbrell, Taylor and Francis Publishers. ISBN 13: 9780415247627.
- Principles of Toxicology, 2nd edition (2006), Stine Karen and Thomas M Brown, CRC press. ISBN-13: 978-0849328565.
- Lu"s basic toxicology: Fundamentals target organ and risk assessment, 5th edition (2009), Frank C Lu and Sam Kacow, Informa Health care. ISBN: 9781420093117.

Reference Book (s)

1. Cassarett and Doull"s Toxicology "The Basic Science of The Poisons" 7th edition (2008), Curtis D. Klaassen Editor, McGrawHill Medical. ISBN: 9780071470513.
2. Cassarett and Doull"s "Essentials of Toxicology" 2nd edition (2010), Klaassen and Whatkins, McGraw Hill Publisher. ISBN-13: 978-0071622400.

Unit-1 TOXIC EXPOSURE AND RESPONSE10 lectures
Different areas of modern toxicology, classification of toxic substances, various definitions of toxicological significance. Effect of duration, frequency, route and site of exposure of xenobiotics on its toxicity. Characteristic and types of toxic response. Types of interactions between two and more xenobiotics exposure in humans. Tolerance and addiction.
Unit-2 EVALUATION AND MECHANISM OF TOXICITY 8 lectures
Various types of dose response relationships, assumptions in deriving dose response, LD50, LC50, TD50 and therapeutic index. Delivery of the toxicant, mechanisms involved in formation of ultimate toxicant, detoxification of ultimate toxicant.
Unit-3 FATE OF XENOBIOTICS IN HUMAN BODY 8 lectures

Absorption, Distribution, Excretion and Metabolism of xenobiotics (biotransformation, Phase-I reactions including oxidations, hydrolysis, reductions and phase II conjugation reactions).Toxic insult to liver, its susceptibility to toxicants with reference to any two hepatotoxicants.
Unit-4 TOXIC AGENTS 10 lectures
Human exposure, mechanism of action and resultant toxicities of the following xenobiotics: Metals: lead, arsenic, Pesticides: organophosphates, carbamates, organochlorine, bipyridyl compounds and anticoagulant pesticides.
Unit-5 ECO-TOXICOLOGY 10 lectures
Brief introduction to avian and aquatic toxicology, movement and effect of toxic compounds in food chain (DDT, mercury), bioaccumulation, biomagnification, acid rain and its effect on ecosystems, concept of BOD and COD.
Unit-6 Recent advances in toxicology (04 lectures) **Research article/ Review paper/ MOOC**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**INDUSTRIAL BIOCHEMISTRY**				
Course Code	**MSDB6022**				
Prerequisite	**Graduation life science and applied science from any recognized university or equivalent examination with a minimum of 50 % marks in aggregate.**				
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:
The students will learn to integrate the knowledge of biochemistry and molecular biology with those of microbiology and biochemical engineering, with emphasis on their application to the biotechnological processes.
Course Outcomes

CO1	**Demonstrate the industrial bioprocesses technology, downstream processing.**
CO2	**Describe the process of fermentation.**
CO3	**Demonstrate the various ways of food processing.**
CO4	**Describe the process of BIOSAFETY, IPR**
CO5	**Discuss the general principles of Quality Control and Good Manufacturing practices in food industry.**
CO6	**Analyze the recent advancement in industrial Biochemistry**

Text Book (s)

- DobleMukesh and Kumar Anil, Biotreatment of industrial effluents.
- WulfCrueger and AnnelieseCrueger, Biotechnology, Panima Publishing company New Delhi.
- Rainbow C. and Rose A.H., A.P., Biochemistry of Industrial micro-organisms.
- P. F. Stanbury, A. Whitaker and S. Hall, Principles of Fermentation Technology.
- Bioethics and Biosafety, 1st edition (2008), M. K Sateesh, I K International Pvt Ltd, ISBN-13: 978-8190675703.
- Bioethics and biosafety in biotechnology, 1st edition (2007), V. Sreekrishna; New Age International (P) Ltd., ISBN-13: 978-8122420852.

Reference Book (s)

1. Biosafety and Bioethics, 1st edition (2006), Rajmohan Joshi; Isha Books ISBN-13: 978-8182053779.
2. Wackett, L.P. and Hershberger, C.D. Biocatalysis and Biodegradation, Microbial Transformation of Organic Compounds, 2001 P.-171-190. ISBN 1-55581-179-5. ASM Press Washington D.C.

Unit-1 INTRODUCTION TO INDUSTRIAL BIOPROCESSESTECHNOLOGY10 lectures
Definition and scope of Industrial Biochemistry,A historical overview of Industrial fermentation processes- traditional and modern biotechnology, Organism, processes and products related to modern biotechnology, Types of Bioreactors, Parameters for Bio process, bioprocess monitoring, downstream processing.
Unit-2 BASICS OF FERMENTATION 8 lectures
Biochemical Basis and Development of Industrial Fermentation process: screening and selection of the organisms for the production of biologically important compounds, Strain improvements, Detection and production of fermentation products, Fermentation media, Scale up of fermentations.
Unit-3 FOOD BIOCHEMISTRY 12 lectures
Introduction to different categories of food; constituents of food products and their functional properties; introduction to food processing; intermediate moisture food; food spoilage; intrinsic and extrinsic factors affecting the quality and life of food material; food storage and

preservation techniques; food poisoning and intoxication; by-product utilization and scale up; molasses and alcohol production.
Unit-4 BIOSAFETY, IPR 10 lectures
Historical background, introduction to biological safety cabinets, primary containment for biohazards, biosafety levels of specific microorganisms, recommended biosafety levels for infectious agents and infected animals. Intellectual property rights (IPR)
Unit-5 QC and GMP 10 lectures
General principles of Quality Control and Good Manufacturing practices in food industry, Determination of shelf – life of food products, Food Adulteration – Common food adulterants, their harmful effects and physical and chemical methods for their detection, Role of ISI Agmark and FDA in food industry.
Unit-6 Recent advances in Industrial Biochemistry (04 lectures) **Research article/ Review paper/ MOOC**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**ADVANCED MICROBIOLOGY**				
Course Code	**MSMB6023**				
Prerequisite	**Graduation life science and applied science from any recognized university or equivalent examination with a minimum of 50 % marks in aggregate.**				
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

The students will understand the basic concept of proteomics, nanotechnology and their application in the field of microbiology. It will help to understand the knowledge of how patent will grant.

Course Outcomes

CO1	**Acquire knowledge on microbial proteomics**
CO2	**Understand the fundamentals of nanotechnology**
CO3	**Illustration of the applications of nanobiotechnology**
CO4	**Application of knowledge on grant of patent and patenting authorities**
CO5	**Evaluation of advanced approach in microbiology**
CO6	**Analyze the recent advancement in advanced microbiology**

Text Book (s)

- Bare Act, 2007.Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., New Delhi.
- Kankanala C (2007). Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution Pvt. Ltd. New Delhi.
- Pradeep T., "A Textbook of Nanoscience and Nanotechnology", Tata McGraw Hill Education Pvt. Ltd., 2012.
- Singh K K (2015). Biotechnology and Intelectual Property Rights: Legal and Social
- Impliocations, Springer India.

- Goel D &Prashar S (2013). IPR, Biosafety and Bioethics. Pearson
- Senthil Kumar Sadhasivam and Mohammed Jaabir, M. S. 2008. IPR, Biosafety and
- Biotechnology Management. Jasen Publications, Tiruchirappalli, India.

Reference Book (s)

1. Nanobiotechnology: Concepts,Applications and Perspectives (2004), ChristofM.Niemeyer (Editor), Chad A. Mirkin (Editor), Wiley VCH.
2. Nanobiotechnology - II more concepts and applications. (2007) - Chad A Mirkin and Christof M. Niemeyer (Eds), Wiley VCH.
3.

Unit-1 MICROBIAL PROTEOMICS12 lectures
Introduction to Proteomics, 2D electrophoresis, Proteomics applications. Protein biomarker,surfaceplasmon resonance (SPR), protein microarraysdual polarisation interferometry, microscalethermophoresis Microbial pathogenesis at the proteome level. Proteomics of *Saccharomyces cerevisiae*-cell wall & transport, differential expression in stress. Proteomics of probiotic lactobacilli-intestinal epithelial cells interactions, Lantibiotics and Immunomodulators. Proteomic Identification of *Mycobacterium tuberculosis*
Unit-2 INTRODUCTION TO NANOTECHNOLOGY 10 lectures
Historical perspectives, Existence of nanostructures in nature, Nanoscale Properties (Electrical, Optical, Chemical) Nanomaterials - Quantum Dots,Wells and Wires, nanotubes, graphene, nanogold, nanosilver and metal oxides, Nanopolymers. Synthesis using Microorganisms, Synthesis using Biological templates, synthesis using plants and plant extracts.
Unit-3 APPLICATIONS OF NANOBIOTECHNOLOGY 8 lectures
Nanobiosensors, molecular imaging using nanoparticles, targeted drug delivery. Applications in health and disease - infectious and chronic. Nanobiotechnological applications in Environment and food - detection and mitigation.
Unit-4 GRANT OF PATENT, AGREEMENTS AND TREATIES 12 lectures
Grant of Patent and Patenting Authorities: Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; An introduction to Patent Filing Procedures; Patent licensing and agreement; Patent infringement- meaning, scope, litigation, case studies, Rights and Duties of patent owner. Agreements and Treaties: GATT, TRIPS, WIPO, Budapest Treaty on international recognition of the deposit of microorganisms etc.
Unit-5 ADVANCE APPROACH IN MICROBIOLOGY 12 lectures
Novel approaches for anti-influenza virus therapy. Use of bacteria in cancer therapy, Protein secretion: from mechanism to exploitation, Microbicides, Biofilm-related infections, Fungal infections: novel diagnostic tools and antifungal agents, Epidemiology of respiratory viruses, Tumor-associated viruses, Virus (HIV) entry as therapeutic target, Applications of CRISPR genome editing to microbiology.
Unit-6 Research advances in advanced microbiology (04 lectures) **Research article/ Review paper/ MOOC**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**PLANT – PATHOGEN INTERACTION**				
Course Code	**MSDB6024**				
Prerequisite	**Graduation life science and applied science from any recognized university or equivalent examination with a minimum of 50 % marks in aggregate.**				
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:
The students will deeper knowledge of host-pathogen interactions at the molecular to organismal level, with emphasis on several model pathosystems and phenomena whose elucidation will have the most power in explaining disease.

Course Outcomes

CO1	**Understanding on microbial infections on plant physiology**
CO2	**Evaluation of important plant diseases and etiology**
CO3	**Evaluation of genetics of diseases**
CO4	**Illustration of plant disease control**
CO5	**Illustration of diseases forecasting and its relevance**
CO6	**Analyse the recent advancement in parasitology**

Text Book (s)

- .
- Plant pathology by R.S. Mehrotra: Tata McGraw –Hill publishing company limited. New Delhi.
- Bacterial plant pathology, cell and molecular aspects by David C. Sigee, Cambridge University Press, 1993.
- The essentials of Viruses, Vectors and Plant diseases by A.N. Basu& B.K. Giri: Wiley Eastern Limited, 1993.
- Biocontrol of Plant Diseases (Vol. I) by K.G. Mukerji& K.L. Garg: CRC Press, Inc., Boca Raton, Florida, 1988.
- Molecular Biology of Filamentous Fungi by U. Stahl & P. Tudzyski: VCH VerlagsgesellschaftmbH, D-6940 Weinheim (Federal Republic of Germany), 1992.

Reference Book (s)

1. Molecular plant pathology by M. Dickinson: BIOS Scientific Publishers, London, 2003.
2. Plant pathology by George N. Agrios: 4th ed., Academic press, New York, 1969.

Unit-1 CONCEPTS AND PHYSIOLOGY OF PLANT DISEASES 8 lectures
What is a disease and what causes disease, pathogenesis, pathogenesis in relation to environment, effect of microbial infections on plant physiology, photosynthesis, respiration, transpiration, translocation. Enzymes and toxins in plant diseases, phytoalexins.
Unit-2 SOME IMPORTANT PLANT DISEASES AND THEIR ETIOLOGICAL STUDIES 10 lectures
Crown gall, symptoms of viral diseases and their control, diseases of some important cereals, vegetables and crops. Diseases caused by fungi: *Sclerotiumrolfsii*and *Macrophominaphaseolina*(collar rot disease, charcoal rot), bacteria: *Xanthomonascampestris*(black rot), actinomycetes: *Streptomyces scabies* (common scab).
Unit-3 GENETICAL BASIS OF PLANT DISEASES 8 lectures
Genetics of host-pathogen interactions, resistance genes, resistance mechanism in plants. Molecular diagnosis, transgenic approach for plant protection, futuristic vision of molecular diagnosis, applications and constraints.
Unit-4 DISEASE CONTROL 10 lectures

Principles of plant disease control, physical and chemical methods of disease control, biocontrol, biocontrol agents - concepts and practices, fungal agents, *Trichoderma*as biocontrol agent, biocontrol agents – uses and practical constraints.
Unit-5 DISEASE FORECASTING 10 lectures
History and important milestones in disease control, disease forecasting and its relevance in Indian farming.
Unit-6 Recent advances in Plant – pathogen interaction (04 lectures) **Research article/ Review paper/ MOOC**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

(Established under Galgotias University Uttar Pradesh Act No. 14 of 2011)

Program: M.Sc. (Forensic Science

Vision:

To be recognized globally as a center of excellence in imparting value-based education in Basic and Applied Sciences by creating innovation in fundamental and multidisciplinary research.

Mission:

M1. To excel in imparting contemporary knowledge and skills by developing an educational ecosystem with diverse interests and talents.

M2. To perform cutting edge research leading to innovation in sciences through national and international collaborations.

M3. To develop solutions for the emerging challenges in Basic and Applied Science to cater the needs of society.

M4. To attract best quality faculty to facilitate knowledge and develop confidence in our graduates to succeed in the world.

Program Educational Objectives:

PEO-1. To develop the undergraduate level students with the specific knowledge of handling different types of evidences and their examinations.

PEO-2. To develop the laboratory skills in examining different types of digital, biological, physical and chemical evidences found at the crime scene.

PEO -3. To prepare the students to compete for employment in the private and government sector (State and Central Forensic Science Labs)

Program Specific Objectives

PSO - 1. Comprehend the need, significance and methodologies of Forensic science investigation alignment with nature and conducive in cultivating skills for successful carrier in research, industry and as an entrepreneurship.

PSO - 2.Explore scientific skills with a sustainable approach to develop a new innovative solutions foremerging problems by providing new knowledge in the biological, chemical, physical science field of forensic science.

Program Outcomes

1. After Completion of the Course, the students can get an employment in the Government Forensic Science Laboratories either in the State FSLs or in the Central FSLs.

2. The students would be equipped with the necessary training and knowledge to work in other firms such as Banks, Insurance Agencies, Detective Agencies, Security Agencies, Pharmaceutical Companies, Chemical Industries, Testing Laboratories and Instrumentation Companies.

3. They can also work as independent Forensic Psychologist Cyber Expert, Questioned Document and Fingerprint Experts and give their valuable opinion to the Court of Law.

4. They would also become eligible to work in Private Forensic Labs as Crime scene investigators, Questioned Document and Fingerprint examiners and Toxicological, anthropological and Serological analysts .

5. They would be equipped with thorough knowledge to clear UGC-NET Examination so that they can pursue a successful career as a researcher.

6. Enhance knowledge, in depth understanding and application of forensic science, policing and criminal investigation by teaching and research.

7. students will be able to select, interpret and critically evaluate information from a range of sources that include books, scientific reports, journals, case studies and the internet.

8. Develop critical and analytical subject specific skills involving the principles, practices and techniques of specific field of forensic science.

9. They can also analyze the legal, ethical, and constitutional tensions between the interests of society, and the rights of individuals in connection with various criminal procedures and contexts.

10. Students will be able to recognize the need to engage in lifelong learning through continuing education and research.

Curriculum

Sl. No	Course Code	Name of the Course	L	T	P	C	IA	MTE	ETE
Semester 1									
Sl. No	Course Code	Name of the Course					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MBS27T1101	Recent adavancement of Forensic Science	4	0	0	4	30	20	50
2	MBS27T1102	Instrumental Methods – Physical	3	0	0	3	30	20	50
3	MBS27T1103	Forensic Photography	2	0	0	2	30	20	50
4	MBS27T1104	Instrumental Methods – Biological & Chemical	3	0	0	3	30	20	50
5	MBS27T1105	Cyber Forensics and Cyber Laws	3	0	0	3	30	20	50
6	MBS27T1106	Crime Scene Management	2			2	30	20	50
7	MBS27P1101	Practicals - Crime Scene Investigation			2	1	50		50
8	MBS27P1102	Lab Forensic Photography			2	1	50		50
9	MBS27P1103	Cyber Forensic Lab			2	1	50		50
10	xxx	Soft Skills				0			
11	xxx	Computer awareness				0			
		Total	17	0	6	20			
Semester II									
Sl No	Course Code	Name of the Course					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MBS27T1107	Finger Prints and other Impressions	4	0	0	4	30	20	50
2	MBS28T2111	Research Methodology	2	0	0	2	30	20	50
3	MBS27T1108	Questioned Documents	3	0	0	3	30	20	50
4	MBS27T1109	Criminal Laws, Judicial System and Police Administration	3	0	0	3	30	20	50
5	MBS27T1110	Introduction to Criminology and Psychology	4	0	0	4	30	20	50
6	MBS27T1111	Elements of Forensic Biology	2	0	0	2	30	20	50
7	MBS27P1104	Practicals – Fingerprints			2	1	50		50
8	MBS27P1105	Practicals – Questioned Documents			2	1	50		50
9	XXX	BEC (B1)				3	30	20	50
10	XXX	IPR				1	30	20	50
		Total	18	0	4	24			
Semester III									
Sl No	Course Code	Name of the Course					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MBS27R2106	Internship (four weeks)				2	50		50
2	MBS27R2107	Major Project Phase I				6	50		50
3	xxx	Campus to Corporate	2			2	50		50
		Total	2	0	0	10			
Semester IV									

Sl No	Course Code	Name of the Course					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MBS27T2112	Forensic Medicine & Medical Jurisprudence	4	0	0	4	30	20	50
2	MBS27T2113	Forensic Toxicology	4	0	0	4	30	20	50
3	MBS27P2108	Practicals – Forensic Toxicology			4	2	50		50
4	MBS27R2109	Major Project Phase II				6	50		50
		Elective (Specialization) Credit				10			
		Total	8		8	26			
		Total Credit of M.Sc				80			

List of Electives

Elective-1: Forensic Biology

Sl No	Course Code	Name of the Electives					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MBS27T5114	Forensic Biology and Anthropology	4	0	0	4	30	20	50
2	MBS27T5115	Forensic Serology and DNA	4	0	0	4	30	20	50
3	MBS27P5110	Practicals – Forensic Serology and DNA			2	1	50		50
4	MBS27P5111	Practicals –Forensic Biology			2	1	50		50

Elective-2: Forensic Physics

Sl No	Course Code	Name of the Elective					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MBS27T5116	Forensic Physics	4	0	0	4	30	20	50
2	MBS27T5117	Forensic Ballistics	4	0	0	4	30	20	50
3	MBS27P5112	Practical Forensic Ballistics			2	1	50		50
4	MBS27P5113	Practicals - Forensic Physics			2	1	50		50

Elective-3 : Forensic Chemistry

Sl No	Course Code	Name of the Elective					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MBS27T5118	Arson and Explosives	4	0	0	4	30	20	50
2	MBS27T5119	Forensic Chemistry	4	0	0	4	30	20	50
3	MBS27P5114	Lab Forensic Chemistry			2	1	50		50
4	MBS27P5115	Explosives Lab			2	1	50		50

Semester I

Name of The Course	**Recent advancement of Forensic Science**				
Course Code	**MBS27T1101**				
Perquisite	**B.Sc Forensic Science**				
Co requisite					
Anti requisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objective:

The students would be able to understand the development and organizational structure of forensic science laboratories. They will also understand the principle of various types of biometric recognition systems and working of advanced techniques for the detection of truth and other forensic tools utilize for the investigation. They would also know the application of nanotechnology and engineering in various domains of forensic science.

Course Outcomes: The student will be able to:

CO1	Understand the role of Forensic scientist, practice the gained knowledge in managing the crime scene in terms of handling of different physical evidences found at the crime scene on the basis principles of forensic science K3.
CO2	Understand concept of principle of various types biometric techniques, their acceptance, advantages and disadvantages in the field of forensic investigation. K6.
CO3	Understand the scope of forensic engineering and investigation of various types of failures including electrical accidents, defects in material evidences and polymer materials. K3.
CO4	To make students understand the application of nanotechnology in in fingerprint development, Military investigation, DNA, Narcotics and Drugs testing. K4.
CO5	Interpret the result acquired from advanced techniques such as narcoanalysis, brain mapping, lie detection to know whether a person is lying or telling truth with other advanced assisting techniques such as remote personal assessment, super imposition technique etc. K2
CO6	Understand and apply the concept and application of alternative light photography, LA-ICP-MS, Digital surveillance for gaming equipment and develop the research aptitude K6.

Text Book (s) & Reference Book (s)

1. DeForest, P., Gaensslen, R., and Lee, H., Forensic Science; An Introduction to Criminalitics, McGraw Hill, New York, 1983.

2. Fisher, B., Techniques of Crime Scene Investigation (6^{th}Edn.) CRC Press, Boca Raton, Florida, 2000.

3. James, S. H. And Nordby, J. J. (Eds) Forensic Science - An Introduction to Scientific and Investigative Techniques, CRC Press, London, 2003.

4. BernadJahne: Digital Image processing, Springer Verlag (1993)

5. David Icove, Karl Seger& William Vonstorch: Computer Crime; O'Reilly &Amocialcis, Inc(1995)

6. Deepti Chopra & Keith Merrill: Cyber Cops, Cyber Criminals & Internet, Ilk International Pvt. Ltd. New Delhi (2002)

7. Eoghan Corey: Computer Crime Investigation, Academic Press (2002)

8. Hand book of biometric, Edt., Anil K. Jain, Patrick Flynn, Arun A. Ross, Springer Pubisher, 2008.

9. Biometrics: Theory, Methods, and Applications, N. V. Boulgouris, Konstantinos N. Plataniotis, Evangelia Micheli-Tzanakou, 2010

10. New perspective of nanotechnology: role in preventive forensic Alok Pandya1 and Ritesh K Shukla, Egyptian Journal of Forensic Sciences, 1-11, (2018) 8:57

11. Introduction of Forensic Nanotechnology as Future Armour in Nanotechnology Science and Technology, Nova Publisher, Edi., Ritesh Kumar Shukla, Alok Pandya, September 2019.

12. Joh, C Russ: Image Processing, CRC Press (1999)

13. John R Vacca, Computer Forensic, Firewall Media Publication, New Delhi, (2002)

14. L C Jain, H Hallic, I Hayaush, S. B Lee & S Tulsi: Intelligent Biometric Techniques in fingerprint and Face Recognition; CRC Press(1999)

15. Tewari, R. K., Sastry, P.K and Ravikumar, K. V. Computer Crime & Computer Forensics select publisher, New Delhi. (2003)

16. V. D. Dudeja: Cyber crimes& Law Vol. 2; Common wealth Pub. (2002)

Unit I: Introduction to Forensic Science

Introduction, History, and development of Forensic Science, Basic principles and significance, Organizational structure of Forensic Science Laboratories, Utilization of Forensic Science at the crime scene and in the court, Role, qualities and importance of an Investigating Officer and a Forensic Scientist at the scene of crime.

Unit-2 Pattern Recognition & Biometrics

Introduction to Biometrics, Pattern Recognition & Biometrics and its types – Face, Iris & retinal imaging, finger and palm print, Computer simulation, Image processing – Image capturing, Image restoration & enhancement. Image editing,Compression Technique – Proactive Forensic science, User Acceptance, Evaluating Accuracy, Advantages &disadvantages

Unit-3 Forensic Engineering:

Definition, causes, types of Failures, Ductile and Brittle Fracture, Fatigue Fracture, Distortion Failures, Wear Failures, Fretting Failures, Liquid Erosion Failures, Stress Corrosion Cracking, Liquid Metal Embrittlement, Hydrogen Embrittlement, Elevated Temperature Failures, Failures Related to Corrosion, Failures of Metallic Orthopedics Implant, Nuclear Failures. Investigation of electrical failures/accidents, Seeking defects in material evidences, Failure of Polymer materials.

Reporting the results of Forensic Engineering Investigation – Role of the Legal System.

Unit-4 Module IV: Forensic Nanotechnology

Definition, Introduction, Scope and Application of nanotechnology, Application of nanotechnology in forensic science such as in fingerprint development, in Military such as explosives detection, GSR analysis, DNA, Narcotics and Drugs testing.

Unit 5: Recent & advanced tools and techniques utilize in Forensic Science Portrait parley method, Narco-analysis, Brain Mapping, Polygraphy, Ballistic Fingerprinting, Binocular for identifying dangerous gases, Remote personal assessment, super imposition technique, Fire technology, 3D Scanner, High speed ballistics photography, Forensic carbon-14 Dating.
Unit 6:Application of advanced technology in forensic investigation: Definition, Concept and application of Alternative light photography, LA-ICP-MS, Digital surveillance for gaming equipment in forensic investigation. One research article.

Continuous Assessment Pattern

Internal Assessment (IA)	Midterm (MTE)	End term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Instrumental Methods – Physical				
Course Code	**MBS27T1102**				
Perquisite	B.Sc. (H) or in B.Sc. having chemistry as one of the main subjects.				
Co requisite	Basic Knowledge of Modern Spectroscopy				
Anti requisite					
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objective:
To impart knowledge of the various instruments used in the analysis of different substances encountered during a criminal investigation and their Forensic application, their methods of sample analysis and the different types of detectors used for detecting the various substances

Course Outcomes:

On completion of this course the students will have a thorough knowledge of the various instruments used in the analysis of different substances encountered during a criminal investigation They would be able to

understand the various types of instrumentation, their Forensic application, their methods of sample analysis and the different types of detectors used for detecting the various substances.

CO1	Explain the conceptual understanding of the various laws, principles and instrumentation of UV-Visible. **(K2)**
CO2	Analyse the basic Principles, instrumentation, and applications of IRS spectrophotometry and Fluorescence - phosphorescence spectrophotometry **(K4)**
CO3	Apply the basic concepts of Principles, instrumentation and techniques of AAS and X-rays spectroscopy **(K3)**
CO4	Analyse the basic Principles, instrumentation, and structural analyses of Raman Spectroscopy and conceptual understanding the principles, theory of nuclear radiations and instrumentation methods of Radiochemical Techniques. **(K4)**
CO5	Explain the basic Principles, instrumentation, and structural analyses of Mass Spectrophotometry **(K2)**
CO6	Elaborate the knowledge of recent advancement in the field of Instrumentation physical chemistry **(K6)**

Text Book (s) & Reference Book (s)

- · Chapmen, J.R., Practical Organic Mass spectrometry, A Guide for Chemical and Biochemical Analysis, Wiley, New York, 1993.
- Lide, D.R., Handbook of Chemistry & Physics C.R.C. 75th ed. CRC Press Washington D.C., 1994.
- · Stout G.H., & Jensten, L.H., X-ray Structure Determination – A practical Guide, 2nd Ed., Wiley, New York, 1989.
- · Gchristian, Gray D and Fredric J. Feldman, Atomic Absorption Spectroscopy; Wiley-Interscience, London, 1970.
- · Willard, H.H. et al, Instrumental Methods of Analysis, CBS Publishers and Distributors, Delhi 1986.
- · Bassett, J., et al,Vogel's Text Book of Quantitative Inorganic Analysis including Elementary Instrumental Analysis (Fourth Ed.), Long man Essex, 1978.
- · Sneddon, J., Advances in Atomic Spectroscopy, Vol. I & II, JNI Press 1992 & 1994.
- · Jarris, K.E., Gray, A.L., & Hock, R.S., EDS, Handbook of Inductively Coupled Plasma Mass Spectrometry, GlasgowBlockie, 1992.
- · Azaroff, L.V., Elements of X-Ray Crystallography, McGraw Hill, New York, 1968.

· Lin – Vien, D & Other – Infrared & Raman Characteristics frequencies of organic molecules; San Diego Acad, Press 1991.

- ·Maclaffrty, F.W. & F. Turecek, Interpretation of Mass spectra, 4thedMillValley, C A Univ Science Books, 1993.
- · R.M. Silverstein, Baster, G.C. &Morsill, T. C., Spectrometric identification of Organic Compounds, 4thEdn., Wiley, New York, 1981.
- · S.J. Haswell, Atomic Absorption spectrometry, Elsevier, Amsterdam, 1992.
- · Senders, I & Hunter B., Modern Spectroscopy- A center for Chemists; 2nd ed. Oxford Univ. Press, UK, 1993.
- · https://www.sciencedirect.com/topics/chemistry/physico-chemical-analysis-method
- https://www.sciencedirect.com/topics/chemistry/ir-spectroscopy

Unit 1 UV- Visible spectrophotometry Introduction of electromagnetic spectrum, Lamberts Beers law, Introduction of UV visible spectroscopy, Types of electrons and types of transitions, Chromophors and Auxochromes, Band Shifts, Instrumentation of single and double beam UV spectrophotometer and Applications of UVspectrophotometry
Unit 2 **IR and Fluorescence and phosphorescence spectrophotometry** Introduction of IR spectroscopy, Types of vibrations- Stretching and bending vibrations,Instrumentation-Dispersive and Fourier Transform spectrophotometry and Applications of IR spectroscopy. Fluorescence and phosphorescence spectrophotometry Concept of Fluorescence and phosphorescence, Instrumentation -Fluorimetry and Perrin-Jablonski diagram.
Unit 3 AAS and X- rays spectroscopy Atomic absorption spectrometry: Introduction, Instrumentation and application. X-ray spectroscopy: Introduction, General method for production of X-rays, bragg's law and applications
Unit -4: Raman Spectroscopy and Radiochemical technique: Raman spectroscopy:Scattering of light, Elastic and Inelastic collisions, Stoke's, Anti-stoke's and Rayleigh lines, polarization measurements- water and carbondioxide molecules, Instrumentation and applications Neutron Activation Analysis (NAA). Basic concept and theory, Instrumentation, types (Instrumental Neutron Activation Analysis and Radiochemical Neutron Activation Analysis (RNAA)), Forensic application of NAA.
Unit-5 Mass Spectrometry: Introduction, General principle, working and Instrumentation, Types of Ionization Methods- Gas phase, Desorption and Evaporation, Types of Mass Analyzers- Magnetic field deflection, Quadrupole, Time of flight and applications,

Unit-6: Recent advancement in Instrumental Methods – Physical Physico Chemical Analysis Methods, Advanced instrumental techniques, Medical Science applications etc

Continuous Assessment Pattern

Internal Assessment (IA)	Midterm (MTE)	End term Test (ETE)	Total Marks
30	**20**	**50**	**100**

Name of The Course	**Forensic Photography**				
Course Code	**MBS27T1103**				
Perquisite	**optics**				
Co requisite	**Crime scene management**				
Anti requisite					
		L	**T**	**P**	**C**
		2	**0**	**0**	**2**

Course Objective: This course will impart the knowledge regarding the photographic methods and techniques. Also it aims to appraise the importance of photography in Forensic science .

Course Outcomes:

CO1	Understand the basis and working of camera and its attachments.
CO2	Identify the type of camera and file format to be used of a crime scene.
CO3	design the evidence presentation in the court of law in relation with photography
CO4	Construct the crime scene again for the court of law and investigators using photography.
CO5	Appraise the modern techniques of photography for the purpose of recording the crime scene.
CO6	Design the scene of crime using 3D modelling techniques

Text Book (s) & Reference Book (s)

1. Redsicker, D. R., The Practical methodology of Forensic Photography, CRC Presss, London, 1994.
2. Criminalistics, An Introduction to Forensic Science: Richard Saferstein, 10th Edition, Pearson Education International.
3. Forensic Science An Introduction to Scientific and Investigative Techniques : Stuart H. James and Jon J. Nordby., 3rd Edition CRC Press, Taylor & Francis Group.
4. Edward M Robinson, Crime Scene Photography
5. Herbert L Blitzer, Forensic Digital Imaging and Photography
6. Tom Ang, Digital Photography, 1999
7. Forensic Digital Image Processing: Optimization of Impression Evidence 1st Edition by Brian Dalrymple, Jill Smith
8. The Practical Methodology of Forensic Photography (Practical Aspects of Criminal and Forensic Investigations) by David R. Redsicker
9. Fundamentals of Forensic Photography: Practical Techniques for Evidence Documentation on Location and in the Laboratory (Applications in Scientific Photography) 1st Edition, by Keith Mancini , John Sidoriak
10. Forensic Photography: Importance of Accuracy 1st Edition, by Sanford L. Weiss

UNIT 1: CAMERA Types of Cameras and their working, attachments of camera, types of camera lenses Image sensors, spectral sensitivity of photographic materials, reproduction of colors- photographic processing, Exposing, Camera exposure determination, Working of Camera, F-Number, Depth of field, ISO, Exposure Index, angle, scale, ambient light, color, temperature, flash/ strobe. Developing and Printing.
UNIT 2: DIGITAL PHOTOGRAPHY Digital photography, Working of SLR & DSLR Cameras and basics of Digital Imaging Photography, photo-morphing, digital water marking and digital imaging, software for digital photography, file formats for digital photographs – jpg, gif , bmp, tiff, mpeg, etc.Videography/high speed videography.
UNIT 3: FORENSIC PHOTOGRAPHY Basic use of forensic photography, including selection and use of equipment, photographs as evidence, Photography in indoor and outdoor scene of crime; aerial photography,close-up, midrange and bird-eye view photography, trick photography, contact photography. Significance Photography in Forensic Science.
UNIT 4: SPECIALIZED PHOTOGRAPHY Methods, techniques and tactics of: Surveillance photography, High-speed photography, UV, IR, transmitted light and side light photography, Photomicrography, microphotography, telephoto and processing. Aerial Photography. Document and finger print photography. Photography in identification of docile and hostile human objects, etc. 3-D Photography/Videography,

Unit 5: Recent Technology used in forensic photography:

3-D Modelling using photographs and its application in forensic science

https://www.sciencedirect.com/science/article/pii/S0895717711000033

Continuous Assessment Pattern

Internal Assessment (IA)	Midterm (MTE)	End term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Instrumental Methods – Biological & Chemical				
Course Code	**MBS27T1104**				
Perquisite	**Basics of sedimentation, microscopy, immunochemical interactions, chromatography, and electrophoresis**				
Co requisite	**Spectroscopy**				
Anti requisite					
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objective:

To impart knowledge of the various instruments used in the analysis of different substances encountered during a criminal investigation and their Forensic application, their methods of sample analysis and the different types of detectors used for detecting the various substances

Course Outcomes:

On completion of this course the students will have a thorough knowledge of the various instruments used in the analysis of different substances encountered during a criminal investigation They would be able to understand the various types of instrumentation, their Forensic application, their methods of sample analysis and the different types of detectors used for detecting the various substances.

CO1	Enable students to understand and apply the knowledge of centrifugation in the separation of biomolecules/complex mixtures **(K2/K3)**
CO2	Enable students to apply the principles of microscopy to analyze smaller (microsize) evidences **(K3/K4)**
CO3	Enable students to analyze different immunochemical interactions **(K4)**
CO4	Enable students to analyze the complex mixtures after chromatographic separation **(K4)**
CO5	Enable students to evaluate the different electrophoretic techniques for separation and identification of biomolecules/ complex mixtures**(K5)**
CO6	Enable students to elaborate the knowledge of recent advancement in the field of Instrumentation physical chemistry **(K6)**

Text Book (s) & Reference Book (s)

1. Wilson And Walkers, Principles And Techniques Of Biochemistry And Molecular Biology 8th South Asia Edition 2018 by HOFMANN A, CAMBRIDGE UNIVERSITY PRESS
2. James M. Miller, Chromatography: Concepts and Contrasts, 2nd Edition
3. R J Mayer and J H Walker., Immunochemical Methods in Cell and Molecular Biology Academic Press, London. 1987.
4. Douglas B. Murphy and Michael W. Davidson, Fundamentals of Light Microscopy and Electronic Imaging, Second Edition, First published:13 September 2012
5. Reiner WestermeierElectrophoresis in Practice: A Guide to Methods and Applications of DNA and Protein Separations, Fourth Edition,,First published:25 October 2004
6. Reference: https://www.sciencedirect.com/science/article/abs/pii/S0165993619305953

UNIT 1: **Centrifugation Techniques** Basic principles of sedimentation, various types of centrifuges, Preparative centrifugation-Density gradient centrifugation and differential centrifugation, Analysis of sub-cellular fractions, Ultracentrifuge-Refrigerated Centrifuges
UNIT 2: Microscopy Definition and theory of microscopy ,Different types of microscopes (Optical microscope -.Instrumentation and working of simple, compound, comparison, phase contrast and stere-omicroscope) and Electron microscope (Instrumentation and working of SEM and TEM)

UNIT 3: **Immuno-chemical Techniques** Structure and types of antibodies, Precipitin reaction, Gel immuno-diffusion- single and double diffusion, Immuno-electrophoresis, , Radio Immuno Assay (RIA), ELISA, Fluorescence immuno assay.
UNIT 4: **Chromatographic Techniques** General principles, column chromatography, Paper chromatography, TLC, Gas chromatography, HPLC HPTLC, UPLC
UNIT 5: Electrophoretic Techniques General principles, Factors affecting electrophoresis, Low voltage thin sheet electrophoresis, High voltage electrophoresis, Sodium dodecylsulphate (SDS) polyacrylamide gel electrophoresis
Unit 6: Advancements in chemical and biological intrumentation Reference: https://www.sciencedirect.com/science/article/abs/pii/S0165993619305953

Continuous Assessment Pattern

Internal Assessment (IA)	**Midterm (MTE)**	**End term Test (ETE)**	**Total Marks**
30	**20**	**50**	**100**

Name of The Course	Cyber Forensics and Cyber Laws				
Course Code	**MBS27T1105**				
Perquisite	**Basics of computer functioning**				
Co requisite	**Computer programing, cyber security**				
Anti requisite					
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objective: The objective is to impart students the basic knowledge of computers and its application in forensic science and the different types of computer based crimes encountered in the society.

Course Outcomes:

CO1	Understand the basis of cyber crime.
CO2	Identify the type of mode and manner used for the commencement of cyber crime
CO3	Appraise the type of cyber crime
CO4	Demonstrate the use of analysis tools used for the investigation of cyber crime
CO5	Appraise the laws in relation to cyber crimes.
CO6	Identify the changing trends in the cyber crimes

Text Book (s) & Reference Book (s)

1. Leshin, C.B., Internet Investigation in Criminalistics, Prentice Hall, New Jersey, 1997.
2. Tessarolo, A.A. and Marignani, A., Forenisc Science and the Internet. The Canadian Society of Forensic Science Journal, Vol. 29, 1996.
3. IT Act (2005)
4. Incident Response and Computer Forensic by Kelvin Mandia, TMH Publication.
5. Digital Forensics: Digital Evidence in Criminal Investigations by Angus McKenzie Marshall

6. Cyber Forensic A Field Manual for Collecting, Examining and Preserving Evidence of Computer Crimes by Albert J Menendez. Auerbach Publications.
7. First Responder's Guide to Computer Forensics by Richard Nolanetal. - Carnegi Mellon, 2005.
8. Cyber Forensic by Marecella Menendez.
9. Computer Forensic by Newman.
10. Cyber Crime Investigation Field Guide, by B Middleton.
11. John. R.Vacca, 2005, Computer Forensics: Computer Crime Scene Investigation, Cengage Learning

UNIT 1: Introduction & Classification: Definition of Cyber Crime, Characteristics of Cyber Crime, Motives of Cyber Crime, Classification of cyber crime, Cyber Crime against Individuals, Cyber Crime against Organization, Cyber Crime against Society.
UNIT 2: <u>Modes & Manner of Cyber Crime</u> Modes & Manner of committing Cyber Crime, Cracking & Hacking, Data Theft, Email bombing, Data Didling, Salami attacks, DOS & D-DOS attack, Virus/worm attacks, Logic bombs, Internet time theft, Electronic eavesdropping, Cyber stalking& Cyber Bullying, Password sniffing, Cyber-squatting, Spoofing & masquerading, Identity theft, Cyber venting, Cyber defamation.
UNIT 3: Types of Cyber Crime Industrial Espionage, Piracy, Patent & Copyright Infringement, Child Pornography,Email Scams (Phishing/Credit Card), Cyber laundering, Online gambling, Cyber Terrorism, Email Spoofing, Illegal trafficking
UNIT 4: **<u>Cyber Tools and Forensic investigation of cyber crime</u>** Definition & Importance of Cyber forensics, Cardinal Rules of cyber Forensic, Tools used for Cyber Forensic Analysis, Command line forensic tools, GUI based forensic tools, Hardware and Software tools, Licensed and Open-Source tools. Search & Seizures of evidence, Imaging of digital media. Performing Forensic analysis on various operating systems

Unit-5: Major IT Laws related to Cyber Crimes Definition of IT Act 2000., Important Sections of IT ACT: Section 3, Section 4, Section 5. Section 6. Section 43. Section 65 and 65B, Section 66, 66A, 66B, 66C, 66D, 66E and 66F. Section 67, 67A and 67B.Section 70. Section 71. Section 72
Unit VI: Changing face of cyber crimes: Digital terrorism, Social Media Crimes

Continuous Assessment Pattern

Internal Assessment (IA)	Midterm (MTE)	End term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Crime Scene Management					
Course Code	MBS27T1106					
Perquisite	Forensic science, laws related to crime					
Co requisite	Forensic photography					
Anti requisite						
			L	T	P	C
			2	0	0	2

Course Objective: This course would introduce the students to Forensic Science and its role in the investigative system. The students would be appraised about the crime scene management using which they can successfully evaluate a crime scene.

Course Outcomes:

CO1	Understand the basics of crime scene types, role of first responders and Forensic scientist.
CO2	Resolve the issues arising in relation with crime scene management.
CO3	Practice the gained knowledge in handling of different physical evidences found at the crime scene and generalized the cause of conduct based on type of crime scene and pattern of physical evidences found at scene of crime.
CO4	Reconstruct the case by generating the hypothesis based on research knowledge followed by experimental techniques and interpreting the acquired results.
CO5	Interpret the results acquired from advanced techniques for reconstruction of crime scene.
CO6	Understand the geometric approach for reconstruction of crime scene

Text Book (s) & Reference Book (s)

1. DeForest, P., Gaensslen, R., and Lee, H., Forensic Science; An Introduction to Criminalitics, McGraw Hill, New York, 1983.
2. Fisher, B., Techniques of Crime Scene Investigation (6thEdn.) CRC Press, Boca Raton, Florida, 2000.
3. James, S. H. And Nordby, J. J. (Eds) Forensic Science - An Introduction to Scientific and Investigative Techniques, CRC Press, London, 2003.
4. B.R. Sharma, Forensic Science in Criminal Investigation and trials - Universal Law Publishing Company, 2003, ISBN 817534332X, 9788175343320
5. Crime Scene Investigation Procedural Guide 1st Edition by Michael S. Maloney, Donald Housman, Ross M. Gardner
6. Fundamentals of Forensic Science 3rd Edition 2015 Max M. Houck and Jay A. Siegel
7. The Encyclopedia of Crime Scene Investigation (Facts on File Crime Library) 1st Edition by Michael Newton

UNIT 1: **CRIME SCENE and TYPES OF CRIME SCENE**

Defining a crime scene Types of Crime Scene: Indoor, outdoor; Primary and secondary and crime scenes based on size of evidence. Special crime scene: underwater crime scene, virtual crime scene, serial crime scenes.

Initial response, role of first responding officer, duty management; Role and qualities of an Investigating officer, Role of forensic scientists, forensic doctors, fire brigade and judiciary.

UNIT-2 CRIME SCENE MANAGEMENT

Crime scene Management- Securing and Recording the Crime Scene, Avoiding contamination & cross contamination, Protecting a scene of crime – various steps involved, contamination issues. Recording a crime scene: Crime Scene Survey, Forensic Photography, sketching, field notes, handling clues, modern aids. Case study - : Lindberg Kidnapping case,The murder of Gianni Versace, Arushi Talwar Double Homicide, Geeta and Sanjay Chopra Case

UNIT 3: **EVIDENCE HANDLING**

Definition, types and importance of evidences, Collection, preservation, packing and forwarding of different types of evidences to the laboratories – chemical evidences, biological evidence, physical evidences, digital evidences, document evidences. Evidence recovery log, Chain of Custody, Forwarding & Authorization letters and documentation. Report writing and Evidence Evaluation, Mobile FSL- Role & Functioning. Case Study – OJ Simpson case, Ted Bundy, Killer Clown, Butcher of Rostov, Francisca Rojas case, Grover Murder case.

UNIT 4: **CRIME SCENE RECONSTRUCTION**

Crime scene reconstruction and its utility. Steps involved - Recognition of evidence, Evaluation of evidence, Hypothesis, Testing & Theory formation; Pattern evidence; Writing a reconstruction report of cases of Special Importance pertaining to forensics..

Unit 5: Crime Scene Reconstruction Using a Fully Geomatic Approach:

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3707450/

https://pubmed.ncbi.nlm.nih.gov/32111294/

Continuous Assessment Pattern

Internal Assessment (IA)	**Midterm (MTE)**	**End term Test (ETE)**	**Total Marks**
30	**20**	**50**	**100**

Name of The Course	**Practicals- Crime Scene Investigation**				
Course Code	MBS27P1101				
Prerequisite	Forensic Science				
Corequisite	Forensic photography				
Antirequisite					
		L	**T**	**P**	**C**
		0	0	2	1

Course Objectives: The objective of this course is to give practical exposure to the students in the different aspects of crime scene investigation, give hands-on experience in handling physical evidences, packing and forwarding the evidences and their examination. To give the students hands-on experience in Computer Forensics related aspects.

Course Outcomes

CO1	Reconstruct the indoor and outdoor scene of crime using triangulation methods.
CO2	Formulate the sketch of indoor and outdoor crime scene by base line method.
CO3	Apply the gained knowledge in collection, packing and forwarding of various types of physical evidences to forensic laboratories for their analysis
CO4	Resolve the issues arising in relation with crime scene management.
CO5	Reconstruct the case by generating the hypothesis using experimental techniques and interpreting the acquired results.

Text Book (s) & Reference Book (s)

1. Bodziak, W., Footwear Impression Evidence (2nd Edn.) CRC Press, Boca Raton, Florida, 2000.
2. DeForest, P., Gaensslen, R., and Lee, H., Forensic Science - An Introduction to Criminilastics, McGraw Hill, New York, 1983.
3. Fisher, B., Techniques of Crime Scene Investigation (6th Edn.) CRC Press, Boca Raton, Florida, 2000.
4. James, S., and Eskerc, W., Interpretaion of Blood Stain Evidence at Crime Scenes, (2nd Edn) CRC Press, Boca Raton, Florida, 1999.

5. James, S.H., and Nordby, J.J., (Eds), Forensic Science; An Introduction to Scientific and Investigative Techniques, CRC Press, London, 2003.
6. Nanda, B.B. and Tewari, R.K; Forensic Science in India- A vision for the twenty first century, Select Publisher, New Delhi (2001)
7. Saferstein: Criminalistics – An Introduction to Forensic Science, Prentice Hall Inc. USA (1995)

List of Experiments
1. Investigation and sketching of indoor scene of crime using triangulation method. 2. Investigation and sketching of outdoor scene of crime using triangulation method. 3. Investigation and sketching of indoor scene of crime using baseline method. 4. Investigation and sketching of outdoor scene of crime using baseline method. 5. To collect, pack different types of evidences by using druggist fold method and forwarding of these evidences to the FSLs 6. To understand how a Crime scene should be managed and reconstructed by simulating hit and run case. 7. To understand how a Crime scene should be managed and reconstructed by simulating hanging case. 8. To understand how a Crime scene should be managed and reconstructed bysimulating murder case. 9. To understand how a Crime scene should be managed and reconstructed by simulating burglary case. 10. To understand how a Crime scene should be managed and reconstructed by simulating drug overdose case. 11. To understand how a Crime scene should be managed and reconstructed by simulating cybercrime.

Continuous Assessment Pattern

Internal Assessment (IA)	End Term Test (ETE)	Total Marks
50	50	100

Name of The Course	**Lab Forensic Photography**				
Course Code	MBS27P1102				
Prerequisite					
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		0	0	2	1

Course Outcomes

CO1	Understand the working of analog and digital camera.
CO2	Resolve the issues arising in taking focussed photographs
CO3	Practice the gained knowledge for indoor crime scene photography**.**
CO4	Practice the gained knowledge for outdoor crime scene photography.
CO5	Interpret the results acquired from photography evidence and reconstruct the crime scene.

Text Book (s)&Reference Book (s)

1. Redsicker, D. R., The Practical methodology of Forensic Photography, CRC Presss, London, 1994.
2. Criminalistics, An Introduction to Forensic Science: Richard Saferstein, 10th Edition, Pearson Education International.
3. Forensic Science An Introduction to Scientific and Investigative Techniques : Stuart H. James and Jon J. Nordby., 3rd Edition CRC Press, Taylor & Francis Group.
4. Edward M Robinson, Crime Scene Photography
5. Herbert L Blitzer, Forensic Digital Imaging and Photography
6. Tom Ang, Digital Photography, 1999
7. Forensic Digital Image Processing: Optimization of Impression Evidence 1st Edition by Brian Dalrymple, Jill Smith
8. The Practical Methodology of Forensic Photography (Practical Aspects of Criminal and Forensic Investigations) by David R. Redsicker
9. Fundamentals of Forensic Photography: Practical Techniques for Evidence Documentation on Location and in the Laboratory (Applications in Scientific Photography) 1st Edition, by Keith Mancini , John Sidoriak
10. Forensic Photography: Importance of Accuracy 1st Edition, by Sanford L. Weiss

List of Experiments

1. To understand the working of digital and analog camera.
2. To take photography of individual /group under various light conditions (bright, moderate, dark) in full passport and postcard size
3. To perform landscape photography and distance photography for understanding the phenomenon of focusing camera.
4. To take sequential photography
5. To perform photography for fixing the location of crime scene (indoor and outdoor – five scenarios).
6. To perform crime scene photography for indoor crime scene (burglary)
7. To perform crime scene photography for indoor crime scene (hanging)
8. To perform crime scene photography for indoor crime scene (murder)
9. To perform crime scene photography for outdoor crime scene (vehicular accident)
10. To perform crime scene photography for outdoor crime scene (murder)
11. To perform crime scene photography for outdoor crime scene (fall from height)

Continuous Assessment Pattern

Internal Assessment (IA)	**End Term Test (ETE)**	**Total Marks**
50	50	100

Name of The Course	**Cyber Forensic Lab**				
Course Code	MBS27P1103				
Prerequisite	Basics of computer functioning				
Corequisite	Cyber security				
Antirequisite					
		L	**T**	**P**	**C**
		0	0	2	1

Course Objectives: To teach the fundamentals of computer, the various storage devices, concepts of Operating Systems and to use Windows System. To apprise the students regarding the various ways in which Cyber crimes are committed, their investigation and the tools that are used for the analysis.

Course Outcomes

CO1	To understand the structure of HTML, XML and PHP
CO2	Appraise the functioning of wireless devices
CO3	Demonstrate the working of image processing tools
CO4	Appraise the usage of softwares for analysis of cyber crimes
CO5	Identify the fake accounts on social media platforms

Text Book (s)&Reference Book (s)

1. Leshin, C.B., Internet Investigation in Criminalistics, Prentice Hall, New Jersey, 1997.
2. Tessarolo, A.A. and Marignani, A., Forenisc Science and the Internet. The Canadian Society of Forensic Science Journal, Vol. 29, 1996.

3. Incident Response and Computer Forensic by Kelvin Mandia, TMH Publication.
4. Digital Forensics: Digital Evidence in Criminal Investigations by Angus McKenzie Marshall
5. Cyber Forensic A Field Manual for Collecting, Examining and Preserving Evidence of Computer Crimes by Albert J Menendez. Auerbach Publications.
6. First Responder's Guide to Computer Forensics by Richard Nolanetal. - Carnegi Mellon, 2005.
7. Cyber Forensic by Marecella Menendez.
8. Computer Forensic by Newman.
9. Cyber Crime Investigation Field Guide, by B Middleton.
10. John. R.Vacca, 2005, Computer Forensics: Computer Crime Scene Investigation, Cengage Learning

List of Experiments
1. Structure of HTML, XML and PHP 2. Creating webpage using Structure of HTML, XML and PHP. 3. Understanding dynamic and static pages, 4. Viewing HTML Source and HTTP Headers, and understanding Header Information. 5. Study of wireless devices. 6. Study of wireless networks and wireless network analysis. 7. Working with wireshark for Network analysis. 8. Studying of packets and packet formats. 9. Image processing and pattern Recognition framework 10 Log Collections and analysis. 11. Network evidence collection offline and online. 12. Detection of origin of e-mails (IP address) etc 13. Software for protection of data & security 14. Softwares in detection of various aspects of cyber crime 15. Tools to check fake social media accounts (new added as module 6)

Continuous Assessment Pattern

Internal Assessment (IA)	End Term Test (ETE)	Total Marks
50	50	100

Semester II

Name of The Course	Finger Prints and other Impressions				
Course Code	**MBS27T1107**				
Perquisite					
Co requisite					
Anti requisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objective:

The objective of the course is to impart knowledge of fingerprints as an important physical evidence at the scene of crime. The students would be able to study the manner in which it is developed, identified, classified, collected, packed and forwarded to the Fingerprint Bureau

Course Outcomes: Course Outcomes:

On completion of this course, the students would acquire knowledge regarding fingerprint patterns, the different types of fingerprint classification, the various methods of fingerprint development and their recording.they'll get the knowledge of latest trends occurring for fingerprint development.

CO1	**To learn History of Fingerprints and also about classification of fingerprints .**
CO2	**To gain knowledge of Types of fingerprints and methods of Developing Fingerprints**
CO3	**To understand about Comparison and analysis of fingerprints**

CO4	**To gain knowledge of Biometric Methods of Identification, report writing and Presentation of Evidence in a Court**
CO5	**To understand about the other types of impressions like palm prints, foot prints, lip prints, bite marks and gait pattern etc.**
CO6	**To understand about vacuum metal division and other advance method for development of fingerprint**

Reference BooksText Books

1. J. A., Sukoo, R. J, and Knupfer (2000), "Encyclopedia of Forensic Science", Siegel, Academic Press.

2. Champod, C., Lennard, C. J., Margot, P., & Stoilovic, M. (2017). Fingerprints and other ridge skin impressions. CRC press.

3. Henry C. Lee and R. E.Gaensslen, "Advances in Fingerprint Technology", Second Edition.

4. Fingerprint Manual, Division of Health Improvement.

5. Edward Hueske, "Firearms and Fingerprints", Viva Books Private limited

6. "Crime Scene Investigation", Aric W. Dutelle, Jones and Bartlett learning, Second Edition.

7. J.E. Cowger, Friction Ridge Skin, CRC Press, Boca Raton (1983).

8. D.A. Ashbaugh (2000), Quantitative-Qualitative Friction Ridge Analysis, CRC Press, BocaRaton.

9. Criminalistics, An Introduction to Forensic Science: Richard Saferstein, 10th Edition, Pearson Education International.

10. Forensic Science An Introduction to Scientific and Investigative Techniques: Stuart H. James and Jon J. Nordby., 3rd Edition CRC Press, Taylor & Francis Group.

11. C. Champod, C. Lennard (2004), P. Margot an M. Stoilovic, Fingerprints and other Ridge Skin Impressions, CRC Press, Boca Raton.

12. Lee and Gaensleen's, Advances in Fingerprint Technology, 3rd Edition, R.S.

13. Ramotowski (2013), CRC Press, Boca Raton.

14. Encyclopedia of Forensic Science, Volume 1-3: Jay A Siegel, Pekka J Saukko, GeofferyKnupfer. Academic Press.

1. Encyclopedia of Forensic Science, Volume 1-3: Jay A Siegel, Pekka J Saukko, GeofferyKnupfer. Academic Press.

2. Criminalistics, An Introduction to Forensic Science: Richard Saferstein, 10th Edition, Pearson Education International.

3. Champod, C., Lennard, C. J., Margot, P., & Stoilovic, M. (2017). Fingerprints and other ridge skin impressions. CRC press.

4. Ashbaugh, D. R. (1999). Quantitative-qualitative friction ridge analysis: an introduction to basic and advanced ridgeology. CRC press.

Unit 1 History and Classification of Fingerprints **History and Development of Fingerprints, Poroscopy, Dactyloscopy,formation of ridges, pattern types, pattern areas, classification of fingerprints- Henry System of Classification, Single digit Classification, Extension of Henry System, Search of fingerprints, Development of Fingerprint Bureau and its function and role in forensic investigation**
Unit 2 Types of fingerprints and methods of Developing Fingerprints **Chance Fingerprints, Latent & Visible Fingerprints, Plastic Fingerprints, Composition of Sweat, Development of latent fingerprints, conventional methods of development of fingerprints– fluorescent method, magnetic powder method, fuming method, chemical method etc.,**
Unit 3 Other Methods of Developing Fingerprints **Digital imaging and enhancement of fingerprints, application of laser and other radiations to develop latent fingerprints, metal deposition method and development of latent prints on skin, Taking of finger prints from living and dead persons, preserving and lifting of fingerprints**
Unit 4 Comparison and analysis of fingerprints **Photography of fingerprints, digital transmission, comparison of fingerprints, basis of comparison, class characteristics, individual characteristics, various types of ridge characteristics, Automatic fingerprint identification system**

Unit-5 other impression **Foot prints-Types,Location,Inportance,Gait, Pattern,Casting of footpribts in different medium, electrostatic lifting of latent footprints,collection methods for control samples.** **Tyre marks/prints and skid marks, taking of control samples.** **Tyre Impressions Examinations Process,Skid marks ,Drag Marks Track Marks-Hoof Marks,PawMarks,Hoop Marks** **Lip Prints – Nature, location, collection and evaluation.** **Bite Marks – Forensic Significance, Photography, Lifting and preservation of bite marks and evaluation.** **Ear Prints - Forensic Significance, location, collection and evaluation** **Taking of control samples for comparison**
Unit 6: Use of Recent Advance techniques in development of Fingerprints
Vacuum metal deposition method for development of fingerprints on porous and non porous surfaces.finger print enhancement software.

Continuous Assessment Pattern

Internal Assessment (IA)	Midterm (MTE)	End term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Research Methodology				
Course Code	**MBS28T2111**				
Prerequisite					
Corequisite					
Antirequisite					
		L	T	P	C
		2			**2**

Course Objectives:

Course Outcomes

CO1	13. Understand the Principles of Scientific Research and different steps involved in doing research.
CO2	14. Know how to design research and frame up different steps in design.
CO3	15. Appraise the application of sampling through statistics.
CO4	16. Build up the method for data collection and analyse the data.
CO5	17. Develop the Concept of hypothesis preparation.
CO6	18. Developthe statistical analysis indulges in modern research for drug designing.

Text Books:

17. K. Ramakant; Elementary Statistics in a world of applications, Goodyear California Pub. Co.,1979.
18. K. D. Broota, Experimental designs in psychological research, Wiley eastern, New York, 1992.
19. Guilford, Statistics in Psychology and Education, McGraw hill, New York, 1986.
20. Katz and Kahn, Research in Behavioural Sciences, Methuen, USA, 1979.

Reference Books:

17. Kerlinger, F., Foundations of Behavioural Research, Surjeet Publications, Delhi, 1983.
18. Rajamanickam, M., Statistical Methods in Psychological and Educational Research, Concept Publishing Co. New Delhi, India, 1983.
19. Smith, Jonathan, A. (Ed.), Qualitative Psychology: A Practical Guide to Research Methods, Sage Publications, 2003.
20. Woodworth and Schlosberg, Experimental Psychology, Methuen and co. ltd, London, 1971.
  21. Chanin Nantasenamat, Chartchalerm Isarankura-Na-Ayudhya, Thanakorn Naenna, Virapong Prachayasittikul, A Practical Overview of Quantitative Structure- Activity Relationship.EXCLI Journal 2009;8:74-88.
  22. Wiktor Pronobis,Alexandre Tkatchenko,and Klaus-Robert Muller, J. Chem. Theory Comput. 2018, 14, 2991−3003
  23. Leo, A., & Hoekman, D. H. (1995). *Exploring QSAR*. American Chemical Society.

Unit – 1: Principles of Scientific Research	**6 Lectures**
Research and research methodology, Procedures in research, Identification of the problem - Literature survey - Reference collection - Familiarity with ideas and concept of investigation - Qualitative and Quantitative analysis - Results - Synopsis writing - Art of writing a Research paper and Thesis.	
Unit – 2: Research Design, Sampling & Probability	**5-Lectures**
Research Design: Features of a Good Design, Different Research Designs, Sampling: Principles, methods, types of sampling, rationale for using a particular sampling procedure, Probability: Classical definition of Probability.	
Unit – 3: Data collection & analysis	**6- Lectures**
Types of Data, Collection of Data, double blind procedures, incidence and prevalence studies, Data Analysis: Measures of Central Tendency, Measures of Dispersion, Measures of Asymmetry	
Unit-4: Correlation and Regression	**5-Lectures**
Methods of correlation, Types of correlation (Pearson r& Rho); Regression analysis, linear regression, Non-linear regression.	
Unit – 5: Hypothesis and Statistics	**5-Lectures**
Hypothesis Testing: Problems and hypothesis, variables and type of variables, Parametric and nonparametric statistics; level of significance, the various nonparametric tests with sample.	
Module 6: Recent research advances	
Descriptors, Quantitative structure-activity relationship (QSAR), Quantitative structure-property relationship(QSPR), Drug designing	

Continuous Assessment Pattern

Internal Assessment (IA)	Midterm (MTE)	End term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Questioned Documents				
Course Code	**MBS27T1108**				
Perquisite					
Co requisite					
Anti requisite					
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objective:
To know the different types of questioned documents, the types of forgery generally encountered. To learn the methods of their detection and examination and handwriting identification. To identify and do analysis of typewritten documents.

Course Outcome:
On completion of this course, the students would be able to know the different types of questioned documents, the types of forgery generally encountered, methods of their detection and examination, handwriting and typewriting identification.

CO1	Students will be able to delineate the basics of questioned documents and the sections dealing with expert testimony in IPC, IEA,Cr.PC. (K2)
CO2	Students will be able to handle, preserve and manage the questioned documents found at the scene of crime.(K4)
CO3	Students will be able to distinguish between the counterfeit and genuine currencies, passports ,cheques ,credit and debit cards. (K3)
CO4	Students will be able to examine, analyze and differentiate various inks, papers and pens used in preparing a document. (K4)
CO5	Students will be able to identify class and individual characteristics, compare and form an opinion about the authorship of handwriting and signatures. (K6)

CO6	Students will be able to identify writers on the basis of forensic linguistics and stylistics. (K6)

Text Book (s) & Reference Book (s)

- Albert, S. Osborn, Questioned Documents, Second Ed., Universal Law Publishing, Delhi, 1998.
- Albert, S. Osborn, The Problem of Proof, Second Ed., Universal Law Publishing, Delhi, 1998.
- Charles, C. Thomas, I.S.Q.D. Identification System for Questioned Documents, Billy Prior Bates, Springfield, Illinois, USA, 1971.
- Charles C. Thomas, Typewriting Identification I.S.Q.D.; Billy Prior Bates; Springfield, Illinois, USA, 1971.
- Hard less, H.R., Disputed Documents, handwriting and thumbs – print identification: profusely illustrated, Low Book Co., Allahabad, 1988.
- Kurtz, Sheila, Grapholypes a new plant on handwriting analysis, Crown Publishers Inc., USA, 1983.
- Lerinson, Jay, Questioned Documents, Acad Press, London, 2001.
- Morris, Ron, N., Forensic handwriting identification, Acad Press, London, 2001.
- Ordway Hilton, Scientific Examination of Questioned Documents, Rev. ED., Elsevier, New York, 1982.
- Wilson, R., Harrison, Suspect Documents – Their Scientific Examination; Universal Law Publishing, Delhi, 1997.

Unit 1 Introduction to Questioned Documents	**10 H**
Definition, importance, classification of documents- suspected/questioned documents, various types of documents, holographic documents, problems of document examination, standard documents- Specimen and Admitted documents, procurement of standard (admitted/ specimen) writings, care, handling, preservation, preliminary examination of documents, writing instruments and material used to prepare document.	
Unit 2 Handwriting	**8 H**
Basis of handwriting identification – development of individuality in handwriting, different vernacular Indian languages and scripts, natural variations, process of comparison, basic rule of handwriting, various writing features and their estimation, general characteristics of handwriting, individual characteristic of handwriting, fundamental divergences, basic tools needed for forensic documents examination and their use.	
Unit 3 Methods of Forgery and Forgeries and their Detection	**10 H**

Disguised writing and anonymous letters – identification of writer, Examination of signatures – characteristics of genuine and forged signatures, Various types of forgeries and their detection, Examination of alterations, erasers, overwriting, additions and obliterations, Decipherment of secret, indented and charred document, Examination of seal impression and other mechanical impressions, , Examination of built up documents – determination of sequence of strokes, Physical matching of documents.	
Unit -4: Examination of Type writings, Printed matter and other Documents	**10 H**
Working of typewriter, Identification of type writings – identification of typist, electronic typewriter, Examination of computer print out, identification of dot-matrix, ink-jet and laser printers, security documents, passports, visa, stamp papers, postal stamps, Printing of currency notes, examination of counterfeit currency notes, Examination of black & white, colour Xeroxed copies, carbon copies, fax massages Forgeries etc.	
Unit-5 Examination of Different types of Documents & Report Writings	**8 H**
Determination of age of documents by examination of signatures – Paper, ink and writing/signatures etc. Forensic stylistics, forensic linguistics, Evidence and testimony in court, Information required by the Forensic expert, Components of Forensic Reports, Preparation of Report, Presenting findings in a Report format.	
Unit 6: Recent trend in identification of questioned documents	**4H**
Use of raman spectroscopy and semi electron microscope in documents examination, Ink profiling	

Continuous Assessment Pattern

Internal Assessment (IA)	Midterm (MTE)	End term Test (ETE)	Total Marks
30	**20**	**50**	**100**

Name of The Course	Criminal Laws, Judicial System and Police Administration				
Course Code	**MBS27T1109**				
Perquisite	**IPC and CrPC**				
Co requisite					
Anti requisite					
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objective:

The objective of the course is to impart knowledge of Criminal Laws, Judicial System and Police Administration. To show the importance of it in forensic science.

Course Outcomes:

On completion of this course, the students would acquire knowledge regarding the different criminal laws relevant in forensic Science and Criminology. The arrangement of judicial system and how police administration deals with all the victims and criminals and the setup of the organizations.

CO1	To gain the knowledge of criminal laws and different offences comes under the criminal law section.
CO2	To understand the criminal justice system and the work performed under the system.
CO3	To understand the history of the judiciary system and the changes made in the modern judiciary system.
CO4	To gain the knowledge of police administration and the way of organization of crime statistics and dealing with victims/suspects.
CO5	To understand the role of police administration and different organizations that work as special units.
CO6	To gain the knowledge of new build laws and other changes in criminal justice system.

Text Book (s) & Reference Book (s)

- Introduction to the Constitution of India: D. D. Basu., 21st Edition, Lexisnexis Publishers.
- India's Constitution – Cornerstone of a Nation: Granville Austin. Oxford, Clarendom

Publication, (1966).

- Indian Government and Politics, Vol 1 & 2: J C Johari: Shobhan Lal Publication.
- Dynamics of Indian Government and Politics: J R Siwach: Sterling Publishers, (1985).
- Indian Government & Politics: D C Gupta: Vikas Publishing House, 8th Edition, (2007).

(1993).

- Swanson, Charles, R. (1983). “Police administration: Structure, processes and behavior” New York: MacMillan Publishing Co., Inc.
- Police Administration: Rajinder Prasher, Deep &Deep Publication, New Delhi, (1986).
- The Police and Political Development in India: D.H. Baylay , Princeton University

Press, (1969).

- Ramanujam, T. (1992) “Prevention and detection of crime” Madras: Madras Book Agency.
- Thurman, Q., & Mc Garrell, E. (1997) “Community policing in a rural setting “Cincinnati: Anderson.
- The Law of Criminal Procedure: S.C. Sarkar, S.C. Sarkar and Sons, Calcutta, (1978).
- The Law of Evidence: M. Hidayatullah, Wadhwa and Company Private Limited, Nagpur,

(1987).

- Indian Penal Code: Ratan Lal & Dhiraj Lal: Revised BY Justice K.T. Thomas & M.A. Rashid,34th Edition, (2015).
- Indian Evidence Act: Dr. V. Wageswara Rao, Lexisnexis, 1st Edition.

- Mathur, K. M. (1994), “Indian police: Role and challenges” New Delhi: Gyan Publishing House.
- Snyman, R. (1997) “Policing and human rights”. Kenwyn, UK: Juta.
- Diaz, S. M. (1976), “New dimensions to the police role and functions in India” Hyderabad: National Police Academy.

UNIT 1: Module I: CRIMINAL LAWS

Indian Penal Code, Criminal Procedure Code - Powers of police to Arrest, Search and Seizure and Indian Evidence Act (Special provision for women and children). Enactment of statues towards women and child issues – IPC Sections: 304B, 315, 316, 366-A&B, 369, 372, 373, 375-377. Difference between criminal law and law of Torts. Cognizable and Non-cognizable offences, Bailable and Non-bailable offences. Recidivism: - Causes and prevention National commission for women, UNISCO –Child Rights, Child labor, Child abuse and prostitution. CRPC – Towards Women Rights
UNIT 2: CRIMINAL JUSTICE SYSTEM
Criminal Justice System - Introduction, meaning, purpose and social relevance. Criminal Justice System in India and its importance. Accusatorial and inquisitorial systems of criminal justice system. Organizational structure, co-operation and co-ordination among the various sub-systems of the Criminal Justice System. Fundamental elements of crime. Stages of crime: Intention, preparation, attempt and commission.
UNIT 3: JUDICIARY SYSTEM IN INDIA
Meaning and role of judiciary. Structure and functions of Indian judiciary - Hierarchy of Courts in India. Historical development of prison in India. Present conditions of Prison Administration in India Prison organization in India. Modernization of Indian prison system. Fundamental concepts of Rule of law, Concept of practice, Speedy trial, writ provisions, Due process of Law – Status of victim of crime.
UNIT 4: **POLICE ADMINISTRATION**
History of Indian Police: Ancient period, Medieval period, British period , Community policing, Modern policing, Police Commission Reforms and Recommendations - Police Act, 1861, Police research and Crime Statistics Organizations, Latest trend in treatment of victims/suspects – Victim assistance in developing countries, National Police Commission recommendations (NPC), 1979
Unit-5: ROLE OF POLICE ORGANIZATIONS
Functioning of State Police – Law and Order, Intelligence and Special Unit Central police organizations: CBI, CISF, RPF, RAW, IB, CRPF, INTERPOL Approach of police towards victims and offenders as per Indian provisions. Measures to prevent drug abuse, prevent child abuse, and ensure safety of senior citizens. On site responsibilities of police officers, Crime prevention: Beat and patrolling, surveillance, intelligence, traffic regulation, law & order, Collection of intelligence and its use - Use of scientific methods to tackle crime.
Unit 6: Recent changes in criminal justice system
Recent development in criminal laws, judiciary system and police administration

Continuous Assessment Pattern

Internal Assessment (IA)	Midterm (MTE)	End term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Introduction to Criminology and Psychology				
Course Code	**MBS27T1110**				
Perquisite					
Co requisite					
Anti requisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objective: **The objective of this course is to introduce to the students the concepts of criminology & forensic psychology and the factors that contribute to a person becoming antisocial, the different types of theories for crime and various tools for assessing psychology of criminal**

Course Outcomes:

CO1	**Students will able to understand basic concepts of criminology ,victimology & scope of criminology.**
CO2	**Students will gain knowledge about various theories for crime & factors responsible for criminal behaviour.**
CO3	**Students will be able to gain knoledge ablut the crime against women & youth crime various factors responsible for it.**
CO4	**Students wil be introduced withthe new concept of psychology what are the ethical issues involved and key concepts .**
CO5	**Students will gain knowledge about the various tools & technique used in psychology .**
CO6	**Student gain knowledge about forensic psychiatry**

Text Book (s) & Reference Book (s)

Art & science of polygraph technique :J.A Matte

Handbook of forensic psychology -O Donohue levensky

Detecting lies& Deceit-A Vrij

Brain Experience-C.R Mukundan

- **, M.K., Child, I.L and Barry, H., A Cross- cultural Study of Correlates of Crime, Journal of Abnormal and Social Psychology, 1963.**
- **Bajpai, G.S., Development without Disorders, VishwavidyalayaPrakashan, Sagar (M. P.), 2002.**
- **Ellis, L. and Walsh, Criminology – A Global Perspective, Allyn, and Bacon, Boston, 2000.**
- **M. Meguire, R. Morgan & R. Reiner; Oxford Handbook of Criminology, 2nd ed. Biddles Ltd, Lyon, 1997.**
- **Ram Ahuja, Criminology; Rewal Pub. Jaipur , 2000.**

Unit 1 Introduction to Criminology & Typology **Definition & scope of crime and criminology, Classification of crime according to IPC, Victimology: definition of victim and victimization, types of victimization. Various Crimes: Economic offences, Organized crime, White collar crime, Occupational crime, Political crime, Habitual criminals.**
Unit 2 Correlates and Theories of Crime & punishment **Biological co-relates of crime. Cognitive correlates of crime, Differential association theory, Social learning theory, Strain theory and Sub-culture of violence theory. Punishments: Definition, types, Controversy regarding death penalty, Principles underlying punishment.**
Unit 3: Crime against Women and Youth and Crime **Harassment & humiliation of women, female victims, motivation of crime against women, self-image, self- esteem and adjustment of the victims, creating awareness in the society** **Trends and characteristics of crime among the youth, Genesis of youth crime, Typology of Youth criminals, explanation of crime amongst youth**

Unit 4 Basics of Psychology **Forensic Psychology and the Law, Ethical Issues in Forensic Psychology, Civil and criminal case assessment, Assessing mental competency, Mental disorders and Forensic Psychology, Eye witness testimony, Criminal profiling- need and types, Forensic Scientific evidence, Crime and Psychopathology, Genetics and Crime, Serial murders, Modus Operandi: Psychological Assessment Tools, Detection of deception, Various methods for detection of deception, Interview, Non-verbal detection, statement assessment, Hypnosis, Psychological assessment, voice stress analyzer, Polygraph, thermal imaging, Brain Electrical Oscillation Signature Profiling, Functional Magnetic Resonance study, Current research in detection of deception/truth finding mechanisms**
Unit-5 Module V: Psychological Assessment **Polygraph: Historical aspects of Polygraph, Principles of polygraph, psycho physiological aspects, operational aspects, Question formulation techniques, Interviewing technique procedure, The Art-Polygraph, Legal and Ethical aspects, Human rights of individual. Narco-Analysis: Historical aspects, Principle and Theory, General Procedure –Legal and Ethical aspects, Human rights of individual.Brain Electrical Oscillation Signature (BEOS) Profiling: Principle and Theory, General Procedure – Legal and Ethical aspects, Human rights of individual.**
Unit 6:Elements of forensic psychiatry
Introduction to different mental illness,neurosis(Depression,mood disorder,insanity,psychosis,delusion,delirium,schizophrenia)Antisocial control stress disorder ,post traumatic stress disorder

Continuous Assessment Pattern

Internal Assessment (IA)	Midterm (MTE)	End term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Elements of Forensic Biology				
Course Code	**MBS27T1111**				
Perquisite					
Co requisite					
Anti requisite					
		L	**T**	**P**	**C**
		2	**0**	**0**	**2**

Course Outcomes:

CO1	To understand the various aspects of forensic biology & its various branches and how do they relate to real applications
CO2	To present comprehensive knowledge of blood s and laboratory examination of blood
CO3	To present complete knowledge to the student regarding the blood grouping and blood stain pattern analysis.
CO4	To understand the various methods of analysis and laboratory examination of semen
CO5	Assess the nature of the body fluid found at the crime scene and to present comprehensive knowledge of the various methods of analysis and laboratory examination of different types of body fluids.
CO6	To apply the knowledge of forensic biology in the field of forensic science and to elaborate the knowledge of recent advancement in the field of forensic biology .

Text Book (s) & Reference Book (s)

1. Albert’s, B. Bray, D, Lewis, J, Roberts K & Watson, J. D., Molecular Biology of Cell, 2nd Ed Garland Pub., New York, 1989.

2. Pandey, B. P., Plant Anatomy; S. Chand, New Delhi, 1998.

3. Simon, Ball, Environment Law – The Law and policy relating to protection of environment, Universal Law Pub Co, Delhi, 1991.

4. Biology Methods manual, Metropolitan Police Forensic Science Laboratory, London, 1978.

5. Byrd, J. H. &Castner, J. L., Forensic Entomology, The Utility of Arthorpods in legal Investigation, CRC Press, USA, 2000.

6. Catts, E.P & Haskell N.H., Entomology and death: A procedural guide, Joyce's Print Shop, 1990.

7. Clifford, B.J.,The examination and typing of Bloodstains in the Crime Laboratory, US Court Printing Press, 1971.

8. Gardner, E. J., Simmons, M. J. and Snustad, D.P., Principles of Genetics, John Wiley, New York, 1991.

9. Mc Caney, Edwin, H., Human Genetics, The Molecular Revolution, Jones& Bartlett Pub. London, 1993.

10. Greenish, H. G., & Collin, E., An anatomical Atlas of vegetable Powders, J&A Churchill, London, 1904.

11. Mauersberger , Herbert R., & Mathews, Textile Fibres – Their physical, Microscopic and chemical properties, John Wiley, New York, 1954.

12. Kimball, John W; Biology; Arvind Publishing Co. New Delh (1974)

13. Lewis, B Gene IV, OxfordUniversityPress, England (1980)

14. Morrison, Robert D; Environmental Forensics Principles and Applications, CRC Press, Boca Raton, New York, (2000)

15. Oates, D W, Brown, C W &Weigel, D L; Blood and tissue identification of selected birds and mammals; JPR study Projects Lincoln NE Nebraska Gome and Perks Commission (1974)

16. P. L. Williams and R.Warwick; Gray's anatomy; Churchill Livingston, London; (1980)

17. Richard Saferstein; Forensic Science Hand Book; Ed.; Prentice – Hall, Englewood Cliff, New jersey; (1982)

Unit 1 Forensic Biology: Introduction, sub-disciplines, Important Cases involving Forensic Biology. Forensic Serology: Introduction, basic concepts- antigens, antibodies (Polyclonal and monoclonal), Affinity, avidity, Antigen-antibody binding reactions- primary and secondary. Introduction to Tools and techniques involving analysis of Biology and serology.

Unit 2 Examination of Blood I Classification of different biological evidences, Principals of collection and preservation of biological exhibits. Blood: Composition and functions, Physical examination, presumptive test, Confirmatory and spectroscopic examination.
Unit-3 Examination of Blood II
Examination of Menstrual blood & its stains-Physical & Microscopic examination, Identification by Fibrin Degradation product. Human Blood groups: General Principles, theory of their inheritance, Blood group determination from fresh blood, titer, rauleaux formation and Bombay blood group. Forensic Characterization of Bloodstains, Stain Patterns of Blood.
Unit 4 Examination of semen Semen: Composition, functions and morphology of spermatozoa, Forensic significance, location, collection, evaluation, examination.
Unit 5 Examination of other body fluids and Hair
Body fluids: Forensic significance of other body fluids as Saliva,urine, Sweat and fecal matters, their collection and identification. Hair: Introduction, types, location, collection evaluation and forensic significance of Hair
Unit 6:Recent advances in Forensic Biology
Recent technological and scientific development in the field of forensic biology,touch DNA profiling, forensic phenotyping, microbial forensics, virtual autopsy and DNA methylation

Continuous Assessment Pattern

Internal Assessment (IA)	**Midterm (MTE)**	**End term Test (ETE)**	**Total Marks**
30	**20**	**50**	**100**

Name of The Course	**PRACTICALS - Fingerprints and other impressions**				
Course Code	MBS27P1104				
Prerequisite					
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		0	0	2	1

Course Objectives: **The objective of this course is to give practical exposure to the students in the different aspects of analysis of fingerprints using various chemical and physical methods.**

Course Outcomes: **The students will gain hands-on experience in the different aspects analysis of various impression evidences and fingerprints using various chemical and physical methods which are taught by way of conduction of practicals in the Laboratory.**

CO1	**Demonstrate different methods of fingerprint classification**
CO2	**Employ the various methods of fingerprint development, collection and their recording**
CO3	**Examine the methods of fingerprint comparison**
CO4	**Systematize a comparison method for the exhibit and suspected fingerprint evidence**
CO5	**Plan and set-up the experiments various impression evidences viz., foot prints lip-prints, ear-prints, etc. with their forensic significance**

Text Book (s) **Henry, E.R., Classification and Uses of Finger Prints, George Routledge and Sons Ltd**

Nath, S., Fingerprint Identification, Shiv Shakti Book Traders, New Delhi, 2010.

Sudha, S.I., Biometrics and Fingerprint Analysis, Selective and Scientific Books, New Delhi,

2012

James, S. H. and Nordby, J. J. (Eds), Forensic Science - An Introduction to Scientific and Investigation Techniques, CRC Press, London, 2003

PRACTICAL No -

1. **To take plain and rolled inked fingerprints**
2. **To identify the fingerprint patterns**
3. **To perform 10-Digit classification of fingerprints**
4. **To identify and compare ridge characteristics**
5. **To develop latent fingerprints with physical methods**
6. **To develop latent fingerprints using chemical method**
7. **Lifting and comparison of fingerprints**
8. Examination of Foot/Foot wear impressions
9. To examine the given lip print sample
10. To examine the given ear print samples.
11. To analyse the gait pattern
12. **To develop latent fingerprints with fuming methods**

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Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
50	**0**	**50**	**100**

Name of The Course	**PRACTICALS– Questioned Document**				
Course Code	MBS27P1105				
Prerequisite					
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		0	0	2	1

Course Objectives: **The objective of this course is to give practical exposure to the students in the different aspects of questioned documents, the types of forgery generally encountered. To learn the methods of their detection and examination and handwriting identification. To identify and do analysis of typewritten documents.**

Course Outcomes: **The students will gain hands-on experience in the different aspects of questioned documents, the types of forgery generally encountered, methods of their detection and examination, handwriting and typewriting identification.**

CO1	**Discuss and recognize different types of documents and questioned documents**
CO2	**Demonstrate the various methods to decipher secret, indented and charred writings/documents.(**
CO3	**Construct a relational methodfor comparison of questioned and standard handwriting/signatures**
CO4	**Appraise the various security features present in Indian Currency notes and security documents**
CO5	**Value the security of e-documents**

- Text Book (s) **Albert, S. Osborn, Questioned Documents, Second Ed., Universal Law Publishing, Delhi, 1998.**
- **Albert, S. Osborn, The Problem of Proof, Second Ed., Universal Law Publishing, Delhi, 1998.**
- **Charles, C. Thomas, I.S.Q.D. Identification System for Questioned Documents, Billy Prior Bates, Springfield, Illinois, USA, 1971.**
- **Charles C. Thomas, Typewriting Identification I.S.Q.D.; Billy Prior Bates; Springfield, Illinois, USA, 1971.**
- **Hard less, H.R., Disputed Documents, handwriting and thumbs – print identification: profusely illustrated, Low Book Co., Allahabad, 1988.**
- **Kurtz, Sheila, Grapholypes a new plant on handwriting analysis, Crown Publishers Inc., USA, 1983.**

- **Lerinson, Jay, Questioned Documents, Acad Press, London, 2001.**
- **Morris, Ron, N., Forensic handwriting identification, Acad Press, London, 2001.**
- **Ordway Hilton, Scientific Examination of Questioned Documents, Rev. ED., Elsevier, New York, 1982.**
- **Wilson, R., Harrison, Suspect Documents – Their Scientific Examination; Universal Law Publishing, Delhi, 1997.**

List of Experiments
Identification of normal/disguise writing. 2. Detection of forgeries including traced and simulated forgery and built up documents. 3. Examination of rubber stamp and other mechanical impressions. 4. Examination of typescripts and printed matters. 5. Examination alterations-additions, overwriting & obliteration in the documents. 6. Examination of erasures-mechanical and chemical erasures. 7. Decipherment of indented writings, secret writings and charred documents. 8. Examination of ink by TLC and spectrophotometry. 9. Examination of paper. 10. Examination of security documents- Currency notes, Indian Passports, Stamp Papers, lottery tickets etc.

Continuous Assessment Pattern

Internal Assessment (IA)	**End Term Test (ETE)**	**Total Marks**
50	50	100

Name of The Course	**Internship (4 Weeks)**				
Course Code	MBS27R2106				
Prerequisite					
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		0	0	0	2

Course Objective:

The Internship for students of forensic science will consist of the attachment to a FSL, CFSL, Court, Mortuary, Pharmaceutical Laboratory or Testing Laboratory for four weeks. They would observe the expert on his job as to how the investigations, are done, analysis are made and interpreted. The student is also to learn how to write the report in addition to learning the methodologies of presenting the evidence in the court.

Course Outcome:

Through this form of training/internship, the students would be exposed to the actual on the filed work carried out on the area of forensic and allied sciences. They acquire knowledge regarding handling of various equipments for their analytical work pertaining to research or case related work.

Examination Scheme:

Work done during the Internship Period: **50**

Internship Report: **25**

Viva Voce: **25**

Total: 100

Name of The Course	**Major Project Phase I**
Course Code	MBS27R2107

Prerequisite					
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		0	0	0	6

During the 3rd semester, students are expected to carry out an innovative project work, in or related to the specialization of the Programme the student undergoes, by applying the knowledge they have gained in the courses/ labs they have undergone so far.

Course Outcome:

Through the project work, students are expected to prove their analytical ability and practical skills obtained in the area that they have specialized in. This course also would build the research acumen among students who are interested to pursue a research as their career.

Course Contents:

The students will be required to undertake a research project in the field of the forensic sciences and in the area of interest to the student. This should be done in consultation with the faculty supervisor and agency supervisor under whom he / she is getting trained. The project report will be around 100 pages and should have chaperization as follows:

Chapter I: Introduction

Chapter II: Review of Literature

Chapter III: Methodology

Chapter IV: Data Analysis and Results

Chapter V: Discussion of Results

Chapter VI: Summary and Conclusion

The research should be original and should be action oriented in that the results should be able to throw light on some of the important unexplored areas that would be of practical use to the forensic experts.

Students are expected to decide on the specific project area and title, and carry out substantial portion of the literature survey during the end of their 2nd emester.After the end of their 2nd semester TEEs, a presentation will be made to the Student Project Monitoring Committee constituted by the HOD. The Project Work may be a work based on theoretical analysis, modelling & simulation, experimentation & analysis, prototype design, fabrication of new equipment, correlation and analysis of data, etc. or a combination of these. The final project report will be evaluated by a panel of examiners consisting of HOD

, Guide and Co-guide (wherever applicable) and an External Examiner. An oral examination for the same will be conducted.

The following weightage is assigned at each stage of Student Project evaluation.

Activity	**Weightage**	**Remarks**
1st Review (acceptance of project title)	**5%**	To be held after the completion of 3rd semester TEEs
2nd Review	**40%**	To be part of the continuous assessment during the IVth semester
3rd Review (Final)	**50%**	To be scheduled during the TEE period as Viva Voce examination
Submission of Project Report to the Department	**5%**	Two weeks before the viva-voce exam

Semester IV

Name of The Course	Forensic Medicine & Medical Jurisprudence					
Course Code	**MBS27T2112**					
Perquisite	**Legal aspect of Death**					
Co requisite						
Anti requisite						
				T	**P**	**C**
				0	**0**	**4**
Course Objective: To understand legal procedures followed in a medical profession. To study the various parameters of personal identification and the procedures followed in autopsy. To learn about the cause manner and mechanism of death and the types of asphyxial deaths. Course Outcomes:						

CO1	Demonstrate Indian judiciary system along with knowledge of medical jurisprudence. **K2**
CO2	Examine the cases of death and changes occurring in the body with time providing a scientific basis of time since death and cause of death. **K4**
CO3	Interpret different types of injuries caused by different weapons enabling to find out type of weapon used, cause of the injury and mode used to cause injury. **K3**
CO4	Compare different types of natural and unnatural sexual offence including the examination of victim and accused. **K4**
CO5	Evaluate the cases like infanticide including abortion, still-born & dead born child**. K5**
CO6	Diagnose different types of mental illness and learn the civil and criminal responsibility of the mentally ill. **K6**

Text Book (s) & Reference Book (s)

- Sharma, B.R., Forensic Science in Criminal Investigation and Trials (3rdEdn.) Universal Law Publishing Co. Ltd. New Delhi
- Modi, Jaishing P, Textbook of Medical Jurisprudence & Toxicology, M.M. Tripathi Pub. 2001.
- Parikh, Textbook of Medical Jurisprudence & Toxicology, 2001.

Unit 1 Medical Jurisprudence , Medico legal Autopsy and Personal Identification

Introduction and legal procedure in India, Personal Identification**:** Parameters of personal Identification-race, religion, sex, age, height, stature and miscellaneous, Identification in mass disasters

Unit 2 Death

Diagnosis of death-somatic & molecular, early, intermediate and late changes following death, Determination of time since death. Post-mortem examinations; external examination; internal examination, collection, preservation and packaging of viscera

Asphyxial Deaths: Definition, violent asphyxial deaths- hanging, strangulation, suffocation, Drowning, Death from starvation, cold and heat, anaphylatic deaths.

Unit 3 Injuries

Injury, Mechanism of injury, Types of injuries: abrasions, bruises, lacerations, incised wounds, stab wounds, firearm injuries, defence wounds, self-inflicted wounds, medico legal aspects of injuries, ante-mortem and post-mortem injuries, aging of injury, **Thermal Injuries-**Burns, dowry deaths, scalds, electricity, lightning, explosions, Firearm injuries

Unit 4 Sexual Offences and Forensic Psychiatry

Sexual offences: Natural sexual offences-Rape, Incest, Examination of the victim, examination of the accused. Unnatural sexual offences- sodomy, Buccal Coitus, Tribadism, Bestiality. Sexual perversions.

Forensic Psychiatry: Definitions, Classification, dementia, psychosis, confusional states, Schizophrenia, Diagnosis of mental illness, restraint & discharge of the mentally ill, civil & criminal responsibility of the mentally ill, McNaghten Rules

Unit-5 Abortion& Infanticide

Definition, classification, Examination of the woman, Examination of the aborted material, developmental stages of a foetus; **Infanticide:** Definition, still-born & dead born child, Postmortem examinations, Causes of death in the new born, SIDS.

Unit 6: Recent Advancement in the field of forensic medicine-

3D forensic facial reconstruction,Torture medicine: Medico-legal aspects

Continuous Assessment Pattern

Internal Assessment (IA)	**Midterm (MTE)**	**End term Test (ETE)**	**Total Marks**
30	**20**	**50**	**100**

Name of The Course	Forensic Toxicology				
Course Code	**MBS27T2113**				
Perquisite					
Co requisite					
Anti requisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objective:

To teach the student the various types of drugs and toxic substances encountered in a\n investigation. To know the various techniques by which these toxic substances can be isolated and then analyzed in the lab to determine their type.

Course Outcomes:

CO1	Analyze various types of drugs and toxic substances encountered in an investigation. (K6)
CO2	Handle various techniques which are used to isolate toxic substances and thereafter analyzed the nature/type of toxic substance.(K5)
CO3	Examine type of intoxication based on varied toxicological signs and symptoms of different toxins on the body after administered.(K4)

CO4	Handle, preserve and manage the toxic substances found at the crime scene.(K5)
CO5	Understand the pharmacology of various drugs and toxic substances. (K2)
CO6	Understand the new development in the field of toxicology, (K2)

Text Book (s) & Reference Book (s)

- A. Stolemen, Progress in Chemical Toxicology: Acad. Press, New York, 1963.
- Clark, E.G.C., Isolation and identification of Drugs, Vol. I and Vol. II, Academic Press, 1986.
- Connors. , A test book of Pharmaceuticals analysis, Interscience, New York, 1975.
- Cravey, R.H., Baselt, R.C., Introduction to Forensic Toxicology, Biochemical publications, Davis C A, 1981.
- Curry A.S., Analytical Methods in Human Toxicology, Part-II, 1986.,
- Curry, A.S., Poison Detection in Human Organs, C. Thomas Springfield, Illinois USA, 1963.
- Gleason, M.N. et.al, Clinical Toxicology of Commercial products, Williams and Williams, Baltimore, USA, 1969.
- Modi, Jaishing P., Textbook of Medical Jurisprudence & Toxicology, M.M. Tripathi Pub., 2001.
- Mule, S.J. et al., Immunoassays for Drugs subjects to ab, CRC Press USA, 1974.
- Sunshine, I., Guidelines for Analytical Toxicology Programme, Vol. I, CRC Press, USA,1950.
- Sunshine, I., Guidelines for Analytical Toxicology, CRC Press USA, 1975.
- Sunshine, Methods of Analytical Toxicology, CRC Press USA, 1975.
- Working Procedure Manual – Toxicology, BPR&D Publication, 2000.

Unit 1 Introduction of Toxicology and Forensic Toxicology Introduction to toxicology, Principle of toxicology, Different classification of poisons, Types of Poisoning - Sample Collection and Preservation of Toxicological Exhibits in Fatal and Survival Cases - Storage of Samples - Signs and Symptoms of Poisoning – Modes of administration of poisons, routes of elimination, Action of poisons and Factors affecting the Intensity of Poisoning, Identifying route of Administration of Poison – Estimation of time and dose after administration of poison
Unit 2 Toxicological Analysis Introduction – Classification of Matrices: Biological, Non-Biological and Viscera – Significance of Analytical Studies in Forensic Examination – Extraction, Isolation and Clean-up Procedures in Toxicological Analysis from viscera and other relevant materials Field Testing in Toxicological Investigation/Examination of Poisoned Death.

Unit 3 Analysis of Heavy metal and corrosive poisons Introduction to heavy metal poisoning (Pb, As, Hg, Cd), Sign and symptoms, Isolation of heavy metals and their chemical analysis. Corrosive poisons: - Mineral acids- Nitric acid, Hydrochloric acid, Sulphuric acid Strong Base: Potassium hydroxide, Sodium hydroxide
Unit 4 General Study and Analysis of Gases, volatile poisons and drugs carbon monoxide, carbon dioxide, phosphine, ammonia, cyanides, alcohols, chloroform, Barbiturates, Amphetamine, LSD, cocaine, Phenylcyclidine, Benzodiazepines
Unit-5 General Study and Analysis of drugs, insecticides ,vegetable poisons and animal poison Insecticides (organochloro, organophosphorous, and carbamates, ,AbrusP recatorius, Calotropis Gigantia, Opium, Cannabis, Dhatura, Marking Nut, NuxVomica,Ergot, Digitalis,animal poisons (Snake venom, Cantharides, scorpions), Food intoxication, Food Infection, Botulism, Mushroom poisoning
Unit 6: Entomotoxicology: Definition and Forensic utility

Continuous Assessment Pattern

Internal Assessment (IA)	**Midterm (MTE)**	**End term Test (ETE)**	**Total Marks**
30	**20**	**50**	**100**

Name of The Course	**PRACTICALS – Forensic Toxicology**
Course Code	MBS27P2108
Prerequisite	Analytical Chemistry
Corequisite	
Antirequisite	

		L	T	P	C
		0	0	2	1

Course Objectives:

The objective of this course is to give practical exposure to the students in the different aspects of Toxicology regarding examination of Poisons.

Course Outcomes

CO1	Detect and determine Narcotic Drugs, Psychotropic substances eg. Opiates, cannabis, Barbiturates, Benzodiazepines and Amphetamines by spot colour tests and Chromatographic methods . (K6)
CO2	Do isolation and Instrumental analysis of drugs or toxic substances using UV-Vis spectrophotometer.(K5)
CO3	Examine Petroleum Products such as Petrol, Kerosene, and diesel. (K5)
CO4	Analyse phenolphthalein (Qualitative) in bribe trap cases. (K4)

Text Book (s) & Reference Book (s)

- Forensic Laboratory Handbook procedure and practice, Ashraf Mozayani, 2011
- DFS Manual, 2005
- Forensic Science Experiments, Manteshwer, 2011
- Lab Manual Criminalistics An introduction to Forensic Science, Richard Saferstein (2007) Ninth Edition.

List of Experiments

1. Isolation techniques of different toxic substances
2. Detection of metallic poisons (Arsenic and mercury)
3. Detection and determination of Insecticides and pesticides by spot colour tests.
4. Detection and determination of Insecticides and pesticides by chromatographic methods.
5. Detection and determination of Narcotic Drugs, Psychotropic substances eg. Opiates, cannabis, Barbiturates, Benzodiazepines and Amphetamines by spot colour tests.
6. Detection and determination of Narcotic Drugs, Psychotropic substances eg. Opiates, cannabis, Barbiturates, Benzodiazepines and Amphetamines by chromatographic methods.
7. Analysis of alcohol and other volatile poisons.
8. Analysis of non-volatile poisons.
9. Analysis of vegetable poisons
10. Spot test of nitrates, nitrites, carbonates, sulphates, sulphites, chlorates.
11. Spot test of mercury, iron, copper, Aluminum, cadmium, zinc and lead.
12. Instrumental analysis of drugs or toxic substances using UV-Vis spectrophotometer.
13. Examination of Petroleum Products such as Petrol, Kerosene, diesel
14. Analysis of phenolphthalein (Qualitative) in bribe trap cases.

Continuous Assessment Pattern

Internal Assessment (IA)	**End Term Test (ETE)**	**Total Marks**
50	50	100

Name of The Course	Major Project Phase II				
Course Code	**MBS27R2109**				
Perquisite					
Co requisite					
Anti requisite					
		L	**T**	**P**	**C**
		0	**0**	**0**	**6**

Name of The Course	Forensic Biology and Anthropology (Forensic Biology Specialization)				
Course Code	**MBS27T5114**				
Perquisite					
Co requisite					
Anti requisite					
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

regarding the various aspects of forensic biology,the various methods of analysis and laboratory examination of different types of body fluids. The students would also be introduced to other branches of Forensic Biology like, Forensic Anthropology and Forensic Odontology.

Course Objective:The objective of this course is to impart complete and thorough knowledge to the students

Course Outcomes:

CO1	Identify and examine hair and fiber evidence and correlate them with other evidences found at crime scene for forensic investigation
CO2	To present complete knowledge to the student regarding the various aspects of forensic botany and Illustrate the use of botanical evidences in criminal investigation.
CO3	Interpret the time since death by using insects as a evidence from the decomposed body and evaluate its forensic importance
CO4	Predict the age, sex and personal identity from the skeleton remains by understanding about Forensic Anthropology
CO5	Appraise the methods to establish identity from odontological evidences.
CO6	Elaborate the knowledge of forensic Biology and anthropology

Text Book (s) & Reference Book (s)

Unit 1 **Hair and fibre** Collection of forensic hair evidence, Morphology and biochemistry of human and animal hair. Hair growth. Phases of growth and growth rate Characteristics of hair from different sites , microscopic examination of hair, determination of origin, species, race, sex, site, Types of fibres – forensic aspects of fibre, Fibre examination-microscopic, color, solubility, density, , refractive index, birefringence, dye analysis etc , identification and comparison of man–made and natural fibre, Fabrics & cordage- sample handling, analysis, fabric examination, cordage examination .

Unit 2 Forensic botany

Introduction to Various botanical evidences: wood, timber, seeds and leaves– their identification and matching. Diatoms –types and morphology, methods of isolation from different tissue, water bodies and forensic importance of planktons- especially diatom, forensic significance in drowning cases. Identification, microscopic examination and biochemical examination of pollen grains, Paper and Pulp material.

Unit 3 Forensic entomology and Wild life Forensics

Introduction and Importance of wild life, Protected and endangered species of Animals and Plants, Wild life species – Identification and examination of wild life evidences such as skin, fur bones, nails. horn and teeth, Types of wildlife crimes. Different methods of killing and poaching of wildlife animals.pug marks and Identification of pug marks of various animals. Wildlife/Environment protection Act.

General Entomology, arthropod biology Significance of terrestrial and aquatic insects in forensic investigations and their role in crime detection, collection of entomological evidence during legal investigations; collection of : meteorological data, specimens before body removal, ground-crawling arthropods on and around the body, entomological samples from the body, entomological samples during autopsy, specimens from buried remains, from enclosed structures & aquatic habitats. Insect’s succession and its relationship to determine time since, Impact of ecological factors on insect’s developments. Entomo-toxicology, molecular methods for forensic entomology.

Unit 4 Forensic anthropology

Forensic Physical Anthropology: Definition and Scope within the medical-legal context of personal identification of human remains as in cases of homicides or mass disasters, Brief introduction to Forensic Archeology and Anthropometry. Human skeletal system: Nature and formation of bones, introduction to Human skeleton, Classification of human bones, Determination of Species of Origin, Sex , Age, Stature, and individual identification through skeletal remains. Two Dimensional and 3 Dimensional Methods, Importance of tissue depth to reconstruct various facial features

Unit-5 Forensic odontology Definition and Scope of Forensic Odontology, Types of dentition, Basic structure of human teeth, types of teeth & their morphology, and determination of age from teeth using various methods, Eruption sequence, Gustafson's method, dental anomalies and their role in Personal Identification. Bite marks: Types & forensic importance. Collection and preservation of samples, analysis of Bite marks, presentation of bite mark evidences in court of law. Role of Forensic Odontology in mass disaster victim identification. Dental Charting. Comparison of Ante-mortem and postmortem dental records.
Unit 6:Recent Trends in Forensic Biology and anthropology
Advance method of 3D facial reconstruction, Forensic odontology in DVI: current practice and recent advances.

Text book and References

1. **Richard Saferstein; Forensic Science Hand Book; Ed.; Prentice – Hall, Englewood Cliff, New jersey; (1982**
2. **Dutelle, Aric W. An introduction to crime scene investigation. Jones & Bartlett Publishers, 2011.**
3. **Tersigni-Tarrant, MariaTeresa A., and Natalie R. Shirley, eds. Forensic anthropology: an introduction. CRC Press, 2012**
4. **. Coyle, Heather Miller, ed. Forensic botany: principles and applications to criminal casework. CRC Press, 2004.**
5. **Smith; DGV; A manual of Forensic Entomology Ithaca New York Camstock Univ. Press, USA, (1986)**

Continuous Assessment Pattern

Internal Assessment (IA)	Midterm (MTE)	End term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Forensic Serology and DNA (Forensic Biology Specialization)				
Course Code	**MBS27T5115**				
Perquisite					
Co requisite					
Anti requisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objective:To understand the basic concepts of genetics, immunological aspects of the human body, determination of origin of species using using various body tissues and body fluids. To acquire knowledge regarding some of the important serogenetic markers found in blood. To understand the genetic basis of DNA typing, types and techniques of DNA typing and the practical applications and forensic importance of DNA typing

Course Outcomes:

CO1	To understand the basic concept of Immunology, antigen and antibody interaction
CO2	Assess the nature of the body fluid found at the crime scene and to present comprehensive knowledge of the various methods of analysis and laboratory examination of different types of body fluids
CO3	To acquire complete knowledge regarding the important serogentic markers , genetic polymorphism and their forensic importance.
CO4	To understand the genetic basis of DNA and able to quantify DNA from the forensic evidences using different techniques
CO5	Enable students to understand the concept of DNA typing system and interpret the result of DNA Typing.
CO6	To apply the knowledge of genetic markers ad DNA typing in the field of forensic science and to elaborate the knowledge of recent advancement in the field of serology and DNA typing.

Text Book (s) & Reference Book (s)

Text Books

1. Calledine, C.R., Understanding DNA: The molecule and How it works, Acad, Press London, 1992.
2. Hartl, D.L., Friedfelder, D. and Synder L. A., Basic Genetics, Jones and Bartlet, Boston, USA, 1988.
3. Glover, D.M., and Hames, B.D., DNA cloning, Vols. 1 to 4, Oxford University Press, Oxford, UK, 1995.
4. Freidfielder, David, Molecular Biology; Narosa, USA, 1995.
5. Simon, Easteal, DNA profiling, Principles, pitfalls and potential, Harwood Acad. Publishers, 1992.
6. Gardner, Eldon J, Human Heredity, John Wiley and sons, USA, 1983.
7. Burns, George V., The science of Genetics – An Introduction to heredity, Macmillan, 1980.
8. Jorg T. Epplen Thomas Lubjumhin, DNA Profiling and DNA Fingerprinting; BirkhauserVerlag, Basel,1995.
9. K.C. Malhotra, Statistical Methods in Human Population Genetics, Indian Statistical Institute, Calcutta, 1988.
10. Kirby, Lorne T, DNA Fingerprinting: An Introduction, W.H Freeman & Co. New York, 1990.
11. Krawczak, M., and Schmidtke, J., DNA Finger Printing, Bios Scientific, Oxford, UK, 1995.
12. Daniel, W.W., Biostatistics, John Wiley & Sons, USA, 1995.
13. Working Procedure Manual: DNA, BPR&D Publication, 200

Reference Books

1. Butler JM. Fundamentals of forensic DNA typing. Academic press; 2009 Sep 30

2. Benecke M. DNA typing in forensic medicine and in criminal investigations: a current survey. Naturwissenschaften. 1997 May 1;84(5):181

Unit 1 Immunology

Introduction to Immunology,basic concepts of Antigens, antibody, haptenes and adjuvants, Determination of secretor/ non secretor .Immunoglobulin – types, physico-chemical properties and functions, Lectins – their forensic significance, Raising of Anti-sera ,Buffers and serological reagents, methods of sterilization employed for serological work.

Unit 2 Blood and other body fluids

Human blood group systems. History, biochemistry and genetics of ABO, Rh, Mn and other forensically significant blood group systems. Determination of human and animal origin from biological sample through immuno – diffusion and immuno – electrophoresis, Rocket immune-electrophoresis, Two dimensional electrophoresis, cross-over electrophoresis Methods of ABO blood grouping (absorption-inhibition, mixed agglutination and absorption elution) from blood stains and other body fluids/stains. s. New approaches in bloodstain grouping. Blood group specific ABH substances. Blood groups that make racial distinctions. Lewis antigen. Bombay Blood groups. HLA antigens and HLA typing. Role of sero-genetic markers in individualization and paternity disputes. Pitfalls in red cell typing.

Unit 3 Genetic markers

Biochemical marker, molecular marker, mRNA, Polymorphic enzymes typing – PGM, GLO – I, ESD, EAP, AK, ADA etc., and their forensic significance, Serum proteins: Genetics, polymorphism and typing of – Hb, HP, Tf, Bf, C3 etc. and their forensic significance. Non-genetic approaches to individualization- biochemical profiling, antibody profiling and persistent disease agents.

Unit 4 Introduction to DNA

Structure and function of DNA, RNA and genome organization, Sample collection and preservation. DNA Extraction Methods. Quantification and Quality assessment methods. PCR amplification ,types of PCR, PCR inhibitors, optimization and solution to PCR inhibition. Stochastic effect. PCR Primer designing. DNA separation methods: Slab gel and Capillary Electrophoresis. Capillary electrophoresis. DNA detection methods: Fluorescent Dyes and Silver–staining.

Unit-5 DNA typing system

Forensic DNA typing system – RFLP, Amp-RFLP, SNP, STR. Mini STR. Y-STR. XSTR. Mitochondrial DNA. Single Nucleotide Polymorphism. Microbial DNA testing, Non-Human DNA testing, Plant DNA testing. STR allele nomenclature. STR loci of Forensic significance. STR kits. STR typing: Manual and Capillary Electrophoresis. Gender identification. Interpretation of the DNA typing results. CODIS, Statistical evaluation of DNA typing results Application in disputed paternity cases, child swapping, missing person’s identity and preparation of reports. RNA and its application in Forensics, Emerging molecular techniques in Forensics

Unit 6:Current trends in Forensic Serology and DNA Profiling

long ssDNA polynucleotides to amplify STRs *loci* in degraded DNA samples, Microfluidic Devices for Forensic DNA Analysis.

Continuous Assessment Pattern

Internal Assessment (IA)	**Midterm (MTE)**	**End term Test (ETE)**	**Total Marks**
30	**20**	**50**	**100**

Name of The Course	**PRACTICALS – Forensic serology and DNA**			
Course Code	**MBS27P5110**			
Prerequisite				
Corequisite				
Antirequisite				
	L	T	P	C
	0	**0**	**2**	**1**

Course Objectives:**The objective of this course is to give practical exposure to the students in the different aspects of give hands-on experience on the identification and examination of various body fluids.**

Course Outcomes

CO1	**To identify and examine blood stains using various biochemical and microscopic method**

CO2	**To identify and examine biological fluids using various biochemical and microscopic method**
CO3	**To determine origin of species from various biological species**
CO4	**To isolate and quantify DNA from various body fluids.**

Text Book (s) & Reference Book (s)

Forensic Laboratory Handbook procedure and practice, Ashraf Mozayani, 2011
- **DFS Manual, 2005**
- **Forensic Science Experiments, Manteshwer, 2011**
- **Lab Manual Criminalistics An introduction to Forensic Science, Richard Saferstein (2007) Ninth Edition**

List of Experiments
1. To identify blood stains. **2. To determine blood group from fresh blood and blood stains.** **3. To identify and examine semen stains: crystal tests, chemical, biochemical, microscopic methods.** **4. To identify saliva stains: microscopic and chemical tests.** **5. To identify and examine urine and sweat stains** **6. To perform precipitin test for species of origin determination.** **7. To perform Immunodiffusion test for species of origin** **8. To prepare gel plates for electrophoresis.** **9. Organic extraction of DNA from blood.** **10. Extraction of DNA from other body fluids.** **11. Quantification of DNA** **12. PCR for DNA samples** **13. Accessing of DNA databases**

Continuous Assessment Pattern

Internal Assessment (IA)	End Term Test (ETE)	Total Marks
50	**50**	**100**

Name of The Course	**PRACTICALS – Forensic Biology**				
Course Code	**MBS27P5111**				
Prerequisite					
Corequisite					
Antirequisite					
		L	T	P	C
		0	**0**	**2**	**1**

Course Objectives:The objective of this course is to give practical exposure to the students in the different aspects of Forensic Biology.

Course Outcomes

CO1	**To identify and examine different types of hairs.**
CO2	**To identify , isolate and examine Diatoms and pollen grains**
CO3	**To identify and determine sex, age and stature from dfifferent bones**
CO4	**To identify and determine sex, age and stature from skull and mandible.**

Text Book (s) & Reference Book (s)

Forensic Laboratory Handbook procedure and practice, Ashraf Mozayani, 2011

- **DFS Manual, 2005**
- **Forensic Science Experiments, Manteshwer, 2011**
- **Lab Manual Criminalistics An introduction to Forensic Science, Richard Saferstein (2007) Ninth Edition**

List of Experiments
1. To prepare slides of scale patterns of human hair. **2. To examine human hair for the cortex and medulla.** **3. To examine Barr bodies from hair roots.** **4. Examination of hair of different domestic animals as cat, dog, cow, horse and goat.** **5. Identification of Diatoms.** **6. To carry out microscopic examination of pollen grain** **7. To study identification and description of bones.** **8. Determination of age from skull and mandible.** **9. Determination of sex from skull.** **10. Determination of sex from Pelvis.** **11. Estimation of stature using long bones** **12. Preparation of Dental chart** **13. To analyze and preserve bite marks.**

Continuous Assessment Pattern

Internal Assessment (IA)	End Term Test (ETE)	Total Marks
50	**50**	**100**

Name of The Course	Forensic Physics (Forensic Physics Specialization)				
Course Code	**MBS27T5116**				
Perquisite					
Co requisite					
Anti requisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objective:

To study the characteristics and properties of different evidences like glass, soil, paint, tool marks, hair and fiber which are normally encountered at the scene of crime. To study the various methods by which these substances can be examined in the laboratory. To study the different methods of speaker identification.

Course Outcomes:

CO1	Analyze various types of glass and their composition, examine physical properties of class and elemental analysis. (K6)
CO2	Handle various techniques which are used to examine soil sample, interpretation of soil evidence for forensic consideration. (K5)
CO3	Examine various types of paint samples and their interpretation. (K4)
CO4	Handle, preserve and examine the tool marks found in crime scene.(K5)
CO5	Understand the concepts of speaker identification. (K2)
CO6	Handle various new techniques in the field of forensic physics.(K5)

Text Book (s) & Reference Book (s)

- B. Caddy, Forensic Examination of glass and paints analysis and interpretation, ISBN 078405749 2001.
- Bengold and Nelson Morgan, Speech and Audio Signal Processing, John Wiley and Sons, USA, 1999.
- C.E. O ‘Hara and J.W. Osterburg, An Introduction to Criminalistic, Indiana University Press, Blomington, 1972.
- Denis Shaw, Physics in the Prevention and Detection of Crime, Contem Phys. Vol.17, 1976.
- Carper, K. (ed.), Forensic Engineering, 2ndEdn. CRC Press, Bocarida, Florida, 2001.

- Field, J., and Carper, K., Construction Failure, 2ndEdn. John Wiley and Sons, New York, 1996.
- James, S.H. and Nordby, J.J. Eds., Forensic Science An Introduction to Scientific and Investigative Techniques, CRC Press, London, 2003.
- Nickolls, L.C., Scientific Investigation of Crime, Bulterwest, London, 1956.
- Philip Rose, Forensic Speaker Identification, Taylor & Francis Forensic Science series, London 2001.
- R. Saferstein, Forensic Science Handbook, Vols. I, II, (Ed), Prentice Hall, Eaglewood Cliffs, NJ; 1988.
- Raymond C Murray and John C.F Tendrew, Forensic Geology, Prentice Hall, New Jersey, 1991.
- Working Procedure Manual: Physics BPR&D Publication, 2000.

Unit 1 Examination of Glass

Types of glass and their composition, Forensic examination of glass fractures under different conditions, determination of direction of impact: cone – fracture, rib marks, hackle marks, backward fragmentation, colour and fluorescence, physical matching, density comparison, physical measurements, refractive index by refractometer, elemental analysis, interpretation of glass evidence.

Unit 2 Examination of Soil and Paint

Formation and types of soil, composition and colour of soil, particle size distribution, turbidity test, microscopic examination, density gradient analysis, ignition loss, differential thermal analysis, elemental analysis, interpretation of soil evidence, Discussion on importance case studies of glass & soil. Types of paint and their composition, macroscopic and microscopic studies, pigment distribution, micro-chemical analysis- solubility test, pyrolysis chromatographic techniques, TLC, colorimetry, IR spectroscopy and X-ray diffraction, elemental analysis, interpretation of paint evidence.

Unit 3 Tool marks

Types of tool marks: compression marks, striated marks, combination of compression and striated marks, repeated marks, class characteristics and individual characteristics, tracing and lifting of marks, Photographic examination of tool marks and cut marks on clothes and walls etc. Restoration of erased / obliterated marks: method of marking- cast, punch, engrave; methods of obliteration, method of restoration- etching (etchings for different metals), magnetic, electrolytic etc., recording of restored marks – restoration of marks on wood, leather, polymer etc.

Unit 4 Audio-video examination Forensic audio video analysis, voltage, decibels, audio line levels, frequency measurements, spectrum analysis, noise characteristics, digital filters and audio enhancement, authentication of recorded audio, speech spectrographic analysis, magnetic developing and optical methods Falsification in video recording, video frame sequence, method – waveform – vectroscope, videogrametry and photogrametry techniques, video image analysis, , CCTVs, Retrieval of images and their evidence analysis facial image recognition from video frame image
Unit-5 Speaker Identification Basic factors of sound in speech, components of speech, analogue and digital speech signal, Fourier analysis, Fourier transforms, acoustic speech production, speech anatomy, mechanism of speech production, phonetic aspects of speech, principles of speaker recognition, methods of speaker recognition, various approaches in forensic speaker identification, concept of test and error in speaker identification, application in automatic speaker identification and verification system.
Unit VI: Miscellaneous Clue Materials- Examination of strings/ropes, Wires/cables, Seals, Counterfeit coins

Continuous Assessment Pattern

Internal Assessment (IA)	**Midterm (MTE)**	**End term Test (ETE)**	**Total Marks**
30	**20**	**50**	**100**

Name of The Course	Forensic Ballistics (Forensic Physics Specialization)
Course Code	**MBS27T5117**
Perquisite	**Physics**
Co requisite	**Explosives**
Anti requisite	

		L	T	P	C
		4	0	0	4

Course Objective:

The objective of the course is to impart students knowledge regarding the types of firearms and ammunition, characteristics of identification, determination of range of firing and introduction to exterior ballistics.The legal aspects involving firearms cases.

Course Outcomes:

On the completion of this course, the students will be able to understand the role of ballistics in Forensic Science, classification of firearms, determination of the range of firing, methods of laboratory examination of fired cartridges and firearms. The students will also learn to reconstruct the sequence of events in cases involving firearms.

CO1	Explain the history and development of the firearm and describe the various types of firearms and their mode of operation.
CO2	Identify the science behind underpinning internal ballistics and the concepts involved in projectile external ballistics
CO3	Interpret the velocity of the bullet, recoil force, barrel pressure, ballistic coefficient, angle of elevation of the barrel when a bullet is fired.
CO4	Predict the range by which a bullet is fired and to reconstruct the sequence of events in a shooting case.
CO5	Demonstrate an understanding of the factors affecting wound ballistics
CO6	Critically analyse the recent developments in the field of Forensic Ballistics

Text Book (s) & Reference Book (s)

1. Sharma, B.R.; "Firearms in Criminal Investigation & Trials", Universal Law Publishing Co Pvt Ltd, New Delhi, 4th Edition, 2011.

2. Hatcher, Jury and Weller; "Firearms Investigation, Identification and Evidence", Stackpole Books, Harrisburg, Pa, 1997.

3. Heard, B.J; "Handbook of Firearms and Ballistics", John Wiley, England, 1997.

4. Jauhari M; "Identification of Firearms, Ammunition, & Firearms Injuries", BPR&D, New Delhi.

5. Hogg, I.V; "The Cartridge guide – A Smallarms Ammunition Identification Manual", The Stackpole publishing Co., Harrisburg, Pa, 1982.

6. Janes, T.J.G; "Infantry Weapons", Janes Information Group, Sentinal House, Surrey, U.K. (2004-05)

7. Burrard; "The Identification of Firearms and Forensic Ballistics", Herbert Jenkins, London, 1956.

8. Gunther and Gunther; "The Identification of Firearms", New York, 1935.

9. Wilber; "Ballistic Science for the Law Enforcement Officer", Charles C. Thomas, USA, 1977.

10.Hayes, T.J; "Elements of Ordnance", John Wiley & Sons, Inc, London, 2013.

11.Smith and Smith; "Book of Rifles", Stackpole Books, Harrisburg, Pa, 1972.

12.Smith and Smith; "Book of Pistols and Revolvers", Stackpole Books, Harrisburg, Pa, 1968.

Unit-1 Introduction to Ballistics
History of Firearms, Match Lock, Wheel Lock, Flint Lock, Percussion Fire firearm and Pin fir Firearm. Classification of Firearms, smooth bore and rifled firearm, Hand Gun- Pistol, Revolver, Shoulder Firearms-Rifle, Shotguns. Different systems and their functions, Arms & Explosives Act. improvised/ country-made/ imitative firearms, Purpose of rifling, types of rifling and methods of producing rifling, trigger and firing mechanism, cartridge-firing mechanism
Unit-2 Ammunition
History, Classification and constructional features of different types of cartridges, types of primers and priming composition, propellants and their compositions, velocity and pressure characteristics under different conditions, various types of bullets and compositional aspects
Unit-3 Internal and External Ballistics
Definition, ignition of propellants, shape and size of propellants, manner of burning Various factors affecting the internal ballistics: lock time, ignition time, barrel time, Equation of motion of projectile, Theory of recoil, Projectile velocity determination Principal problems of exterior ballistics, vacuum trajectory, effect of air resistance on trajectory, base drag, yaw, shape of projectile and stability, trajectory computation, ballistics coefficient and limiting velocity
Unit-4 Terminal and Wound Ballistics
Effect of projectile on hitting the target: function of bullet shape, striking velocity, striking angle and nature of target, Tumbling of bullets, Cavitations – temporary and permanent cavities, Ricochet and its effects, stopping power. Threshold velocity for penetration of skin/flesh/bones, nature of wounds of entry, exit, initial track with various ranges and velocities with various types of projectiles, explosive wounds. Evaluation of injuries caused due to shot-gun, and rifle firearms, methods of measurements of wound ballistics parameters

Unit-5 Identification of Firearms and Ammunition and Determination of range of fire and GSR analysis
Principles and practice of identification of firearms, ammunition and their components, different types of marks produced during firing process on cartridge-firing pin marks, breech face marks, chamber marks, extractor and ejector marks. Different types of marks produced during firing process on bullet-number/direction of lands and grooves, striation marks on lands and grooves, techniques for obtaining test material from various types of weapons and their linkage with fired ammunition Burning, scorching, blackening, tattooing and metal fouling, shots dispersion and GSR distribution, time of firing – different methods employed, and their limitations. Mechanism of formation of GSR, source and collection, spot test, chemical test, identification of shooter and instrumental methods of GSR Analysis
Unit VI: Recent advancement in Forensic Ballistics
Analytical contributions of lanthanide based metal-organic frameworks as luminescent markers: Recent trends in gunshot residue analysis. Fully automatic method for comparing cartridges case images. Recent Amendments in Arms Act,2019.

Continuous Assessment Pattern

Internal Assessment (IA)	**Midterm (MTE)**	**End term Test (ETE)**	**Total Marks**
30	**20**	**50**	**100**

Name of The Course	PRACTICALS –Forensic Ballistics
Course Code	**MBS27P5112**
Prerequisite	
Corequisite	
Antirequisite	

	L	T	P	C
	0	**0**	**2**	**1**

Course Objectives:

The objective of this course is to give practical exposure to the students in the different aspects of Ballistics regarding examination of cartridge cases, comparison of bullets, various parts of firearms, chemical analysis of Gunshot residues and firearm injury evaluation.

Course Outcomes

CO1	**Discriminate between different types of firearms and their operation.**
CO2	**Describe those factors that affect the relationship between projectile and target**
CO3	**Construct a relational comparison method for identification of Firearm and ammunition linkage**
CO4	**Select the methods for the detection of GSR residues and access the nature of the firearm injury inflicted to the body from various ranges.**

Text Book (s) & Reference Book (s)

- **Brian J. Heard; Hand book of Firearms and Ballistics; John Willey, England; (1997)**
- **Ballistics DFS Manual, 2005**
- **Forensic Laboratory Handbook procedure and practice, Ashraf Mozayani, 2011**
- **Lab Manual Criminalistics An introduction to Forensic Science, Richard Saferstein (2007) Ninth Edition.**

List of Experiments

1. Identification of firearms, cartridges and bullets

2. Study of caliber and rifling characteristics

3. To study the working mechanism of firearms

4. Determination of shot number from size and weight of shots.

5. Physical examination of propellant of ammunition

6. Study of choking in shotgun

7. Study of constructional features of improvised firearms

8. To study proof mark of firearm

9. Study of constructional features of cartridge

10. To study proof mark of cartridge

11. GSR testing; Bullet entry characteristics in tissue and clothing; Blood spatter interpretation at shooting scenes

12. Determination of range of fire

13. Matching bullets and cartridge cases by comparison microscope.

Continuous Assessment Pattern

Internal Assessment (IA)	End Term Test (ETE)	Total Marks
50	**50**	**100**

Name of The Course	PRACTICALS – Forensic Physics			
Course Code	**MBS27P5113**			
Prerequisite				
Corequisite				
Antirequisite				
	L	T	P	C
	0	**0**	**2**	**1**

Course Objectives:

The objective of this course is to give practical exposure to the students in the different aspects of give hands-on experience in handling physical evidences and their examination.

Course Outcomes

CO1	**Examine, Lift and cast different tool marks. (K6)**
CO2	**Perform physical and chemical examination of paint samples. (K5)**
CO3	**Analyse glass fragments and examine glass fractures.(K5)**
CO4	**Do Physical, chemical and biological examination of soil samples. (K5)**
CO5	**Examine Cement, mortar and other construction materials found at the scene of crime. (K4)**

Text Book (s)&Reference Book (s)

- Forensic Laboratory Handbook procedure and practice, Ashraf Mozayani, 2011
- DFS Manual, 2005

- Forensic Science Experiments, Manteshwer, 2011
- Lab Manual Criminalistics An introduction to Forensic Science, Richard Saferstein (2007) Ninth Edition.

List of Experiments
1. Microscopic Examination of different Tool Marks **2. Casting and lifting of different Tool Marks** **3. Microscopic Examination of paint chip** **4. Chemical Examination of paint samples** **5. Restoration of obliterated marks** **6. Physical Examination of glass fragments** **7. Examination of glass fractures** **8. Physical Examination of soil samples** **9. Microscopic Examination of soil samples** **10. Chemical Examination of soil samples** **11. Biological Examination of soil samples** **12. Examination of cement/mortar** **13. Examination of motor-vehicular accidents**

Continuous Assessment Pattern

Internal Assessment (IA)	End Term Test (ETE)	Total Marks
50	**50**	**100**

Name of The Course	Arson and Explosives (Forensic Chemistry Specialization)				
Course Code	**MBS27T5118**				
Perquisite	**Basic of Explosives**				
Co requisite					
Anti requisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objective:

To learn the kinetics and thermochemistry of explosives.To gain knowledge of the explosion effects and manufacturing of different explosives.To understand analysis of various explosive residues.

Course Outcomes

CO1	**To Understand the concept of explosives focusing on classification of explosives**
CO2	**To understand about the development of explosives**
CO3	**To understand and IEDs Fire arson cases, crackers**
CO4	**Knowledge about methods for collection, of explosive materials**
CO5	**Assess about the explosive analysis and legal aspects and laws related to explosives.**

Text Book (s) & Reference Book (s)

Unit-1 History of Explosives and its Composition, Classification and Characteristics Definition of Explosives, Definition as per Indian Explosive Acts. History of explosives, classification of explosives, chemistry of explosives and characteristics of high and low explosives. What is an Explosion, Basic types of Explosions, Explosives and their effects, Detonation Velocity, Deflagration, High-order Detonation, Low-order Detonation..

Unit-2 Development of Explosives and Detonators:

Development of black powder, picric Acid, tetrazene, lead azide, lead styphnate, nitroglycerine, mercury fulminate, nitrocellulose, dynamite, ammonium nitrate, Gelatines, emulsion, slurries. ANFO. Development of military explosives: picric acid, tetryl, TNT, PETN, RDX and HMX. Introduction, plain and electric detonators, delay detonators, detonating and safety fuse, high explosive mixtures.

Unit – 3 Fire, Arson and IEDs and pyrotechniques:

Introduction to Fire & Arson, origin of fire, Chemistry of Fire, Firefighting operations, preservation of fire scene, collection of evidences, Seat of fire, cause of fire, motives, **Analysis of fire debris: Extraction of fire accelerants from fire debris, advantages and their limitations. Methods and techniques used in identification of fire accelerant.**

Introduction to IEDs**,** Components of IED, Type of IEDs, (Molotov cocktail, Letter bomb, Pipe bomb, VBIED and CBRN), Explosives Initiation (Explosive Trains), IEDs explosion process and affects, types of hazard, effect of blast wave on structures, human etc. specific approach to scene of explosion. Definition of pyrotechniques and their composition, characteristics, types, mechanism of firework.

Unit -4 Location, Collection and disposal of explosives residues:

Bomb Scene Investigation: Documentation, Collection of different type of pre and post blast explosive material (IEDs, fireworks, home-made bombs, traps bombs and letter bombs) and preservation of explosive residues and Blast Materials from crime scene and their safety handing. Role of Bomb Squad, Use of field kit for detection of explosives or explosion residues Specific approach to scene of explosion (Evaluation and assessment) Reconstruction of sequence of events, Evaluation and assessment of scene of explosion. Disposal of an explosive device, dispatch of explosive device and exploded material. Do‟s and Don‟ts. Case studies related to explosives.

Unit – 5 Examination of Explosive Residue and their Legal Aspects

Systematic examination of explosives and explosion residues by using chemical and instrumental techniques (TLC, HPLC, X-ray imaging) in the laboratory and interpretation of results. Vapor detection method: adsorption and concentration of explosive vapors

Preparation of reports, Presentation of Evidence in the Court of Law, Queries of Investigating Officers. Explosives Act 1884, (Definition, Powers of Central Govt. and Licensing Authority, Offencesand Penalties) and Section 286 of IPC, 1860, (Negligent conduct with respect to explosive substance), Explosive Substances Act 1908, (Definition, Offences and Penalties). Explosives (Amendments) Rules - 2018

Unit 6: Current Trends in Explosive Detection Techniques

Terahertz spectroscopy, Cavity ring down spectroscopy, Laser-induced breakdown spectroscopy

Continuous Assessment Pattern

Internal Assessment (IA)	Midterm (MTE)	End term Test (ETE)	Total Marks
30	**20**	**50**	**100**

Name of The Course	Forensic Chemistry (Forensic Chemistry Specialization)				
Course Code	**MBS27T5119**				
Perquisite	Organic and analytical chemistry				
Co requisite					
Anti requisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objective:

The objective of this course is to introduce the forensic chemistry basics with special focus on arson chemistry, details of adulterants in petroleum products and analytical tools for examination of alcoholic and non-alcoholic beverages, abuse of drugs.

Course Outcomes:

CO1	assess the value of different analytical techniques used for forensic chemistry applications
CO2	describe the chemistry used indifferent methods to identify alcoholic and non alcoholic beverages
CO3	define the most common illicit drugs, doping agents and injurious substances outline
CO4	describe the chemistry utilised in different methods used to identification of adulterants in foods or cosmetics
CO5	suggest and use appropriate methods for determination of petroleum products trap chemicals

Text Book (s) & Reference Book (s)

1. Niesink, RJM; Toxicology- Principles and Applications, CRC Press,1996
2. Modi, JP, Textbook of Medical Jurisprudence & Toxicology, N.M. Tripathi Pub,2001
3. Chadha, PV; Handbook of Forensic Medicine & Toxicology, Jaypee Brothers, New Delhi,2004
4. Parikh, C.K; Text Book of Medical Jurisprudence, Forensic Medicine & Toxicology, CBS Pub. New Delhi,1999
5. Morrison R.T and Boyd R. N;Organic Chemistry 6th Ed Prentice Hall, 2003

6. Laboratory Procedure Manual : Petroleum Products ,Directorate of Forensic Science, MHA, Govt. of India, 2005
7. Working Procedure Manual on Chemistry ; Directorate of Forensic Science MHA Govt. of India
8. Bureau of Indian Standard Specifications related to Alcohols and Petroleum Products.
9. Welcher F; Standard Methods of Chemical Analysis, 6th Ed.VanNostrand Reinhold, New York, 1969
10. Watson C. A; Official and Standardised Methods of Analysis, Royal Society of Chemistry, UK,1994.
11. Central Excise Act ; Universal Law Publication.
12. Essential Commodity Act, 1955
13. Feigl, F; Spot Test in Inorganic Analysis , Elsevier Publ. New Delhi, 2005.
14. Curry A.S ; Analytical Methods in Human Toxicology : Part II ,CRC Press Ohio, 1986.
15. Curry, A.S : Poison Detection in Human Organs, C Thomas Spring field, CRC Press, Costa Rica, 1976
16. Clark E.G.C; Isolation and Identification of drugs, Academic Press, London, 1986
17. Sunshine I : Handbook of Analytical Toxicpology, CRC Press, Costa Rica,1969.

Introduction to Forensic Chemistry Forensic Chemistry: Introduction, role of forensic chemist, types of cases encountered in forensic chemistry, types of exhibits, sampling of chemical evidences, Chemical Screening: Preliminary and confirmatory methods used in Forensic chemistry, chemistry of colour formation and their limitation and chemical colour test method, microcrystal test techniques and its advantages and disadvantages.
Unit 2 Examination of Alcoholic Beverages Definition, classification and Characteristics of liquors (alcoholic beverages), Composition and Analysis of Alcoholic & Non- alcoholic beverages: Analysis of various types of denaturants of alcohols, country made liquor, illicit liquor, Congeners in alcoholic beverages, medicinal preparations and liquor of forensic importance as per BIS specifications, by colour test and Instrumental technique. Determination of blood alcohol concentration and significance of alcohol in breath and breath screening devices, Laws and penalties as per Excise/ Act.
Unit 3 Examination of Drugs and Drug abuse in Sports Introduction, classification of drugs of abuse and NDPS Drugs (Opiates, Cannabis, Cocaine, Amphetamines, Benzodiazepines, Psylocybin, Mescaline and MDMA, LSD), drugs of abuse in sports and doping, narcotics drugs and psychotropic substances, designers drugs, Club Drugs and their forensic examination, Drugs and Cosmetic Act, Excise Act, NDPS Act. Drug Profiling – Drug Addiction in adolescent and its Problems

Unit 4 Food adulteration and Cosmetics Analysis of Milk product: Detection of adulterants in milk and milk products by physical, chemical and instrumental techniques. Oils and Fats: Chemical composition and analysis of different common oils and their adulterants by physical, chemical and instrumental technique. Analysis of adulteration in different spices. Forensic significance of Cosmetics: Introduction to cosmetics of forensic interest and their role in crime
Unit-5: Analysis of Petroleum Products and Trap cases
Examination of petroleum products: distillation and fractionation, chemical composition of various fractions and their commercial uses, standard methods of analysis of petroleum products for adulteration. Examination of adulteration in petrol, kerosene, Lubricants and diesel BIS methods. Essential Commodity Act & Petroleum Act. Examination of chemical used in trap cases: Phenolphthalein, Anthracene and related legal issues. Analysis of gold and other metal in cheating cases
Unit 6: Advancement in forensic chemistry
Forensic Chemistry: Analytical Developments and Pharmacological Aspects

Continuous Assessment Pattern

Internal Assessment (IA)	**Midterm (MTE)**	**End term Test (ETE)**	**Total Marks**
30	**20**	**50**	**100**

Name of The Course	**PRACTICALS – Forensic Chemistry**				
Course Code	MBS27P5114				
Prerequisite					
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		0	0	2	1

Course Objectives:

The objective of this course is to give practical exposure to the students in the different aspects of Toxicologyregarding examination of Poisons.

Course Outcomes

CO1	**Detect and determine Narcotic Drugs, Psychotropic substances eg. Opiates, cannabis,Barbiturates, Benzodiazepines and Amphetamines by spot colour tests and Chromatographic methods . (K6)**
CO2	**Do isolation and Instrumental analysis of drugs or toxic substances using UV-Vis spectrophotometer.(K5)**
CO3	**Examine Petroleum Products such as Petrol, Kerosene, and diesel. (K5)**
CO4	**Analyse phenolphthalein (Qualitative) in bribe trap cases. (K4)**

Text Book (s)&Reference Book (s)

- Forensic Laboratory Handbook procedure and practice, Ashraf Mozayani, 2011
- DFS Manual, 2005
- Forensic Science Experiments, Manteshwer, 2011
- **Lab Manual Criminalistics An introduction to Forensic Science, Richard Saferstein (2007) Ninth Edition.**

List of Experiments

1. Isolation techniques of different toxic substances

2. Detection of metallic poisons (Arsenic and mercury)

3. Detection and determination of Insecticides and pesticides by spot colour tests, chromatographic methods.

4. Detection and determination of Narcotic Drugs, Psychotropic substances eg. Opiates, cannabis, Barbiturates, Benzodiazepines and Amphetamines by spot colourtests,chromatographic methods.

5. Analysis of alcohol and illicit liquor.
6. Instrumental analysis of drugs or toxic substances using UV-Vis spectrophotometer and colorimeter.

7. Examination of Petroleum Products such as Petrol, Kerosene, diesel

8. Analysis of phenolphthalein (Qualitative) in bribe trap cases.

Analysis of corrosive poiso

Continuous Assessment Pattern

Internal Assessment (IA)	End Term Test (ETE)	Total Marks
50	50	100

Name of The Course	Explosives Lab				
Course Code	MBS27P5115				
Prerequisite					
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		0	0	2	1

ourse Objectives: The objective of this course is to give practical exposure to the students about different types of explosives and examination of explosive remains and to gain the knowledge of different accelerants and its reaction in arson scenes, chemical examination of such accelerants, investigation of Arson scene and Pre &Post explosive bomb scene management.

Course Outcomes

CO1	**Discriminate between different types of explosives, based on performance and structure.**
CO2	**Demonstrate and Practice the various methods of identification of explosive devices and techniques of locating hidden explosives and bomb scene management.**
CO3	**Construct a relational method for searching, collecting, preserving and analysing arson evidence.**
CO4	**Assess the methods of analysing trace amounts of petroleum products in crime scene evidence.**

Text Book (s) & Reference Book (s)

Text Books:

1. **S. Ballou, M. Houck, J.A. Siegel, C.A. Crouse, J.J. Lentini and S. Palenik in Forensic Science, D.H. Ubelaker (Ed.), Wiley-Blackwell, Chichester (2013).**
2. **W.J. Tilstone, M.L. Hastrup and C. Hald, Fisher's, Techniques of Crime Scene Investigation, CRC Press, Boca Raton (2013).**

References:

1. **J.D. DeHaan, Kirk's Fire Investigation, 3rd Edition, Prentice Hall, New Jersey (1991).**
2. **A.A. Moenssens, J. Starrs, C.E. Henderson and F.E. Inbau, Scientific Evidence in Civil and Criminal Cases, 4th Edition, The Foundation Press, Inc., New York (1995).**
3. **R. Saferstein, Criminalistics, 8th Edition, Prentice Hall, New Jersey (2004).**
4. **Forensic Laboratory Handbook procedure and practice, Ashraf Mozayani, 2011**
5. **Explosives DFS Manual, 2005**
6. **Lab Manual Criminalistics An introduction to Forensic Science, Richard Saferstein (2007) Ninth Edition.**

List of Experiments

1. Forensic investigation of arson scene of crime.
2. Forensic analysis of arson related evidences. (extraction, spot test)
3. Analysis of explosion residues (Preliminary analysis)
4. Thin layer chromatography of explosive substances
5. Analysis of petroleum product by density gradient method
6. Characterization and analysis of adulteration of Petroleum products.
7. Analysis of Kerosene and Petrol, Diesel by color test
8. Analysis of Kerosene and Petrol, Diesel by UV spectroscopy
9. Bomb scene investigation
10. Systematic analytical approach to pre-blast and post-blast explosives

Continuous Assessment Pattern

Internal Assessment (IA)	**End Term Test (ETE)**	**Total Marks**
50	50	100

(Established under Galgotias University Uttar Pradesh Act No. 14 of 2011)

Program: M.Sc in Mathematics

Scheme: 2020-2021

SCHOOL OF BASIC AND APPLIED SCIENCES

Vision: To be recognized globally as a center of excellence in imparting value-based education in Basic and Applied Sciences by creating innovation in fundamental and multidisciplinary research.

Mission

M1: To excel in imparting contemporary knowledge and skills by developing an educational ecosystem with diverse interests and talents.

M2: To perform cutting edge research leading to innovation in sciences through national and international collaborations.

M3: To develop solutions for the emerging challenges in Basic and Applied Science to cater the needs of society.

M4: To attract best quality faculty to facilitate knowledge and develop confidence in our graduates to succeed in the world.

Program Educational Objectives

PEO1: The Post Graduates will be successful professionals in Academia, Research, Industry, Government and Entrepreneurship**.**

PEO2: The Post Graduates will play important role in research-oriented organizations to enhance the quality for products and processes.

PEO3: The Post Graduates will be successful team members in an interdisciplinary set up for solving real word problems.

Program Specific Objectives

PSO1. An ability to apply basic and research based mathematical knowledge to model and simulate various complex problems of our society through experiments, analysis and interpretation of data and to provide the optimal solution.

PSO2. An ability to select and apply appropriate cutting-edge mathematical and computational tool(s) to provide solution(s) effectively and efficiently.

Program Outcomes

PO1.Critical thinking: Identify the assumptions that frame our thinking and actions, checking out the degree to which these assumptions are accurate and valid, and looking at our ideas and decisions (intellectual, organizational, and personal) from different perspective.

PO2. Problem analysis: Analysis of complex real-life mathematical problems by using concept, formulation and reaching conclusions by analytical and numerical methods.

PO3. Development of concepts: Develop the ability to critically evaluate theories, methods, principles, and applications of pure and applied mathematics.

PO4. Modern tool usage: Develop professional skills required for industry through learning of demandable mathematics, programming languages and software tools.

PO5. Communication: Communicate effectively through soft skills, report writing, documentation and effective presentations.

PO6. Environment and sustainability: Develop contemporary mathematical knowledge to predict the effect of environment changes and contribute to the sustainable development.

PO7. The society and team work: Apply logical reasoning obtained from the contextual knowledge to perform professionally with social, cultural and ethical responsibility as an individual as well as in multifaceted teams with positive attitude.

PO8. Lifelong learning: Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Curriculum

Semester 1

Sl. No	Course Code	Name of the Course					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MSCM101	Linear Algebra	3	1	0	4	30	20	50
2	MSCM102	Real Analysis	3	1	0	4	30	20	50
3	MSCM104	Ordinary Differential Equations	3	1	0	4	30	20	50
4	MSCM206	Computer Programming in Python	3	0	0	3	30	20	50
5	MSCM211	Computer Programming Lab in Python	0	0	2	1	50		50
6		BEC(B1)	2	0	0	2			
		Total				**18**			

Semester II

Sl No	Course Code	Name of the Course					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MSCM201	Abstract Algebra	3	1	0	4	30	20	50
2	MSCM202	Complex Analysis	3	1	0	4	30	20	50
3	MSCM203	Partial Differential Equations	3	1	0	4	30	20	50
4	MSCM205	Topology	3	1	0	4	30	20	50
5	MSCM103	Mathematical Statistics	3	1	0	4	50		50
6	MSCM111	Mathematical Statistics in R	0	0	2	1	30	20	50
7		IPR				1			
8	MBS28T2111	Research Methodology	2	0	0	2	30	20	50
		Total				**24**			

Semester III

Sl No	Course Code	Name of the Course					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MSCM301	Functional Analysis	3	1	0	4	30	20	50
2	MSCM302	Operations Research	3	1	0	4	30	20	50
3	MSCM401	Probability theory	3	1	0	4	30	20	50
4	MBS30T5998	Project (Phase I)		0	0	4			30
5	MBS30P1997	Summer Internship			4	2	30	20	50
6		Campus to Corporate				2			
		Total				**20**			

Semester IV (Track 1)

Sl No	Course Code	Name of the Course					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MSCM402	Applied Numerical Analysis	3	0	0	3	30	20	50
2	MSCM411	Applied Numerical Analysis Lab	0	0	2	1	50		50
3	MSCM421	Advanced Optimization Techniques	3	1	0	4	30	20	50

4	MSCM427	Multivariable Statistical Techniques	3	1	0	4	30	20	50
5	MBS30P5999	Project (Phase II)	1	0	0	6	30	20	50
		Total				**18**			
		Semester IV (Track 2)							
Sl No	**Course Code**	**Name of the Course**					**Assessment Pattern**		
			L	**T**	**P**	**C**	**IA**	**MTE**	**ETE**
1	MSCM402	Applied Numerical Analysis	3	0	0	3	30	20	50
2	MSCM411	Applied Numerical Analysis Lab	0	0	2	1	50		50
3	MSCM303	Integral Equations and Calculus of Variation	3	1	0	4	30	20	50
4	MSCM321	Fluid Mechanics	3	1	0	4	30	20	50
5	MBS30P5999	Project (Phase II)	1	0	0	6	30	20	50
		Total				**18**			
		Semester IV (Track 3)							
Sl No	**Course Code**	**Name of the Course**					**Assessment Pattern**		
			L	**T**	**P**	**C**	**IA**	**MTE**	**ETE**
1	MSCM402	Applied Numerical Analysis	3	0	0	3	30	20	50
2	MSCM411	Applied Numerical Analysis Lab	0	0	2	1	50		50
3	MSCM323	Fuzzy Mathematics	3	1	0	4	30	20	50
4	MSCM327	Measure theory	3	1	0	4	30	20	50
5	MBS30P5999	Project (Phase II)	0	0	0	6	30	20	50
		Total				**18**			
		Semester IV(Track 4)							
Sl No	**Course Code**	**Name of the Course**					**Assessment Pattern**		
			L	**T**	**P**	**C**	**IA**	**MTE**	**ETE**
1	MSCM402	Applied Numerical Analysis	3	0	0	3	30	20	50
2	MSCM411	Applied Numerical Analysis Lab	0	0	2	1	50		50
3	MSCM421	Advanced Optimization Techniques	3	1	0	4	30	20	50
4	MSCM322	Stochastic Processes	3	1	0	4	30	20	50
5	MBS30P5999	Project (Phase II)	0	0	0	6	30	20	50
		Total				**18**			
		Semester IV(Track 5)							
Sl No	**Course Code**	**Name of the Course**					**Assessment Pattern**		
			L	**T**	**P**	**C**	**IA**	**MTE**	**ETE**
1	MSCM402	Applied Numerical Analysis	3	0	0	3	30	20	50
2	MSCM411	Applied Numerical Analysis Lab	0	0	2	1	50		50
3	MSCM421	Advanced Optimization Techniques	3	1	0	4	30	20	50
4	MSCM325	Artificial Intelligence	3	1	0	4	30	20	50
5	MBS30P5999	Project (Phase II)	0	0	0	6	30	20	50
						18			
		Total Credits				**80**			

List of Electives

Elective-1

Sl No	Course Code	Name of the Electives					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MSCM421	Advanced Optimization Techniques	3	1	0	4	30	20	50
2	MSCM427	Multivariable Statistical Techniques	3	1	0	4	30	20	50
3	MSCM303	Integral Equations and Calculus of Variation	3	1	0	4	30	20	50
4	MSCM321	Fluid Mechanics	3	1	0	4	30	20	50
5	MSCM323	Fuzzy Mathematics	3	1	0	4	30	20	50
6	MSCM327	Measure theory	3	1	0	4	30	20	50
7	MSCM322	Stochastic Processes	3	1	0	4	30	20	50
8	MSCM325	Artificial Intelligence	3	1	0	4	30	20	50

Name of The Course	**Linear Algebra**				
Course Code	**MSCM101**				
Prerequisite	**Basic concepts of matrices**				
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		3	**1**	**0**	**4**

Course Objectives:

The subject material is of importance in all fields of mathematics and in science in general. The knowledge on this course will provide the basis for further studies in advanced linear algebra and analysis like, linear groups, functional analysis etc. which forms the basics of higher mathematics.

Course Outcomes

CO1	Explain linear transformation, dual spaces & its basis, transpose of a linear transformation, Isomorphism.
CO2	Determine eigen value &eigen vector, diagonalization and describe orthogonalization and Jordan canonical form.
CO3	Apply Gram-Schmidt orthonormalization, orthogonal projection, linear functional, normal operators, Min-Max Principle and Rayleigh quotient.
CO4	Apply Singular Value Decomposition (SVD) to PCA, Image compression, facial recognition etc.
CO5	Explain Bilinear forms, real quadratic forms, Sylvester's law of inertia
CO6	Apply essence of eigen value and eigen vectors to solve problem in Machine learning

Text Book (s)

1. *Hoffman, K. and R. Kunze, Linear Algebra, 2nd ed., Pearson Education (India), 2003.*

2. *Artin, M., Algebra, Prentice Hall of India, 1994.*

3. *Lax, P., Linear Algebra, John Wiley & Sons, New York, Indian Ed. 1997.*

Reference Book (s)

1. ***Ramachandra, A.R. and P. Bhimasankaram, Linear algebra, Tata McGraw-hill,1992.***

2. *Rose,* H. E., *Linear Algebra, Birkhauser, 2002.*

3. *Lang, S., Algebra, 3rd ed., Springer (India), 2004.*

4. *Zariski, O. and P. Samuel, Commutative Algebra, Vol. I, Springer, 1975*

Unit-1	**8 Hours**
Linear transformation, algebra of linear transformation, Isomorphism, Linear functional, Dual spaces, dual basis, double dual, transpose of a linear transformation and its matrix in the dual basis	
Unit-2	**8 Hours**
Annihilators. eigen spaces of a linear operator, diagonalizability, invariant subspaces and Cayley-Hamilton theorem, the minimal polynomial for a linear operator, Generalized eigen vector, canonical forms.	
Unit-3	**9 Hours**
Inner product spaces and norms, Gram-Schmidt orthogonalization process, orthogonal complements, Bessel's inequality, the adjoint of a linear operator, Normal and self-adjoint operators, Rayleigh quotient, Min-Max Principle.	
Unit-4	**10 Hours**

Orthogonal projections, Eigen Decomposition (Spectral Decomposition), Singular Value Decomposition, Dimension Reduction, Image Compression, facial recognition, Principal component Analysis (PCA)	
Unit-5	**9 Hours**
Bilinear forms, symmetric and skew-symmetric bilinear forms, real quadratic forms, Sylvester's law of inertia, positive definiteness.	
Unit - 6	**3 Hours**
The essence of eigenvalues and eigenvectors in Machine Learning, Spectral Clustering, Intersect point detection in computer vision.	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Name of The Course	**Real Analysis**				
Course Code	**MSCM102**				
Prerequisite	**Calculus**				
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		3	**1**	**0**	**4**

Course Objectives: To make students understand real numbers, least upper bounds, and the triangle inequality, set theory, convergence and divergence of series, metric spaces, continuity and differentiability of functions**.**

Course Outcomes

CO1	Explain fundamental properties of the metric spaces that lead to the formal development of real analysis.
CO2	Illustrate function of several variables as a linear transform from R^n to R^m and their properties.
CO3	Apply the concept of improper integrals and Explain the theory of Riemann-Stieltjes.
CO4	Apply different theorems to find the convergence of series of arbitrary terms.
CO5	Solve the problems related to uniform convergence of sequence and series of functions and explain power series.
CO6	Know applications of real analysis in practical life.

Text Book (s)

1. Rudin, W., Principles of Mathematical Analysis, 3rd ed., McGraw-Hill, 1983.

2. Royden, H.I., Real Analysis,4rth ed.,Pearson’s Education ISBN-13: 978-0131437470.

3. Apostol, T., Mathematical Analysis, 2nd ed., Narosa Publishers, 2002.

Reference Book (s)

1. Ross, K., Elementary Analysis: The Theory of Calculus, Springer Int. Edition, 2004.

2. Malik, S.C., Savita Arora, Mathematical Analysis ,2nd ed., New age publication,1999.

Unit-1	**10 Hours**

Metric spaces, Frechet Spaces, Open sets, Closed Sets, Convergence, Continuity, Continuous functions, Extension Theorem, Uniform continuity, Isometry and homeomorphism, Equivalent metric spaces, Complete metric, Banach fixed point theorem, Dense subsets, Nowhere dense set, Perfect sets, Cantor Sets, Baire Category theorem, Separable, second countable and first countable spaces. Compactness, Sequential compactness, Totally bounded sets. Finite intersection property. Lebesgue numbers for coves, Connectedness.	
Unit-2	**9 Hours**
Functions of several variables, Derivative of functions in a open subset of $\Re^n$ into $\Re^m$ as a linear transformation, Chain rule, Partial derivatives, Taylor's theorem, Inverse function theorem, Implicit function theorem. Partitions of unity, Differential forms, Stokes Theorem.	
Unit-3	**8 Hours**
Definition and existence of Riemann-integral & Riemann-Stieltjes integral, Conditions for R-S integrability, Properties of the R-S integral, R-S integrability of functions of a function.	
Unit-4	**8 Hours**
Series of arbitrary terms. Convergence, divergence and oscillation, Abel's and Dirichilet's tests. Multiplication of series, Rearrangements of terms of a series, Riemann's theorem.	
Unit-5	**10 Hours**
Sequences and series of functions, point wise and uniform convergence, Cauchy's criterion for uniform convergence. Weierstrass M-test, Abel's and Dirichlet's tests for uniform convergence, uniform convergence, continuity and differentiation. Weierstrass approximation theorem. Powerseries. Uniqueness theorem for power series, Abel's and Tauber's theorems.	
Unit-6	**4 Hours**
Applications of real analysis in- Computer Sciences, Daily life, Medical Sciences and Technology.	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Ordinary Differential Equations**				
Course Code	**MSCM104**				
Prerequisite	**Basic Calculus**				
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		3	**1**	**0**	**4**

Course Objectives: To impart existing knowledge of calculus and apply it towards the construction and solution of mathematical models in the form of differential equations.

Course Outcomes

CO1	Know the behavior of differential equations about the existence and uniqueness of solutions.
CO2	Learn about the solution of linear ODE's and their general solutions.
CO3	Learn about the solutions of 2^{nd} order or higher order ODE's.
CO4	Learn the different kinds of singularity behavior in ODE's.
CO5	Know the series solution of ODE's.
CO6	To understand the use of ODE in real life problems.

Text Book (s)

1. **Raisinghania, M.D., Ordinary and Partial Equations,18th ed., S.Chand.**
2. **Coddington, E.A., An Introduction to Ordinary Differential Equations, Prentice-Hall of India Private Ltd., New Delhi.**
3. **Simmon, G.F., Differential equations with applications and Historical notes,2nd ed., McGraw- Hill, 1991**
4. **Ross, S.L., Differential Equations,3rd ed.,Wiley.**

Reference Book (s)

1. **Martain, W.T. and E. Relssner, Elementary Differential Equations, 3rd ed., Addison Wesley Publishing Company, inc., 1995.**
2. **Codington, E.A. and N. Levinson, Theory of Ordinary Differential Equations , TataMc Graw hill Publishing Co. Ltd. New Delhi, 1999.**
3. **Braun, M., Differential Equations and Their Applications, Springer-Verlag, New York Heidelberg, Berlin.**

Unit-1	**8 Hours**
Lipschitz condition, Existence and uniqueness of solution of ordinary differential equation of first order, Existence theorem in complex plane, Existence and uniqueness theorem for simultaneous differential equations of first order, The method of successive approximations, convergence of successive approximations, Existence and uniqueness of solution Initial value problem, Non-local existence of the solution, Existence and uniqueness of solutions of equations of order n.	
Unit-2	**8 Hours**
Systems of differential equations, algebraic properties of solutions of linear systems, Applications of linear algebra to differential equations, the theory of determinants, Solutions of simultaneous linear equations, the eigenvalue-eigenvector method of finding solutions, Complex roots, Equal roots, Fundamental matrix solutions: e^{At}.	
Unit-3	**8 Hours**
Second order equations: General solutions of homogeneous equations, Non- Homogeneous equations, Wronskian, Method of variation of parameters, Strum comparison theorem, Strum separation theorem, Boundary value problems, Green's function, Strum-Liouville problems.	
Unit-4	**8 Hours**
Linear equations with regular singular points – introduction; Euler equation, second order equations with regular singular points – example and the general case, convergence proof, exceptional cases, Bessel equation, regular singular points at infinity.	
Unit-5	**10 Hours**
Series Solution : Ordinary point and singularity of a second order linear differential equation in the complex plane, Fuch's theorem, solution about an ordinary point, solution of Hermite equation as an example, Regular singularity, Frobenius' method – solution about a regular singularity, solutions of hypergeometric, Legendre, Laguerre and Bessel's equation as examples.	
Unit – 6	**3 hours**
Applications of ODE: Growth and diffusion: mathematical frameworks, Geometric interpretation of autonomous systems, motion of a charged particle, motion of a binary system, fluid dynamics, Satellite Orbiting an Oblate Planet.	

Continuous Assessment Pattern

Internal Assessment (IA)	**Mid Term Test (MTE)**	**End Term Test (ETE)**	**Total Marks**
30	**20**	**50**	**100**

Name of The Course	**Computer Programming in Python**				
Course Code	**MSCM206**				
Prerequisite					
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives: To learn the fundamental concepts of python programming and develop the software using the concept of 'Python' Language.

Course Outcomes

CO1	Understand the basic terminology used in programming and able to write, compile and debug programs in python programming and acquire knowledge about basic elements of programming with conditional and control statements to solve problem.
CO2	Learn string concepts in python and understand the special data structures like tuple, set, list and dictionary usage in python.
CO3	Understand the modular techniques such as functions and difference between call by value and call by reference methods.
CO4	Develop programs with file handling concepts in python.
CO5	Implement python programs with object-oriented programming concepts like class, object, data hiding and inheritance to solve real world problems.
CO6	Applications of Python programming.

Text Book (s)

1. Programming and Problem solving with Python, Ashok Namdev Kamthane, Amit Ashok Kamthane, McGraw Hill.
2. Guttag, John, Introduction to Computation and Programming using Python, PHI Publisher
3. Thareja, Reema, Python Programming using problem solving Approach, 1st ed. (10 June 2017) Oxford University, Higher Education Oxford University Press, ISBN-10: 0199480173

Reference Book (s)

1. Lambert, Kenneth A, Fundamentals of Python first Programmers ,1st ed (6th February 2009) Copyrighted material Course Technology Inc.
2. Budd, T., Exploring Python, 1st ed, Tata Mac Graw Hill, 2011

Unit-1	**8 Hours**
Python identifiers and reserved words, Lines and indentation, multi-line statements, Comments, Input/output with print and input functions, Command line arguments and processing command line Arguments, Standard data types - basic, none, Boolean (true & False), Numbers, Data type conversion, Python basic operators (Arithmetic, comparison, assignment, bitwise logical), Python membership operators (in & not in), Python identity operators (is & is not), Operator precedence, Control Statements, Python loops, Iterating by subsequence index, loop control statements (break continue, pass).	
Unit-2	**8 Hours**
String - Concept, escape characters, String special operations, String formatting operator, Single quotes, Double quotes, Triple quotes, Raw String, Unicode strings, Built-in String methods Creating	

& deleting tuples, Accessing values in a tuple, Updating tuples, delete tuple elements, Indexing, slicing and Matrices, built- in tuple functions, Sets - Concept, operations, Python Lists - concept, creating and accessing elements, updating & deleting lists, basic list operations, built-in List functions Using Lists as stacks and Queues, List comprehensions.	
Unit-3	**8 Hours**
Defining a function, Calling a function, Function arguments - Pass by value, Keyword Arguments, default arguments, Scope of variable - basic rules, Documentation Strings, Variable Number of Arguments, Call by Reference, Order of arguments (positional, extra & keyword), Generators (functions and expressions) and iterators, list Anonymous functions, Recursion, Treatment of Input and Output Arguments, Unpacking argument lists.	
Unit-4	**8 Hours**
Creating files, Operations on files (open, close, read, write), File object attributes, file positions, Listing Files in a directory, Testing File Types, Removing Files and Directories, Copying and Renaming Files, Splitting Pathnames, Creating and Moving to Directories, Traversing Directory Trees, built-in dictionary functions and methods.	
Unit-5	**8 Hours**
Object oriented programming and classes in Python - creating classes, instance objects, accessing members, Data hiding (the double underscore prefix), Built-in class attributes, Garbage collection: the constructor, Overloading methods and operators, Inheritance - implementing a subclass, overriding methods, recursive calls to methods, class variables, class methods, and static methods.	
Unit-6	**4 Hours**
Applications of Python programming in domain related problems such as data analysis, mathematical modelling, signal processing etc.	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Computer Programming Lab in Python**
Course Code	**MSCM211**
Prerequisite	
Corequisite	
Antirequisite	

	L	T	P	C
	0	0	2	1

CO1	**Understand the basic terminology used in programming and able to write, compile and debug programs in python programming and acquire knowledge about basic elements of programming with conditional and control statements to solve problem.**
CO2	**Learn string concepts in python and understand the special data tsructures like tuple, set , list and dictionary usage in python.**
CO3	**Understand the modular techniques such as functions and difference between call by value and call by reference methods**

CO4	**Develop programs with file handling concepts in python**
CO5	**Implement python programs with object-oriented programming concepts like class, object, data hiding and inheritance to solve real world problems.**

1.	**Overview, Basic syntax, Mathematical Operators, Predefined constants.**
2.	**Write a python program to double the values in a list.**
3.	**Write a python program to print all prime numbers among the interval given by user.**
4.	**Write a python program to show the importance of operator precedence and associativity of different operators**
5.	**Write a python program to do the following operations** **a. Reversing a given integer number.** **b. Find the sum of digits of given integer number.**
6.	**Write a python program to implement Dice game for 2 players using random().**
7.	**Write a python program to utilize all in-built mathematical functions.**
8.	**Write a python program to check the given string is palindrome or not, without using In-built functions.**
9.	**Write a python program to find a character and number of occurrence of a given character in a string.**
10.	**Write a python program to manage student's details using dictionary.**
11.	**Write a python program to design groceries billing system using dictionary.**
12.	**Write a python program to get a date from user and give the day as output**
13.	**Write a python program to find the number of days between two dates given by user. (Age Calculator)**
14.	**Write a python program to find Factorial of a given number without using Recursion Concept.**
15.	**Write a python program to find sum of N given numbers using Recursion by using Function.**
16.	**Write a python program to copy the content of one file to another file.**
17.	**Write a python program to search the give character or string is present in a file.**
18.	**Write a python program which defines a function f. f takes two arguments a and b and do (a+b) / (a-b) computation.**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
50	**-**	**50**	**100**

Second Semester

Name of The Course	**Abstract Algebra**				
Course Code	**MSCM201**				
Prerequisite					
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		3	**1**	**0**	**4**

Course Objectives: This course aims to provide a first approach to the subject of algebra, which is one of the basic pillars of modern mathematics. The focus of the course will be the study of certain structures called groups, rings, fields and some related structures.

Course Outcomes

CO1	Introduction of group, subgroup, quotient group, group isomorphism and Sylow subgroup.
CO2	Ability to understand advanced group structures like solvable group, nilpotent group and free abelian groups.
CO3	Develop understanding and knowledge of various ring structures like Euclidean domain PID, UID and polynomial rings.
CO4	Exposure to various field structures like finite fields, separable and inseparable extensions, Splitting fields and Cyclotomic fields.
CO5	Get familiar with fundamental concepts of Galois theory.
CO6	Introduce some recent research areas related with different structures of abstract algebra.

Text Book (s)

1. **I. N. Herstein, Topics in Algebra, Wiley & Sons publications 1975.**
2. **D.S. Malik, J. N. Mordeson and M. K. Sen, Introduction to Abstract Algebra, USA, 2007**
3. **N. Jacobson, Basic Algebra I, 2nd Ed., Hindustan Publishing Co., 1984.**

Reference Book (s)

1. **J. A. Gallian, Contemporary Abstract Algebra, 4th Ed., Narosa, 1999.**
2. **J. S. Milne, Fields and Galois Theory, 2017**
3. **J. B. Fraleigh, A first course in Abstract Algebra, 3rd Ed., Narosa Publishing, 1986**
4. **M. Artin, Algebra, Prentice Hall of India, 1994.**
5. **D.S. Dummit and R. M. Foote, Abstract Algebra, 2nd Ed., John Wiley, 2002.**

Unit-1	**9 Hours**
Group, subgroup, Lagrange's theorem, Normal subgroup, Quotient group, Homomorphism, Isomorphism, class equation, Sylow's theorems, Sylow's p-subgroups, Application of Sylow's Theorem, Direct product of groups.	
Unit-2	**9 Hours**
Simple groups and solvable groups, nilpotent groups, simplicity of alternating groups, Normal and subnormal series, composition series, Jordan-Holder Theorem. Semi-direct products. Free groups, free abelian groups.	
Unit-3	**9 Hours**

Rings, Rings of fractions, Ring Isomorphism, Chinese Remainder Theorem for pairwise co-maximal ideals. Euclidean Domains, Principal Ideal Domains and Unique Factorizations Domains. Polynomial rings over UFD's.	
Unit-4	**9 Hours**
Fields, Characteristic and prime subfields, Field extensions, Finite, algebraic and finitely generated field extensions, Classical ruler and compass constructions, Splitting fields and normal extensions, algebraic closures. Finite fields, Cyclotomic fields, Separable and inseparable extensions.	
Unit-5	**9 Hours**
Galois groups, Fundamental Theorem of Galois Theory, Composite extensions, Examples (including cyclotomic extensions and extensions of finite fields). Norm, trace and discriminant. Solvability by radicals, Galois' Theorem on solvability.	
Unit 6	**9 Hours**
Module theory, Algebraic number theory, Algebraic topology, Lie groups, Representation theory, Boolean algebra	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Complex Analysis**				
Course Code	**MSCM202**				
Prerequisite	**Real Analysis**				
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		3	**1**	**0**	**4**

Course Objectives: To introduce the fundamental ideas of the functions. of *complex* variables and developing a clear understanding of the holomorphic functions and its various features.

Course Outcomes

CO1	Determine continuity/differentiability/analyticity and integral of a complex function.
CO2	Apply the concepts of Cauchy Integral theorem and formula to solve complex integration.
CO3	Classify singularities of an analytic function and to find the Laurent's and Taylor's series of a complex function.
CO4	Compute the residue of a function and use the residue theory to evaluate a contour integral or an integral over the real line.
CO5	Understand the concept of transformation in a complex space (linear and non-linear) and sketch their associated diagrams.
CO6	Understand different theorems which assert that two boundary points of a simply connected

Text Book (s)

1. Churchill & Brown, Complex Variables and Applications, McGraw-Hill Higher Education; 8th edition (*1* October 2013)
2. S. Ponuswamy, Foundation of Complex Analysis (Second edition). Publisher: Alpha Science Int Ltd, 2006, ISBN 10: 1842652230 ISBN 13: 9781842652237
3. Murray Spiegel, Seymour Lipschutz, Complex Variables (Schaum's Outlines), 2nd ed., McGraw-Hill Profesional

Reference Book (s)

1. A.R. Shastri, An Introduction to Complex Analysis, Macmilan India, New Delhi, 1999
2. J.B. Conway, Functions of One Complex Variable, 2nd ed., Narosa, New Delhi
3. Walter Rudin, Real and Complex Analysis, 3rd ed., McGraw-Hill International Editions Mathematics Series.

Unit-1	**10 Hours**
Quick Review of Complex numbers, Elementary functions, Limit, Continuity, Differentiability of function, Analytic function, Cauchy-Riemann Equations in Cartesian and Polar form, Necessary and sufficient conditions for a function to be analytic, Harmonic functions and simple application to flow problems.	
Unit-2	**10 Hours**
Integration of complex valued functions, Cauchy theorem, Cauchy- Goursat theorem (Statement only), Cauchy Integral formula, Generalized Cauchy Integral formula, Liouville’s theorem, fundamental theorem of algebra, Identity theorem, Uniqueness theorem, Maximum modulus principle, Schwarz’s lemma.	
Unit-3	**8 Hours**
Radius of convergence of power series, and power series as an analytic function, Taylor’s and Laurent's series, Zeroes and Singularities of complex valued functions.	
Unit-4	**10 Hours**
Residues, Cauchy’s residue theorem, evaluation of definite and improper integrals using contour integration, Meromorphic functions, argument principle, Rouche’s theorem, open mapping theorem, Singularity and residue at ∞.	
Unit-5	**7 Hours**
Introduction, Conformal Mapping, Some special transformations, Möbius transformations, Cross ratio, invariance of circles, symmetry and orientation principles (statement only), determination of Möbius transformations mapping real line onto itself, upper half plane onto itself, upper half plane onto open disc and an open disc onto an open disc.	
Unit-6	**6 Hours**
Hurwitz theorem, Basic results on univalent functions, The Riemann mapping theorem, Picard’s theorem	

Continuous Assessment Pattern

Internal Assessment (IA)	**Mid Term Test (MTE)**	**End Term Test (ETE)**	**Total Marks**
30	**20**	**50**	**100**

Name of The Course	**Partial differential equations**				
Course Code	**MSCM203**				
Prerequisite					
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		3	**1**	**0**	**4**

Course Objectives: Students will gain knowledge about the partial differential equations (pde’s) and how they can serve to model many physical processes such as mechanical vibrations, transport phenomena including diffusion, heat transfer, advection and electrostatics etc. They will learn about heat and wave equations in 1D, 2D and 3D using the divergence Theorem.

Course Outcomes

CO1	Define the partial diff. equations and their solutions by some well known methods Like Lagrange's, Charpit and Monge's method.
CO2	To classify the 2nd order pde's and define canonical forms.
CO3	To know and solve elliptic, hyperbolic and Laplace equations and wave equations by using separations of variables.
CO4	Establish the properties of solutions like existence, uniqueness, weakness and strongness etc.
CO5	Define Green's functions of heat, wave and Laplace equations.
CO6	Understand the advanced topics like Sobolev, Poincaré inequalities and Rellich-Kondrachov-spaces

Text Book (s)

I. N. Sneddon, Elements of partial differential equations, Dover Publications, New York, 2006.
2. F. John, Partial Differential Equations, Springer-Verlag, New York, 1985.
3. C. Constanda, Solution techniques For elementary partial Differential Equations, Chapman and Hall/CRC, New York,2002.
4. S.J Farlow, Partial Differential Equations for scientist and Engineers, Birkh, auser, New York, 1993.
5. E. DiBenedetto, Partial Differential Equations, Birkhauser, Boston, 1995.

Reference Book (s)

1. L.C. Evans, Partial Differrential Equations, Graduate Studies in Mathematics, Vol. 19, AMS, Providence, 1998.
2. E. Zauderer, Partial Differential Equations of Applied Mathematics, 2nd ed., John Wiley andSons, New York, 1989.
3. K. Sankara Rao, Introduction to Partial Differential Equations, 3rdedition,PHI, ISBN-13: 9788120342224

Unit-1	**9 Hours**
Formation and classification of First order PDEs, linear and quasi-linear first order PDEs, Cauchy's problem for first order PDE's, The Cauchy Kowalevski Theorem, Integral Surfaces passing through a given curve,, non linear first order PDEs, The method of characteristics, Compatible systems, Charpit's method and Jacobi's method for non linear PDEs.	
Unit-2	**8 Hours**
Classification, canonical forms, well posed problems, Superposition principles, Introduction to Fourier series, Convergence of FS for continuous and piecewise continuous functions, Differentiation and Integration of FS,Fourier cosine and sine series.	
Unit-3	**8 Hours**
Derivation of the heat equation, The maximum and minimum Principles, Uniqueness, Continuous dependences, Method of separation of variables, The method of Green's function, Time independent boundary conditions, Time dependent boundary conditions. Duhamel's Principle, Fourier transform method for heat flow problems in infinite and semi infinite rod,	
Unit-4	**10 Hours**
Derivation of wave equation, The infinite string problem, The D'Alembert's solution, Thesemi infinite string problem, The finite vibrating string problem, The method of separation of variables, The method of Green's function , Fourier transform method for infinite string problems, The in homogenous wave equation.	
Unit-5	**10 Hours**
Basic concept, Types of boundary value problems, The maximum and minimum principle, Green's identity and fundamental solution, The Poisson integral formula, The method of separation of variables, The method of Green's function, Fourier transform method for Laplace equation in half plane, The Dirichlet problem for rectangle, The Dirichlet problem for annuli and disk, The exterior Dirichlet problem.	

Unit-6	4 Hours
Sobolev spaces, theory of Sobolev/Poincaré inequalities and Rellich-Kondrachov-compactness.	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Topology			
Course Code	MSCM205			
Prerequisite				
Corequisite				
Antirequisite				
	L	T	P	C
	3	1	0	4

Course Objectives: This course aims to teach the fundamentals of point set topology and constitute an awareness of need for the topology in Mathematics.

Course Outcomes

CO1	Explain a topological space and construct a topology on a set in a number of 4-Mandate: Course Handout ways so that to make it in to a topological space.
CO2	Summarize some of the elementary concepts associated with topological spaces, Continuous spaces and Subspaces.
CO3	Explain Connectedness and Compactness in topological spaces and apply them to Construct new topological spaces from the given ones.
CO4	Classify the countability and separation axioms and prove related theorems.
CO5	Apply rules of Product space to prove related theorems as well as Urysohnlemma.
CO6	Know about various applications of Topology.

Text Book (s)

1. J. R. Munkres, Topology A First Course, 2nd ed., Prentice Hall of India Pvt. Ltd., New Delhi, 2000. 2. T. B. Singh, Elements of topology, CRC press, New Delhi, 2013

Reference Book (s)

1. M. A. Armstrong, Basic Topology, Springer (India), 2004.

2. K.D. Joshi, Introduction to General Topology, New Age - International, New Delhi, 2000.

3. J.L. Kelley, General Topology, Van Nostrand, Reinhold Co., New York, 1995

4. J. Dugundji, Topology, Allyn and Bacon, 1966 (reprinted in India by Prentice Hall of India Pvt. Ltd.).

Unit-1	9 Hours
Topological spaces, comparison of topologies. Basis and Subbasis for a Topology. Order topology. Closed sets, interior and closure of a set, limit points of a set, boundary of a set.	
Unit-2	**8 Hours**
Subspace topology. Continuous functions, Homeomorphisms. Product topology and box topology. Metric topology. Quotient topology.	
Unit-3	**10 Hours**

Connectedness, Path connectedness; Connected subspaces of the real line; Components and local connectedness. Compact spaces, Limit point compactness, Sequential compactness; Local compactness.
Unit-4 **10 Hours**
First countable spaces, Second countable spaces, Separable spaces, Lindeloff spaces. Hausdorff, Regular and Normal spaces. Completely regular and completely normal spaces.
Unit-5 **8 Hours**
Urysohn's lemma, Urysohn'sMetrization theorem, Tychonoff theorem, Stone Cechcompactification.
Unit-6 **4 Hours**
Applications of Topology in Dynamical System, Network Topology, Knot theory

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Mathematical Statistics**				
Course Code	**MSCM103**				
Prerequisite	**Basic concepts of probability**				
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		3	**1**	**0**	**4**

Course Objectives: To provide the students foundational introduction to the fundamental concepts in statistics.

Course Outcomes

CO1	Summarize the basic concepts of probability, random variable and probability distributions
CO2	Summarize the concept of bivariate distribution and correlation and regression.
CO3	Explain the concepts of sampling distributions and apply it to estimate the confidence intervals.
CO4	Explain the concepts of estimator and estimates.
CO5	Identify the type of statistical test and Apply it to solve the hypothesis testing problems.
CO6	Understand the application of statistics in recent advancement.

Text Book (s)

1.R.V. Hogg, A. Craig, Probability and Statistical Inference, 6th.Ed.,Pearson Education. 2006.
2.I. Miller, M. Miller, "Mathematical Statistics with Applications", Pearson Education. 2006

Reference Book (s)

1.W. H. William, C. M. Douglas, D. M. Goldman, C. M. Borror, Probability and Statistics in Engineering", John Wiley. 2003
2. S.C. Gupta and V.K. Kapoor, Fundamental of Mathematical Statistics, S. Chand Pub.

Unit-1 **12 Hours**
Discrete, continuous and mixed random variables, probability mass, probability density and cumulative distribution functions, mathematical expectation, moments, moment generating

function, Chebyshev's inequality. Special Distributions: Discrete uniform, binomial, geometric, negative binomial, hypergeometric, Poisson, uniform, exponential, gamma, normal, beta, lognormal, Weibull, Laplace, Cauchy, Pareto distributions.	
Unit-2	**7 Hours**
Bivariate random variables, joint and marginal distributions, covariance, correlation and regression analysis, transformation of variables product moments, correlation, independence of random variables, bivariate normal distribution, simple, multiple and partial correlation, regression.	
Unit-3	**10 Hours**
Law of large numbers, Central Limit Theorem, Distributions of thesample mean and the sample variance for a normal population, Random sampling and sampling distribution, fundamental distributions derived from normal distribution viz. ,t, F, χ 2 and Z (central) distributions, confidence intervals for the mean(s) and variance(s) of normal populations.	
Unit-4	**7 Hours**
Properties of a good estimator, Unbiasedness, Consistency, Efficiency and Sufficiency, The method of moments and the method of maximum likelihood estimation.	
Unit-5	**9 Hours**
Statistical Inference: Baysian inference, estimation-point an interval, testing of hypothesis, Neyman-Pearson Lemma. Some tests based on t, χ^2 and F distributions. Testing of Hypothesis: Null and alternative hypotheses, the critical and acceptance regions, two types of error, power of the test, the most powerful test and Neyman-Pearson Fundamental Lemma, Standard tests for one and two sample problems for normal populations.	
Unit-6	**4 Hours**
Data Science: the impact of statistics, Statistics without tears: Populations and samples. Statistical Inference Enables Bad Science; Statistical Thinking Enables Good Science	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	**20**	**50**	**100**

Name of The Course	Mathematical Statistics Lab using R				
Course Code	MSCM111				
Prerequisite					
Corequisite					
Antirequisite					
		L	T	P	C
		0	**0**	**2**	**1**

List of Experiments:

Lab 1. Graphical representation of data using R.

Lab 2. Problems based on measures of central tendency and based on measures of dispersion.

Lab 3. Testing of significance and confidence intervals for single proportion and difference of two proportions

Lab 4. Testing of significance and confidence intervals for single mean and difference of two means and paired tests.

Lab 5. Testing of significance and confidence intervals for difference of two standard deviations.

Lab 6. Exact Sample Tests based on Chi-Square Distribution.

Lab 7. Testing if the population variance has a specific value and its confidence intervals.

Lab 8. Testing of goodness of fit.

Lab 9. Testing of independence of attributes.

Lab 10. Testing based on 2 X 2 contingency table without and with Yates' corrections.

Lab 11. Testing of significance and confidence intervals of an observed sample correlation coefficient

Lab 12. Testing and confidence intervals of equality of two population variances.

Recommended Books

1. **R.V. Hogg, A. Craig, Probability and Statistical Inference, 6th.Ed.,Pearson Education. 2006**
2. **I. Miller, M. Miller, "Mathematical Statistics with Applications", Pearson Education. 2006**
3. **W. H. William, C. M. Douglas, D. M. Goldman, C. M. Borror, Probability and Statistics in Engineering", John Wiley. 2003**
4. **S.C. Gupta and V.K. Kapoor, Fundamental of Mathematical Statistics, S. Chand Pub.**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
50		**50**	**100**

Name of The Course	**Research Methodology**				
Course Code	**MBS28T2111**				
Prerequisite					
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		2	**0**	**0**	**2**

Course Objectives:

Course Outcomes

CO1	19. Understand the Principles of Scientific Research and different steps involved in doing research.
CO2	20. Know how to design research and frame up different steps in design.
CO3	21. Appraise the application of sampling through statistics.
CO4	22. Build up the method for data collection and analyse the data.
CO5	23. Develop the Concept of hypothesis preparation.
CO6	24. Developthe statistical analysis indulges in modern research for drug designing.

Text Books:

21. K. Ramakant; Elementary Statistics in a world of applications, Goodyear California Pub. Co.,1979.
22. K. D. Broota, Experimental designs in psychological research, Wiley eastern, New York, 1992.
23. Guilford, Statistics in Psychology and Education, McGraw hill, New York, 1986.
24. Katz and Kahn, Research in Behavioural Sciences, Methuen, USA, 1979.

Reference Books:

24. Kerlinger, F., Foundations of Behavioural Research, Surjeet Publications, Delhi, 1983.
25. Rajamanickam, M., Statistical Methods in Psychological and Educational Research, Concept Publishing Co. New Delhi, India, 1983.
26. Smith, Jonathan, A. (Ed.), Qualitative Psychology: A Practical Guide to Research Methods, Sage Publications, 2003.
27. Woodworth and Schlosberg, Experimental Psychology, Methuen and co. ltd, London, 1971.
5. Chanin Nantasenamat, Chartchalerm Isarankura-Na-Ayudhya, Thanakorn Naenna, Virapong Prachayasittikul, A Practical Overview of Quantitative Structure- Activity Relationship.EXCLI Journal 2009;8:74-88.
6. Wiktor Pronobis,Alexandre Tkatchenko,and Klaus-Robert Muller, J. Chem. Theory Comput. 2018, 14, 2991−3003
7. Leo, A., & Hoekman, D. H. (1995). *Exploring QSAR*. American Chemical Society.

Unit – 1: Principles of Scientific Research	**6 Lectures**
Research and research methodology, Procedures in research, Identification of the problem - Literature survey - Reference collection - Familiarity with ideas and concept of investigation - Qualitative and Quantitative analysis - Results - Synopsis writing - Art of writing a Research paper and Thesis.	

Unit – 2: Research Design, Sampling & Probability	**5-Lectures**
Research Design: Features of a Good Design, Different Research Designs, Sampling: Principles, methods, types of sampling, rationale for using a particular sampling procedure, Probability: Classical definition of Probability.	

Unit – 3: Data collection & analysis	**6- Lectures**
Types of Data, Collection of Data, double blind procedures, incidence and prevalence studies, Data Analysis: Measures of Central Tendency, Measures of Dispersion, Measures of Asymmetry,	

Unit-4: Correlation and Regression	**5-Lectures**
Methods of correlation, Types of correlation (Pearson r& Rho); Regression analysis, linear regression, Non-linear regression.	

Unit – 5: Hypothesis and Statistics	**5-Lectures**
Hypothesis Testing: Problems and hypothesis, variables and type of variables, Parametric and nonparametric statistics; level of significance, the various nonparametric tests with sample.	

Unit 6: Recent research advances
Descriptors, Quantitative structure-activity relationship (QSAR), Quantitative structure-property relationship(QSPR), Drug designing.

Continuous Assessment Pattern

Internal Assessment (IA)	**Mid Term Test (MTE)**	**End Term Test (ETE)**	**Total Marks**
30	**20**	**50**	**100**

Third Semester

Name of The Course	**Functional Analysis**				
Course Code	**MSCM301**				
Prerequisite					
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		3	**1**	**0**	**4**

Course Objectives: To develop with the purpose to cover theoretical needs of Partial Differential Equations and Mathematical Analysis. The Functional Analysis is related to problems arising in Partial Differential Equations, Measure Theory and other branches of Mathematics.

Course Outcomes

CO1	Summarize the basic concepts on Normed Spaces and Banach Spaces.
CO2	Summarize concept Fundamental Theorems for Normed and Banach Spaces.
CO3	Apply the concepts of continuity and reflexivity for Normed and Banach Spaces.
CO4	Identify and Apply the concepts of Inner Product Spaces.
CO5	Able to use Bessel's inequality and Parseval's identity.
CO6	Summarize the basic concept of Distribution(Generalized) theory.

Text Book (s)

1. **E. Kreyszig: Introductory Functional Analysis with Applications: Wiley student Edition 2007**
2. **B.V. Limaye, Functional Analysis: New Age International Publications, Third Edition 2014**

Reference Book (s)

1. **J. B. Conway: A course in Functional Analysis, Springer: Second Edition, 2007**

Unit-1	**9 Hours**
Normed Linear spaces, Quotient space of normed linear spaces and its completeness, Banach spaces and examples, Bounded linear transformations, Normed linear space of bounded linear transformations.	
Unit-2	**8 Hours**
Equivalent norms, Basic properties of finite dimensional normed linear spaces and compactness, ReiszLemma , Open mapping theorem, Closed graph theorem, Uniform boundness theorem	
Unit-3	**9 Hours**
Continuous linear functional, Hahn-Banach theorem and its consequences, Embedding and reflexivity of normed spaces, Dual spaces with examples, Boundedness and Continuity of Linear operators.	
Unit-4	**9 Hours**
Inner product spaces, Hilbert space and its properties. Orthgonality in Hilbert spaces, Phythagorean theorem, Projection theorem, Orthonormal sets, Bessel's inequality.	
Unit-5	**8 Hours**

Complete orthonormal sets, Parseval's identity, Basic concepts of spectral theory.	
Unit-6	**6 Hours**
Test Functions, Linear Functionals and the Schwartz-Sobolev theory Of Distributions, Algebraic Operations on Distributions, Analytic Operations On Distributions.	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Operations Research**				
Course Code	**MSCM302**				
Prerequisite					
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		3	**1**	**0**	**4**

Course Objectives: Operation research aims to introduce students to use quantitive methods and techniques for effective decisions–making; model formulation and applications that are used in solving decision problems.

Course Outcomes

CO1	understand the concept of optimization.
CO2	formulate the real life problem into mathematical form and apply various techniques to get their optimal solution.
CO3	understand the concept of assignment problem.
CO4	explain different measures of queues, used to design a service facility.
CO5	explain the concept of Inventory policy .
CO6	apply concept of optimization on Project Management and Planning Process

Text Book (s):

1. Hamdy A.Taha: Operations Research, Prentice Hall of India, 9th ed. 2010
2. Kanti Swarup, Gupta &Manmohan : Operations Research, S.Chand, 14th ed.

Reference Book (s):

1. **Wagner :Principles of Operations Research (PH)**
2. **Sasievir, Yaspan, Friedman : Operations Research: Methods and Problems (JW)**
3. **J. K. Sharma : Operations Research – Theory and Applications, Macmillan Publishers**
4. **Kasana and Kumar :Introduction to Operations research, Springer**
5. **Schaum's Outline Series : Operations Research ,Tata McGraw**
6. **Hillier & Lieberman : Introduction to Operations Research , Tata McGraw Hill Education Private Limited**
7. **Donald Gross, John F. Shortle, James M. Thompson, Carl M. Harris Fundamentalsof Queueing Theory, 4th Edition, Wiley**
8. **L. Kleinrock ,Queueing System(Vol 1) Theory,John Wiley and Sons**
9. **G. Hadly: Linear Programming, Narosa Publishing House**

Unit-1	11 Hours
Introduction to Linear Programming: Graphical method ,Simplex algorithm, feasible solution, the artificial basis techniques, Two phase and Big-M method with artificial variables. General Primal-Dual pair, formulating a dual problem, primal-dual pair in matrix form, Duality theorems, complementary slackness theorem, duality and simplex method, economic interpretation of duality, dual simplex method.	
Unit-2	**7 Hours**
General transportation problem, transportation table, duality in transportation problem, loops in transportation tables, LP formulation, solution of transportation problem, test for optimality, degeneracy, Transportation algorithm (MODI method). Mathematical formulation of assignment problem, assignment method, typical assignment problems.	
Unit-3	**8 Hours**
Introduction, Queuing System, elements of queuing system, distributions of arrivals, inter arrivals, departure and service times. Classification of queuing models, Steady- state solutions of Markovian Queuing Models .Single service queuing model with infinite capacity (M/M/1):(/FIFO), (M/M/1): (N/FIFO), Generalized Model: Birth-Death Process, (M/M/C):(/FIFO), (M/M/C) (N/FIFO), M/G/1.	
Unit-4	**8 Hours**
Inventory Control: The inventory decisions, costs associated with inventories, Classification of Inventories, Advantage of Carrying Inventory, Features of Inventory System factors affecting Inventory control, economic order quantity (EOQ). Deterministic inventory problems with no shortage and with shortages, EOQ problems with price breaks, Multi item deterministic problems.	
Unit-5	**7 Hours**
Analysis of a project thorough network diagram, Network scheduling by CPM, PERT, Financial planning through network, Network crashing.	
Unit 6	**4 hours**
Project Management and Planning Process: Introduction, need, Project Management Principles, Essentials of Project Management Philosophy, Project Planning, Project Process Flows.	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Probability theory			
Course Code	MSCM401			
Prerequisite				
Corequisite				
Antirequisite				
	L	T	P	C
	3	1	0	4

Course Objectives:

To introduce axiomatic approach to probability theory, to study some statistical characteristics, discrete and continuous distribution functions and their properties, characteristic function and basic limit theorems of probability.

Course Outcomes

CO1	Understand the concept of probability and sequence.
CO2	Explain the concept and application of random variable and random vector.
CO3	Understand the concept and application of probability distribution.
CO4	Understand the meaning and concept of Characteristic function.
CO5	Understand Stochastic convergence of sequence of random variables.

CO6	Understand the recent trends in probability theory.

Text Books:

(1) Laha R.G and RohatgiV.K ,“ Probability Theory”, JohnWiley, New York (1979)

(2) Johnson N.L and Kotz S “Distributions in Statistics: Discrete Distributions”, John Wiley, New York (1969)

(3) Johnson N.L, and Kotz S “ Distributions in Statistics: Continuous Univariate Distributions”, Vol 1 and 2 ,John Wiley, New York (Paperback, 1970)

References:

(1). Ash R.B- “Basic Probability Theory”, John wiley, New York (1970)

(2). Bhat B.R-“Modern Probability Theory: An Introduction Text Book”, Wiley Eastern (Second Edition) 1985

(3). Gnedenko B.V-“The Theory of Probability”, Mir Publishers Moscow (1969)

(4). Luckacs.E-“Characteristic Functions”, Hafner, New York (Second Edition, 1970)

Unit-1
Probability, liminf, limsup, and limit of sequence of events, Monotone and continuity property of probability measure, Addition Theorem, Independence of finite number of events, Sequence of events, Borel Cantalls Lemma, Borel Zero one law.
Unit-2
Random variable, Its probability distribution function, Properties of distribution function, Discrete and continues type random variables, Discrete, Continuous and other types of distributions, Expectation and moments of random variables, Inequalities of Liaponov (for moments) , Random vectors, Independence of random variables and sequence of random variables, Markov and Chebychev’s inequalities.
Unit-3
Standard distributions and their properties Bernoulli, Binomial, Geometric, Negative Binomial, Hyper geometric, Beta, Cauchy, Chi square, Double Exponential, Exponential, Fisher’s F, Gamma, Log Normal, Normal,, Parents, Students’s t, Uniform and Heibull.
Unit-4
Characteristic functions and their elementary properties, Uniform continuity and non negative definiteness of characteristic functions, Characteristic functions and moments, Statement (without proof) and application of each of the three theorems Inversion Theorem, Continuity Theorem and Bochner Khintchine Theorem of characteristic functions, Statement and proof of Fourier Inversion Theorem.
Unit-5
Stochastic convergence of sequence of random variables, Convergence in distributions, Convergence in probability, Almost sure convergence and convergence in the rth mean, Their inter-relation ship - Examples and counter examples, Slutsky’s Theorem.
Unit-6
A New Approach to Learning Probability,Effect of Probability Information on Bayesian Reasoning: A Study of Event-Related Potentials. C.R. Rao’s Influence on Theory and Practice of Sample Surveys

Continuous Assessment Pattern

Internal Assessment (IA)	**Mid Term Test (MTE)**	**End Term Test (ETE)**	**Total Marks**
20	**30**	**50**	**100**

Fourth Semester

Name of The Course	**Applied Numerical Analysis**				
Course Code	**MSCM402**				
Prerequisite					
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

1. To develop a numerical method foundation as a tool.
2. To understand error analysis in numerical methods in comparison with analytical methods.
3. To understand the role of numerical methodS in various numerical problems.
4. Analyse solution of partial differential equation by numerical method.

Course Outcomes

CO1	Summarize the error analysis in numerical methods and its stability.
CO2	Compute eigenvalues and eigenvectors for different kind of matrices by several numerical techniques.
CO3	Describe the role of interpolation, differentiation and integration in numerical methods for solving a mathematical problem.
CO4	Summarize various methods and techniques of numerical methods to solve ODE problems and analysis its error estimation.
CO5	Differentiate between elliptic, parabolic and hyperbolic partial differential equations and apply various method to solve PDE problems. Apply numerical techniques to solve hyperbolic PDE and assess the reliability of numerical results through extensive error analysis.
CO6	Apply numerical method in different engineering discipline.

Text Book (s)

1. **Jain, M. K., Iyengar, S.R.K & Jain, R.K " Numerical Methods", New age international publishers,Sixth Edition (2012).**
2. **Jain, M. K., " Numerical Solution of Differential Equations", John Wiley (1997).**
3. **Gerald, C. F. and Wheatly P. O., "Applied Numerical Analysis", 6th Ed., Addison-Wesley Publishing (2002).**

Reference Book (s)

1. Smith, G. D., " Numerical Solution of Partial Differential Equations", Oxford University Press (2001)

Unit-1	**10Hours**
Error analysis and stability of algorithms. Nonlinear equations: Newton Raphson method, Muller's method, criterion for acceptance of a root, system of non-linear equations. Roots of polynomial equations.	
Unit-2	**9Hours**

Power method for dominant, sub-dominant and smallest eigen-values, Jacobi, Givens and Householder methods for symmetric matrices, Rutishauser method for general matrices.	
Unit-3	**8Hours**
Newton's, Lagrange and Hermite interpolating polynomials, cubic splines; least square and minimax approximations. Numerical differentiation, Numerical integration: Newton-Cotes formula and Gaussian type quadrature methods.	
Unit-4	**8Hours**
Initial value problems: Multistep methods; Predictor-corrector Adam-Bashforth, Milne 's method,their error analysis and stability analysis. Boundary value problems: Shooting and difference methods.	
Unit-5	**10Hours**
Classification of PDEs. Solution of partial differential equation by finite difference method. Solution of Laplace equation: Standard and diagonal five point formula for solving Laplace and Poisson equations. Solution of One dimensional Heat equation: Schmidt method, Crank-Nicolson method. Solution of wave equation. Introduction to finite element methods. Solution of boundary value problem by finite element methods.	
Unit -6	**8Hours**
Examples from algebraic and transcendental equations where analytical methods fail. Explicit and Implicit method of solving Cauchy problem of one dimensional wave equation. Idea of convergence and stability. Application in mathematical model of Mass-spring-dashpot (present in shock absorbed, mechanical engineering problems), Chemical reaction, Drug absorption from blood stream. Gauss-Chebychev formulas.	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	**20**	**50**	**100**

Name of The Course	**Applied Numerical Analysis Lab**				
Course Code	**MSCM411**				
Prerequisite					
Corequisite					
Antirequisite					
		L	T	P	C
		0	0	2	1

Course Objective:

The objective of this course is to continue with the exploration on facilities provided by software (C language) to the computation related to eigenvalue & eigenvectors and solving Ordinary and Partial differential equations (Laplace, Heat & Wave) in general and then extending the exploration to solving domain related problems by numerical method approach.

Sl No	List of Experiments
1.	WAP in C to evaluate the smallest eigenvalue using the power method
2.	WAP in C to evaluate the largest eigenvalue & eigenvectors using the power method
3.	WAP in C to evaluate the eigenvalue & eigenvectors using the Jacobi's method.
4.	WAP in C to reduce in tridiagonal form a symmetric matrix by Given's method.
5.	WAP in C to solve first order ODE by Milne's method.

6.	WAP in C to solve first order ODE by Adams-Bashforth method.
7.	WAP in C to solve Laplace Equation by Jacob's method.
8.	WAP in C to solve Laplace Equation by Gauss - Seidal method.
9.	WAP in C to solve Heat Equation by Crank –Nicolson method.
10	WAP in C to solve Heat Equation by Du Fort and Frankel method.
11	WAP in C to solve Wave Equation by implicit scheme.
12	WAP in C to solve Wave Equation by explicit scheme.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
50	**-**	**50**	**100**

Electives

Name of The Course	**Advanced Optimization Techniques**				
Course Code	**MSCM421**				
Prerequisite	**LPP**				
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		3	**1**	**0**	**4**

Course Objectives: Many real-world problems require advanced techniques to formulate and to solve, and sometimes new optimization algorithms and procedures need to be designed. This course focuses on advanced techniques.

Course Outcomes

CO1	Solve a nonlinear problem through its linear approximation.
CO2	Apply concept of Dynamic programming .
CO3	Solve constrained and unconstrained optimization problems.
CO4	Understand the concept of Neural Network.
CO5	Understand the basic theory and some advanced topics in nature inspired optimization techniques.
CO6	Apply Markov Analysis for prediction of shares for future periods.

Text Book (s)

1. G. Hadley, Nonlinear and Dynamic Programming, Addison-Wesley, 1972.
2. I.C. Hu, Integer Programming and Network Flows, Addison-Wesley, 1970.
3. M.S. Bazaraa, H.D. Sherali, C.M. Shetty, Nonlinear Programming, J. Wiley & Sons.
4. Hillier, Lieberman, Introduction to Operations Research, McGraw Hill Book Company, 1989.
5. Mangasarian O.L., Non-linear Programming, McGraw Hill, New York

Reference Book (s):

1. Optimization for Engineering Design - Kalyanmoy Deb.

2.Optimization Theory and Applications - S.S. Rao.

3. Analytical Decision Making in Engineering Design - Siddal.

4. **Linear Programming – G. Hadley**

Unit-1	**10 Hours**
Nonlinear programming, Karush-Kuhn-Tucker necessary and sufficient conditions of optimality, Quadratic programming, Wolfe's method, Beale's method, Affine and convex sets, Convex programming.	
Unit-2	**8 Hours**
Dynamic programming, Bellman's principle of optimality, Recursive relations, System with more than one constraint, Solution of LPP using dynamic Programming.	
Unit-3	**10 Hours**
Constrained optimization: Characteristics of a constrained problem. Direct methods: The complex method, Cutting plane method, Indirect method: Transformation Technique, Unconstrained Optimization: Search Methods-Fibonacci search, Golden section search. Gradient Methods- Method of steepest descent.	
Unit-4	**9 Hours**
Adaptive Filtering Problem, Unconstrained Organization Techniques, Linear Least Square Filters, Least Mean Square Algorithm, Learning Curves, Learning Rate Annealing Techniques.	
Unit-5	**8 Hours**
Genetic Algorithm, Working principles, GAs for constrained optimization, Other GA operators, Simulated Annealing method, working principles. Particle swarm optimization method.	
Unit-6	**8 Hours**
Markov Analysis: Brand switching analysis, Prediction of market shares for future periods, Equilibrium conditions, Uses of Markov analysis.	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Multivariable Statistical Techniques**				
Course Code	**MSCM427**				
Prerequisite					
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		3	**1**	**0**	**4**

Course Objectives: The course aims to shape the attitudes of learners regarding the field of advanced Statististical techniques. Students communicate the purposes of the analyses, the findings from the analysis, and the implications of those findings.

Course Outcomes

CO1	Understand the concept of Markov chains and their application.
CO2	Understand the concept of Factor analysis and their application.
CO3	Apply the concept of Principles Component Analysis.
CO4	Understand the concept of Multivariate analysis and their application.
CO5	Understand the concept of Discriminant analysis and their application.
CO6	Understand the recent trends in multivariate analysis.

Text Book (s):

1. Johnson, D.E.: Applied Multivariate Methods for Data Analysis. Duxbury, USA, 1998.

2. Rencher, A.C.: Methods of Multivariate Analysis, John Wiley, New York, 1995.

3. Srivastava, M.S.: Methods of Multivariate Statistics, John Wiley, New York, 2002.

Reference Book (s):

1. Rohatgi, V.K., and Saleh, A.K.Md. Ehsanes (2009). An introduction to probability and statistics. Second Edition, Wiley India.

2. Introduction to the Theory of Statistics; Alexander M. Mood, Franklin A. Graybill, Duane C. Boes, Tata McGraw Hill.

Unit-1	**9 Hours**
Illustrations of stochastic processes, stochastic matrices, Markov chains: finite and countably infinite state spaces, Classification of states, strong markov property, stationary distributions, time reversible markov chains, Branching processes, ergodic and nonergodic markov chains, recurrent and transient random walk, General Markov processes in discrete and continuous state spaces.	
Unit-2	**10 Hours**
Objectives of factor Analysis, The factor Analysis Model, Factor Analysis Equations, Solving the Factor Analysis Equations, Choosing the Appropriate Number of Factors, Computer Solutions of the Factor Analysis Equations, Rotating Factors, Oblique Rotation Methods, Factor Scores.	
Unit-3	**9 Hours**
Objectives of Principal Components Analysis, Principal Components Analysis on the Variance – Covariance Matrix Σ Principal Component Scores, Component Loading Vectors, Estimation of Principal Components – Estimation of Principal Components Scores, Determining the Number of Principal Components – Method 1 & 2, PCA on the Correlation Matrix P – Principal Component Scores, Component Correlation Vectors, Sample correlation Matrix, Determining the Number of Principal Components	
Unit-4	**9 Hours**
Multivariate normal distribution and its properties, MLEs of parameters, Distribution of sample mean vector, Wishart matrix-its distribution (without derivation) and properties, Null distribution of Hotelling $\boldsymbol{T^2}$ statistic and its application (including simultaneous confidence interval), Mahonalobis $\boldsymbol{D^2}$ statistic, Union-intersection principle (application only), MANOVA (one way and two way): statement and use, Wilk's Λ criteria	
Unit-5	**8 Hours**
Discrimination for Two Multivariate Normal Populations, Cost Functions and prior Probabilities (Two Populations), A General Discriminant Rule (Two populations), Discriminant Rules (More than	

Two populations), Variable Selection Procedures, Canonical Discriminant Functions, Nearest Neighbour Discriminant Analysis, Classifications Trees. Cluster Analysis: Measures of Similarity and Dissimilarity, Graphical aids in Clustering, Clustering Methods.
Unit-6 **4 Hours**
A procedure of linear discrimination analysis with detected sparsity structure for high-dimensional multi-class classification, Testing normality of data on a multivariate grid.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Integral Equations & Calculus of Variations			
Course Code	MSCM303			
Prerequisite				
Corequisite				
Antirequisite				
	L	T	P	C
	3	1	0	4

Course Objectives: The course is aimed to lay a broad foundation for an understanding of the problems of the calculus of variations , its many methods and techniques . Also to make the students familiar with the methods of solving Integral Equations.

Course Outcomes

CO1	To classify integral equation and its relation to ordinary differential.
CO2	To understand the use of Resolvent kernels and Neumann series methods to solve the integral equation.
CO3	To demonstrate the Abel's integral equations and tantochrone problem.
CO4	To use of Laplace and Fourier transforms to solve integral equations.
CO5	To solve problems related to calculus of variations.
CO6	Apply **integral equations & calculus of variations to boundary value problems**

Text Books:

1. **R. P. Kanwal, Linear Integral Equations: Theory and technique, Academic Press, NewYork, 1971.**
2. **A. S. Gupta, Text Book on Calculus of Variation, Prentice-Hall of India, New Delhi.**

Reference Books:

1. **Harry Hochsdedt, Integral Equations, John-Wiley & Sons, Canada, 1973.**
2. **Murry R. Spiegal, Laplace Transform (SCHAUM Outline Series), McGraw-Hill, 1965.**
3. **N. Kumar, An Elementary Course on Variational Problems in Calculus, Narosa Publications, New Delhi, 2005.**

Unit-1 **8 Hours**

Classification of integral equations of Volterra and Fredholm types. Conversion of initial and boundary value problem into integral equations. Conversion of integral equations intodifferential equations (when it is possible). Volterra and Fredholm integral operators and their iterated kernels.	
Unit-2	**8 Hours**
Resolvent kernels and Neumann series method for solution of integral equations. Solving integral equations of second kind by the method of successive approximations.Fredholm integral equation of second kind with degenerated kernels.	
Unit-3	**8 Hours**
Abel's integral equations. Hilbert-transform. Cauchy type integral equations. Use of Laplace and Fourier transforms to solve integral equations. Applications of integral equations andGreen's function.	
Unit-4	**9 Hours**
Functionals, Deduction of Euler's equations for functionals of first order and higher order for fixed boundaries. Shortest distance between two non-intersecting curves. Isoperimetric problems. Jacobi and Legendre conditions (applications only).	
Unit-5	**8 Hours**
Advanced variational problems: Constraints and Lagrange multipliers, variable end points, Sturm-Liouville problems, Hamilton's principle, Lagrange's equation, the Rayleigh-Ritz method.	
Unit 6	**9 Hours**
Advance applications of integral equations & calculus of variations ,On Taylor-series expansion methods for the second kind integral equations ,Integral boundary value problems for first order integro-differential equations with impulsive integral conditions. Hybrid function method for solving Fredholm and Volterra integral equations of the second kind.	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Fluid Mechanics**				
Course Code	**MSCM321**				
Prerequisite					
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		3	**1**	**0**	**4**

Course Objectives: To give fundamental knowledge of fluid, its properties and behavior under various conditions of internal and external flows. To develop understanding about hydrostatic law, principle of buoyancy and stability of a floating body and application of mass, momentum and energy equation in fluid flow.

Course Outcomes

CO1	Know basic definition, about fluid motion, equation of continuity.
CO2	Study the irrotational motion, cyclic motions, Vortex motion, sources and sinks and some related theorems.
CO3	Study motion of circular and elliptic cylinders, theorem of Kutta and Juokowski, some special transformation,
CO4	Learn about the Source, sinks, doublets and their images with regards to a plane and sphere.
CO5	Learn about the Vortex motion in detail
CO6	Apply the various laws of energy in fluid mechanics

Text Books:

1. **A. S. Ramsay, "Hydrodynamics: A Treatise on Hydromechanics – Part II ", Bell, 1913.**
2. **L. D. Landau and E. M. Lifshitz, "Fluid Mechanics", Pergamon Press,1959.**

Reference Books:

1. **H. Lamb, "Hydrodynamics", Cambridge University Press, 1932.**
2. **L. M. MilneThomson, "Theoretical Hydrodynamics", MacMillan, 1955.**
3. **S. Swaroop, "Fluid Dynamics", Krishna Prakashan, 2000.**

Unit-1	**10 Hours**
Lagrange's and Euler's methods in fluid motion. Equation of motion and equation of continuity, Boundary conditions and boundary surface stream lines and paths of particles. Irrotational and rotational flows, velocity potential. Bernoulli's equation. Impulsive action. Equations of motion and equation of continuity in orthogonal curvilinear co-ordinates. Euler's momemtum theorem and D'Alemberts paradox.	
Unit-2	**10 Hours**
Theory of irrotational motion flow and circulation. Permanence irrotational motion. Connectivity of regions of space. Cyclic constant and acyclic and cyclic motion. Kinetic energy. Kelvin's minimum. Energy theorem. Uniqueness theorem.	
Unit-3	**8 Hours**
Complex potential, sources. sinks, doublets and their images circle theorem. Theorem of Blasius. Motion of circular and elliptic cylinders. Steady streaming with circulation. Rotation of elliptic cylinder. Theorem of Kutta and Juokowski. Conformal transformation. Juokowski transformation. Schwartz-chirstoffel theorem.	
Unit-4	**7 Hours**
Motion of a sphere. Stoke's stream function. Source, sinks, doublets and their images with regards to a plane and sphere.	
Unit-5	**8 Hours**
Vortex motion. Vortex line and filament equation of surface formed by stream lines and vortex lines in case of steady motion. Strength of a filament. Velocity field and kinetic energy of a vortex system. Uniqueness theorem rectilinear vortices. Vortex pair. Vortex doublet. Images of a vortex with regards to plane and a circular cylinder. Angle infinite row of vortices. Karman's vortex sheet.	
Unit-6	**8 Hours**
Phase transition of the energy flux in the near-inertial wave-mesoscale eddy coupled turbulence, Dust vortex flow analysis in weakly magnetized plasma, On the simulation of multicomponent and multiphase compressible flows, An Infinitesimal Quantum Group Underlies Classical Fluid Mechanics	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Fuzzy Mathematics**				
Course Code	**MSCM323**				
Prerequisite	**Set theory**				
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		3	**1**	**0**	**4**

Course Objectives: To introduce the basic mathematical concepts of the theory of fuzzy sets and its differences from crisp sets and understanding the concept of fuzzy number and its graphical representation.

Course Outcomes:

CO1	Introduce the basics of fuzzy set theory and its differences from classical set theory.
CO2	Able to understand the structure of fuzzy relation.
CO3	Get familiar with the fundamental concepts of fuzzy arithmetic with graphical representation.
CO4	Develop understanding of fuzzy logic and it's application in possibility theory.
CO5	Exposure to various application areas like control systems, decision making, image processing etc.
CO6	Introduce the recent research areas based on fuzzy set theory and fuzzy logic.

Text Book (s):

1. H.J. Zimmerman: Fuzzy Set Theory and its Application, 3rd Ed., Springer India Pvt. Ltd., 2006.

2. G. Klir and B. Yuan: Fuzzy Set and Fuzzy Logic: Theory and Applications, Prentice Hall of India Pvt. Ltd., 2002.

Reference Book (s):

1. T.J. Ross: Fuzzy Logic with Engineering Applications, 3rd Ed., Wiley India Pvt. Ltd., 2011.

2. G. Klir and T. Folger: Fuzzy Sets, Uncertainty and Information, Prentice Hall of India Pvt. Ltd., 2002.

Unit 1	**12 Hours**
Fuzzy sets and their representations, Membership functions and their designing, Types of Fuzzy sets, Operations on fuzzy sets, Convex fuzzy sets. Alpha-level cuts, Zadeh's extension principle, Geometric interpretation of fuzzy sets. Fuzzy t-norm and t-conorm.	
Unit 2	**8 Hours**
Crisp versus fuzzy relations, projections and cylindrical extensions, binary fuzzy relations, fuzzy equivalence relations, fuzzy compatibility relations, Fuzzy ordering relations, Composition of fuzzy relations	
Unit 3	**9 Hours**
Fuzzy numbers, triangular and trapezoidal fuzzy numbers, linguistic variables, arithmetic operations on intervals, arithmetic operations on fuzzy numbers, lattice of fuzzy numbers, fuzzy equations, fuzzification and defuzzification.	
Unit 4	**8 Hours**
Fuzzy propositions, Fuzzy quantifiers, Linguistic variables, Fuzzy inference, Fuzzy measures, Possibility theory, Fuzzy sets and possibility theory, Possibility theory versus probability theory.	
Unit 5	**8 Hours**

Type-2 fuzzy sets, rough sets, and Intuitionistic fuzzy sets. Applications of fuzzy sets and logics in areas of image processing, control, AI, computing with words, Decision making in Fuzzy environment.

Unit 6	**5 Hours**
An overview of Fuzzy rough set theory, Fuzzy optimization, Fuzzy topology, Fuzzy automata, Fuzzy time series analysis	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Measures theory**				
Course Code	**MSCM327**				
Prerequisite					
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		3	**1**	**0**	**4**

Course Objectives: Measure theory provides a foundation for many branches of mathematics such as harmonic analysis, theory of partial differential equations and probability theory. It is a central, extremely useful part of modern analysis, and many further interesting generalizations of measure theory have been developed. The aim of this course is to learn the basic elements of Measures and Probability Theory.

Course Outcomes

Students will be able

CO1	To understand the basic concepts of measurable sets and measurable functions
CO2	To discuss the difference between Riemann integration and Lebesgue integration,
CO3	To extend the concept of analysis in General measurable space
CO4	To explain the space of measurable function
CO5	To learn the Dual of space of measurable continuous function
CO6	To understand relation between Linear transformations and Lebesgue measure on R^n .

Text Books:

1. Royden, H.L. and Fitzpatrick, P. M., Real Analysis, 4th Edition, Pearson, 2010.

2. Barra, G. De. Measure Theory and Integration (New Age International(P) Ltd, Publishers, New Delhi 2003).

3.P. Billingsley, Probability and Measure, 3rd ed., John Wiley & Sons, New York, 1995

4.G. De Barra, Measure theory and Integration, New age international publishers, 2012

Reference Books:

1. Rana, I. K. An Introduction to Measure and Integration, 2nd edition, Narosa Publishing House India, 2000.

2. Halmos, P. R. Measure Theory, Springer-Verlag, 1974.

3. Jain, P. K. and Gupta, V. P. Lebesgue Measure and Integration, New Age International (P) Limited, New Delhi, 1986.

4.J. Rosenthal, A First Look at Rigorous Probability, World Scientific, Singapore, 2000.

5.A.N. Shiryayev, Probability, 2nd ed., Springer, New York, 1995.
6.K.L. Chung, A Course in Probability Theory, Academic Press, New York, 1974.

Unit-1	**10 Hours**
Outer measure, Lebesgue Measure and its properties, Borel sets and their measure, σ algebra of Lebesgue Measurable set, Cantor set and Cantor–Lebesgue function, Non Measurable Sets. Measurable Function,Step function, characteristic function, Simple function,Sequence of function, Sequentional pointwise limits, Littlewood's Three Priciple, Egoroff's Theorem and Lusin Theorem.	
Unit-2	**9 Hours**
Riemann integration and Lebesgue integration, Lebesgue integration of bounded measurable function and non-negative measurable function, General Lebesgue integral, General Vitali Convergence Theorem, Convergence in measure. Differentiation of Monotone function, Lebesgue's Theorem, Jordon Theorem, Absolute Continuous Function.	
Unit-3	**7 Hours**
General measurable space, Signed measure, The Han and Jordon Decompositions Theorem, the Caratheodory Han Theorem, integration of non-negative measurable function and General measurable function, The Radon Nikodym Theorem, The Vitali Han Saks Theorem.	
Unit-4	**9 Hours**
Completeness of General $L^p(X,\mu), 1 \leq p \leq \infty$, The Riesz representation theorem for Dual of $L^p(X,\mu), 1 \leq p \leq \infty$, the contorovitch Representation Theorem for Dual of $L^\infty(X,\mu)$, weak Sequential compact in $L^p(X,\mu)$, The Dunford Pettis Theorem, Product Measure, The Theorem of Fubini and Tonelli, The Lebsgue measure on Euclidean SpaceR^n, Caratheodory Outer measure and Hausdorff measure on Metric space.	
Unit-5	**10 Hours**
Locally Compact Topological Space, The Riesz Markov theorem, The Riesz Representation Theorem for Dual of C(X), Regularity properties of Bair measure, Invariant measure, The General linear group, Kakutani's fixed point theorem,Von Neumann' Theorem, The Bogoliubou- Krilov Theorem.	
Unit-6	4 hours
Rectangles in R^n and some properties,Outer measure on R^n, Properties of outer measure on R^n, Lebesgue measurable sets and Lebesgue measure on R^n, Complex measures , Completeness of product measures, Linear transformations and Lebesgue measure on R^n	

Continuous Assessment Pattern

Internal Assessment (IA)	**Mid Term Test (MTE)**	**End Term Test (ETE)**	**Total Marks**
30	**20**	**50**	**100**

Name of The Course	**Stochastic Processes**				
Course Code	**MSCM322**				
Prerequisite	**Probability Theory**				
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		3	**1**	**0**	**4**

Course Objectives: The aim of this course is to make students understand the concept of Random process and its applicability.

Course Outcomes:

CO1	Understand the concept of Random processes.
CO2	Apply the concept of Discrete time Markov Chain.
CO3	Apply the concept of Continuous time Markov Chain.
CO4	Understand the concept of Random walk, Weiner process.
CO5	Analyze the concept of Renewal process.
CO6	Identify the multidimensional random walks.

Text Book (s):

1.J. Medhi, Stochastic Processes, 3rd Edition, New Age International, 2009.

2.S.M. Ross, Stochastic Processes, 2nd Edition, Wiley, 1996.

3. Kishor S. Trivedi, Probability, Statistics with Reliability, Queueing and Computer Science Applications, 2nd edition, Wiley, 2001.

Reference Book (s):

1..Liliana Blanco Castaneda, Viswanathan Arunachalam and S. Dharmaraja, Introduction to Probability and Stochastic Processes with Applications, Wiley, 2012.

2.. S Karlin and H M Taylor, A First Course in Stochastic Processes, 2nd edition, Academic Press, 1975.

3..S. E. Shreve, Stochastic Calculus for Finance, Vol. I & Vol. II, Springer, 2004.

4. V. G. Kulkarni, Modelling and Analysis of Stochastic Systems, Chapman & Hall, 1995.

5..G. Sankaranarayanan, Branching Processes and Its Estimation Theory, Wiley, 1989

Unit-1	**10 Hours**
Definition and examples of SPs, classification ofrandom processes according to state space and parameter space, types of SPs, elementary problems, Weakly stationary and strongly stationary processes, moving average andauto regressive processes.	
Unit-2	**7 Hours**
Definition and examples of MCs, transition probabilitymatrix, Chapman-Kolmogorov equations; calculation of n-step transition probabilities, limiting probabilities, classification of states, ergodicity, stationary distribution, transient MC; random walk and gambler's ruin problem, applications.	
Unit-3:	**10Hours**
Kolmogorov- Feller differential equations,infinitesimal generator, Poisson process, birth-death process, stochastic Petri net, applications to queueing theory and communication networks. Martingales:Conditional expectations, definition and examples of martingales.	
Unit-4	**10Hours**
Wiener process as a limit of random walk; process derived from Brownianmotion, stochastic differential equation, stochastic integral equation, Ito formula, Some important SDEs and their solutions, applications to finance. Limit of Random Walk, Its Defining Characteristics and Peculiarities. Its Variations: Standard Brownian Motion, Brownian Bridge, Brownian Motion Reflected at Origin, Geometric Brownian Motion, Brownian Motion with Drift. Reflection Principle. Some Applications	
Unit-5	**8 Hours**
Renewal Processes and Renewal Limit Theorems, Statement and uses of key renewal theorem, study of residual lifetime process.Galton-Watson branching process, Markovian Branching Process.	

Unit-6	3 Hours
Patterns for recurrent events: One-dimensional, two-dimensional and three-dimensional random walks.	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Artificial Intelligence**				
Course Code	**MSCM325**				
Prerequisite	**Linear Algebra & Statistics**				
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		3	**1**	**0**	**4**

Course Objectives:

The main purpose of this course is to provide the most fundamental knowledge to the students so that they can understand AI.

Course Outcomes

CO1	Identify problems where artificial intelligence techniques are applicable
CO2	Learn different knowledge representation techniques
CO3	Participate in the design of systems that act intelligently and learn from experience
CO4	Understand the notions of state space representation, exhaustive search, heuristic search along with the time and space complexities
CO5	Possess the ability to apply AI techniques to solve problems of Game Playing, Expert Systems, Machine Learning and Natural Language Processing
CO6	Overview of Explainable Artificial Intelligence

Text Book (s)

1. Stuart Russell, Peter Norvig, “Artificial Intelligence – A Modern Approach”, Pearson Education
2. Elaine Rich and Kevin Knight, “Artificial Intelligence”, McGraw-Hill

Reference Book (s)

1. E Charniak and D McDermott, “Introduction to Artificial Intelligence”, Pearson Education
2. Dan W. Patterson, “Artificial Intelligence and Expert Systems”, Prentice Hall of India
3. Expert Systems: Principles and Programming- Fourth Edn, Giarrantana/ Riley, Thomson.
4. PROLOG Programming for Artificial Intelligence. Ivan Bratka- Third Edition – Pearson Education.
5. Neural Networks Simon Haykin PHI

Unit-1	7 Hours

Introduction to Artificial Intelligence, Foundations and History of Artificial Intelligence, Applications of Artificial Intelligence, Intelligent Agents, Structure of Intelligent Agents. Computer vision, Natural Language Possessing.	
Unit-2	**9 Hours**
Searching for solutions, Uniformed search strategies, Informed search strategies, Local search algorithms and optimistic problems, Adversarial Search, Search for games, Alpha - Beta pruning	
Unit-3	**9 Hours**
Propositional logic, Theory of first order logic, Inference in First order logic, Forward & Backward chaining, Resolution, Probabilistic reasoning, Utility theory, Hidden Markov Models (HMM), Bayesian Networks.	
Unit-4	**10Hours**
Concept and concept learning, Pattern classification and recognition, Feature vector representation of patterns, Nearest neighbor based learning, Discriminant function and decision boundary, Multi-class pattern recognition, General formulation of machine learning, The k-means algorithm.	
Unit-5:	**10 Hours**
Neural network, Model of one neuron, Learning rules for one neuron, Feature extraction/selection, Self-organizing neural network, Winner-take-all learning strategy, Learning vector quantization, R4-rule, Layered neural network,	
Unit- 6:	**4 Hours**
Overview of Explanation Methods and Transparent Machine Learning Algorithms: Reflection, Global vs. local explainability, Ante-hoc vs. Post-hoc interpretability, Ante-hoc: GAM, S-AOG, Hybrid models, iML	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

GALGOTIAS UNIVERSITY
(Established under Galgotias University Uttar Pradesh Act No. 14 of 2011)

School of Basic and Applied Sciences
Department of Life Sciences
Division of Biological Science

Program: M.Sc. Biological Science

Scheme: 2020 – 2022

Galgotias University

Vision

"To be known globally for value-based education, research, creativity and innovation"

Mission

5. **Establish state-of-the-art facilities for world class education and research.**
6. **Collaborate with industry and society to align the curriculum,**
7. **Involve in societal outreach programs to identify concerns and provide sustainable ethical solutions.**
8. **Encourage life-long learning and team-based problem solving through an enabling environment.**

School of Basic and Applied Sciences

Vision:

To be recognized globally as a center of excellence in imparting value-based education in Basic and Applied Sciences by creating innovation in fundamental and multidisciplinary research.

Mission

M1. To excel in imparting contemporary knowledge and skills by developing an educational ecosystem with diverse interests and talents.

M2. To perform cutting edge research leading to innovation in sciences through national and international collaborations.

M3. To develop solutions for the emerging challenges in Basic and Applied Science to cater the needs of society.

M4. To attract best quality faculty to facilitate knowledge and develop confidence in our graduates to succeed in the world.

Preamble of Programme:

Biological Science is regarded as the ever expanding field of science. This M.Sc. programme of three years is designed to trained explorative and innovative young mind in versatile field of Biological Science. The ultimate aim is to enable the students to develop an integrated approach for understanding the various life science problems at the molecular level. The subject of Biology can offer a wide range of employment opportunities to candidates in both private as well as government sectors. A person with a higher education degree in Biological Sciences has a great career scope. With a Master's degree in Biology, it will be easy to find lucrative jobs as Ecologist, Biochemist, Geneticist and Microbiologist, Weed Scientist, Science Adviser, Research Development, in Multinational Companies, Public Sectors, Quality Control Labs, Biopharmaceuticals companies as well as in Universities.

Scope of the Proposed Programme

The M.Sc., programme of two years is designed to help all the students to get good quality education in the field of Biological Science so that they can pursue Higher education or find employment. After M.Sc. the opportunities for students are responsible positions in technical production, planning and policy making, both in research and industry will open.

The curriculum is designed in such a way, that after their postgraduate studies, students will be able to work directly in the applied field (industry or research institute). After completing this curriculum the students will be able to take up the following responsibilities:

5. Research at national, international level.
6. Higher positions in biotech production units as Biochemist, Geneticist and Microbiologist, Weed Scientist, etc.

7. Planning and policy making for Life science.
8. Teaching at undergraduate / postgraduate level courses in Life science.

Eligibility

Graduation in Botany/ Zoology/ Biochemistry/ Biotechnology/ Microbiology/ Biomedical Sciences/ Genetics/ Medicine/ Agriculture/ Life Sciences/ Chemistry/ Pharmacy from any recognized university or equivalent examination with a minimum of 50 % marks in aggregate.

Programme Outcome:

PO1	**Apply knowledge of basic and applied sciences to the solution of complex biochemical conditions.**
PO2	**Perform experiments and researches, perform analysis and interpret data for complex biochemical conditions.**
PO3	**Identify, investigate, analyse and generate solutions for biological processes.**
PO4	**Use research-based knowledge together with design of experiments, analysis and interpretation of data, to provide valid conclusions with an understanding of their limitations.**
PO5	**Create, select and apply appropriate techniques, resources and modern science and research tools within a defined specification that meet specified needs with appropriate consideration for public health and safety.**
PO6	**Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal issues and the consequent responsibilities relevant to the professional biologist.**
PO7	**Understand the impact of professional life sciences solutions in communal and environmental contexts and demonstrate knowledge and need for sustainable development.**
PO8	**Execute responsibility professionally and ethically.**
PO9	**Function effectively as an individual, and as a member or leader in diverse resource teams.**
PO10	**Articulate ideas, comprehend and write effective reports, documentation and to communicate effectively with the basic and applied sciences community and with society at large.**
PO11	**Demonstrate knowledge and understanding of science and technical principles to manage projects in multidisciplinary research areas.**
PO12	**Seeking stimulation and to exploring numerous opportunities to engage in independent and life-long learning in the broadest context of technological change.**

Programme Educational Objectives (PEOs):

PEO1	**The graduated young minds will be ignited to understand the world of biological science concepts through application based learning.**
PEO2	**The graduates will be emphasized on applied aspects of advance biological techniques by hands-on training and to inculcate ethics and professional attitude.**
PEO3	**The graduates of Biological science will be trained for self-directed learning, recognizing, continuing educational needs in occupying positions in research, industries and related organization.**

Programme Specific Outcome (PSOs):

PSO1	**At the end of the two year programme the student will understand and be able to explain different branches of Biological Science such as Cell Biology, Molecular Biology, Microbiology, Biotechnology, Clinical and Industrial biochemistry,. The student will be able to explain about various applications of Biological Science such as Analytical techniques, Industrial Microbiology, Genetic enginnering, and Microbial Pathogenicity.**
PSO2	**Student will be able to design and execute experiments related to Basic Microbiology, Immunology, Molecular Biology, Cell Biology, Recombinant DNA Technology, and Plant physiology, and will be able to execute a short research project incorporating techniques of Biological Science under supervision. The student will be equipped to take up a suitable position in academia or industry, and to pursue a career in research if so desired.**

Programme Structure
Curriculum

Sl. No	Course Code	Name of the Course	L	T	P	C	IA	MTE	ETE
Semester I									
Sl. No	Course Code	Name of the Course					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MSDB5013	Cell Biology	3	1	0	3	30	20	50
2	MSDB5002	Molecular Biology	4	0	0	4	30	20	50
3	MSDB5004	Fundamentals of Biochemistry	4	0	0	4	30	20	50
4	MSBS5004	Ecology	0	0	0	4	30	20	50
5	MSBS5005	Advanced Biological Science Lab- I	0	0	4	2	50	-	50
6	XXXX	Soft Skills				0			
7	XXXX	Computer awareness				0			
Total Credits						17			
Semester II									
Sl No	Course Code	Name of the Course					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MSDB5006	Immunology	4	0	0	4	30	20	50
2	MSDB5007	Bioanalytical and Microbial Techniques	4	0	0	4	30	20	50
3	MSDB5008	Biotechnology and Genetic Engineering	4	0	0	4	30	20	50
4	MSDB5010	Microbiology	4	0	0	4	30	20	50
5	MSBS5014	Animal Physiology	3	1	0	3	30	20	50
6	MSBS5012	Advanced Biological Science Lab- II	0	0	4	2	50	-	50
7	XXXX	BEC (B1)				3			
8	MBS28T2111	Research Methodology	2	0	0	2	30	20	50
9	XXXX	IPR				1			
Total Credits						27			
Semester III									
Sl No	Course Code	Name of the Course					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MSDB6001	Genetics	4	0	0	4	30	20	50
2	MSBS6002	Plant Physiology	4	0	0	4	30	20	50
3	MSBS6003	Summer Training	0	0	0	2	50	--	50
4	MSBS6004	Protein Biology	4	0	0	4	30	20	50
5	MSBS6005	Evolution	4	0	0	4	30	20	50
6	MSDB60##*	Elective	3	0	0	3	30	20	50
7	MSBS6007	Advanced Biological Science Lab- III	0	0	4	2	50	-	50
8	XXX	Campus to Corporate	0	0	2	1			
Total Credits						24			
Semester IV									
Sl No	Course Code	Name of the Course					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MSBS9997	Dissertation	0	0	0	12	50	-	50
Total Credits						12			

List of Electives									
Sl No	Course Code	Name of the Electives					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MSDB6019	Computational Biology	3	0	0	3	30	20	50
2	MSDB6020	Bioethics, Bio-safety and IPR	3	0	0	3	30	20	50
3	MSDB6021	Toxicology	3	0	0	3	30	20	50
4	MSDB6022	Industrial Biochemistry	3	0	0	3	30	20	50
5	MSDB6023	Advanced Microbiology	3	0	0	3	30	20	50
6	MSDB6024	Plant –Pathogen interaction	3	0	0	3	30	20	50

SEMESTER-I

Name of The Course	**Cell biology**				
Course Code	**MSDB5013**				
Prerequisite	**Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.**				
Corequisite	**Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.**				
Antirequisite					
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

1. Students will understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles.

2. These can include responses to environmental or physiological changes, or alterations of cell function brought about by mutation.

Course Outcomes

CO1	**Identify cell types, structure, functions and cell division.**
CO2	**Demonstrate the function and structure of various cell organelles**
CO3	**Interpret the models of biological membrane and illustrate membrane biochemistry**
CO4	**Interpret the membrane biochemistry and transport of ions across the membrane.**
CO5	**Elucidate the knowledge in the area of cell aging and death**
CO6	**Evaluate the significance of cell biology**

Text Book (s)

- The Cell: A Molecular Approach (2009) 5th ed., Cooper, G.M. and Hausman, R.E., ASM Press & Sunderland (Washington DC), Sinauer Associates, MA, ISBN:978-0-87893-300-6.
- Molecular Cell Biology (2012) 7th ed., Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell. J., W.H. Freeman & Company (New York), ISBN:13:978-1- 4641-0981-2 / ISBN: 10: 1-4641-0981-8.
- Molecular Biology of the Cell (2008) 5th ed., Alberts, B., Johnson,A., Lewis, J., and Enlarge, M., Garland Science (Princeton), ISBN:0-8153-1619-4.

Reference Book (s)

- Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13: 978-1-4641-0962-1 / ISBN:10:1-4292-3414- 8.
- Molecular Biology of the Cell (2008) 5th ed., Alberts, B., Johnson,A., Lewis, J., and Enlarge, M., Garland Science (Princeton), ISBN:0-8153-1619-4.

Unit-1 introduction to cell biology (8 hours) **Introduction to the cell, its chemical composition, Cell types - organization of prokaryotic and eukaryotic cells, Plant and animal cells: variation in structure and function, cell theory, cell cycle - phases of cell cycle; cell division - mitosis and meiosis**
Unit-2 structure and function of different cell organelles (10 lectures)

Cell organelles; structure and function of endoplasmic reticulum, Golgi body, endosome, lysosome, vacuole, peroxisome, ribosome, mitochondria, chloroplast, nucleus, cytoskeleton, cell wall; subcellular fractionation; cytoplasm and cytosol, Structure of nuclear envelope, nuclear pore complex.
Unit-3 Membrane biochemistry (10 lectures) Membrane: chemical composition and its structural plan; membrane lipids; Overview of membrane protein - peripheral and integral; molecular model of cell membrane - fluid mosaic model and membrane fluidity; factors affecting the membrane fluidity.
Unit-4 Cellular communication and transport (10 lectures) Microvilli, tight junctions, epithelia, Bell and sqot desmosomes, Types of Cell Junctions; membrane transport; small molecules - passive transport, active transport by ATP powered pumps, Overview of types of transport systems and macromolecule transport: Exocytosis; Endocytosis; Pinocytosis and phagocytosis.
Unit-5 Cell cycle and cell death (08 lectures) Cell cycle regulation, Cell aging and death - necrosis and apoptosis
Unit-6 Recent advances in cell biology (04 lectures) Research article/ Review paper/ MOOC

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Molecular Biology				
Course Code	MSDB5002				
Prerequisite	Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.				
Corequisite	Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.				
Antirequisite					
		L	T	P	C
		4	0	0	4

Course Objectives:

Molecular biology deals with nucleic acids and proteins and how these molecules interact within the cell to promote proper growth, division, and development. It is a large and ever-changing discipline. This course will emphasize the molecular mechanisms of DNA replication, repair, protein synthesis etc.

Course Outcomes

CO1	Generalize the prokaryotic and eukaryotic mechanism of transcription.
CO2	Illustrate of genetic code and the process of translation.

CO3	**Interpret of protein targeting and degradation mechanism.**
CO4	**Determine the regulation of gene expression in prokaryotes and eukaryotes.**
CO5	**Evaluate the procedure of recombinant DNA technology**
CO6	**Evaluate the application of molecular biology**

Text Book (s)

- Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13: 978-1-4641-0962-1 / ISBN:10:1-4292-3414- 8.
- Molecular biology of the gene, (4^{th}ed)J D Watson, Benjamin/Cummings publ. Co Inc.
- Molecular Cell Biology (2012) 7th ed., Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell. J., W.H. Freeman & Company (New York), ISBN:13:978-1- 4641-0981-2 / ISBN:10: 1-4641-0981-8.
- Molecular Biology of the Cell (2008) 5th ed., Alberts, B., Johnson,A., Lewis, J., and Enlarge, M., Garland Science (Princeton), ISBN:0-8153-1619-4 / ISBN:0-8153-1620-8.

Reference Book (s)

- **Alberts B, Bray D, Johnson A et al. (1997) Essential Cell Biology. London: Garland Publishing.**
- **Darwin C (1859) On the Origin of Species. London: Murray.**
  - **Graur D & Li W-H (1999) Fundamentals of Molecular Evolution, 2nd edn. Sunderland, MA: Sinauer Associates.**

Unit-1 Nucleic acid structure and function (10 lectures) **Historical account of DNA discovery; Overview of flow of genetic information; DNA and RNA as genetic material; Unnatural structures of DNA; DNA topology and supercoiling. Nucleosome structure and packaging of DNA into higher order structures; Organelle genomes; chromosome diversity; Clusters and tandem repeats, Microsatellite Repeat Sequences and transposons.**
Unit-2 DNA replication, mutagenesis, DNA damage and repair mechanisms (12 lectures) **The Origin of Replication; Unwinding of DNA; Formation of the Replication Fork; The DNA Polymerase Complex; Initiation & Elongation of DNA Synthesis; Replication Exhibits Polarity; Formation of Replication Bubbles; Reconstitution of Chromatin Structure; DNA Synthesis Occurs During the S Phase of the Cell Cycle. Mutagenesis and replication fidelity; Types of Damage to DNA; DNA repair mechanisms - Mismatch repair of DNA, Base Excision-Repair, Nucleotide Excision-Repair, Double-Strand Break Repair**
Unit-3 Transcription (10 lectures) **Prokaryotic transcription- promoters, properties of bacterial RNA polymerase, steps: initiation, elongation and termination; Eukaryotic transcription- promoters, enhancer factors and properties of RNA polymerase I, II and III; Reverse transcription; Inhibitors of transcription. RNA processing, splicing, capping and polyadenylation, rRNA and tRNA processing.**
Unit-4 Genetic code, protein translation, targeting and degradation (10 lectures) **Genetic code - definition, deciphering of the genetic code, salient features of genetic code; Protein biosynthesis - initiation, elongation and termination; post-translational modifications;**

Inhibitors of protein synthesis. Intracellular protein targeting; Signal hypothesis, signal sequences, glycosylation, Targeting of protein to mitochondria, lysosomes, ER, plasma membrane, peroxisomes, chloroplast; Destruction of proteins; Protein folding.
Unit-5 Regulation of gene expression (12 lectures) **Positive and negative control; Repressor & Inducer; concept of operon- lac, ara, trp operons; attenuation, catabolite repression, autogenous regulation, lytic cycle of bacteriophage; stringent response of rRNA synthesis. Hormonal control, transcription factors, steroid receptors. DNA binding motifs in pro- and eukaryotes – Helix-turn-helix, zinc fingers, leucine zippers, helix loop helix motifs.**
Unit-6 Recent advances in molecular biology (04 lectures) **Research article/ Review paper/ MOOC**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Fundamentals of Biochemistry**				
Course Code	**MSDB5004**				
Prerequisite	**Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.**				
Corequisite	**Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.**				
Antirequisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives: The course objectives are as following -

- **Demonstrate knowledge and understanding of the molecular machinery of living cells;**
- **Demonstrate knowledge and understanding of the principles that govern the structures of macromolecules and their participation in molecular recognition;**

Course Outcomes

CO1	**Discuss the effect of water, electrolyte, acid-base balance and structure of special microbial biomolecules**
CO2	**Describe the different classes and function of carbohydrates and lipids.**
CO3	**Summarize the different classes of amino acids, proteins and nucleotides and their functions**
CO4	**Knowledge on enzymes and vitamins**
CO5	**Explain the concept of energy production in the living cell.**
CO6	**Evaluate the significance and application of fundamentals of biochemistry in life**

Text Book (s)

- Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN: 13: 978-1-4641-0962-1 / ISBN:10:1-4292-3414- 8.

- Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New York), ISBN:978-0-470-28173-4.
- Biochemistry (2011) 4th ed., Donald, V. and Judith G.V., John Wiley & Sons Asia Pvt. Ltd. (New Jersey), ISBN:978-1180-25024.

Reference Book (s)

- Berg, J. M., Tymoczko, J. L. and Stryer, L. Biochemistry. Freeman, 7th edition, 2011.
- Mathews, C. K. & Van Holde, K. E. & Ahern, K. G. Biochemistry. Addison Wesley, 4th edition, 2012.
- Wilson, K. & Walker, J. Principles and Techniques of Biochemistry and Molecular Biology. CUP, 7th edition.

Unit-1 Chemistry of life and special microbial molecules (08 lectures) Bonds: ionic bonding, Ion-dipole, covalent, H-bonds, Van der Wall's interaction, Hydrophobic and hydrophilic interactions Water as a biological solvent and its role in biological processes pH, Henderson-Hasselbalch equation, concept of buffer, strength of buffer, range of buffer, important biological buffers. Structure of Special Microbial Molecules: Peptidoglycan, bacteriorhodopsin, biphytanyl chains and lipids in archaeal cell membranes and their significance in adaptation in extreme conditions.
Unit-2 Carbohydrates and lipids (10 lectures) **Carbohydrates: Classification, basic chemical structure, monosaccharides, aldoses, and ketoses, cyclic structure of monosaccharides, steroisomerism, anomers and epimers. Sugar derivatives, deoxy sugars, amino sugars, and sugar acids. Lipids classification: Bacterial lipids, prostaglandins, structure, function, Major steroids of biological importance.**
Unit-3 Proteins and nucleic acid (10 lectures) Proteins and amino acids: Properties of amino acids, structure, confirmation and properties of proteins, metabolism of amino acids, biosynthesis and degradation – an overview. Nucleic acids: Structure and properties of purines, pyrimidine, nucleosides and nucleotides. Metabolism of purines and pyrimidine - Biosynthesis and degradation.
Unit-4 Enzymes and vitamins (08 lectures) Enzymes nomenclature, classification methods for determination of enzyme activity. Isolation and purification of enzymes. Enzyme kinetics: Effect of pH, substrate concentration, temperature and inhibitors. Isoenzymes. Competitive and non-competitive inhibition. Methods for increased microbial enzymes production and activity. Vitamins and cofactors: structure, distribution and biological properties.
Unit-5 Bioenergetics (08 lectures) Laws of thermodynamics, entropy, enthalpy, free energy, free energy and equilibrium constant, Gibbs free energy equation, determination of free energy of hydrolytic and biological oxidation reduction reactions, under standard and non-standard conditions, high energy compounds, coupled reactions, determination of feasibility of reactions. ATP and other different groups of high energy phosphate compounds.
Unit-6 Recent advances in fundamentals of biochemistry (04 lectures)

Research article/ Review paper/ MOOC

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Ecology**				
Course Code	**MSBS5004**				
Prerequisite	**Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.**				
Corequisite	**Students should have understanding of general biology, including a basic knowledge of biological systems and interaction with the environment.**				
Antirequisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives:

Ecology is "the scientific study of the distribution and abundance of organisms and the interactions that determine distribution and abundance". It is a tremendously diverse field of study, reflecting the incredible diversity of life, as well as the many types and levels of interactions that influence organisms.

Course Outcomes

CO1	**Describe the concepts of ecology.**
CO2	**Explain the different components of Ecosystem.**
CO3	**Describe the fundamentals of population ecology**
CO4	**Discuss about community and Ecosystem Ecology**
CO5	**Explain the different type of bioremediation process.**
CO6	**Evaluate the application of ecology in research.**

Text Book (s)

- Colinvaux, P. A. (1993). Ecology. II Edition. Wiley, John and Sons, Inc.
- Krebs, C. J. (2001). Ecology. VI Edition. Benjamin Cummings.
- Odum, E.P., (2008). Fundamentals of Ecology. Indian Edition. Brooks/Cole
- Ricklefs, R.E., (2000). Ecology. V. Edition. Chiron Press.

Reference Book (s)

- Basic Ecology: E. P. Odum, Indian Edition. Brooks/Cole
- P. D. Sharma Ecology and Environment, Rastogi publications, india.
- R. H. Whittaker, Communities and Ecosystems, New York and London: Macmillan Publishing Co. Inc., 1975. Second edition. Octavo, pp xx, 385.

Unit-1 Concepts of Ecology (08 lectures)
Introduction to ecology, evolutionary ecology, environmental concepts – laws and limiting factors, ecological models. Characteristics of population, population size and exponential growth, limits of population growth, population dynamics, life history pattern, fertility rate and age structure. Competition and coexistence, intraspecific and inter-specific interactions,

scramble and contest competition model, mutualism and commensalism, prey-predator interactions.
Unit-2 Ecosystem, Biome, Biosphere and Ecosphere (08 lectures) Physical environment; biotic environment; biotic and abiotic interactions. Abiotic Factors: Laws of limiting factors- Liebig's law of minimum and Shelford's law of tolerance. A brief account of light and temperature as limiting factors, soil types and soil erosion.
Unit-3 Population Ecology (12 lectures) Population density, natality, mortality, life tables, fecundity tables, survivorship curves, Exponential/Malthusian and Sigmoid growth patterns, Verhulst-Pearl growth equation, 'r' and 'k' strategies. Population Growth regulation;Intrinsic mechanism- Density dependent fluctuations and oscillations, Extrinsic mechanism- Density independent, environmental and climatic factors, population interactions- types in a tabular form with examples. Niche concept, Gause's principle of competitive exclusion with laboratory and field examples, Lotka Volterra Equation for prey predator interaction, functional and numerical responses of prey and predator
Unit-4 Community and Ecosystem Ecology (12 lectures) Nature of communities; community structure and attributes, community stratification, ecotone/edge effect, succession, stages of primary succession, climax community. Ecosystem structure; ecosystem function; energy flow and mineral cycling (C,N,P); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, eustarine). Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis. Major terrestrial biomes; theory of island biogeography; biogeographical zones of India.
Unit-5 Bioremediation (10 lectures) Major classes of contaminants. Uptake, biotransformation, detoxification, elimination and accumulation of toxicants. Factors influencing bioaccumulation from food and trophic transfer. Pesticides and other chemical in agriculture, industry and hygiene and their disposal. Impact of chemicals on biodiversity of microbes, animals and plants. Bioindicator and biomarkers of environmental health. Biodegradation and bioremediation of chemicals.
Unit-6 Recent advances in ecology (04 lectures) Research article/ Review paper/ MOOC

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Advance Biological Science Lab – I
Course Code	MSBS5005
Prerequisite	Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.
Corequisite	Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics,

	regulation, structure/function, interaction with the environment, and evolution.				
Antirequisite					
		L	**T**	**P**	**C**
		0	**0**	**4**	**2**

Course Objectives:

- Supporting or strengthening theoretical knowledge.
- Experiencing the pleasure of discovery and development of their psycho-motor skills.
- Teaching how scientific knowledge may be used in daily life.
- Increasing creative thinking skills.
- Gains in scientific working methods and higher order thinking skills.
- Developing manual dexterity by using tools and equipment and allowing students to apply skills instead of memorizing.

Course Outcomes

CO1	**Display the various GLP with basic concentration problems**
CO2	**Construct various buffer solutions.**
CO3	**Handle extraction of enzymes using different sources**
CO4	**Measures the various factors affecting enzyme activity.**
CO5	**Perform the analysis of carbohydrates, Lipids and protein**
CO6	**Evaluation in research advances in laboratory experiments**

Text Book (s)

- Myer's and Koshi's Manual of Diagnostic Procedures in Medical Microbiology and Immunology / Serology. Published by Department of Clinical Microbiology, CMC and Hospital, Vellore, Tamil Nadu. 2001.
- Kalaichelvan PT. Microbiology and Biotechnology – A Laboratory Manual 1st Edition, MJP Publishers, A Unit of Tamil Nadu Book House, Chennai. 2005.

Reference Book (s)

- Chellam Rajamanicam – Experiments Protocols in Basic Molecularbiology. Osho Scientific Publications, Madurai.
- Teresa Thiel, Shirley Bissen & Eilence M Lyons. Biotechnology – DNA & Protein – A laboratory project in Molecular biology. International edition, published by Tata Mc. Graw – Hill publishing company, 2002.

S.N.	Name of Practicals
1.	**Introduction to Biological science Laboratory**
2.	**Brief review of analytical chemistry**
3.	**Hydrogen ion concentration and preparation of Buffer**
4.	**Diffusion and Osmosis**
5.	**General Tests for Carbohydrates**
6.	**General Tests for Lipids**
7.	**General Tests for Proteins**
8.	**Salivary amylase activity**
9.	**Isolation of enzyme**
10.	**Effect of pH on enzyme activity**
11.	**Effect of temperature on enzyme activity**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
50	0	50	100

SEMESTER-II

Name of The Course	Immunology				
Course Code	MSDB5006				
Prerequisite	Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.				
Corequisite	Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.				
Antirequisite					
		L	T	P	C
		4	0	0	4

Course Objectives:

- The students will be able to identify the cellular and molecular basis of immune responsiveness.
- The students will be able to describe the roles of the immune system in both maintaining health and contributing to disease.
- The students will be able to describe immunological response and how it is triggered and regulated.

Course Outcomes

CO1	Explain the basic concepts of Immunology.
CO2	Describe the working of adaptive immune response.
CO3	Demonstrate the types of vaccines and different immunological techniques.
CO4	Illustrate the genetic basis of immunology, transplant and tumor immunology.
CO5	Discuss the various types of immune system disorder
CO6	Evaluation of latest research and application of immunology against various diseases

Text Book (s)

- Immunology, 6th edition, (2006), J. Kuby et al, W.H. Freeman and Company, New York. ISBN-13: 978-1429202114.
- Roitt‟s Essential Immunology, 12th edition, (2011), Wiley-Blackwell Science. ISBN-13: 978-1405196833.
- Cellular and Molecular Immunology, 7th edition, (2011). Abul K. Abbas, Andrew H. Lichtman, Shiv Pillai. Saunders. ISBN-13: 978-1437715286.

Reference Book (s)

- Immunology, 6th edition, (2006), J. Kuby et al, W.H. Freeman and Company, New York. ISBN-13: 978-1429202114.
- Cellular and Molecular Immunology, 7th edition, (2011). Abul K. Abbas, Andrew H. Lichtman, Shiv Pillai. Saunders. ISBN-13: 978-1437715286.

Unit-1 Basic concepts of immunology (08 lectures)
Types of immunity; organs and cells involved in immune system; Antigen, haptens, adjuvants, antigenicity, antigenic determinants and epitopes;Antibodystructure and functions; Theories of antibody formation; Antibody diversity.

Unit-2 Complement system and adaptive immune response (10 lectures)

Complement system - components, nomenclature, activation of complement, complement receptors and alternate pathway; Antigen recognition - T cell and B cell receptor complexes, antigen processing and presentation; Interaction of T and B cells; Cytokines; Immunological memory; Cytotoxicity - immunotolerance, immunosuppression; Basic concepts of abzymes, immunotoxin, chimera, hybrid antibodies, antigen-antibody interactions

Unit-3 Vaccines and immunological techniques (10 lectures)

Vaccines - Types and their characteristics; Immunization practices-immunoprophylaxis and immunotherapy. Immunological techniques - Affinity and avidity, cross reactivity, precipitation, agglutination, immunodiffusion, immunoelectrophoresis, ELISA (indirect, sandwich, competitive, chemiluminescence, and ELISPOT assay), immunofluorescence, flow cytometry and fluorescence, and immunoelectron microscopy.

Unit-4 Genetic basis of immunology, transplantation and tumor immunology

(10 lectures)

Major Histocompatibility Complex - Organization of MHC and inheritance in humans, concepts of polygeny and polymorphism with respect to MHC; Histocompatibility testing; Transplantation - types, genetics of transplantation, graft versus host reactions; Tissue matching and immuno suppressive agents; Tumor immunology - immune surveillance, tumor antigens, immune response to tumors, immunotherapy of tumors.

Unit-5 Dysfunctions of the immune system (10 lectures)

Hypersensitivity - definition and classification, mechanism involved, diagnosis and treatment; Autoimmunity and autoimmune diseases - mechanism of development, diagnosis and treatment; Immunodeficiency disorders-B cell deficiencies, T cell deficiencies, secondary immunodeficiency diseases-pathogenesis, diagnosis and treatment of AIDS.

Unit-6 Recent advances in immunology (04 lectures)

Research article/ Review paper/ MOOC

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Bioanalytical and Microbial Techniques				
Course Code	MSDB 5007				
Prerequisite	Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.				
Corequisite	Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.				
Antirequisite					
		L	T	P	C
		4	0	0	4

Course Objectives:

- To provide the knowledge of the scientific instruments in life sciences and biotechnology along with the applications.
- This will enable the students to understand all the subjects of biological sciences as these tools and techniques will be used therein.
- Also acquire the basic knowledge of the microbiological techniques to be applied in the laboratory.
- To know the general microbiological techniques for isolation of pure cultures of microorganisms.

Course Outcomes

CO1	**Demonstrate the basic principles, working and applications of different microscopic techniques.**
CO2	**Demonstrate the principle and applications of centrifugation technique.**
CO3	**Illustrate the principle and functioning of electrophoresis and chromatography.**
CO4	**Evaluate the different types of spectroscopic techniques**
CO5	**Deduce fundamental concept of radioactivity and radioisotopic techniques**
CO6	**Evaluate the application of Bioanalytical and microbial techniques in various aspects**

Text Book (s)

- Physical Biochemistry: Principles and Applications (2010) 2nd ed., Sheehan, D., Wiley Blackwell (West Sussex), ISBN:978-0-470-85602-4 / ISBN:978-0-470-85603-1.
- Physical Biochemistry: Applications to Biochemistry and Molecular Biology (1982) 2nd ed., Freifelder, D., W.H. Freeman and Company (New York), ISBN:0-7167-1315-2 / ISBN:0-7167-1444-2.
- An Introduction to Practical Biochemistry (1998) 3rd ed., Plummer D. T., Tata McGraw Hill Education Pvt. Ltd. (New Delhi), ISBN:13: 978-0-07-099487-4 / ISBN:10: 0-07-099487-0.

Reference Book (s)

- Principles and techniques of biochemistry and molecular biology. 6th ed. Wilson, Keith, Walker, John M Cambridge; New York : Cambridge. ISBN-10: 9780521178747.
- An Introduction to Practical Biochemistry (1998) 3rd ed., Plummer D. T., Tata McGraw Hill Education Pvt. Ltd. (New Delhi), ISBN:13: 978-0-07-099487-4 / ISBN:10: 0-07-099487-0

Unit-1 Microscopy (08 lectures) **Light, electron (scanning and transmission), phase contrast, fluorescence microscopy, freeze-fracture technique, specific staining of organelles or marker enzymes.**
Unit-2 Viscosity and centrifugation (10 lectures) **Viscosity – Viscosity of macromolecules, relationship with conformational changes; Centrifugation – Principles of centrifugation, concepts of RCF, different types of instruments and rotors, preparative, differential and density gradient centrifugation, analytical ultra-centrifugation, determination of molecular weights and other applications, subcellular fractionation.**
Unit-3 : Electrophoresis and chromatography (08 lectures) **Electrophoresis - Moving boundary and zonal electrophoresis, paper and gel electrophoresis, isoelectric focusing; Chromatography -Principles of partition chromatography, paper, thin layer, ion exchange and affinity chromatography, gel permeation chromatography, HPLC and FPLC.**
Unit-4 Spectroscopy (08 lectures)

Spectroscopy - Concepts of spectroscopy, Visible and UV spectroscopy, Laws of photometry. Beer-Lambert's law, Principles and applications of colorimetry; Basic concepts and applications of MS, ORD, CD, X-ray diffraction, X-ray absorption, NMR.
Unit-5 Radioisotopic techniques (08 lectures) **Nature of radioactivity, properties of α-, β-, and γ-rays; measurement of radioactivity, use of radioisotopes in research. In vivo and in vitro labeling techniques, double labeling, quenching, internal standard, channel ratio, external standard ratio, emulsion counting, radioactive decay, autoradiography.**
Unit-6 Recent advances in bioanalytical and microbial techniques (04 lectures) **Research article/ Review paper/ MOOC**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Biotechnology and Genetic Engineering**				
Course Code	**MSDB 5008**				
Prerequisite	**Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.**				
Corequisite	**Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.**				
Antirequisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives:

The objective of the course is to familiarize the students with the basic concepts in genetic engineering; to acquaint the students to versatile tools and techniques employed in genetic engineering and recombinant DNA technology; and to appraise them about applications genetic engineering.

Course Outcomes

CO1	**Interpret the basic concept of animal and plant biotechnology using animal and of plant cell culture.**
CO2	**Demonstrate the isolation, purification of nucleic acid Construction DNA library and DNA sequencing.**
CO3	**Illustrate the various Gene transfer techniques.**
CO4	**Evaluate the concept of plant genetic Engineering, PCR and application of transgenic science in plant and animal improvement.**
CO5	**Analysis of gene therapy and stem cell therapy.**
CO6	**Evaluate the application of Biotechnology and genetic engineering in research and deployment**

Text Book (s)

- Principles of Gene Manipulations 1994 by Old and Primrose Blackwell Scientific Publications.
- DNA Cloning: A Practical Approach by D.M. Glower and B.D. Hames, IRL Press, Oxford. 1995.
- Molecular Biotechnology 2nd Edition by S.B. Primrose. Blackwell Scientific Publishers, Oxford. 1994.

- Genetic Engineering and Introduction to Gene Analysis and Exploitation in Eukaryotes by S.M. Kingsman and A.J. Kingsman, Blackwell Scientific Publications, Oxford 1998.

Reference Book (s)

- PCR Technology - Principles and Applications for DNA Amplification by Henry A. Erlich (Ed.) Stockton Press. 1989.
- Biotechnology: A Guide to Genetic Engineering by Peters.
- Genetic Engineering – 2000 by Nicholl.
- Recombinant DNA and Biotechnology: Guide for Teachers. 2nd Edition by Helen Kreuz. 2001. ASM Publications.
- Molecular Biotechnology: Principles and Applications of Recombinant DNA. 2 nd Edition. 1998 by Bernard R. Glick and Jack J. Pastemak, ASM Publications.

Unit-1 Introduction to animal and plant biotechnology (08 lectures) **Basic introduction to animal and plant biotechnology; types of plant tissue culture, germplasm conservation, Animal Biotechnology - organ culture; cell culture and initiation of cell culture; evolution of continuous cell lines.**
Unit-2 Construction of DNA libraries (08 lectures) **Isolation and purification of nucleic acid (genomic/plasmid DNA and RNA), Quantification and storage of nucleic acids, Construction ofcDNA library, Construction of Genomic library, Screening and preservation of DNA libraries, DNA Sequencing and cloning strategies.**
Unit-3 Gene transfer techniques (06 lectures) **Gene transfer techniques: biological methods; chemical methods; physical or mechanical methods.**
Unit-4 Transgenics (10 lectures) **Plant Genetic Engineering: Restriction enzymes; Transformation of plant cells; different type of vectors including viral vectors and their benefits; Screening and selection of transformants, PCR and hybridization methods; Transgene selection and silencing; Generation and maintenance of transgenic plants, Bt cotton, golden rice and some others as examples; Application of transgenic science in plant and animal improvement.**
Unit-5 Gene therapy and stem cell (08 lectures) **Gene therapy: Introduction and Methods, Gene targeting and silencing, Gene therapy in the treatment of diseases, Challenges, future and ethical considerations in human gene therapy. Stem cells: Culture, identification, maintenance, characterization and proliferation heterogeneity.**
Unit-6 Recent advances in biotechnology and genetic engineering (04 lectures) **Research article/ Review paper/ MOOC**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks

30	20	50	100

Name of The Course	**Microbiology**				
Course Code	**MSDB5010**				
Prerequisite	**Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.**				
Corequisite	**Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.**				
Antirequisite					
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

- Knowledge on Landmark discoveries in Microbiology and different domains classification of living organisms.
- Familiarity with general characters of prokaryotic and Eukaryotic microorganisms for conventional and molecular characterization using modern methods.
- Knowledge of cellular organization, life cycle and economic importance of prokaryotic (Eubacteria, Archaea, Cyanobacteria) and Eukaryotic (Algae, Fungi and protozoans).

Course Outcomes

CO1	**Discuss about history, diversity and scope of microbiology.**
CO2	**Explain microbial nutrition, growth and control of microorganism.**
CO3	**Describe microbial molecular biology and genetics.**
CO4	**Demonstrate viruses and microbial pathogenicity.**
CO5	**Interpret various applications of food and industrial microbiology.**
CO6	**Evaluate the application of microbiology for human welfare.**

Text Book (s)

- Prescott & Dunn's Industrial Microbiology. Ed. E.G. Reed (1987). CBS Publishers, New Delhi.
- Biotechnology: A Text book of Induxctrial Microbiology 2nd Edition. Crueger, W. and Cruger, A. (2000) Panima Publishing Corporation, New Delhi.
- Manual of Industrial Microbiology and Biotechnology 2nd Edition. Ed. Arnold L. Demain and Julian E. Davies (1999) ASM Press Washington D.C.
- Microbiology, Pelczar Jr. M.J.: Chan E.C.S. and Krieg, N. R. (1993) Tata Mc. Graw Hill, New Delhi.

Reference Book (s)

- Prescott & Dunn's Industrial Microbiology. Ed. E.G. Reed (1987). CBS Publishers, New Delhi.
- Biotechnology: A Text book of Induxctrial Microbiology 2nd Edition. Crueger, W. and Cruger, A. (2000) Panima Publishing Corporation, New Delhi.

Unit-1 History, diversity and scope of microbiology (10 lectures) **Discovery of microorganisms, spontaneous generation, germ theory of disease, members of the microbial world, scope and relevance of microbiology, Microbial taxonomy and phylogeny, Archaea, Bacteria, fungi, slime molds, water molds, algae, protozoa, helminths, the future of microbiology.**
Unit-2 Microbial nutrition, growth and control (12 lectures)

Microbial nutrition; culture media; isolation and cultivation of pure cultures, bacterial growth curve and measurement of growth; staining techniques, differences between Gram-positive and Gram-negative bacteria, Control of microorganism by physical and chemical agents. antimicrobial agents: structure and mechanisms.
Unit-3 Microbial molecular biology and genetics (12 lectures) **Structure and function of the genetic material, identification and isolation of bacterial mutants; bacterial and phage genetics; DNA repair, microbial recombination and bacterial plasmids, transposable elements, gene transfer in bacteria: conjugation, transformation and transduction.**
Unit-4 Viruses and microbial pathogenicity (08 lectures) **The Viruses: Introduction and general characteristics, the bacteriophages, viruses of eukaryotes. Pathogenicity of microorganisms, diseases caused by viruses, bacteria, fungi and protozoa.**
Unit-5 Food and industrial microbiology (08 lectures) **Microbiology of food, food processing and preservation, probiotic and prebiotic, applied and industrial microbiology: major products of industrial microbiology.**
Unit-6 Recent advances in microbiology (04 lectures) **Research article/ Review paper/ MOOC**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Animal Physiology**				
Course Code	**MSBS5014**				
Prerequisite	**Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.**				
Corequisite	**Students should have understanding of general biology, including a basic knowledge of the Animal physiology interaction with the environment.**				
Antirequisite					
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

- The major aims of this course are to provide students with a basic understanding of the fundamental processes and mechanisms that serve and control the various functions of the body.
- It should be noted that, although introductory, this course in Human Physiology is comprehensive in scope. Areas treated in detail include both relatively simple cellular mechanisms as well as more complex interactions between whole organ systems.
- The major areas of study include excitable tissues, muscle, blood, the cardiovascular system and neurophysiology.

- To learn to properly and safely use animals and modern laboratory equipment to conduct research.

Course Outcomes

CO1	**Explain blood circulation and cardiovascular system**
CO2	**Describe respiratory system.**
CO3	**Discuss about Nervous system**
CO4	**Explain digestive system**
CO5	**Describe endocrinology and reproductive system**
CO6	**Evaluate the application of animal physiology in understanding their systems**

Text Book (s)

- Guyton A.C, Hall J.E, Textbook of Medical Physiology, 11th Ed., Saunders Company, 2005.
- Widmaier E. P, Raff H, Strang K. T. Vander's, Human Physiology : The mechanism of Body Function, 9th Ed. Mc. Graw Hill, 2003.
- Ganong W. E, Review of Medical Physiology, 21st Ed., Mc. Graw Hill, 2003.
- Reddy, P. (2015). Dr.P.B.Reddy's TEXT BOOK OF ANIMAL PHYSIOLOGY. 10.13140/RG.2.1.4807.9441.
- P.S. Verma, V.K. Agarwal and B.S. Tyagi (2000). Anima Physiology by S. Chand Publication, India.

Reference Book (s)

- Reddy, P. (2015). Dr.P.B.Reddy's Text Book of Animal Physiology. 10.13140/RG.2.1.4807.9441.
- P.S. Verma, V.K. Agarwal and B.S. Tyagi (2000). Anima Physiology by S. Chand Publication, India.

Unit-1 Blood Circulation and Cardiovascular System (12lectures) **Blood Corpuscles, haemopoiesis and formed elements, plasma function, blood volume, blood volume regulation, blood groups, haemoglobin, immunity, haemostasis. Comparative anatomy of heart structure, myogenic heart, specialized tissue, ECG-its principle and significance, cardiac cycle, heart as a pump, blood pressure, neural and chemical regulation.**
Unit-2 Respiratory System (08 lectures) **Comparison of respiration in different species, anatomical considerations, transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration.**
Unit-3 Nervous System (10 lectures) **Neurons, action potential, gross neuro anatomy of the brain and spinal cord, central and peripheral nervous systems, neural control of muscle tone and posture. Vision, Hearing and Tactile response**
Unit-4 Digestive System (12 lectures) **Comparative physiology of excretion, kidney, urine formation, urine concentration, waste elimination, micturition, regulation of water balance, acid-base balance, Renin-Angiotensin System, Digestion: absorption, energy balance, BMR.**
Unit-5 Endocrinology and reproduction (08 lectures) **Endocrine glands: basic mechanism of hormone action, hormones and diseases; Reproductive processes, Neuroendocrine regulation.**

Unit-6 Recent advances in animal physiology (04 lectures) **Research article/ Review paper/ MOOC**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Research Methodology				
Course Code	MBS28T2111				
Prerequisite	Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.				
Corequisite	Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.				
Antirequisite					
		L	T	P	C
		2	0	0	2

Course Objectives:

The primary objective of this course is to develop a research orientation among the students and scholars and to acquaint them with fundamentals of research methods. Specifically, the course aims at introducing them to the basic concepts used in research and to scientific social research methods and their approach. It includes discussions on sampling techniques, research designs and techniques of analysis.

Course Outcomes

CO1	Understand the Principles of Scientific Research and different steps involved in doing research.
CO2	Know how to design research and frame up different steps in design.
CO3	Appraise the application of sampling through statistics.
CO4	Build up the method for data collection and analyse the data.
CO5	Develop the Concept of hypothesis preparation.
CO6	Develop the statistical analysis indulges in modern research for drug designing.

Text Books:

25. K. Ramakant; Elementary Statistics in a world of applications, Goodyear California Pub. Co.,1979.
26. K. D. Broota, Experimental designs in psychological research, Wiley eastern, New York, 1992.
27. Guilford, Statistics in Psychology and Education, McGraw hill, New York, 1986.
28. Katz and Kahn, Research in Behavioural Sciences, Methuen, USA, 1979.

Reference Books:

28. Kerlinger, F., Foundations of Behavioural Research, Surjeet Publications, Delhi, 1983.
29. Rajamanickam, M., Statistical Methods in Psychological and Educational Research, Concept Publishing Co. New Delhi, India, 1983.
30. Smith, Jonathan, A. (Ed.), Qualitative Psychology: A Practical Guide to Research Methods, Sage Publications, 2003.
31. Woodworth and Schlosberg, Experimental Psychology, Methuen and co. ltd, London, 1971.

32. Chanin Nantasenamat, Chartchalerm Isarankura-Na-Ayudhya, Thanakorn Naenna, Virapong Prachayasittikul, A Practical Overview of Quantitative Structure- Activity Relationship. EXCLI Journal 2009;8:74-88.
33. Wiktor Pronobis, Alexandre Tkatchenko, and Klaus-Robert Muller, J. Chem. Theory Comput. 2018, 14, 2991−3003
34. Leo, A., & Hoekman, D. H. (1995). *Exploring QSAR*. American Chemical Society.

Unit-1 Principles of Scientific Research (6 hours) Research and research methodology, Procedures in research, Identification of the problem - Literature survey - Reference collection - Familiarity with ideas and concept of investigation - Qualitative and Quantitative analysis - Results - Synopsis writing - Art of writing a Research paper and Thesis.
Unit-2 : Research Design, Sampling & Probability (5 hours) Research Design: Features of a Good Design, Different Research Designs, Sampling: Principles, methods, types of sampling, rationale for using a particular sampling procedure, Probability: Classical definition of Probability.
Unit-3 Data collection & analysis (6 hours) Types of Data, Collection of Data, double blind procedures, incidence and prevalence studies, Data Analysis: Measures of Central Tendency, Measures of Dispersion, Measures of Asymmetry
Unit-4 Correlation and Regression (5 hours) Methods of correlation, Types of correlation (Pearson r& Rho); Regression analysis, linear regression, Non-linear regression.
Unit-5 Hypothesis and Statistics (5 hours) Hypothesis Testing: Problems and hypothesis, variables and type of variables, Parametric and nonparametric statistics; level of significance, the various nonparametric tests with sample.
Unit-6 Recent research advances (4 hours) Descriptors, Quantitative structure-activity relationship (QSAR), Quantitative structure-property relationship (QSPR), Drug designing.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Advanced Biological Science Lab – II				
Course Code	MSBS5012				
Prerequisite	Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.				
Corequisite	Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.				
Antirequisite					
		L	T	P	C
		0	0	4	2

Course Objectives:

- This will enable the students to understand all the subjects of biological sciences as these tools and techniques will be used therein.
- Also acquire the basic knowledge of the microbiological techniques to be applied in the laboratory.
- To know the general microbiological techniques for isolation of pure cultures of microorganisms.

Course Outcomes

CO1	**Display the various methods of sterilization.**
CO2	**Construct various culture media.**
CO3	**Handle pure culture techniques.**
CO4	**Perform the isolation and estimation of DNA, RNA.**
CO5	**Perform the blood grouping, agglutination inhibition Assay.**
CO6	**Evaluate the application of metabolism of biomolecule in understanding of various pathway of biomolecule**

Text Book (s)

- Aneja KR. Experiments in Microbiology, Plant pathology and Biotechnology. 4th Edition, New Age International Publishers, Chennai. 2005.
- Horold J Benson. Microbiological Applications. Laboratory Manual in General Microbiology. 7th International Edition, WCB McGraw – Hill, Boston. 1998 .
- James G Cappuccino & Natalie Sherman Microbiology: A Laboratory manual. 6th Edition, Published by Pearson Education. 2004 .
- Dubey RC and Maheswari DK. Practical Microbiology 1st Edition, S. Chand & Company Ltd., New Delhi. 2004

Reference Book (s)

- James G Cappuccino & Natalie Sherman Microbiology: A Laboratory manual. 6th Edition, Published by Pearson Education. 2004 .
- Dubey RC and Maheswari DK. Practical Microbiology 1st Edition, S. Chand & Company Ltd., New Delhi. 2004

S.N.	Name of Practicals
1.	To study different methods of sterilization.
2.	To preparation different types of culture media liquid, solid, slant and plate.
3.	Bacterial culture: establishing a pure culture; Spread plate, streak plate; Pour Plate.
4.	To perform Gram staining for identification of bacteria.
5.	To estimate the concentration of protein in given sample.
6.	To perform immuno-diffusion by Ouchterlony/ Mancini method.
7.	To perform ELISA experiment for elucidating antigen-antibody interaction.
8.	To determine the effect of exercise on heart rate in human.
9.	To determine the effect of physical exercise on the circulation
10.	To study the effect of cold (vasoconstriction) on blood pressure.
11.	To demonstrate knee-jerk reflex.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
50	00	50	100

SEMESTER-III

Name of The Course	Genetics				
Course Code	MSDB6001				
Prerequisite	Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.				
Corequisite	Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.				
Antirequisite					
		L	T	P	C
		4	0	0	4

Course Objectives:

The objective of the course is to familiarize the students with the basic concepts in genetic engineering; to acquaint the students to versatile tools and techniques employed in genetic engineering and recombinant DNA technology; and to appraise them about applications genetic engineering.

Course Outcomes

CO1	Describe the basic concept of "Mendelian Genetics"
CO2	Evaluate the mechanism of co-dominance, epistasis
CO3	Illustrate the process of Linkage and crossing over.
CO4	Explain different types of genetic disorders
CO5	Analyse the effect of natural selection on population genetics.
CO6	Evaluate the application of genetics in improvement of animal, plant and human races development and treatment of various disease

Text Book (s)

- Benjamin A. Pierce. 2003. Genetics: A Conceptual Approach. W.H, Freeman and Company, New York.
- NY. Gardner E.J., Simmons, M.J., and Snustad, D.P. 1991. Principles of Genetics, (8th edition) John Wiley & Sons Inc., New York.
- Griffith A.F. J., Miller, J.H, Suzuki, D.T., Lewontin, R.C., Geibart. W.M, 1993. An Introduction to Genetic analysis (7th edition). W.H Freeman & Company, New York.

Reference Book (s)

- 1. NY. Gardner E.J., Simmons, M.J., and Snustad, D.P. 1991. Principles of Genetics, (8th edition) John Wiley & Sons Inc., New York.
- Griffith A.F. J., Miller, J.H, Suzuki, D.T., Lewontin, R.C., Geibart. W.M, 1993. An Introduction to Genetic analysis (7th edition). W.H Freeman & Company, New York.

Unit-1 1 Introduction to Mendelian Genetics (08 lectures)
Genetic terminology: Definition of genetics, Gene, Alleles, Homozygous and Heterozygous, Genotype and Phenotype, Dominant and recessive, Mendelian Laws of inheritance: Law of Dominance, Law of segregation, Law of independent Assortment. Results of Genetic crosses by

various methods including Test cross and Back cross, Difference between complementary gene and duplicate gene.
Unit-2 Deviations from Mendelian Genetics (12 lectures) **Codominance, incomplete dominance, gene interactions: Epistasis, Dominant epistasis and recessive Epistasis or supplementary gene, Multiple alleles, Lethal alleles, Cytoplasmic inheritance, Genomic imprinting in mice, human disorders related to imprinting, Prader Willi and Angelmen syndrome, Molecular basis of Epigenetic regulation in H19 and Igf2 region, histone modification marks, Position effect variegation., penetrance and expressivity, probability.**
Unit-3 Linkage and crossing over (10 lectures) **Genetic linkage and gene mapping, Linkage group, Recombination, Crossing over, Determination of frequency of crossing over, calculation of Map distance, Chromosomal basis of Sex determination, Genetic balance theory of Sex determination, sex linked inheritance, Sex Influenced inheritance, Sex limited inheritance, Pleiotropy, Phylogentic tree**
Unit-4 Chromosomal Aberration (10 lectures) **Chromosomal anomalies including autosomal and sex chromosomal, genetic disorders; Albinism, phenylketonuria, alkaptonuria, Types of mutations i.e. point mutations, deletions, rearrangements, insertions, dynamic mutations (repeat expansions) with appropriate examples.**
Unit-5 Population Genetics (10 lectures) **Definition, aim and scope of population genetics, population structure, factors maintaining population boundaries, effective breeding size, gene pool, Hardy-Weinberg equilibrium, Deviation of the Hardy-Weinberg Law, Human polymorphism (transient and balanced), relationship between sickle cell polymorphism and malaria, other ploymorphisms that may be an adaptation to malaria eg: G6PD deficiency. Duffy blood groups, thalassemia and haptoglobins. X linked polymorphism (G6PD and colour blindness).**
Unit-6 Recent advances in genetics (04 lectures) **Research article/ Review paper/ MOOC**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Plant Physiology**				
Course Code	**MSBS6002**				
Prerequisite	**Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.**				
Corequisite	**Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.**				
Antirequisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives:

Plant physiology is the study of how plants function. In this course we will explore the link between form and function in plants. This course is designed to survey contemporary aspects of plant physiology with emphasis on recent research progress in related fields. Topics covered plant water relations water transport, mineral nutrition, carbon and nitrogen metabolism (photosynthesis, respiration, and N assimilation), plant growth and development.

Course Outcomes

CO1	**Describe the basic of plant physiology**
CO2	**Evaluate the mechanism of photophosphorylation.**
CO3	**Describe the process of respiration in plant**
CO4	**Explain Nitrogen metabolism in plants**
CO5	**Illustrate the procedure of tissue culture**
CO6	**Evaluate the application and significance of plant physiology**

Text Book (s)

- Ainsworth C (2006) Flowering and its Manipulation, Annual Plant Reviews, Vol. 20, Blackwell Publishing, Oxford, U.K.
- Brown TA. (2002) Genomes, BIOS Scientific Publishers Ltd, Oxford, UK.
- Buchanan B, Gruissem G and Jones R. (2000) Biochemistry and Molecular Biology of Plants, American Society of Plant Physiologists, USA.
- Davies P J. (2004) Plant Hormones: Biosynthesis, Signal Transduction, Action. 3rd Edition, Kluwer Academic Publisher, Dordrecht, The Netherlands.

Reference Book (s)

- Buchanan B, Gruissem G and Jones R. (2000) Biochemistry and Molecular Biology of Plants, American Society of Plant Physiologists, USA.
- Davies P J. (2004) Plant Hormones: Biosynthesis, Signal Transduction, Action. 3rd Edition, Kluwer Academic Publisher, Dordrecht, The Netherlands.

Unit-1 I Introduction to Plant Physiology	**(08 lectures)**
Plant water relations, mechanism of water transport through xylem, transpiration, stomatal physiology, factors affecting transpiration, guttation.	
Unit-2 Photosynthesis	**(12 lectures)**
Photosynthesis: Historical background, photosynthetic pigments and light harvesting complex, photosystems I & II, mechanism of quantum capture and energy transfer system, Calvin cycle, C4 cycle and CAM pathway, translocation of solutes. Carbon allocation.	
Unit-3 Plant Respiration	**(10 lectures)**
Hydrolytic and phosphorilytic degradation of starch and sucrose, Respiration, respiratory quotient, ATP generation, factors influencing the rate of respiration (light, temperature, oxygen availability). Electron Transport system in mitochondria, oxidative phosphorylation.	
Unit-4 Nitrogen Metabolism	**(10 lectures)**

Nitrogen metabolism, biological nitrogen fixation and ammonia assimilation, nitrate reduction and its incorporation in to aminoacids. Study of various plant stress, resistant strategies, plant defence mechanism against biotic and abiotic stress.
Unit-5 Tissue Culture (10 lectures) **Tissue cultures, general tissue culture techniques, totipotency, roles of tissue culture techniques in haploid and triploid production. Biosynthesis, Physiological role and mechanism of action of various plant growth regulators like auxin, gibberellins, cytokine, abscisic acid and ethylene, etc.**
Unit-6 Recent advances in Plant Physiology (04 lectures) **Research article/ Review paper/ MOOC**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Summer Training**				
Course Code	**MSBS6003**				
Prerequisite	**Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.**				
Corequisite	**Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.**				
Antirequisite					
		L	**T**	**P**	**C**
		0	**0**	**0**	**3**

Course Objectives:

- By taking summer internships students will be able to:
- Get hands-on experience about real world problems in a field relevant to their major of studies.
- Acquire confidence for employment after graduation.
- Acquire skills important for time management, discipline, self-learning, effective communication and so on.
- Learn practically about team-work, collaboration, and leadership.

Course Outcomes

CO1	**Demonstrate the use of knowledge of basic and applied sciences in project based learning.**
CO2	**Organizes experiments and researches, perform analysis and interpret data for the designed project.**
CO3	**Cooperate effectively as an individual and as a member in the research team.**
CO4	**Systematize the articulated ideas, comprehend and write effective reports, documentation and to communicate effectively.**
CO5	**Demonstrate knowledge and understanding of research problems and related principles to manage projects in multidisciplinary research areas.**

COURSE CONTENTS:

Summer Training is considered as a special course involving application of knowledge in solving / analysing /exploring a real life situation / difficult problem. Summer training work may be given in lieu of a discipline specific elective paper/Biochemistry. This should be done in consultation with the faculty supervisor and agency supervisor under whom he / she is getting trained. The project report should be around 40 pages and chaptered as follows:

Chapter I: Introduction
Chapter II: Review of Literature
Chapter III: Methodology
Chapter IV: Results
Chapter V: Discussion
Chapter VI: Summary and Conclusion

The following weightage is assigned at each stage of Student Project evaluation.

Activity	Remarks
Zeroth Review	Project scopes and Proposal
1st Review	Methods of project Implementation
2nd Review	Technical Achievement
3rd Review (Final)	Innovation and contribution
Submission of Project Report to the Department	Two weeks before the viva-voce exam

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
50	0	50	100

Name of The Course	Protein biology				
Course Code	MSBS6004				
Prerequisite	Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.				
Corequisite	Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.				
Antirequisite					
		L	T	P	C
		4	0	0	4

Course Objectives:

The students should be able to demonstrate advanced knowledge and understanding in the following core areas-

- The principles of globular protein structure, as well as the techniques used for elucidation of structures and approaches to their prediction from sequence.
- Intermediates in enzyme.
- Identification/quantitation of polypeptide similarity. Identification of polypeptide families & superfamilies. Large scale sequencing projects, data analysis including comparative analysis.
- Protein synthesis mechanisms, especially with respect to ribosome structure-function and accuracy of translation, considered mainly in prokaryotes.

Course Outcomes

CO1	**Describe the biological function of protein**
CO2	**Illustrate the structure of protein**
CO3	**Evaluate the mechanism of protein folding.**
CO4	**Explain the concept of enzymology**
CO5	**Demonstrate the industrial use of enzyme**
CO6	**Evaluate the application of protein biology in drug development and research**

Text Book (s)

- Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN: 13: 978-1-4641-0962-1 / ISBN:10:1-4292-3414- 8.
- Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New York), ISBN:978-0-470-28173-4.
- 2. Biochemistry (2011) 4th ed., Donald, V. and Judith G.V., John Wiley & Sons Asia Pvt. Ltd. (New Jersey), ISBN:978-1180-25024.

Reference Book (s)

- Berg, J. M., Tymoczko, J. L. and Stryer, L. Biochemistry. Freeman, 7th edition, 2011.
- Mathews, C. K. & Van Holde, K. E. & Ahern, K. G. Biochemistry. Addison Wesley, 4th edition, 2012.
- Wilson, K. & Walker, J. Principles and Techniques of Biochemistry and Molecular Biology. CUP, 7th edition.

Unit-1 Amino acids and Protein (08 lectures) **Macromolecules Proteins: Amino acids their physical & chemical properties, Peptides and polypeptides. Peptide group, charges on peptides (pH dependence), Handersen-Haselbalch equation, buffers.**
Unit-2 Structure and function of Protein (12 lectures) **Different levels in protein structure, Ramachandran plot, Secondary structure (α-helix, β-strand, β-sheet, turns and loops), Super secondary structures, tertiary structure, quaternary structure, globular and fibrous proteins. 2. Functions of different protein, Haemoglobin function, oxygen binding, hill equation, Bohr effect, binding of BPG.**
Unit-3 : Protein Folding (10 lectures) **Protein folding Forces stabilizing the native state of proteins (electrostatic, hydrophobic and hydrogen bonding). The denatured state, modes of denaturation. Protein folding. landmark experiments in protein renaturation, folding pathways, techniques to monitor protein folding, landscape theory of protein folding. Accessory proteins in folding: protein disulphide isomerase, Rotamases and molecular chaperones**
Unit-4 Enzymology (12 lectures) **Enzymes: cofactors, catalytic power, specificity and regulation, Ribozymes and abzymes. Enzyme catalysis: Acid-Base, metal ion, covalent and electrostatic catalysis, Reaction coordinates. Transition state**
Unit-5 Industrial Uses Of Enzymes (08 lectures) **Industrial uses of enzymes - sources of industrial enzymes; thermophilic enzymes; Textile industry application and in Laundry detergents; cheesed production.**

Unit-6 Recent advances in Protein Biology (04 lectures) **Research article/ Review paper/ MOOC**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Evolution**				
Course Code	**MSBS6005**				
Prerequisite	**Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.**				
Corequisite	**Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.**				
Antirequisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives:

- To define genotype, allele, phenotype, biological (Darwinian) fitness.
- To define and explain the connections between mutations, variation, genotype, phenotype, environment, survival, reproduction, allele frequencies, individuals, population and fitness.
- To explain why selection works on individuals, but evolution works on populations.
- To explain what it means if two different genotypes differ in relative fitness.
- To explain how natural selection results in altered allele frequencies in subsequent generations.

Course Outcomes

CO1	**Explain the concept of evolutionary biology**
CO2	**Describe the basis of phylogenetics**
CO3	**Explain the endosymbiotic theory.**
CO4	**Discuss about the mode of speciation**
CO5	**Explain the fundamentals of systematic and Biodiversity**
CO6	**Evaluation of principles of evolution**

Text Book (s)

- Evolution, Barton, N. H., Briggs, D. E.G., Eisen, J. A., Goldstein, A. E., Patel, N. H., Cold Spring Harbor Laboratory Press, New York, USA.
- Evolution, Hall, B. K. and Hallgrimsson, B., Jones and Bartlett Publisher, Sudbury, USA.
- Fisher, R. A. 1930. The Genetical Theory of Natural Selection. Oxford: Oxford Univ. Press.
- Bonner, J. T. 1988. The Evolution of Complexity. Princeton: Princeton Univ. Press.
- Hall, B. J. 1992. Evolutionary Developmental Biology. New York: Chapman and Hall.

Reference Book (s)

- Evolution, Barton, N. H., Briggs, D. E.G., Eisen, J. A., Goldstein, A. E., Patel, N. H., Cold Spring Harbor Laboratory Press, New York, USA.
- Evolution, Hall, B. K. and Hallgrimsson, B., Jones and Bartlett Publisher, Sudbury, USA.
- Fisher, R. A. 1930. The Genetical Theory of Natural Selection. Oxford: Oxford Univ. Press.

Unit-1 Introduction to Evolutionary Biology (10 lectures) **An overview of evolutionary biology: concept of organic evolution during pre- and post-Darwin era; evolution and molecular biology- a new synthesis; from molecules to life, life originated from RNA, introns as ancient component of genes.**	
Unit-2 Phylogenetics (14 lectures) **The universal common ancestor and tree of life, three domain concept of living kingdom; molecular phylogeny: history, terms, definition and limitations, construction of phylogenetic trees using molecular data, construction of phylogenetic trees by using 16S rRNA gene sequences and concept of speciation in bacteria; molecular divergence and molecular clocks and molecular drive; complication in inferring phylogenetic trees; origin and diversification of bacteria and archea; diversification of genomes; the nature of bacterial and archeal genomes; origin of genomes by horizontal gene transfer; role of plasmid, transposons, integrons and genomic islands in DNA transfer.**	
Unit-3 Evolution of Life (10 lectures) **Origin and diversification of eukaryotes: origin of cells and first organisms; early fossilized cells; evolution of eukaryotic cell from prokaryotes- a case of symbiosis; evolution of eukaryotic genomes; gene duplication and divergence.**	
Unit-4 Concept of Speciation (6 lectures) **Mode of speciation: factors responsible for speciation; tempo of evolution.**	
Unit-5 Systematics and biodiversity (12 lectures) **Systematics- definition and role in biology, biological classification- theories and objectives, types of taxonomy, taxonomic diversity- definition and types, origination and extinction, rates of change in origination and extinction, causes of extinction, causes of differential rates of diversification, current status and future of biodiversity; human evolution- human evolutionary history; placing humans on tree of life; genomics and humanness; current issues in human evolution.**	
Unit-6 Recent advances in evolution (04 lectures) **Research article/ Review paper/ MOOC**	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Advanced Biological Science Lab – III**
Course Code	**MSBS6007**
Prerequisite	**Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.**
Corequisite	**Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics,**

	regulation, structure/function, interaction with the environment, and evolution.				
Antirequisite					
		L	**T**	**P**	**C**
		0	**0**	**4**	**2**

Course Objectives:

- This will enable the students to understand all the subjects of Biological Science as these tools and techniques will be used therein.
- Acquire the basic knowledge of the techniques to be applied in the laboratory for studying cell physiology and food sample analysis
- To know the general molecular biology and protein analysis technique

Course Outcomes

CO1	**Display the normal and abnormal constituents of urine**
CO2	**Measure the markers for kidney function.**
CO3	**Perform Analysis of food adulteration**
CO4	**Perform Gel electrophoresis for separation of biomolecules**
CO5	**Identify and separate different types of aminoacids and carbohydrates**
CO6	**Evaluation in research advances in laboratory experiments**

Text Book (s)

- Singh S.K. and Sahaney S K Introductory Practical Biochemsitry (Eds) Narosa Publisher
- An Introduction to practical biochemistry (2nd edition): By David T. Plummer. pp. 362 McGraw-Hill Book Company (U.K.) Ltd., London 1978

Reference Book (s)

- Singh S.K. and Sahaney S K Introductory Practical Biochemsitry (Eds) Narosa Publisher
- An Introduction to practical biochemistry (2nd edition): By David T. Plummer. pp. 362 McGraw-Hill Book Company (U.K.) Ltd., London 1978

S.N.	**Name of Practicals**
1.	**Detect the presence of albumin protein and bile salt in urine**
2.	**Detect the presence of creatinin in the given sample of blood**
3.	**Detect the presence of bile salt in urine**
4.	**Determination of cholesterol in urine**
5.	**Estimation of Sugar level in urine.**
6.	**Separation and identification of protein molecule by using SDS-PAGE**
7.	**Identification of different amino acid by paper chromatography.**
8.	**Identification of different carbohydrates by thin layer chromatography**
9.	**Demonstration of principle of PCR**
10.	**Separation of DNA molecule by using agarose gel electrophoresis.**

11.	Determination of protein concentration by Beer Lambert's Law.
12.	Perform experiment to detect adulteration in food material

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
50	00	50	100

SEMESTER IV

Name of The Course	Project Work				
Course Code	MSBS9997				
Prerequisite	Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.				
Corequisite	Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.				
Antirequisite					
		L	T	P	C
		0	0	0	12

Course Objectives:

The aim is to develop an understanding of the processes and skills required to undertake a supervised research project at masters level of study. The objectives are

- To develop research skills commensurate with the accomplishment of a masters degree.
- To develop skills in independent inquiry.
- To produce a coherent and logically argued piece of writing that demonstrates competence in research and the ability to operate independently.
- To address issues of research design, methodology, ethics and theoretical arguments, and apply these to your own research.

Course Outcomes

CO1	Demonstrate the use of knowledge of basic and applied sciences in project based learning.
CO2	Organizes experiments and researches, perform analysis and interpret data for the designed project.

CO3	**Cooperate effectively as an individual and as a member in the research team.**
CO4	**Systematize the articulated ideas, comprehend and write effective reports, documentation and to communicate effectively.**
CO5	**Demonstrate knowledge and understanding of research problems and related principles to manage projects in multidisciplinary research areas.**
CO6	**Evaluate the application of dissertation work in research and development**

Project work/Dissertation is considered as a special course involving application of knowledge in solving / analyzing /exploring a real life situation / difficult problem. A Project/Dissertation work may be given in lieu of a discipline specific elective paper/Biochemistry.This should be done in consultation with the faculty supervisor and agency supervisor under whom he / she is getting trained. The project report should be around 100 pages and chaptered as follows:

Chapter I: Introduction
Chapter II: Review of Literature
Chapter III: Methodology
Chapter IV: Results
Chapter V: Discussion
Chapter VI: Summary and Conclusion

The research should be original and should be action oriented in that the results should be able to throw light on some of the important unexplored areas that would be of practical use to the forensic experts.

Students are expected to decide on the specific project area and title, and carry out substantial portion of the literature survey during the end of their 3rd semester. After the end of their 3rd semester ETEs, each student will be asked to make presentation about the project including literature available, objective sought and work plan including methodologies to the Student Project Monitoring Committee constituted by the Division Chair. The Project Work may be a work based on theoretical analysis, modelling & simulation, experimentation & analysis, prototype design, fabrication of new equipment, correlation and analysis of data, etc. or a combination of these. The final project report will be evaluated by a panel of examiners consisting of Dean, DC, PC, supervisor and Co-supervisor (wherever applicable) and an External Examiner. Viva-voce examination for the same will be conducted.
The following weightage is assigned at each stage of Student Project evaluation.

Activity	Remarks
Zeroth Review	Project scopes and Proposal
1st Review	Methods of project Implementation
2nd Review	Technical Achievement
3rd Review (Final)	Innovation and contribution
Submission of Project Report to the Department	Two weeks before the viva-voce exam

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
50		50	100

Programme Electives

Name of The Course	**Computational biology**				
Course Code	**MSDB 6019**				
Prerequisite	**Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.**				
Corequisite	**Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.**				
Antirequisite					
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

High-throughput technologies produce massive amounts of data, much too large to analyze by hand. The goal of this course is to learn how to analyze DNA, RNA, and protein sequences using computers. The objectives are -

- To know about the properties of DNA, RNA, and proteins, the relationships among these molecules, and some biological questions that have puzzled researchers.
- To know how to convert a biological question into a computational problem that can be solved using computers.
- To know how to read and understand solutions to computational problems, which will be formalized as a series of tasks (an algorithm).
- To learn about general approaches for solving computational problems, and you will be able to apply these approaches to new problems you encounter.
- To know how implement the algorithms by writing computer programs in Python, which can be run and understood by others.

Course Outcomes

CO1	**Illustration of the computational biology and bioinformatics**
CO2	**Interpretation Biological databases and genome browsers**
CO3	**Evaluation of the Sequence alignment and visualization**
CO4	**Evaluation of the Phylogenetic analysis**
CO5	**Analysis of the Microarray analysis and Drug discovery pipeline**
CO6	**Evaluate the application of computational biology in drug development and research**

Text Book (s)

- Introduction to Computational Biology: An Evolutionary Approach by Haubold, Wiele. 1st edition. Springer International. 2006.
- Introduction to Bioinformatics by A. Lesk. 3rd edition. OUP India. 2009.
- Statistical methods in Bioinformatics: An introduction by W. Ewens, G.R. Grant. 2nd Edition. Springer-Verlag. 2006.
- Bioinformatics: Sequence and genome analysis by D. Mount. 2nd edition. Cold Spring Harbor Lab Press. 2004.
- Bioinformatics: A practical guide to the analysis of genes & proteins. Edited by Baxevanis, Outlette. 2nd edition. John Wiley and Sons. 2001.

- An Introduction to Protein Informatics by K-H Zimmermann. 1st edition, Springer International. 2007.

Reference Book (s)

- Fundamental Concepts of Bioinformatics by Krane. 1st edition. Pearson Education. 2003.
- Discovering Genomics, Proteomics and Bioinformatics by Campbell. 2nd edition. Campbell Pearson Education. 2007.
- Structural bioinformatics: an algorithmic approach by F. J. Burkowski. 1st edition, Chapman & Hall/CRC. 2009.
- Structural Bioinformatics edited by J. Gu, P.E. Bourne. 2nd Edition. Wiley-Blackwell. 2009.

Unit-1 Introduction to computers **(10 lectures)**

Units of computers, Block Diagram, Generation of Computers, Characteristics of Computers, Phases of Computers, Different types of Memory, Input and Output Devices.
Logic Development and Program Development Tools: Data Representation, Flowcharts, Problem Analysis, Decision Trees/Tables, Pseudo Code and Algorithms, Program Debugging, Compilation and Execution.
Fundamentals: Character Set, Identifiers and Key Words, Data Types, Constants, Variables, Expressions, Statements, Symbolic Constants.
Operations and Expressions: Arithmetic Operators, Unary Operators, Relational Operators, Logical Operators, Assignment and Conditional Operators, Library functions.

Unit-2 Procedural Concept **(08 lectures)**

Structured Programming – Built-in library function – User defined functions – Pointer introduction – Passing pointer in a function – Structure – Union – File handle: Read and Write character from a file

Unit-3 Programming in C: C language **(10 lectures)**

Introduction – Tokens – Keywords, Identifier, Variables, Constants, Operators – Expression – Data types –Operator precedence - Statement: Input statement, Output statement, Conditional and Unconditional Control Statement – Looping Statement: while, do-while, for – nested loop – Arrays.

Unit-4 Object Oriented Programming: Programming in C++ **(10 lectures)**

C++ programming – Object Oriented Concept: Encapsulation, Inheritance, Polymorphism – Different forms of Constructor – Destructor – Abstract class – Virtual function

Unit-5 PERL **(10 lectures)**

Basic Perl Data Types, References, Matrices, Complex/Nested Data Structures, Scope: my, local, our – Function/Subroutines, System and User Function, File handle and File Tests – stat and lstat Functions – Perl

Unit-6 Recent advances in computational biology **(04 lectures)**

Research article/ Review paper/ MOOC

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Bioethics, Bio-safety and IPR**				
Course Code	**MSDB6020**				
Prerequisite	**Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.**				
Corequisite	**Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.**				
Antirequisite					
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

- To gain awareness about *Intellectual Property Rights* (*IPRs*) to take measure for the protecting their ideas and to devise business strategies by taking account of *IPRs.*
- To assists in technology upgradation and enhancing competitiveness
- To introduce basic concepts of ethics and safety that are essential for different disciplines of science and procedures involved and protection of intellectual property and related rights.
- To understand balanced integration of scientific and social knowledge in sustainable development.

Course Outcomes

CO1	**Understanding on basic principles of bioethics.**
CO2	**Evaluation of the process of biosafety levels**
CO3	**Evaluation of the process of IPR**
CO4	**Illustration of patent and licensing process**
CO5	**Illustration of regulatory aspects of QC, QA, and QM**
CO6	**Evaluate the application of Bioethics biosafety and IPR in research**

Text Book (s)

- Fleming, D.A., Hunt, D.L., (2000). Biotechnology and Safety Assessment (3rd Ed) Academic press.ISBN-1555811804,9781555811808.

- Thomas, J.A., Fuch, R.L. (1999). Biotechnology and safety assessment (3rd Ed). CRC press, Washington. ISBN: 1560327219, 9781560327219
- Law and Strategy of biotechnological patents by Sibley. Butterworth publication.(2007) ISBN: 075069440, 9780750694445.
- Intellectual property rights- Ganguli-Tat McGrawhill. (2001) ISBN-10: 0074638602,

Reference Book (s)

- Biotechnology - A comprehensive treatise (Vol. 12). Legal economic and ethical dimensions VCH. (2nd ed) ISBN-10 3527304320.
- Encyclopedia of Bioethics 5 vol set, (2003) ISBN-10: 0028657748.
- Thomas, J.A., Fuch, R.L. (2002). Biotechnology and safety Assessment (3rd Ed) Academic press.

Unit-1 Introduction and principle of bioethics (10 lectures) **Biotechnology and social responsibility, public acceptance issues in biotechnology, issues of access, ownership, monopoly, traditional knowledge, biodiversity, benefit sharing, environmental sustainability, public viz; private funding, biotechnology in international relations, globalization and development divide. Introduction to bioethics: Social and ethical issues in biotechnology. Principles of bioethics. Ethical conflicts in biotechnology- interference with nature, unequal distribution of risk and benefits of biotechnology, bioethics viz; business ethics.**
Unit-2 Biosafety (10 lectures) **Biosafety: Definition of bio-safety, Biotechnology and bio-safety concerns at the level of individuals, institutions, society, region, country and world with special emphasis on Indian concerns. Biosafety in laboratory institution: laboratory associated infection and other hazards, assessment of biological hazards and level of biosafety. Bio safety regulation: handling of recombinant DNA products and process in industry and in institutions (Indian context).**
Unit-3 Intellectual property protection (08 lectures) **Introduction to IPR: IPR, forms of IPR and Intellectual property protection. Concept of property with respect to intellectual creativity, Tangible and Intangible property. WTO: agency controlling trade among nations, WTO with reference to biotechnological affairs, TRIPs. WIPO, EPO.**
Unit-4 Patent and licensing (10 lectures) **Concept related to patents novelty, non-obviousness, utility, anticipation, prior art etc. Type of patents. Indian patent act and foreign patents. Patentability, Patent application, Revocation of patent, Infringement and Litigation with case studies on patent, Commercialization and Licensing.**
Unit-5 Quality assurance and validation (12 lectures) **Regulatory aspects of QC, QA, and QM. GMP, GLP and CMP in Pharma Industry. ISO, WHO, USFDA certification. Microbial Limit test of Pharma products. Sterility testing, pyrogen testing and LAL test of Sterile Pharma products. Sterilization- heat, D- value, Z-value and survival curve, radioactive, gaseous and filtration. Chemical and biological indicators. Designing layout for microbiology laboratory.**
Unit-6 Recent advances in bioethics, bio-safety and IPR (04 lectures) **Research article/ Review paper/ MOOC**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Toxicology**				
Course Code	**MSDC6021**				
Prerequisite	**Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.**				
Corequisite	**Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.**				
Antirequisite					
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

- **Understand toxicology and associated terms and learn about everyday toxic substances.**
- **Interpret a dose-response curve and acquire information about biological variation.**
- **Define exposure types and familiarity with toxicity episode phases.**
- **Basic understanding of risk assessment**

Course Outcomes

CO1	**Discuss the various routes of toxic exposure and response.**
CO2	**Evaluate the process of evaluation of toxicity.**
CO3	**Explain the fate of xenobiotics in the physiological system.**
CO4	**Summarize the various toxic agents.**
CO5	**Discuss the different eco-toxicological effects.**
CO6	**Evaluate the application of toxicology in treatment of toxic molecules**

Text Book (s)

- Cassarett and Doull‟s Toxicology “The Basic Science of The Poisons” 7th edition (2008), Curtis D. Klaassen Editor, McGrawHill Medical. ISBN: 9780071470513.
- Cassarett and Doull‟s “Essentials of Toxicology” 2nd edition (2010), Klaassen and Whatkins, McGraw Hill Publisher. ISBN-13: 978-0071622400.
- Introduction to Toxicology, 3rd edition (2001), John Timbrell, Taylor and Francis Publishers. ISBN 13: 9780415247627.
- Principles of Toxicology, 2nd edition (2006), Stine Karen and Thomas M Brown, CRC press. ISBN-13: 978-0849328565.

Reference Book (s)

- Introduction to Toxicology, 3rd edition (2001), John Timbrell, Taylor and Francis Publishers. ISBN 13: 9780415247627.
- Principles of Toxicology, 2nd edition (2006), Stine Karen and Thomas M Brown, CRC press. ISBN-13: 978-0849328565.
- Lu‟s basic toxicology: Fundamentals target organ and risk assessment, 5th edition (2009), Frank C Lu and Sam Kacow, Informa Health care. ISBN: 9781420093117.

Unit-1 Toxic exposure and response	**(10 lectures)**
Different areas of modern toxicology, classification of toxic substances, various definitions of toxicological significance. Effect of duration, frequency, route and site of exposure of xenobiotics on its toxicity. Characteristic and types of toxic response. Types of interactions between two and more xenobiotics exposure in humans. Tolerance and addiction.	
Unit-2 Evaluation and mechanism of toxicity	**(08 lectures)**
Various types of dose response relationships, assumptions in deriving dose response, LD50, LC50, TD50 and therapeutic index. Delivery of the toxicant, mechanisms involved in formation of ultimate toxicant, detoxification of ultimate toxicant.	
Unit-3 Fate of xenobiotics in human body	**(08 lectures)**
Absorption, Distribution, Excretion and Metabolism of xenobiotics (biotransformation, Phase-I reactions including oxidations, hydrolysis, reductions and phase II conjugation reactions).Toxic insult to liver, its susceptibility to toxicants with reference to any two hepatotoxicants.	
Unit-4 Toxic agents	**(10 lectures)**
Human exposure, mechanism of action and resultant toxicities of the following xenobiotics: Metals: lead, arsenic, Pesticides: organophosphates, carbamates, organochlorine, bipyridyl compounds and anticoagulant pesticides.	
Unit-5 Eco-toxicology	**(10 lectures)**
Brief introduction to avian and aquatic toxicology, movement and effect of toxic compounds in food chain (DDT, mercury), bioaccumulation, biomagnification, acid rain and its effect on ecosystems, concept of BOD and COD.	
Unit-6 Recent advances in toxicology	**(04 lectures)**
Research article/ Review paper/ MOOC	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Industrial Biochemistry**				
Course Code	**MSDB6022**				
Prerequisite	**Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.**				
Corequisite	**Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.**				
Antirequisite					
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

The course aims to integrate the knowledge of biochemistry and molecular biology with those of microbiology and biochemical engineering, with emphasis on their application to the biotechnological processes.

Course Outcomes

CO1	**Demonstrate the industrial bioprocesses technology, downstream processing.**
CO2	**Describe the process of fermentation.**
CO3	**Demonstrate the various ways of food processing.**
CO4	**Describe the process of BIOSAFETY, IPR**
CO5	**Discuss the general principles of Quality Control and Good Manufacturing practices in food industry.**
CO6	**Evaluate the significance of industrial biochemistry in production and research**

Text Book (s)

- DobleMukesh and Kumar Anil, Biotreatment of industrial effluents.
- Wackett, L.P. and Hershberger, C.D. Biocatalysis and Biodegradation, Microbial Transformation of Organic Compounds, 2001 P.-171-190. ISBN 1-55581-179-5. ASM Press Washington D.C.
- WulfCrueger and Anneliese Crueger, Biotechnology, Panima Publishing company New Delhi.
- Rainbow C. and Rose A.H., A.P., Biochemistry of Industrial micro-organisms.
- P. F. Stanbury, A. Whitaker and S. Hall, Principles of Fermentation Technology.

Reference Book (s)

- Bioethics and Biosafety, 1st edition (2008), M. K Sateesh, I K International Pvt Ltd, ISBN-13: 978-8190675703.
- Biosafety and Bioethics, 1st edition (2006), Rajmohan Joshi; Isha Books ISBN-13: 978-8182053779.
- Bioethics and biosafety in biotechnology, 1st edition (2007), V. Sreekrishna; New Age International (P) Ltd., ISBN-13: 978-8122420852.
- P. F. Stanbury, A. Whitaker and S. Hall, Principles of Fermentation Technology.

Unit-1 Introduction to industrial bioprocesses technology (10 lectures) **Definition and scope of Industrial Biochemistry, A historical overview of Industrial fermentation processes- traditional and modern biotechnology, Organism, processes and products related to modern biotechnology, Types of Bioreactors, Parameters for Bio process, bioprocess monitoring, downstream processing.**
Unit-2 Basics of fermentation (08 lectures) **Biochemical Basis and Development of Industrial Fermentation process: screening and selection of the organisms for the production of biologically important compounds, Strain improvements, Detection and production of fermentation products, Fermentation media, Scale up of fermentations**
Unit-3 Food biochemistry (12 lectures) **Introduction to different categories of food; constituents of food products and their functional properties; introduction to food processing; intermediate moisture food; food spoilage; intrinsic and extrinsic factors affecting the quality and life of food material; food storage and preservation techniques; food poisoning and intoxication; by-product utilization and scale up; molasses and alcohol production.**

Unit-4 Biosafety, IPR	**(10 lectures)**
Historical background, introduction to biological safety cabinets, primary containment for biohazards, biosafety levels of specific microorganisms, recommended biosafety levels for infectious agents and infected animals. Intellectual property rights (IPR)	
Unit-5 QC and GMP	**(10 lectures)**
General principles of Quality Control and Good Manufacturing practices in food industry, Determination of shelf – life of food products, Food Adulteration – Common food adulterants, their harmful effects and physical and chemical methods for their detection, Role of ISI Agmark and FDA in food industry.	
Unit-6 Recent advances in industrial chemistry	**(04 lectures)**
Research article/ Review paper/ MOOC	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Advanced Microbiology**				
Course Code	**MSDB6023**				
Prerequisite	**Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.**				
Corequisite	**Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.**				
Antirequisite					
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

- To understand the impact and the importance of the activity of microorganisms on health and on other living organisms.
- To appreciate the intimate connection between the knowledge of molecular mechanisms underlying the interaction between microorganisms and the capacity to develop new biotechnologies.
- To improve the general skills in the laboratory using modern molecular techniques.
- To contribute to one of the great initiatives of modern times: Wikipedia, with new knowledge in the field of microbiology.
- To develop team working skills while reviewing a cutting edge topic in microbiology

Course Outcomes

CO1	**Acquire knowledge on microbial proteomics**
CO2	**Understand the fundamentals of nanotechnology**
CO3	**Illustration of the applications of nanobiotechnology**
CO4	**Application of knowledge on grant of patent and patenting authorities**
CO5	**Evaluation of advanced approach in microbiology**

CO6	**Evaluation of significance of advanced microbiology in treatment of disease and industrial application**

Text Book (s)

- Bare Act, 2007.Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., New Delhi.
- Kankanala C (2007). Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution Pvt. Ltd. New Delhi.
- Nanobiotechnology: Concepts,Applications and Perspectives (2004), Christof M.Niemeyer (Editor), Chad A. Mirkin (Editor), Wiley VCH.
- Nanobiotechnology - II more concepts and applications. (2007) - Chad A Mirkin and Christof M. Niemeyer (Eds), Wiley VCH.

Reference Book (s)

- Pradeep T., “A Textbook of Nanoscience and Nanotechnology”, Tata McGraw Hill Education Pvt. Ltd., 2012.
- Singh K K (2015). Biotechnology and Intelectual Property Rights: Legal and Social
- Impliocations, Springer India.
- Goel D &Prashar S (2013). IPR, Biosafety and Bioethics. Pearson

Unit-1 Microbial proteomics (12 lectures) **Introduction to Proteomics, 2D electrophoresis, Proteomics applications. Protein biomarker, surfaceplasmon resonance (SPR), protein micro arrays dual polarisation interferometry, micro scale thermophoresis Microbial pathogenesis at the proteome level. Proteomics of *Saccharomyces cerevisiae*-cell wall & transport, differential expression in stress. Proteomics of probiotic lactobacilli-intestinal epithelial cells interactions, Lantibiotics and Immuno modulators. Proteomic Identification of *Mycobacterium tuberculosis***
Unit-2 Introduction to nanotechnology (10 lectures) **Historical perspectives, Existence of nanostructures in nature, Nanoscale Properties (Electrical, Optical, Chemical) Nanomaterials - Quantum Dots,Wells and Wires, nanotubes, graphene, nanogold, nanosilver and metal oxides, Nanopolymers. Synthesis using Microorganisms, Synthesis using Biological templates, synthesis using plants and plant extracts.**
Unit-3 Applications of nano biotechnology (08 lectures) **Nanobiosensors, molecular imaging using nanoparticles, targeted drug delivery. Applications in health and disease - infectious and chronic. Nanobiotechnological applications in Environment and food - detection and mitigation.**
Unit-4 Grant of patent, agreements and treaties (12 lectures) **Grant of Patent and Patenting Authorities: Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; An introduction to Patent Filing Procedures; Patent licensing and agreement; Patent infringement- meaning, scope, litigation, case studies, Rights and Duties of patent owner. Agreements and Treaties: GATT, TRIPS, WIPO, Budapest Treaty on international recognition of the deposit of microorganisms etc.**
Unit-5 Advance approach in microbiology (12 lectures)

Novel approaches for anti-influenza virus therapy. Use of bacteria in cancer therapy, Protein secretion: from mechanism to exploitation, microbicides, Biofilm-related infections, Fungal infections: novel diagnostic tools and antifungal agents, Epidemiology of respiratory viruses, Tumor-associated viruses, Virus (HIV) entry as therapeutic target, Applications of CRISPR genome editing to microbiology.
Unit-6 Recent advances in advanced microbiology (04 lectures) **Research article/ Review paper/ MOOC**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Plant – pathogen interaction**				
Course Code	**MSDB6024**				
Prerequisite	**Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.**				
Corequisite	**Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.**				
Antirequisite					
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

- To gain a deeper knowledge of host-pathogen interactions at the molecular to organismal level, with emphasis on several model pathosystems and phenomena whose elucidation will have the most power in explaining disease.
- To gain an understanding of the virulence mechanisms and pathogenic lifestyles of necrotrophic and biotrophic plant pathogens and of the defenses of plants against these pathogens.
- To understand research tools and their limitations and how technology and knowledge have grown together in the history of our discipline.
- To use knowledge of molecular interactions to understand the basis for current disease controls and identify potential new targets for control.

Course Outcomes

CO1	**Understanding on microbial infections on plant physiology**
CO2	**Evaluation of important plant diseases and etiology**
CO3	**Evaluation of genetics of diseases**
CO4	**Illustration of plant disease control**
CO5	**Illustration of diseases forecasting and its relevance**
CO6	**Evaluate the application of plant – pathogen interaction**

Text Book (s)

- Plant pathology by George N. Agrios: 4th ed., Academic press, New York, 1969.
- Plant pathology by R.S. Mehrotra: Tata McGraw –Hill publishing company limited. New Delhi.
- Bacterial plant pathology, cell and molecular aspects by David C. Sigee, Cambridge University Press, 1993.

- Molecular plant pathology by M. Dickinson: BIOS Scientific Publishers, London, 2003.
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Reference Book (s)

- The essentials of Viruses, Vectors and Plant diseases by A.N. Basu & B.K. Giri: Wiley Eastern Limited, 1993.
- Biocontrol of Plant Diseases (Vol. I) by K.G. Mukerji & K.L. Garg: CRC Press, Inc., Boca Raton, Florida, 1988.
- Molecular Biology of Filamentous Fungi by U. Stahl & P. Tudzyski: VCH Verlagsgesellschaft mbH, D-6940 Weinheim (Federal Republic of Germany), 1992

Unit-1 Concepts and physiology of plant diseases (08 lectures) **What is a disease and what causes disease, pathogenesis, pathogenesis in relation to environment, effect of microbial infections on plant physiology, photosynthesis, respiration, transpiration, translocation. Enzymes and toxins in plant diseases, phytoalexins.**
Unit-2 Some important plant diseases and their etiological studies (10 lectures) **Crown gall, symptoms of viral diseases and their control, diseases of some important cereals, vegetables and crops. Diseases caused by fungi: *Sclerotium rolfsii* and *Macrophomina phaseolina* (collar rot disease, charcoal rot), bacteria: *Xanthomonas campestris* (black rot), actinomycetes: *Streptomyces scabies* (common scab).**
Unit-3 Genetical basis of plant diseases (08 lectures) **Genetics of host-pathogen interactions, resistance genes, resistance mechanism in plants. Molecular diagnosis, transgenic approach for plant protection, futuristic vision of molecular diagnosis, applications and constraints.**
Unit-4 : Disease control (10 lectures) **Principles of plant disease control, physical and chemical methods of disease control, biocontrol, biocontrol agents - concepts and practices, fungal agents, *Trichoderma* as biocontrol agent, biocontrol agents – uses and practical constraints**
Unit-5 Disease forecasting (10 lectures) **History and important milestones in disease control, disease forecasting and its relevance in Indian farming.**
Unit-6 Recent advances in Plant – pathogen interaction (04 lectures) **Research article/ Review paper/ MOOC**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

(Established under Galgotias University Uttar Pradesh Act No. 14 of 2011)

School of Basic and Applied Sciences

Department of Life Sciences

Division of Biomedical Science

Programe: M.Sc. Biomedical Science

Scheme: 2020 – 2022

Vision

"To be known globally for value-based education, research, creativity and innovation"

Mission

9. Establish state-of-the-art facilities for world class education and research.
10. Collaborate with industry and society to align the curriculum,
11. Involve in societal outreach programs to identify concerns and provide sustainable ethical solutions.
12. Encourage life-long learning and team-based problem solving through an enabling environment.

School of Basic and Applied Sciences

Vision:

To be recognized globally as a center of excellence in imparting value-based education in Basic and Applied Sciences by creating innovation in fundamental and multidisciplinary research.

Mission

M1: To excel in imparting contemporary knowledge and skills by developing an educational ecosystem with diverse interests and talents.

M2: To perform cutting edge research leading to innovation in sciences through national and international collaborations.

M3: To develop solutions for the emerging challenges in Basic and Applied Science to cater the needs of society.

M4: To attract best quality faculty to facilitate knowledge and develop confidence in our graduates to succeed in the world.

Salient features of Biomedical Sciences

M.Sc. Biomedical Sciences is a postgraduate course. The duration of M.Sc. Biomedical Sciences programme is of two years duration and is divided into two parts, Part I and Part II. Each part has two Semesters. Biomedical Sciences is the branch of the science that deals with the study of biological sciences and medical sciences.This is basically application of biological science in medical sciences. The purpose of the biomedical sciences to develop drug designing and discovery of drug.Pharmacology, Medicinal chemistry, Medical microbiology, and Physiology subjects are core subjects and backbone of biomedical sciences but biochemistry, molecular biology and immunology, bioinstrumentation are also necessary to fulfill the purpose of biomedical sciences.

Aim of the programme:
The programme aims:

- To help the student to develop the knowledge, skills, attitude and ethical values required providing patient-centred care and working safely and effectively in the NHS as a biomedical scientist.
- To apply scientific principles and theories underpinning biomedical science to patient care.
- To enable students to carry out competently diagnostic investigations relevant to the role of a biomedical scientist.
- To develop the student's ability to apply scientific methods and approaches to research, development and innovation.

- To help the student develop a range of transferable academic skills required for effective life-long learning, communication, teamworking and leadership.
- To give the student an opportunity to gain work experience in a biomedical laboratory.
- To prepare the student for employment in a biomedical science laboratory.
- To provide the student with the skills required for postgraduate studies in biomedical and health sciences.

Eligibility

Candidate for admission to the first year of M.Sc. Biomedical Sciences shall be required to have Degree of B.Sc. in any stream of life science such as Botany, Zoology, Chemistry, Physiology, *Microbiology, Biochemistry, Molecular biology, Biotechnology,* or an equivalent degree in a science stream with a minimum of 50 % marks in aggregate from a recognized board.

Scope of the Proposed Programme

The M.Sc. Programme of two years is designed to assist all students to get good quality education in the field of Biomedical sciences so that they can pursue higher education and find employment in India and abroad. The purpose of biomedical sciences education is to develop biomedical scientist in various research institute and universities. They can research in various fields of life science in hospitals and R&D in Biopharmaceuticals multinational company. The syllabus has been designed in the way that students may able to qualify National Eligibility Test (NET) conducted by CSIR-UGC and get admission Ph.D. program in top rank Institute in India and abroad. After completing M.Sc. in Biomedical sciences students may pursue M. Tech in Biomedical engineering also and serve as Biomedical Engineer. Students may also work as technical officer and EEG technician/ technical officer in various neuroscience research institutes like NIMHANCE and Brain Research Center, Gurgaon.

The ultimate aim is to enable the students to develop an integrated approach for understanding the various life science problems at the molecular level. In addition, the present curriculum gives scope for the students entering different modules to update their knowledge depending upon the employment opportunities in each area. Various practical courses have been designed not only to enable the students to appreciate scientific basis of various life processes but also to train them for self-employment.

There is a greater demand for Biomedical researcher in the area of life sciences. After completion of the course candidate may work as Biochemist, Geneticist, and Medical Microbiologist, in Multinational Companies, Public Sectors, Quality Control Labs, Biopharmaceuticals companies. The course will provide solid foundation for all the students regardless of background and will gain a comprehensive understanding of the Biomedical tools& techniques and allied areas, including clinical and research aspects with the special attention to current development in the discipline.

Programme Educational Objective of M.Sc. Biomedical sciences

1. The graduated young minds will be ignited to understand the knowledge of biological sciences and medical sciences and make link between them.
2. The graduates will be emphasized on applied aspects of advanced laboratory training in included to prepare them for careers in the applied research, industry, agriculture and where biological system is increasingly employed.
3. The graduates of Biomedical sciences will be trained for skilled scientific manpower with apprehension of research ethics involving microorganisms to contribute to application, advancement and impartment of understanding in the field of biomedical sciences and molecular biology globally.

Programme Outcome of M.Sc. Biomedical Sciences

On completion of this programme the successful student will have knowledge and understanding of biomedical sciences and they may:

PO1	**Apply knowledge of Biomedical sciences to the solution of complex biochemical conditions. Students can gain knowledge and understanding through lectures, seminars, laboratory classes, peer presentations, debates, placements in clinical physiology departments**
PO2	**Conduct experiments and researches in laboratory, perform analysis and interpret data of experiment.**
PO3	**Critically evaluate research evidence in the context of current theory or practice. Solve clinical problems**

PO4	**Students will able to design of experiments for research, analysis and interpretation of data.**
PO5	**Create, select and apply appropriate techniques, resources of biomedical sciences and research tools for public health and safety.**
PO6	**Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal issues and the consequent responsibilities relevant to the professional biochemist.**
PO7	**Understand the impact of professional life sciences solutions in communal and environmental contexts and demonstrate knowledge and need for sustainable development.**
PO8	**Execute responsibility professionally and ethically.**
PO9	**Function effectively as an individual, and as a member or leader in diverse resource teams.**
PO10	**Articulate ideas, comprehend and write effective reports, documentation and to communicate effectively with the basic and applied sciences community and with society at large.**
PO11	**Demonstrate knowledge and understanding of science and technical principles to manage projects in multidisciplinary research areas.**
PO12	**Seeking stimulation and to exploring numerous opportunities to engage in independent and life-long learning in the broadest context of technological change.**

Program Specific Outcomes (PSOs) for M.Sc. Biomedical Sciences are defined as:

PSO1: Developing deeper understanding of key concepts of biomedical sciences and biological sciences such as pharmacology Physiology, Medicinal Chemistry, Medical biochemistry and microbiology.

PSO2: Equip students with analytical and technical skills through application-based learning such as use of audio-visual aids, problem/project-based learning, guest lectures, visits to industrial and academic organizations and to practice evidence-based biochemistry

Curriculum

M.Sc. Biomedical Science (2020-2022)

First Semester									
							Assessment Pattern		
Sl. No.	Course Code	Course Title	L	T	P	C	IA	MTE	ETE
1	MSDB5013	Cell Biology	3	1	0	3	30	20	50
2	MSDB5002	Molecular Biology	4	0	0	4	30	20	50
3	MSDB5004	Biomolecules	4	0	0	4	30	20	50
4	MSBM5004	Organic Chemistry	4	0	0	4	30	20	50
6	MSBM5005	Advanced Biomedical Science Lab-I	0	0	4	2	50	-	50
	XXXX	**Soft Skills**				**0**			
	XXXX	**Computer awareness**				**0**			
Total Credits						**17**			

Second Semester									
							Assessment Pattern		
Sl. No.	Course code	Course Title	L	T	P	C	IA	MTE	ETE
1	MSDB5006	Immunology	4	0	0	4	30	20	50
2	MSDB5007	Bioanalytical and Microbial Techniques	4	0	0	4	30	20	50
3	MSDB5008	Biotechnology and Genetic Engineering	4	0	0	4	30	20	50
4	MSDB5010	Metabolism of Biomolecules	4	0	0	4	30	20	50
5	MSBM5011	Physiology	3	1	0	3	30	20	50
6	MSBS5012	Advanced Biomedical Science Lab-II	0	0	4	2	50	-	50
7	**XXXX**	**BEC (B1)**				**3**			
8	MBS28T2111	**Research Methodology**	**2**	**0**	**0**	**2**	**30**	**20**	**50**
9	**XXXX**	**IPR**				**1**			
Total Credits						**27**			

Third Semester									
							Assessment Pattern		
Sl. No.	Course Code	Course Title	L	T	P	C	IA	MTE	ETE
1	MSDB6001	Genetics	4	0	0	4	30	20	50
2	MSDB6002	Medical and Pharmaceutical Microbiology	4	0	0	4	30	20	50

3	MSBM6003	Summer Training	0	0	0	2	50	-	50
4	MSBM6004	Pharmacology and Toxicology	4	0	0	4	30	20	50
5	MSBM6005	Principles of Medicinal Chemistry	4	0	0	4	30	20	50
6	**MSDB60##**	**Elective**	**3**	**0**	**0**	**3**	**30**	**20**	**50**
7	MSBM6007	Advanced Biomedical Science Lab- III	0	0	4	2	50	-	50
8	**XXXX**	**Campus to Corporate**	**0**	**0**	**2**	**1**			
Total Credits						**24**			

Fourth Semester									
							Assessment Pattern		
Sl. No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**	**IA**	**MTE**	**ETE**
1	MSBM9997	Dissertation	0	0	0	12	50	-	50
Total Credits						**12**			

Grand Total					**80**			

Elective course									
							Assessment Pattern		
Sl. No.	**Course code**	**Course Title**	**L**	**T**	**P**	**C**	**IA**	**MTE**	**ETE**
1	MSDB6019	Computational Biology	3	0	0	3	30	20	50
2	MSDB6020	Bioethics, Bio-safety and IPR	3	0	0	3	30	20	50
3	MSDB6021	Toxicology	3	0	0	3	30	20	50
4	MSDB6022	Industrial Biochemistry	3	0	0	3	30	20	50
5	MSDB6023	Advanced Microbiology	3	0	0	3	30	20	50
6	MSDB6024	Plant –Pathogen interaction	3	0	0	3	30	20	50

SEMESTER-I

Name of The Course	**Cell biology**				
Course Code	**MSDB5013**				
Prerequisite	**Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.**				
Corequisite	**Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.**				
Antirequisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives:

1. Students will understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles.

2. These can include responses to environmental or physiological changes, or alterations of cell function brought about by mutation.

Course Outcomes

CO1	**Identify cell types, structure, functions and cell division.**
CO2	**Demonstrate the function and structure of various cell organelles**
CO3	**Interpret the models of biological membrane and illustrate membrane biochemistry**
CO4	**Interpret the membrane biochemistry and transport of ions across the membrane.**
CO5	**Elucidate the knowledge in the area of cell aging and death**
CO6	**Evaluate the significance of cell biology**

Text Book (s)

- The Cell: A Molecular Approach (2009) 5th ed., Cooper, G.M. and Hausman, R.E., ASM Press & Sunderland (Washington DC), Sinauer Associates, MA, ISBN:978-0-87893-300-6.
- Molecular Cell Biology (2012) 7th ed., Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell. J., W.H. Freeman & Company (New York), ISBN:13:978-1- 4641-0981-2 / ISBN: 10: 1-4641-0981-8.
- Molecular Biology of the Cell (2008) 5th ed., Alberts, B., Johnson,A., Lewis, J., and Enlarge, M., Garland Science (Princeton), ISBN:0-8153-1619-4.

Reference Book (s)

- Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13: 978-1-4641-0962-1 / ISBN:10:1-4292-3414- 8.
- Molecular Biology of the Cell (2008) 5th ed., Alberts, B., Johnson,A., Lewis, J., and Enlarge, M., Garland Science (Princeton), ISBN:0-8153-1619-4.

Unit-1 introduction to cell biology	**(8 hours)**
Introduction to the cell, its chemical composition, Cell types - organization of prokaryotic and eukaryotic cells, Plant and animal cells: variation in structure and function, cell theory, cell cycle - phases of cell cycle; cell division - mitosis and meiosis	

Unit-2 structure and function of different cell organelles (10 lectures) **Cell organelles; structure and function of endoplasmic reticulum, Golgi body, endosome, lysosome, vacuole, peroxisome, ribosome, mitochondria, chloroplast, nucleus, cytoskeleton, cell wall; subcellular fractionation; cytoplasm and cytosol, Structure of nuclear envelope, nuclear pore complex.**
Unit-3 Membrane biochemistry (10 lectures) **Membrane: chemical composition and its structural plan; membrane lipids; Overview of membrane protein - peripheral and integral; molecular model of cell membrane - fluid mosaic model and membrane fluidity; factors affecting the membrane fluidity.**
Unit-4 Cellular communication and transport (10 lectures) **Microvilli, tight junctions, epithelia, Bell and sqot desmosomes, Types of Cell Junctions; membrane transport; small molecules - passive transport, active transport by ATP powered pumps, Overview of types of transport systems and macromolecule transport: Exocytosis; Endocytosis; Pinocytosis and phagocytosis.**
Unit-5 Cell cycle and cell death (08 lectures) **Cell cycle regulation, Cell aging and death - necrosis and apoptosis**
Unit-6 Advances in Cell Biology: Review article/Research paper/MOOC

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Concepts in Molecular Biology**				
Course Code	**MSDB5002**				
Prerequisite	**Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.**				
Corequisite	**Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.**				
Antirequisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives:

Molecular biology deals with nucleic acids and proteins and how these molecules interact within the cell to promote proper growth, division, and development. It is a large and ever-changing discipline. This course will emphasize the molecular mechanisms of DNA replication, repair, protein synthesis etc.

Course Outcomes

CO1	**Generalize the prokaryotic and eukaryotic mechanism of transcription.**
CO2	**Illustrate of genetic code and the process of translation.**
CO3	**Interpret of protein targeting and degradation mechanism.**
CO4	**Determine the regulation of gene expression in prokaryotes and eukaryotes.**
CO5	**Evaluate the procedure of recombinant DNA technology**
CO6	**Evaluate the Application of molecular biology**

Text Book (s)

- Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13: 978-1-4641-0962-1 / ISBN:10:1-4292-3414- 8.
- Molecular biology of the gene, (4thed)J D Watson, Benjamin/Cummings publ. Co Inc.
- Molecular Cell Biology (2012) 7th ed., Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell. J., W.H. Freeman & Company (New York), ISBN:13:978-1- 4641-0981-2 / ISBN:10: 1-4641-0981-8.
- Molecular Biology of the Cell (2008) 5th ed., Alberts, B., Johnson,A., Lewis, J., and Enlarge, M., Garland Science (Princeton), ISBN:0-8153-1619-4 / ISBN:0-8153-1620-8.

Reference Book (s)

- Alberts B, Bray D, Johnson A et al. (1997) Essential Cell Biology. London: Garland Publishing.
- Darwin C (1859) On the Origin of Species. London: Murray.
- Graur D & Li W-H (1999) Fundamentals of Molecular Evolution, 2nd edn. Sunderland, MA: Sinauer Associates.

Unit-1 Nucleic acid structure and function (10 lectures) **Historical account of DNA discovery; Overview of flow of genetic information; DNA and RNA as genetic material; Unnatural structures of DNA; DNA topology and supercoiling. Nucleosome structure and packaging of DNA into higher order structures; Organelle genomes; chromosome diversity; Clusters and tandem repeats, Microsatellite Repeat Sequences and transposons.**
Unit-2 DNA replication, mutagenesis, DNA damage and repair mechanisms (12 lectures) **The Origin of Replication; Unwinding of DNA; Formation of the Replication Fork; The DNA Polymerase Complex; Initiation & Elongation of DNA Synthesis; Replication Exhibits Polarity; Formation of Replication Bubbles; Reconstitution of Chromatin Structure; DNA Synthesis Occurs During the S Phase of the Cell Cycle. Mutagenesis and replication fidelity; Types of Damage to DNA; DNA repair mechanisms - Mismatch repair of DNA, Base Excision-Repair, Nucleotide Excision-Repair, Double-Strand Break Repair**
Unit-3 Transcription (10 lectures) **Prokaryotic transcription- promoters, properties of bacterial RNA polymerase, steps: initiation, elongation and termination; Eukaryotic transcription- promoters, enhancer factors**

and properties of RNA polymerase I, II and III; Reverse transcription; Inhibitors of transcription. RNA processing, splicing, capping and polyadenylation, rRNA and tRNA processing.
Unit-4 Genetic code, protein translation, targeting and degradation (10 lectures) **Genetic code - definition, deciphering of the genetic code, salient features of genetic code; Protein biosynthesis - initiation, elongation and termination; post-translational modifications; Inhibitors of protein synthesis. Intracellular protein targeting; Signal hypothesis, signal sequences, glycosylation, Targeting of protein to mitochondria, lysosomes, ER, plasma membrane, peroxisomes, chloroplast; Destruction of proteins; Protein folding.**
Unit-5 Regulation of gene expression (12 lectures) **Positive and negative control; Repressor & Inducer; concept of operon- lac, ara, trp operons; attenuation, catabolite repression, autogenous regulation, lytic cycle of bacteriophage; stringent response of rRNA synthesis. Hormonal control, transcription factors, steroid receptors. DNA binding motifs in pro- and eukaryotes – Helix-turn-helix, zinc fingers, leucine zippers, helix loop helix motifs.**
Unit-6 Advances in Molecular Biology: Review article/Research paper/MOOC

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The	**BIOMOLECULES**				
Course Code	**MSDB5003**				
Prerequisite	**Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.**				
Corequisite	**Students should have understanding of general biology, including a basic knowledge of the biological molecules**				
Antirequisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives: Students are able to understand the concept of biomolecules and their interaction.

Course Outcomes

CO1	**Discuss the effect of water, electrolyte and acid-base balance in the physiological system.**
CO2	**Describe the different classes of carbohydrates and their functions.**
CO3	**Explain the structure and functions of lipids in the living system**
CO4	**Summarize the different classes of aminoacids and proteins and their functions**
CO5	**Demonstrate the types of nucleic acids and its sequencing**
CO6	**Evaluate the significance and application of biomolecule in daily life**

Text Book (s)

- Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13: 978-1-4641-0962-1 / ISBN:10:1-4292-3414- 8.
- Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New York), ISBN:978-0-470-28173-4.

Reference Book (s)

Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13: 978-1-4641-0962-1 / ISBN:10:1-4292-3414- 8.

2) Biochemistry, 5th edition Jeremy M Berg, John L Tymoczko, and Lubert Stryer. New York: W H Freeman; 2002. ISBN-10: 0-7167-3051-0

UNIT I
WATER, ELECTROLYTES AND ACID-BASE BALANCE **Water balance; Electrolytes – distribution and balance, sodium, potassium chloride and bicarbonate; Hydrogen-ion homeostasis – buffer systems, respiratory and renal regulation of pH; disorders of acid-base balance.**
Unit-2
CARBOHYDRATES **Nomenclature and classification of carbohydrates; Isomerism; Structure and classification of monosaccharides, Reactions of monosaccharides; Sugar derivatives – amino sugars and deoxy sugars; Structure and functions of disaccharides and polysaccharides; Glycosaminoglycans and glycoconjugates.**
Unit-3
LIPIDS **Classification of lipids; Structure and biological role of the following: fatty acids, acyl glycerols, phospholipids, plasmalogens, sphingolipids, glycolipids, steroids, eicosanoids – prostaglandins, thromboxanes & leukotrienes, leptin and visfatin; Lipoproteins; Amphipathic lipids - membranes, micelles, emulsions and liposomes.**
Unit-4
AMINO ACIDS AND PROTEINS **Classification, structure and properties of aminoacids; general reactions of aminoacids; Peptide bond; Primary, secondary, tertiary and quaternary structures of proteins; Sequence analysis; Structure and functions of myoglobin and hemoglobin.**
Unit-5
NUCLEIC ACIDS **Purines and pyrimidines; Structure and properties of DNA; A, B and Z forms of DNA; Classes and structure of RNA – mRNA, tRNA and rRNA; Nucleic acid sequencing – Maxam and Gilbert and Sangers method. Nucleosome structure and packaging of DNA into higher order structures; Organelle genomes; chromosome diversity; Clusters and tandem repeats, Microsatellite Repeat Sequences and transposons.**
Unit-6 Advances in Biomolecule: Review article/Research paper/MOOC

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The	**Organic Chemistry**			
Course Code	**MSBM5004**			
Prerequisite	**Higher Secondary Examination with Chemistry and Biology or Chemistry, Botany and Zoology or Biochemistry and Chemistry from a recognized Board in science stream with a minimum of 50 % marks in aggregate**			
Corequisite	**Students should have understanding of general chemistry**			
Antirequisite				
	L	**T**	**P**	**C**
	4	**0**	**0**	**4**

Course Objectives: Students are able to understand basic concept of organic chemistry and can synthesize different kind of drugs for the treatment of various diseases.

Course Outcomes

CO1	**Interpret the fundamentals of Reactive Intermediates.**
CO2	**Explain Stereochemistry of Organic Compounds**
CO3	**Discuss the Chemistry of Heterocyclic compounds**
CO4	**Analyze the Mechanism and stereochemistry.**
CO5	**Illustrate the synthesis of Asymmetric compound.**
CO6	**Evaluate the application of organic chemistry in research and development of new drugs and synthetic molecule**

Text Book (s)

1. Advanced organic chemistry: Part A: structure and mechanisms by Francis A. Carey and Richard J. Sundberg; Ed. 5th; Springer; 2008
2. Asymmetric synthesis: the essentials by Mathias Christmann and Stefan Brase; Wiley-VCH; 2007
3. Organic chemistry by Thomas N. Sorrell; Ed.2nd; University Sceince Books, 2005
4. Organic chemistry by Robert Thorton Morrison and Robert Neilson Boyd; Ed. 6$^{th;}$ Prentice Hall of India; New Delhi; 2002
5. Organic chemistry by T. W. Graham Solomons and Craig B. Fryhle; Ed. 9th; Wiley, 2007

Reference Book (s)

1. Organic chemistry by Robert Thorton Morrison and Robert Neilson Boyd; Ed. 6$^{th;}$ Prentice Hall of India; New Delhi; 2002
2. Organic chemistry by T. W. Graham Solomons and Craig B. Fryhle; Ed. 9th; Wiley, 2007

UNIT I
Reactive Intermediates

Carbocations, carbanions, Free Radicals their stability and applications to biological systems, benzynes, carbenes, radical cations and radical anions.
Unit-2
Stereochemistry of Organic Compounds **Enantiomer, epimer, diastereomer, Absolute and relative configuration; r and s notation; enantiotopic and diastereotopic faces, endo and exo faces, Regioselective, enantioselective, stereoselective and stereospecific reactions, Confirmation of 2,3 dibromomutane, E & z notations, Cyclohexane diols.**
Unit-3
Chemistry of Heterocyclic compounds **Structure, of heterocyclic compounds and their significance in biology: pyrrole, furan thiophene, imidazole, oxazole, thiazole, azepine, thiazine, carbazole, indole pyridine, quinoline and isoquinoline, acridine, phenothiazine, pteridine, purines and pyrimidines**
Unit-4
Mechanism and stereochemistry **Substitution, elimination and addition reactions; oxidation and reduction, Ester formation and ester hydrolysis, Aromaticity, aromatic and Nucleophilic substitution (with appropriate examples; Woodward Hoffman rules and photocyclization,**
Unit-5
Asymmetric synthesis **Cram and Prelog rule, Chiral synthesis (with suitable examples) asymmetric epoxidation.**
Unit-6 Advances in organic chemistry: Review article/Research paper/MOOC

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

ame of The	**Advanced Biomedical Science Lab-I**				
Course Code	**MSBM5005**				
Prerequisite	**Higher Secondary Examination with Chemistry and Biology or Chemistry, Botany and Zoology or Biochemistry and Chemistry from a recognized Board in science stream with a minimum of 50 % marks in aggregate**				
Corequisite	**Students should have understanding of general chemistry and biology**				
Antirequisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

- **Course Objectives:** Supporting or strengthening theoretical knowledge.
- Experiencing the pleasure of discovery and development of their psycho-motor skills.
- Teaching how scientific knowledge may be used in daily life.
- Increasing creative thinking skills.
- Gains in scientific working methods and higher order thinking skills.
- Developing manual dexterity by using tools and equipment and allowing students to apply skills instead of memorizing.

Course Outcomes

CO1	**Display the various GLP with basic concentration problems**
CO2	**Construct various buffer solutions.**
CO3	**Handle extraction of enzymes using different sources**
CO4	**Measures the various factors affecting enzyme activity.**
CO5	**Perform the analysis of carbohydrates, Lipids and protein**
CO6	**Evaluation in research advances in laboratory experiments**

Text Book (s)

- G. Stehli**, The Microscope and How to Use It,** English edition, 1970.
- M. Sayer and A. Mansingh, PHI Learning. Measurement, Instrumentation and Experiment Design in Physics & Engineering, 2005.
- Aliofkhazraei, Mahmood, Handbook of Nanoparticles, Springer, 2016
- Huheey, J.E., Keiter, E.A., Keiter, R.L. & Medhi, O.K. Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Education India, 2006.
- Aneja KR. Experiments in Microbiology, Plant pathology and Biotechnology. 4th Edition, New Age International Publishers, Chennai. 2005
- Horold J Benson. Microbiological Applications. Laboratory Manual in General Microbiology. 7th International Edition, WCB McGraw – Hill, Boston. 1998
- Dubey RC and Maheswari DK. Practical Microbiology 1st Edition, S. Chand & Company Ltd., New Delhi. 2004

1. **Introduction to Biochemistry Laboratory**
2. **Brief review of analytical chemistry**
3. **Hydrogen ion concentration and preparation of Buffer**
4. **Diffusion, Adsorption and surface tension**
5. **General Tests for Carbohydrates**
6. **General Tests for Lipids**
7. **General Tests for Proteins**
8. **Salivary amylase activity**
9. **Isolation of enzyme**
10. **Effect of pH on enzyme activity**
11. **Effect of temperature on enzyme activity**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
50		50	100

SEMESTER-II

Name of The Course	**Immunology**				
Course Code	**MSDB5006**				
Prerequisite	**Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.**				
Corequisite	**Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.**				
Antirequisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives:

- The students will be able to identify the cellular and molecular basis of immune responsiveness.
- The students will be able to describe the roles of the immune system in both maintaining health and contributing to disease.
- The students will be able to describe immunological response and how it is triggered and regulated.

Course Outcomes

CO1	**Explain the basic concepts of Immunology.**
CO2	**Describe the working of adaptive immune response.**
CO3	**Demonstrate the types of vaccines and different immunological techniques.**
CO4	**Illustrate the genetic basis of immunology, transplant and tumor immunology.**
CO5	**Discuss the various types of immune system disorder**
CO6	**Evaluation of latest research and application of immunology against various diseases**

Text Book (s)

- Immunology, 6th edition, (2006), J. Kuby et al, W.H. Freeman and Company, New York. ISBN-13: 978-1429202114.
- Roitt"s Essential Immunology, 12th edition, (2011), Wiley-Blackwell Science. ISBN-13: 978-1405196833.
- Cellular and Molecular Immunology, 7th edition, (2011). Abul K. Abbas, Andrew H. Lichtman, Shiv Pillai. Saunders. ISBN-13: 978-1437715286.

Reference Book (s)

- Immunology, 6th edition, (2006), J. Kuby et al, W.H. Freeman and Company, New York. ISBN-13: 978-1429202114.
- Cellular and Molecular Immunology, 7th edition, (2011). Abul K. Abbas, Andrew H. Lichtman, Shiv Pillai. Saunders. ISBN-13: 978-1437715286.

Unit-1 Basic concepts of immunology (08 lectures)
Types of immunity; organs and cells involved in immune system; Antigen, haptens, adjuvants, antigenicity, antigenic determinants and epitopes; Antibodystructure and functions; Theories of antibody formation; Antibody diversity.

Unit-2 Complement system and adaptive immune response (10 lectures) **Complement system - components, nomenclature, activation of complement, complement receptors and alternate pathway; Antigen recognition - T cell and B cell receptor complexes, antigen processing and presentation; Interaction of T and B cells; Cytokines; Immunological memory; Cytotoxicity - immunotolerance, immunosuppression; Basic concepts of abzymes, immunotoxin, chimera, hybrid antibodies, antigen-antibody interactions**
Unit-3 Vaccines and immunological techniques (10 lectures) **Vaccines - Types and their characteristics; Immunization practices-immunoprophylaxis and immunotherapy. Immunological techniques - Affinity and avidity, cross reactivity, precipitation, agglutination, immunodiffusion, immunoelectrophoresis, ELISA (indirect, sandwich, competitive, chemiluminescence, and ELISPOT assay), immunofluorescence, flow cytometry and fluorescence, and immunoelectron microscopy.**
Unit-4 Genetic basis of immunology, transplantation and tumor immunology **(10 lectures)** **Major Histocompatibility Complex - Organization of MHC and inheritance in humans, concepts of polygeny and polymorphism with respect to MHC; Histocompatibility testing; Transplantation - types, genetics of transplantation, graft versus host reactions; Tissue matching and immuno suppressive agents; Tumor immunology - immune surveillance, tumor antigens, immune response to tumors, immunotherapy of tumors.**
Unit-5 Dysfunctions of the immune system (10 lectures) **Hypersensitivity - definition and classification, mechanism involved, diagnosis and treatment; Autoimmunity and autoimmune diseases - mechanism of development, diagnosis and treatment; Immunodeficiency disorders-B cell deficiencies, T cell deficiencies, secondary immunodeficiency diseases-pathogenesis, diagnosis and treatment of AIDS.**
Unit-6 Advances in Immunology: Review article/Research paper/MOOC

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Bioanalytical and microbial techniques**				
Course Code	**MSDB 5007**				
Prerequisite	**Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.**				
Corequisite	**Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.**				
Antirequisite					
		L	**T**	**P**	**C**

	4	0	0	4

Course Objectives:

- To provide the knowledge of the scientific instruments in life sciences and biotechnology along with the applications.
- This will enable the students to understand all the subjects of biological sciences as these tools and techniques will be used therein.
- Also acquire the basic knowledge of the microbiological techniques to be applied in the laboratory.
- To know the general microbiological techniques for isolation of pure cultures of microorganisms.

Course Outcomes

CO1	**Demonstrate the basic principles, working and applications of different microscopic techniques.**
CO2	**Demonstrate the principle and applications of centrifugation technique.**
CO3	**Illustrate the principle and functioning of electrophoresis and chromatography.**
CO4	**Evaluate the different types of spectroscopic techniques**
CO5	**Deduce fundamental concept of radioactivity and radioisotopic techniques**
CO6	**Evaluate the application of Bioanalytical and microbial techniques in various aspects**

Text Book (s)

- Physical Biochemistry: Principles and Applications (2010) 2nd ed., Sheehan, D., Wiley Blackwell (West Sussex), ISBN:978-0-470-85602-4 / ISBN:978-0-470-85603-1.
- Physical Biochemistry: Applications to Biochemistry and Molecular Biology (1982) 2nd ed., Freifelder, D., W.H. Freeman and Company (New York), ISBN:0-7167-1315-2 / ISBN:0-7167-1444-2.
- An Introduction to Practical Biochemistry (1998) 3rd ed., Plummer D. T., Tata McGraw Hill Education Pvt. Ltd. (New Delhi), ISBN:13: 978-0-07-099487-4 / ISBN:10: 0-07-099487-0.

Reference Book (s)

- Principles and techniques of biochemistry and molecular biology. 6th ed. Wilson, Keith, Walker, John M Cambridge; New York : Cambridge. ISBN-10: 9780521178747.
- An Introduction to Practical Biochemistry (1998) 3rd ed., Plummer D. T., Tata McGraw Hill Education Pvt. Ltd. (New Delhi), ISBN:13: 978-0-07-099487-4 / ISBN:10: 0-07-099487-0

Unit-1 Microscopy (08 lectures) **Light, electron (scanning and transmission), phase contrast, fluorescence microscopy, freeze-fracture technique, specific staining of organelles or marker enzymes.**
Unit-2 Viscosity and centrifugation (10 lectures) **Viscosity – Viscosity of macromolecules, relationship with conformational changes; Centrifugation – Principles of centrifugation, concepts of RCF, different types of instruments and rotors, preparative, differential and density gradient centrifugation, analytical ultra-centrifugation, determination of molecular weights and other applications, subcellular fractionation.**
Unit-3 : Electrophoresis and chromatography (08 lectures) **Electrophoresis - Moving boundary and zonal electrophoresis, paper and gel electrophoresis, isoelectric focusing; Chromatography -Principles of partition chromatography, paper, thin layer, ion exchange and affinity chromatography, gel permeation chromatography, HPLC and FPLC.**

Unit-4 Spectroscopy (08 lectures) **Spectroscopy - Concepts of spectroscopy, Visible and UV spectroscopy, Laws of photometry. Beer-Lambert's law, Principles and applications of colorimetry; Basic concepts and applications of MS, ORD, CD, X-ray diffraction, X-ray absorption, NMR.**
Unit-5 Radioisotopic techniques (08 lectures) **Nature of radioactivity, properties of α-, β-, and γ-rays; measurement of radioactivity, use of radioisotopes in research. In vivo and in vitro labeling techniques, double labeling, quenching, internal standard, channel ratio, external standard ratio, emulsion counting, radioactive decay, autoradiography**
Unit-6 Advances in Bioanalytical and microbial techniques : Review article/Research paper/MOOC

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Biotechnology and genetic engineering**				
Course Code	**MSDB 5008**				
Prerequisite	**Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.**				
Corequisite	**Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.**				
Antirequisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives:

The objective of the course is to familiarize the students with the basic concepts in genetic engineering; to acquaint the students to versatile tools and techniques employed in genetic engineering and recombinant DNA technology; and to appraise them about applications genetic engineering.

Course Outcomes

CO1	**Interpret the basic concept of animal and plant biotechnology using animal and of plant cell culture.**
CO2	**Demonstrate the isolation, purification of nucleic acid Construction DNA library and DNA sequencing.**
CO3	**Illustrate the various Gene transfer techniques.**
CO4	**Evaluate the concept of plant genetic Engineering, PCR and application of transgenic science in plant and animal improvement.**
CO5	**Analysis of gene therapy and stem cell therapy.**
CO6	**Evaluate the application of Biotechnology and genetic engineering in research and deployment**

Text Book (s)

- Principles of Gene Manipulations 1994 by Old and Primrose Blackwell Scientific Publications.
- DNA Cloning: A Practical Approach by D.M. Glower and B.D. Hames, IRL Press, Oxford. 1995.
- Molecular Biotechnology 2nd Edition by S.B. Primrose. Blackwell Scientific Publishers, Oxford. 1994.
- Genetic Engineering and Introduction to Gene Analysis and Exploitation in Eukaryotes by S.M. Kingsman and A.J. Kingsman, Blackwell Scientific Publications, Oxford 1998.

Reference Book (s)

- PCR Technology - Principles and Applications for DNA Amplification by Henry A. Erlich (Ed.) Stockton Press. 1989.
- Biotechnology: A Guide to Genetic Engineering by Peters.
- Genetic Engineering – 2000 by Nicholl.
- Recombinant DNA and Biotechnology: Guide for Teachers. 2nd Edition by Helen Kreuz. 2001. ASM Publications.
- Molecular Biotechnology: Principles and Applications of Recombinant DNA. 2 nd Edition. 1998 by Bernard R. Glick and Jack J. Pastemak, ASM Publications.

Unit-1 Introduction to animal and plant biotechnology (08 lectures) **Basic introduction to animal and plant biotechnology; types of plant tissue culture, germplasm conservation, Animal Biotechnology - organ culture; cell culture and initiation of cell culture; evolution of continuous cell lines.**
Unit-2 Construction of DNA libraries (08 lectures) **Isolation and purification of nucleic acid (genomic/plasmid DNA and RNA), Quantification and storage of nucleic acids, Construction of cDNA library, Construction of Genomic library, Screening and preservation of DNA libraries, DNA Sequencing and cloning strategies.**
Unit-3 Gene transfer techniques (06 lectures) **Gene transfer techniques: biological methods; chemical methods; physical or mechanical methods.**
Unit-4 Transgenics (10 lectures) **Plant Genetic Engineering: Restriction enzymes; Transformation of plant cells; different type of vectors including viral vectors and their benefits; Screening and selection of transformants, PCR and hybridization methods; Transgene selection and silencing; Generation and maintenance of transgenic plants, Bt cotton, golden rice and some others as examples; Application of transgenic science in plant and animal improvement.**
Unit-5 Gene therapy and stem cell (08 lectures) **Gene therapy: Introduction and Methods, Gene targeting and silencing, Gene therapy in the treatment of diseases, Challenges, future and ethical considerations in human gene therapy. Stem cells: Culture, identification, maintenance, characterization and proliferation heterogeneity.**
Unit 6: Resent advances in Biotechnology and genetic engineering: Review article/Research paper/MOOC

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The	**Physiology**				
Course Code	**MSBM5010**				
Prerequisite	**Higher Secondary Examination with Chemistry and Biology or Chemistry, Botany and Zoology or Biochemistry and Chemistry from a recognized Board in science stream with a minimum of 50 % marks in aggregate**				
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives:

Students are able to Understand the concept of digestion, Physiology of respiratory system, mechanism of breathing and its significance, function of kidney and heart, how they circulate blood in body and mind.

Course Outcomes

CO1	**Interpret the fundamentals of human gastrophysiology.**
CO2	**Illustrate the physiology of respiratory system**
CO3	**Demonstrate the physiology of cardiovascular system.**
CO4	**Evaluate of the physiology of renal system.**
CO5	**Analyze the neurophysiology**
CO6	**Evaluate the application of exercise physiology in treatment of various disease**

Text Book (s)

1.Guyton A.C, Hall J.E, Textbook of Medical Physiology, 11th Ed., Saunders Company, 2005.

2.Widmaier E. P, Raff H, Strang K. T. Vander's, Human Physiology : The mechanism of Body Function, 9th Ed. Mc. Graw Hill, 2003.

3.Ganong W. E, Review of Medical Physiology, 21st Ed., Mc. Graw Hill, 2003.

Reference Book (s)

1. Guyton A.C, Hall J.E, Textbook of Medical Physiology, 11th Ed., Saunders Company, 2005.

2. Widmaier E. P, Raff H, Strang K. T. Vander's, Human Physiology : The mechanism of Body Function, 9th Ed. Mc. Graw Hill, 2003.

UNIT I
Gastrophysiology **Digestion- Digestive processes at various regions of digestive system, Salivary Glands; types of salivary glands, composition of saliva, characteristics of Saliva, Transport and mixing of food in the alimentary tract, Ingestion of food. Motor functions of stomach Nervous Regulation of Salivary Secretion, Gastric gland, types of glands, Secretions from the Oxyntic (Gastric) Glands, regulation of Gastric Acid Secretion, Basic Mechanism of Hydrochloric Acid Secretion, Regulation of Pepsinogen Secretion, Pancreatic Digestive Enzymes, Regulation of Pancreatic Secretion, Secretion of Bile by the Liver, role of intestinal hormones in digestion, absorption in intestine.**
Unit-2
Respiratory Physiology **Functional anatomy of air passages and lung- respiratory muscles - Pulmonary ventilation: mechanisms of pulmonary ventilation, pulmonary volumes and capacities, alveolar ventilation, gas exchange in the lung's regulation of respiration. Surfactants, pulmonary edema and pleural fluid. Physical principles of gas exchange transport of oxygen and carbon dioxide in blood and body fluids. Regulation of respiration: respiratory centre, peripheral chemoreceptor system, central chemoreceptor system and their regulatory function.**
Unit-3
Cardiophysiology **Structure of heart, Functional anatomy of heart- genesis and spread of cardiac impulses, systemic circulation, pulmonary circulation, SA node as pacemaker, Self-excitatory nature of SA node, ectopic pace maker, Neuronal Regulation of heart contraction, Period of Isovolumic/isometric contraction, Period of ejection, End Diastolic volume, End systolic volume, Stroke volume, cardiac cycle- heart sounds- cardiac output - cardiovascular regulatory mechanisms – electrocardiogram. Microcirculation and lymphatic system, Cardiac output, venous return and their regulation.**
Unit-4
Renal Physiology **Structure of nephron- glomerular filtration- tubular reabsorption and secretion- formation of urine, Regulation of acid-base balance, Reabsorption and secretion along different parts of nephron, Regulation of tubular reabsorption. Determinants of glomerular filtration rate (GFR), Factor affecting GFR, Renal blood flow, Regulation of extracellular fluid osmolarity and sodium concentration.**
Unit-5
Neurophysiology **Nerve physiology - structure of neuron and synapse- excitability -action potential - conduction of nerve impulse- synaptic transmissions- neurotransmitter systems. Structure of Brain and functions of different areas of brain. Structure of cerebrum and Cerebellum, Cerebral Cortex: intellectual functions of brain, learning and memory. Functions of cortical areas including association areas. Muscle sensory receptors - muscle spindles and Golgi tendon organs and their roles in muscle control, Flexor reflexes and withdrawal reflexes. Function of brain in communication - language input and output. Thoughts, consciousness and memory. Functional anatomy and functions of limbic system and hypothalamus. Sleep. Slow-wave sleep. REM sleep. Basic theories of sleep. Brain waves. Origin in brain of brain waves (EEG). Epilepsy and its types.**
Unit 6: Resent advances in physiology: Review article/Research paper/MOOC

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of the course	**METABOLISM OF BIOMOLECULES**
Course Code	**MSBM5011**
Prerequisite	**Higher Secondary Examination with Chemistry and Biology or Chemistry, Botany and Zoology or Biochemistry and Chemistry from a recognized Board in science stream with a minimum of 50 % marks in aggregate**
Corequisite	**The basic knowledge of biomolecule like carbohydrate, protein amino acid structure and function**
Antirequisite	

L	T	P	C
4	0	0	4

Course Objectives: Students are able to understand the concept of metabolism of biomolecule.

Course Outcomes

CO1	**Explain the concept of energy production in the living cell.**
CO2	**Explain the fundamentals of carbohydrate metabolism.**
CO3	**Illustrate the process of synthesis and degradation of lipids.**
CO4	**Describe the metabolism of essential and non-essential amino acids.**
CO5	**Evaluate the metabolism of nucleotides.**

Text Book (s)

2. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13: 978-1-4641-0962-1 / ISBN:10:1-4292-3414- 8.
3. Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New York), ISBN:978-0-470-28173-4.

Reference Book (s)

1) Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13: 978-1-4641-0962-1 / ISBN:10:1-4292-3414- 8.
2) Biochemistry, 5th edition Jeremy M Berg, John L Tymoczko, and Lubert Stryer.
New York: W H Freeman; 2002. ISBN-10: 0-7167-3051-0

Unit- I
BIOENERGETICS **Laws of thermodynamics, free energy, exergonic and endergonic reactions, coupled reactions. High energy compounds - ATP, synthesis of ATP, ATP-ADP cycle, storage of high energy phosphates. Chemical basis of high standard energy of hydrolysis of ATP, PEP, 1,3-BPG and thioesters. Redox reactions, standard redox potentials and Nernst equation.**
Unit-2
CARBOHYDRATES METABOLISM **Major pathways of carbohydrate metabolism – Glycolysis, Gluconeogenesis, Pentose phosphate pathway, Glycogen metabolism and glycogen storage diseases; Minor pathways of carbohydrate metabolism – uronic acid pathway, metabolism of fructose and galactose, polyol pathway.**
Unit-3
LIPID METABOLISM **Synthesis and degradation of triacylglycerols, phospholipids, glycolipids, eicosanoids; Biosynthesis of fatty acids; Oxidation of fatty acids; Ketone bodies; Metabolism of cholesterol - biosynthesis, catabolism and regulation;Metabolism of lipoproteins.**
Unit-4
AMINO ACID METABOLISM **Biosynthesis and regulation of essential and non-essential aminoacids; Catabolism of individual aminoacids; Conversion of aminoacids to specialized products; Disorders associated with amino acid metabolism. Formation and detoxification of ammonia; Urea cycle– steps, regulation and disorders; Biosynthesis of polyamines– putrescine, spermidine and spermine**
Unit-5
NUCLEOTIDE METABOLISM **Purine metabolism – biosynthesis (de novo and salvage pathways), degradation, regulation and disorders of purine metabolism; Pyrimidine metabolism - biosynthesis (de novo and salvage pathways), degradation, regulation and disorders of pyrimidine metabolism.**
Unit 6: Resent advances in biomolecule metabolism: Review article/Research paper/MOOC

Continuous Assessment Pattern

Internal Assessment (IA)	**Mid Term Test (MTE)**	**End Term Test (ETE)**	**Total Marks**
30	**20**	**50**	**100**

Name of The course	**Advanced Biomedical Science Lab-II**				
Course Code	**MSBM5012**				
Prerequisite	**Higher Secondary Examination with Chemistry and Biology or Chemistry, Botany and Zoology or Biochemistry and Chemistry from a recognized Board in science stream with a minimum of 50 % marks in aggregate**				
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**

	4	**0**	**0**	**4**

Course Objectives:

- Supporting or strengthening theoretical knowledge.
- Experiencing the pleasure of discovery and development of their psycho-motor skills.
- Teaching how scientific knowledge may be used in daily life.
- Increasing creative thinking skills.
- Gains in scientific working methods and higher order thinking skills.
- Developing manual dexterity by using tools and equipment and allowing students to apply skills instead of memorizing.

Course Outcomes

CO1	**Display the various methods of sterilization.**
CO2	**Construct various culture media.**
CO3	**Handle pure culture techniques.**
CO4	**Perform the isolation and estimation of DNA, RNA.**
CO5	**Perform the blood grouping, agglutination inhibition Assay.**
CO6	**Evaluate the application of Metabolism of biomolecule in understanding of various pathway of biomolecule**

Text Book (s)

- G. Stehli**,** The Microscope And How to Use It, English edition, 1970.
- M. Sayer and A. Mansingh, PHI Learning. Measurement, Instrumentation and Experiment Design in Physics & Engineering, 2005.
- Aliofkhazraei, Mahmood, Handbook of Nanoparticles, Springer, 2016
- Huheey, J.E., Keiter, E.A., Keiter, R.L. & Medhi, O.K. Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Education India, 2006.
- Aneja KR. Experiments in Microbiology, Plant pathology and Biotechnology. 4th Edition, New Age International Publishers, Chennai. 2005
- Horold J Benson. Microbiological Applications. Laboratory Manual in General Microbiology. 7th International Edition, WCB McGraw – Hill, Boston. 1998
- Dubey RC and Maheswari DK. Practical Microbiology 1st Edition, S. Chand & Company Ltd., New Delhi. 2004

Reference Book (s)

- Aneja KR. Experiments in Microbiology, Plant pathology and Biotechnology. 4th Edition, New Age International Publishers, Chennai. 2005
- Horold J Benson. Microbiological Applications. Laboratory Manual in General Microbiology. 7th International Edition, WCB McGraw – Hill, Boston. 1998

Practical's	
1.	**Methods of sterilization.**
2.	**Preparation of culture media liquid, solid, slant and plate.**
3.	**Bacterial culture: establishing a pure culture; Spread plate, streak plate; Pour**

	Plate.
4.	**Gram staining techniques; identification of bacteria.**
5.	**Isolation and estimation of DNA.**
6.	**Isolation and estimation of RNA.**
7.	**To perform immuno-diffusion by Ouchterlony/ Mancini method.**
8.	**To perform ELISA experiment.**
9.	**Grouping of blood and Rh typing.**
10.	**To perform Agglutination inhibition Assay.**
11.	**Screening tests for inborn errors of metabolism.**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Research Methodology**				
Course Code	MBS28T2111				
Prerequisite	Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university				
Corequisite	Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.				
Antirequisite					
		L	**T**	**P**	**C**
		2			2

Course Objectives:

Course Outcomes

CO1	25. Understand the Principles of Scientific Research and different steps involved in doing research.
CO2	26. Know how to design research and frame up different steps in design.
CO3	27. Appraise the application of sampling through statistics.
CO4	28. Build up the method for data collection and analyse the data.
CO5	29. Develop the Concept of hypothesis preparation.
CO6	30. Develop the statistical analysis indulges in modern research for drug designing.

Text Books:

29. K. Ramakant; Elementary Statistics in a world of applications, Goodyear California Pub. Co.,1979.

30. K. D. Broota, Experimental designs in psychological research, Wiley eastern, New York, 1992.

31. Guilford, Statistics in Psychology and Education, McGraw hill, New York, 1986.

32. Katz and Kahn, Research in Behavioural Sciences, Methuen, USA, 1979.

Reference Books:

35. Kerlinger, F., Foundations of Behavioural Research, Surjeet Publications, Delhi, 1983.
36. Rajamanickam, M., Statistical Methods in Psychological and Educational Research, Concept Publishing Co. New Delhi, India, 1983.
37. Smith, Jonathan, A. (Ed.), Qualitative Psychology: A Practical Guide to Research Methods, Sage Publications, 2003.
38. Woodworth and Schlosberg, Experimental Psychology, Methuen and co. ltd, London, 1971.
39. Chanin Nantasenamat, Chartchalerm Isarankura-Na-Ayudhya, Thanakorn Naenna, Virapong Prachayasittikul, A Practical Overview of Quantitative Structure- Activity Relationship. EXCLI Journal 2009;8:74-88.
40. Wiktor Pronobis, Alexandre Tkatchenko, and Klaus-Robert Muller, J. Chem. Theory Comput. 2018, 14, 2991−3003
41. Leo, A., & Hoekman, D. H. (1995). *Exploring QSAR*. American Chemical Society.

Unit – 1: Principles of Scientific Research 6 Lectures

Research and research methodology, Procedures in research, Identification of the problem - Literature survey - Reference collection - Familiarity with ideas and concept of investigation - Qualitative and Quantitative analysis - Results - Synopsis writing - Art of writing a Research paper and Thesis.

Unit – 2: Research Design, Sampling & Probability 5-Lectures

Research Design: Features of a Good Design, Different Research Designs, Sampling: Principles, methods, types of sampling, rationale for using a particular sampling procedure, Probability: Classical definition of Probability.

Unit – 3: Data collection & analysis 6- Lectures

Types of Data, Collection of Data, double blind procedures, incidence and prevalence studies, Data Analysis: Measures of Central Tendency, Measures of Dispersion, Measures of Asymmetry,

Unit-4: Correlation and Regression 5-Lectures

Methods of correlation, Types of correlation (Pearson r& Rho); Regression analysis, linear regression, Non-linear regression.

Unit – 5: Hypothesis and Statistics 5-Lectures

Hypothesis Testing: Problems and hypothesis, variables and type of variables, Parametric and nonparametric statistics; level of significance, the various nonparametric tests with sample.

Module 6: Recent research advances

Descriptors, Quantitative structure-activity relationship (QSAR), Quantitative structure-property relationship(QSPR), Drug designing.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

SEMESTER-III

Name of The couse	**Genetics**				
Course Code	**MSDB6001**				
Prerequisite	**Higher Secondary Examination with Chemistry and Biology or Chemistry, Botany and Zoology or Biochemistry and Chemistry from a recognized Board in science stream with a minimum of 50 % marks in aggregate**				
Corequisite	**Basic concept of "Mendelian Genetics" and general Biology**				
Antirequisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives: : Students are able to understand the concept of genetics.

Course Outcomes

CO1	**Description of basic concept of "Mendelian Genetics"**
CO2	**Evaluation of "Deviations from Mendelian Genetics"**
CO3	**Illustration of Linkage and crossing over.**
CO4	**Evaluation of Human genetics.**
CO5	**Analyse the various aspects in the area of population genetics**
CO6	**Evaluate the application of genetics in improvement of animal, plant and human races development and treatment of various disease**

Text Book (s)

Benjamin A. Pierce. 2003. Genetics: A Conceptual Approach. W.H, Freeman and Company, New York,

2)NY. Gardner E.J., Simmons, M.J., and Snustad, D.P. 1991. Principles of Genetics, (8th edition) John Wiley & Sons Inc., New York.

3) Griffith A.F. J., Miller, J.H, Suzuki, D.T., Lewontin, R.C., Geibart., W.M, 1993. An Introduction to Genetic analysis (7th edition). W.H Freeman & Company, New York.

Reference Book (s)

1.NY. Gardner E.J., Simmons, M.J., and Snustad, D.P. 1991. Principles of Genetics, (8th edition) John Wiley & Sons Inc., New York.

2. Klung, W. and Cummings, M. R 2003. Concepts of Genetics. (7thedition) Pearson Education, Singapore.

Uint- I
Introduction to Mendelian Genetics **Genetic terminology: Definition of genetics, Gene, Alleles, Homozygous and Heterozygous, Genotype and Phenotype, Dominant and recessive, Mendelian Laws of inheritance: Law of Dominance, Law of segregation, Law of independent Assortment. Results of Genetic crosses by various methods including Test cross and Back cross, Difference between complementary gene and duplicate gene.**
Unit-2

Deviations from Mendelian Genetics **Codominance, incomplete dominance, gene interactions: Epistasis, Dominant epistasis and recessive Epistasis or supplementary gene, Multiple alleles, Lethal alleles, Cytoplasmic inheritance, Genomic imprinting in mice, human disorders related to imprinting, Prader-Willi and Angelmen syndrome, Molecular basis of Epigenetic regulation in H19 and Igf2 region, histone modification marks, Position effect variegation., penetrance and expressivity, probability.**
Unit-3
Linkage and crossing over **Genetic linkage and gene mapping, Linkage group, Recombination, Crossing over, Determination of frequency of crossing over, calculation of Map distance, Chromosomal basis of Sex determination, Genetic balance theory of Sex determination, sex linked inheritance, Sex Influenced inheritance, Sex limited inheritance, Pleiotropy,**
Unit-4
Human genetics **Chromosomal anomalies including autosomal and sex chromosomal, genetic disorders; Albinism, phenylketonuria, alkaptonuria, Types of mutations i.e. point mutations, deletions, rearrangements, insertions, dynamic mutations (repeat expansions) with appropriate examples.**
Unit-5
Population Genetics **Definition, aim and scope of population genetics, population structure, factors maintaining population boundaries, effective breeding size, gene pool, Hardy-Weinberg equilibrium, Deviation of the Hardy-Weinberg Law, Human polymorphism (transient and balanced), relationship between sickle cell polymorphism and malaria, other polymorphism that may be an adaptation to malaria e.g. G6PD deficiency.Duffy blood groups, thalassemia and haptoglobins. X linked polymorphism (G6PD and color blindness).**
Unit 6: Resent advances in Genetics: Review article/Research paper/MOOC

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	30	50	100

Name of The Course	**MEDICAL AND PHARMACEUTICAL MICROBIOLOGY**				
Course Code	**MSDB6002**				
Prerequisite	**Graduation life science and applied science from any recognized university or equivalent examination with a minimum of 50 % marks in aggregate.**				
Corequisite	**Basic knowledge of microbiology and biology.**				
Antirequisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives:

Student will understand basic principles and various mechanism infections and control of disease. The course will also focus on many etiological agents responsible for global infectious diseases. The course will provide the conceptual basis for understanding pathogenic microorganisms and their pathogenicity. It will also provide the basic concept of role of microorganism in pharma industry.

Course Outcomes

CO1	**Get general information about various mechanisms of infection and control measures of diseases**
CO2	**Evaluation of methods used to identify infectious agents in the clinical microbiology lab**
CO3	**Explain general and specific mechanisms of different bacterial, viral and fungal infection.**
CO4	**Identify the role of microorganism in pharma industry**
CO5	**Ideas on the regulatory aspect, quality assurance and validation in microbiological labs**
CO6	**Evaluate the application and significance of Medical and pharmaceutical microbiology**

Text Book (s)

6. Chaechter M. Medoff G. and Eisenstein BC. (1993) Mechanism of Microbial Diseases 2nd edition. Williams and Wilkins, Baltimore.
7. Collee, JG. Duguid JP, Fraser AG, Marimon BP. (1989) Mackie and Mc Cartney Practical Medical Microbiology, 13th Edition. Churchill Livingstone.
8. David Greenwood, Richard CD, Slack, John Forrest Peutherer. (1992) Medical Microbiology. 14th edition. ELBS with Churchill Livingstone.
9. Hugo WB and Russell AD. (1989) Pharmaceutical Microbiology IV edition. Blackwell Scientific Publication, Oxford.
10. Joan Stokes E, Ridgway GL and Wren MWD. (1993). Clinical Microbiology, 7th edition. Edward Arnold. A division of Hodder and Stoughton.

Reference Book (s)

4. Baron EJ, Peterson LR and Finegold SM (1994). Bailey and Scott's – Diagnostic Microbiology. 9th Edition, Mosby Publications.
5. Topley & Wilsons (1995). Principles of Bacteriology, Virology and Immunology, Edward Arnold, London.
6. Morag C 7 MC Timbury (1994). Medical virology. 10th Edition, Churchill Livingstone, London. 4. Patric R Murray (1990). Medical Microbiology. Mosby Publications.

Unit-1 BASICS IN MEDICAL MICROBIOLOGY 8 hours
Infectious diseases overview. Medically important microbes. Microbial diseases - sources, route of transmission. Pathogenesis, Microbial virulence and virulence factors - Signs and symptoms of microbial diseases. Treatment, Prevention and control of microbial infections. Immunity of microbial diseases.
Unit-2 DIAGNOSIS OF MICROBIAL DISEASES 8 hours
• Collection, transport and preliminary processing of clinical pathogens. Clinical, microbiological, immunological and molecular diagnosis of microbial diseases. Modern methods of microbial diagnosis.
Unit-3 BACTERIOLOGY, VIROLOGY, MYCOLOGY 8 hours
Characteristics, diagnosis, treatment, prevention and control of diseases caused by Bacteria, DNA, RNA Virus, Human mycotic infections, parasites, Laboratory techniques in parasitology.
Unit-4 ANTIBIOTICS, SYNTHETIC ANTIMICROBIAL AGENTS AND ACTION MECHANISM OF ANTIBIOTICS 10 hours
Antibiotics and synthetic antimicrobial agents,Antifungal antibiotics. Peptide antibiotics, Chloramphenicol, Sulphonamides and Quinolinone antimicrobial agents. Chemical disinfectants, antiseptics and preservatives, Mechanism of action of antibiotics (inhibitors of cell wall synthesis, nucleic acid andprotein synthesis). Bacterial resistance to antibiotics, Penetrating defenses – How the

antimicrobial agents reach the targets (cellular permeability barrier, cellular transport system and drug diffusion).	
Unit-5 REGULATORY PRACTICES, QUALITY ASSURANCE	**10 hours**
Financing R&D capital and market outlook. IP, BP, USP., Government regulatory practices and policies, FDA perspective, Application of microbial enzymes in pharmaceuticals, Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) in pharmaceutical industry. Regulatory aspects of quality control. Quality assurance and quality management in pharmaceuticals ISO, WHO and US, Certification, Sterilization control and sterility testing, Safety in microbiology laboratory.	
Unit 6: Resent advances in Medical and pharmaceutical microbiology: Review article/Research paper/MOOC	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**SUMMER TRAINING**				
Course Code	**MSBM6003**				
Prerequisite	**Graduation life science and applied science from any recognized university or equivalent examination with a minimum of 50 % marks in aggregate.**				
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		0	**0**	**0**	**3**

Course Objectives:

The course will develop the skill and introduce the students to exciting basic techniques of microbiology, fermentation technology and Biosensors. Student will learn to organize the experiments, collection of results and interpretation of results and analysis. The course will also emphasize on the knowledge and understanding the research process.

Course Outcomes

CO1	**Demonstrate the use of knowledge of basic and applied sciences in project based learning.**
CO2	**Organizes experiments and researches, perform analysis and interpret data for the designed project.**
CO3	**Cooperate effectively as an individual and as a member in the research team.**
CO4	**Systematize the articulated ideas, comprehend and write effective reports, documentation and to communicate effectively.**
CO5	**Demonstrate knowledge and understanding of research problems and related principles to manage projects in multidisciplinary research areas.**

COURSE CONTENTS:

Summer Training is considered as a special course involving application of knowledge in solving / analyzing /exploring a real life situation / difficult problem. Summer training work may be given in lieu of a discipline specific elective paper/Biochemistry.This should be done in consultation with the faculty supervisor and agency supervisor under whom he / she is getting trained. The project report should be around 40 pages and chaptered as follows:

Chapter I: Introduction
Chapter II: Review of Literature
Chapter III: Methodology
Chapter IV: Results
Chapter V: Discussion
Chapter VI: Summary and Conclusion

The following weightage is assigned at each stage of Student Project evaluation.

Activity	Remarks
Zeroth Reveiw	**Project scopes and Proposal**
1st Review	Methods of project Implementation
2nd Review	Technical Achievement
3rd Review (Final)	Innovation and contribution
Submission of Project Report to the Department	Two weeks before the viva-voce exam

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
50	**-**	**50**	**100**

Name of The	**Pharmacology and Toxicology**				
Course Code	**MSBM6004**				
Prerequisite	**Higher Secondary Examination with Chemistry and Biology or Chemistry, Botany and Zoology or Biochemistry and Chemistry from a recognized Board in science stream with a minimum of 50 % marks in aggregate**				
Corequisite	**Concept of general biology and chemistry**				
Antirequisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives: To understand the basic concept of pharmacology and it can be applied in various aspect of life like drug designing in pharmaceutical industry and research laboratories.

Course Outcomes

CO1	**Explain the basic concepts of pharmacology.**
CO2	**Infer the process of pharmacokinetics and pharmacodynamics.**
CO3	**Illustrate the classes of drugs acting on the different systems of the body.**
CO4	**Interpret the toxicity in different organs.**
CO5	**Discuss the neural toxicity in CNS.**
CO6	**Evaluate the application of Pharmacology and Toxicology in drug development and toxicology research**

Text Book (s)

1.Essentials of Medical Pharmacology, 7thedition (2010), K.D. Tripathi, Jaypee Brothers, ISBN: 9788184480856.

2.Pharmacology, 7th edition (2011), H.P. Rang, M.M. Dale, J.M. Ritter and P.K. Moore, Churchill Livingstone. ISBN: 9780702045042.

3.Hand book of Experimental Pharmacology, 4thedition (2012), S.K. Kulkarni, VallabhPrakashan, 2012. ISBN 13: 9788185731124.

Reference Book (s)

1.Essentials of Medical Pharmacology, 7thedition (2010), K.D. Tripathi, Jaypee Brothers, ISBN: 9788184480856.

UNIT I
General Pharmacology **Nature and Source of drugs, Routes of drug administration and their advantages, receptor and receptor subtypes. Measurement of TD 50/ TC 50 and LD 50/ LC 50.**
Unit-2
Pharmacokinetics and Pharmacodynamics **Absorption, Distribution, Metabolism and Excretion (ADME) of drugs and chemicals bioavailability, Biological half-life of drug and its significance, Drug-drug interactions. Principles and mechanism of drug action, Factors affecting drug action.**
Unit-3
Introduction and classification of drugs: **Drugs acting on central and autonomic nervous system, neurotoxic agents. Cardiovascular system and cardiotoxic agents. Kidney and nephrotoxic agents. Anti-inflammatory and analgesic drugs. Endocrine drugs. Antimicrobial chemotherapeutic drugs.**
Unit-4
Organ toxicities **Hepatotoxicity: A brief description of morphological and functional aspects of liver with special reference to hepatotoxicity, various hepatotoxic agents, types of liver injuries- Fatty liver formation, Necrosis, Cholestasis, Hepatitis, Fibrosis, Cirrhosis, Carcinogenesis. Nephrotoxicity: A brief description of morphological and functional aspects of kidney in relation of nephrotoxicity, nephrotoxic agents, Detailed mechanisms of chemical induced nephrotoxicity. Cardiovascular toxicity: A brief description of mechanisms of cardiovascular toxicity and cardiotoxic agents-subcellular and biochemical mechanisms.**
Unit-5
Neurotoxicity: A brief description neurotoxic agents and types of neurotoxic effects- Axonopathy, Neuropathy, Neuronopathy, Mylenopathy. Broncho-pulmonary (inhalation) toxicity. Gastro-intestinal toxicity. Skin toxicity/ photosensitivity. Tests for evaluation of toxicities in different organs. Therapeutic aspects: General measures and treatment of poisoning cases, Specific antidotes, Agents of first choice, Contraindications

Unit 6: Resent advances in Pharmacology and Toxicology: Review article/Research paper/MOOC

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Principles of Medicinal Chemistry	**Principles of Medicinal Chemistry**				
Course Code	**MSBM6005**				
Prerequisite	**Higher Secondary Examination with Chemistry and Biology or Chemistry, Botany and Zoology or Biochemistry and Chemistry from a recognized Board in science stream with a minimum of 50 % marks in aggregate**				
Corequisite	**General concept of Pharmacology and organic chemistry**				
Antirequisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives: Students are able to understand the concept of medicinal chemistry and can work in pharmaceutical company. They can synthesize the various antimicrobial drugs and understand the interaction between molecules using the concept of drug designing and molecular modelling .

Course Outcomes

CO1	**Interpret the classification of drug targets.**
CO2	**Explain the Physiochemical properties of drug action.**
CO3	**Discuss the Drug receptor interactions.**
CO4	**Analyze the principles of drug designing.**
CO5	**Summarize the drug discovery and pharmainformatics.**
CO6	**Evaluation of Principles of Medicinal Chemistry in drug development**

Text Book (s)

1. Introduction to Medicinal Chemistry, 4th edition (2009), Graham l. Patrick, Oxford University Press. ISBN-13: 978-0199234479.
2. The Organic Chemistry of Drug Design and Drug Action, 2nd edition (2004), Richard B. Silvermann, Elsevier, Academic Press. ISBN-13: 978-0126437324.
3. Medicinal Chemistry: A Molecular and Biochemical Approach, 3rd edition (2005), Thomas Nogrady and Donal F. Weaver, Oxford University Press. ISBN-13: 978-0195104561.

Reference Book (s)

1. Medicinal Chemistry: A Molecular and Biochemical Approach, 3rd edition (2005), Thomas Nogrady and Donal F. Weaver, Oxford University Press. ISBN-13: 978-0195104561.

UNIT I
DRUG TARGET RECEPTOR **Definition and scope of drug design. Proteins as drug targets: Receptors - receptor role, ion channels, membrane bound enzyme activation, agonist and antagonists, concept of inverse agonist, desensitization and sensitization of receptors, affinity, efficacy and potency. Enzymes - Enzyme inhibitors (competitive, non-competitive, suicide inhibitors), medicinal use of enzyme inhibitors. Nucleic acids as drug targets: Classes of drugs that interact with DNA: DNA intercalators and DNA alkylators.**
Unit-2
PHYSICOCHEMICAL PRINCIPLES OF DRUG ACTION **Partition coefficient, drug dissolution, acid-base properties, surface activity, bioavailability, stereochemical aspects of drug action.**
Unit-3
DRUG RECEPTOR INTERACTIONS **Kinetic analysis of ligand receptor interactions using scatchard plot, double reciprocal plot, Hill plot, forces involved, relationship between dose and effect (graded and quantal response).**
Unit-4
PRINCIPLES OF DRUG DESIGN **Introduction to SAR, strategies in the search for new lead compounds, analogue synthesis versus rational drug design, concept of prodrugs.**
Unit-5
DRUG DISCOVERY AND PHARMAINFORMATICS **Drug discovery pipeline, drug target identification and validation for microbial pathogen, selection of gene unique to the pathogen, screening for its presence in other microbes and human host, Drug Databases, PubChem, Calculating drug-like properties, introduction to rational drug design methods, optimization of lead compounds, protein 3D structure and binding site analysis, similarity based virtual screening using online tools.**
Unit 6: Resent advances in Principles of Medicinal Chemistry: Review article/Research paper/MOOC

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The	**BIOMEDICAL SCIENCES LAB - III**				
Course Code	**MSBM6007**				
Prerequisite	**Higher Secondary Examination with Chemistry and Biology or Chemistry, Botany and Zoology or Biochemistry and Chemistry from a recognized Board in science stream with a minimum of 50 % marks in aggregate**				
Corequisite	**Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.**				
Antirequisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives:

- Supporting or strengthening theoretical knowledge.
- Experiencing the pleasure of discovery and development of their psycho-motor skills.
- Teaching how scientific knowledge may be used in daily life.
- Increasing creative thinking skills.
- Gains in scientific working methods and higher order thinking skills.
- Developing manual dexterity by using tools and equipment and allowing students to apply skills instead of memorizing.

Course Outcomes

CO1	**Demonstrate the basic principle and applications of important instruments**
CO2	**Construct various buffer solutions.**
CO3	**Handle extraction of enzymes using different sources**
CO4	**Measures the various factors affecting enzyme activity.**
CO5	**Perform the analysis of carbohydrates, Lipids and protein**
CO6	**Evaluation in research advances in laboratory experiments**

Practical's

1. **Study of the life history of the following scientists and their contributions with the help of their photographs: Anton von Leeuwenhoek, Edward Jenner, Louis Pasteur, Robert Koch and Alexander Fleming.**
2. **To study the principle and applications of important instruments (Microscope, biological safety cabinets, autoclave, BOD incubator and hot air oven) used in the microbiology laboratory.**
3. **Cleaning and preparation of glassware for sterilization.**
4. **Qualitative analysis of carbohydrates in given solution.**
5. **Qualitative analysis of lipids in given solution.**
6. **Qualitative analysis of amino acid and protein present in the given solution.**
7. **Demonstration of different stages of mitosis.**
8. **Demonstration the different stages of meiosis.**
9. **Salivary amylase activity**
10. **Effect of pH on enzyme activity**
11. **Effect of temperature on enzyme activity**
12. **Isolation and estimation of DNA.**

13. **Isolation and estimation of RNA.**

Text Book (s)

- G. Stehli**, The Microscope And How to Use It,** English edition, 1970.
- M. Sayer and A. Mansingh, PHI Learning. Measurement, Instrumentation and Experiment Design in Physics & Engineering, 2005.
- Aliofkhazraei, Mahmood, Handbook of Nanoparticles, Springer, 2016
- Huheey, J.E., Keiter, E.A., Keiter, R.L. & Medhi, O.K. Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Education India, 2006.
- Aneja KR. Experiments in Microbiology, Plant pathology and Biotechnology. 4th Edition, New Age International Publishers, Chennai. 2005
- Horold J Benson. Microbiological Applications. Laboratory Manual in General Microbiology. 7th International Edition, WCB McGraw – Hill, Boston. 1998
- Dubey RC and Maheswari DK. Practical Microbiology 1st Edition, S. Chand & Company Ltd., New Delhi. 2004

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Reference Book (s)

- Aliofkhazraei, Mahmood, Handbook of Nanoparticles, Springer, 2016
- Huheey, J.E., Keiter, E.A., Keiter, R.L. & Medhi, O.K. Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Education India, 2006.
- Kannan N. Handbook of Laboratory Culture Media, Reagents, Stains and Buffers. Panima Publishing Corporation, New Delhi. 2003
- Kalaichelvan PT. Microbiology and Biotechnology – A Laboratory Manual 1st Edition, MJP Publishers, A Unit of Tamil Nadu Book House, Chennai. 2005.
- Chellam Rajamanicam – Experiments Protocols in Basic Molecularbiology. Osho Scientific Publications, Madurai

SEMESTER IV

Name of The Course	**DISSERTATION**				
Course Code	**MSMB9999**				
Prerequisite	**Graduation life science and applied science from any recognized university or equivalent examination with a minimum of 50 % marks in aggregate.**				
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		0	**0**	**0**	**16**

Course Objectives:

The course will develop the skill and introduce the students to exciting basic techniques of microbiology, fermentation technology and Biosensors. Student will learn to organize the experiments, collection of results and interpretation of results and analysis. The course will also emphasize on the knowledge and understanding the research process.

Course Outcomes

CO1	**Demonstrate the use of knowledge of basic and applied sciences in project based learning.**

CO2	**Organizes experiments and researches, perform analysis and interpret data for the designed project.**
CO3	**Cooperate effectively as an individual and as a member in the research team.**
CO4	**Systematize the articulated ideas, comprehend and write effective reports, documentation and to communicate effectively.**
CO5	**Demonstrate knowledge and understanding of research problems and related principles to manage projects in multidisciplinary research areas.**
CO6	**Evaluate the application of dissertation work in research**

Project work/Dissertation is considered as a special course involving application of knowledge in solving / analyzing /exploring a real life situation / difficult problem. A Project/Dissertation work may be given in lieu of a discipline specific elective paper/Microbiology. This should be done in consultation with the faculty supervisor and agency supervisor under whom he / she is getting trained. The project report should be around 100 pages and chaptered as follows:

Chapter I: Introduction
Chapter II: Review of Literature
Chapter III: Methodology
Chapter IV: Results
Chapter V: Discussion
Chapter VI: Summary and Conclusion

The research should be original and should be action oriented in that the results should be able to throw light on some of the important unexplored areas that would be of practical use to the forensic experts.
Students are expected to decide on the specific project area and title, and carry out substantial portion of the literature survey during the end of their 3rd semester. After the end of their 3rdsemester ETEs, each student will be asked to make presentation about the project including literature available, objective sought and work plan including methodologiesto the Student Project Monitoring Committee constituted by the Division Chair. The Project Work may be a work based on theoretical analysis, modeling & simulation, experimentation & analysis, prototype design, fabrication of new equipment, correlation and analysis of data, etc. or a combination of these. The final project report will be evaluated by a panel of examiners consisting of Dean, DC, PC, supervisor and Co-supervisor (wherever applicable) and an External Examiner. Viva-voce examination for the same will be conducted.
The following weightage is assigned at each stage of Student Project evaluation.

Review #	Agenda	Description	Marks weightage	Rubric	PO
Zeroth Review	Project scopes and Proposal		10	R1	
Review I	Methods of project Implementation		10	R2	
Review II	Technical Achievement		15	R3	
Review III	Innovation and contribution		15	R4	
Final Evaluation (External evaluation)	Overall achievement		30	R5	
	Project Report Evaluation		20	R6	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
50	**-**	**50**	**100**

Programme Electives

Name of The Course	**COMPUTATIONAL BIOLOGY**				
Course Code	**MSDB6019**				
Prerequisite	**Graduation life science and applied science from any recognized university or equivalent examination with a minimum of 50 % marks in aggregate.**				
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives:

The student will understand the connections between computes and engineering with biology. It is an interdisciplinary course. The students will gain an understanding of the computational challenges (and their solutions) in the analysis of large biological data. Also, they will understand the commonly used bioinformatics tools work and evaluate research articles in the field.

Course Outcomes

CO1	**Understand about the computers, Logic Development and Program Development Tools, Operations and Expressions.**
CO2	• **Interpret theapplications of Pointers, Initializing Pointers,** • **Creating the data files.**
CO3	• **Express the knowledge in the area of C.**
CO4	**Express the knowledge in the area of C++.**
CO5	**Explain the fundamentals of PERL.**

Text Book (s)

9. P KanetkarYashvant, Let us C, BPB Publications, New Delhi, Seventh Edition.
10. E. Balagurusami, Programming in ANSI C, Tata McGraw Hill, Fourth Edition.
11. Schaum Outline Series,Programming in C.
12. HerbtzSchildt, "C++: The Complete Reference", Fourth Edition, McGrawHill.
13. John R. Hubbard, "Programming with C++", Schaum's Series, 2nd Edition,2000.
14. 1. Programming in ANSI C (4th Ed.) by E. Balagurusamy. Tata McGrawHill Publishing Company Limited. 2007
15. 2. Object Oriented Programming using C++ (4th Ed.) by Lafore, R. Sams Publishers. 2002
16. Beginning PERL for Bioinformatics by James Tisdall. O'Reilly publications.2001.

Reference Book (s)

5. E. Balagurusami, Programming in ANSI C, Tata McGraw Hill, Fourth Edition.
6. Schaum Outline Series,Programming in C.
7. HerbtzSchildt, "C++: The Complete Reference", Fourth Edition, McGrawHill.
8. John R. Hubbard, "Programming with C++", Schaum's Series, 2nd Edition,2000.

Unit-1 INTRODUCTION TO COMPUTERS 10 hours
• Units of computers, Block Diagram, Generation of Computers, Characteristics of Computers, Phases of Computers, Different types of Memory, Input and Output Devices. • Logic Development and Program Development Tools: Data Representation, Flowcharts, Problem Analysis, Decision Trees/Tables, Pseudo Code and Algorithms, Program Debugging, Compilation and Execution. • Fundamentals: Character Set, Identifiers and Key Words, Data Types, Constants, Variables, Expressions, Statements, Symbolic Constants. Operations and Expressions: Arithmetic Operators, Unary Operators, Relational Operators, Logical Operators, Assignment and Conditional Operators, Library functions.
Unit-2 PROCEDURAL CONCEPT 8 hours
Structured Programming – Built-in library function – User defined functions – Pointer introduction – Passing pointer in a function – Structure – Union – File handle: Read and Write character from a file
Unit-3 PROGRAMMING IN C: C LANGUAGE 10 hours
Introduction – Tokens – Keywords, Identifier, Variables, Constants, Operators – Expression – Data types –Operator precedence - Statement: Input statement, Output statement, Conditional and Unconditional Control Statement – Looping Statement: while, do-while, for – nested loop – Arrays.
Unit-4 OBJECT ORIENTED PROGRAMMING: PROGRAMMING IN C++ 10 hours
C++ programming – Object Oriented Concept: Encapsulation, Inheritance, Polymorphism – Different forms of Constructor – Destructor – Abstract class – Virtual function
Unit-5 PERL 10 hours
Basic Perl Data Types, References, Matrices, Complex/Nested Data Structures, Scope: my, local, our – Function/Subroutines, System and User Function, File handle and File Tests – stat and l stat Functions – Perl
Unit 6: Resent advances in INTRODUCTION TO COMPUTERS 4hours : Review article/Research paper/MOOC

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**BIOETHICS, BIO-SAFETY AND IPR**				
Course Code	**MSDB6020**				
Prerequisite	**Graduation life science and applied science from any recognized university or equivalent examination with a minimum of 50 % marks in aggregate.**				
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives:

The student will understand the fundamentals of the ethical theories and principles that apply to bioethical dilemmas. The students will gain the knowledge to identify the potential hazardous biological materials and its risk associated with them. This course will also give the fundamental knowledge of intellectual property right.

Course Outcomes

CO1	**Understanding on basic principles of bioethics.**
CO2	**Evaluation of the process of biosafety levels**
CO3	**Evaluation of the process of IPR**
CO4	**Illustration of patent and licensing process**
CO5	**Illustration of regulatory aspects of QC, QA, and QM**
CO6	**Evaluate the application of Bioethics biosafety and IPR in research**

Text Book (s)

- Fleming, D.A., Hunt, D.L., (2000). Biotechnology and Safety Assessment (3rd Ed) Academic press.ISBN-1555811804,9781555811808.
- Thomas, J.A., Fuch, R.L. (1999). Biotechnology and safety assessment (3rd Ed). CRC press, Washington. ISBN: 1560327219, 9781560327219
- Law and Strategy of biotechnological patents by Sibley. Butterworth publication.(2007) ISBN: 075069440, 9780750694445.
- Intellectual property rights- Ganguli-Tat McGrawhill. (2001) ISBN-10: 0074638602,
- Intellectual Property Right- Wattal- Oxford Publicatiopn House.(1997) ISBN:0195905024.
- Biotechnology - A comprehensive treatise (Vol. 12). Legal economic and ethical dimensions VCH. (2nd ed) ISBN-10 3527304320.
- Encyclopedia of Bioethics 5 vol set, (2003) ISBN-10: 0028657748.
- Thomas, J.A., Fuch, R.L. (2002). Biotechnology and safety Assessment (3rd Ed) Academic press.
- B.D. Singh. Biotechnology expanding horizons.
- H.K.Das. Text book of biotechnology 3rd edition.

Reference Book (s)

Unit-1 INTRODUCTION AND PRINCIPLE OF BIOETHICS	**10 hours**
Biotechnology and social responsibility, public acceptance issues in biotechnology, issues of access, ownership, monopoly, traditional knowledge, biodiversity, benefit sharing, environmental sustainability, public vs private funding, biotechnology in international relations, globalization and development divide. Introduction to bioethics: Social and ethical issues in biotechnology. Principles of bioethics. Ethical conflicts in biotechnology- interference with nature, unequal distribution of risk and benefits of biotechnology, bioethics vs business ethics.	

Unit-2 BIOSAFETY 10 hours
Biosafety: Definition of bio-safety, Biotechnology and bio-safety concerns at the level of individuals, institutions, society, region, country and world with special emphasis on Indian concerns. Biosafety in laboratory institution: laboratory associated infection and other hazards, assessment of biological hazards and level of biosafety. Bio safety regulation: handling of recombinant DNA products and process in industry and in institutions (Indian context).
Unit-3 INTELLECTUAL PROPERTY PROTECTION 8 hours
Introduction to IPR: IPR, forms of IPR and Intellectual property protection. Concept of property with respect to intellectual creativity, Tangible and Intangible property. WTO: agency controlling trade among nations, WTO with reference to biotechnological affairs, TRIPs. WIPO, EPO.
Unit-4 PATENT AND LICENCING 10 hours
Concept related to patents novelty, non-obviousness, utility, anticipation, prior art etc. Type of patents. Indian patent act and foreign patents. Patentability, Patent application, Revocation of patent, Infringement and Litigation with case studies on patent, Commercialization and Licensing.
Unit-5 QUALITY ASSURANCE AND VALIDATION 12 hours
Regulatory aspects of QC, QA, and QM. GMP, GLP and CMP in Pharma Industry. ISO, WHO, USFDA certification. Microbial Limit test of Pharma products. Sterility testing, pyrogen testing and LAL test of Sterile Pharma products. Sterilization- heat, D- value, Z-value and survival curve, radioactive, gaseous and filtration. Chemical and biological indicators. Designing layout for microbiology laboratory.
Unit 6: Resent advances in Bioethics, Biosafety and IPR: Review article/Research paper/MOOC 4 hours

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**TOXICOLOGY**				
Course Code	**MSDB6021**				
Prerequisite	**Graduation life science and applied science from any recognized university or equivalent examination with a minimum of 50 % marks in aggregate.**				
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives:

The students will learn to apply their knowledge of basic toxicokinetic principles and metabolic systems to elucidate mechanisms of toxicity induced by xenobiotic compounds. In addition, they will learn basic principles of omics-based approaches and methodologies, and how such data can be integrated to assess and predict adverse effects of chemical exposures across multiple levels of biological complexity.

Course Outcomes

CO1	**Discuss the various routes of toxic exposure and response.**
CO2	**Evaluate the process of evaluation of toxicity.**
CO3	**Explain the fate of xenobiotics in the physiological system.**
CO4	**Summarize the various toxic agents.**
CO5	**Discuss the different eco-toxicological effects.**
CO6	**Evaluate the application toxicology in treatment of toxic molecules**

Text Book (s)

- Cassarett and Doull‟s Toxicology "The Basic Science of The Poisons" 7th edition (2008), Curtis D. Klaassen Editor, McGrawHill Medical. ISBN: 9780071470513.
- Cassarett and Doull‟s "Essentials of Toxicology" 2nd edition (2010), Klaassen and Whatkins, McGraw Hill Publisher. ISBN-13: 978-0071622400.
- Introduction to Toxicology, 3rd edition (2001), John Timbrell, Taylor and Francis Publishers. ISBN 13: 9780415247627.
- Principles of Toxicology, 2nd edition (2006), Stine Karen and Thomas M Brown, CRC press. ISBN-13: 978-0849328565.
- Lu‟s basic toxicology: Fundamentals target organ and risk assessment, 5th edition (2009), Frank C Lu and Sam Kacow, Informa Health care. ISBN: 9781420093117.

Reference Book (s)

3. Cassarett and Doull‟s Toxicology "The Basic Science of The Poisons" 7th edition (2008), Curtis D. Klaassen Editor, McGrawHill Medical. ISBN: 9780071470513.
4. Cassarett and Doull‟s "Essentials of Toxicology" 2nd edition (2010), Klaassen and Whatkins, McGraw Hill Publisher. ISBN-13: 978-0071622400.

Unit-1 TOXIC EXPOSURE AND RESPONSE	**10 hours**
Different areas of modern toxicology, classification of toxic substances, various definitions of toxicological significance. Effect of duration, frequency, route and site of exposure of xenobiotics on its toxicity. Characteristic and types of toxic response. Types of interactions between two and more xenobiotics exposure in humans. Tolerance and addiction.	
Unit-2 EVALUATION AND MECHANISM OF TOXICITY	**8 hours**
Various types of dose response relationships, assumptions in deriving dose response, LD50, LC50, TD50 and therapeutic index. Delivery of the toxicant, mechanisms involved in formation of ultimate toxicant, detoxification of ultimate toxicant.	
Unit-3 FATE OF XENOBIOTICS IN HUMAN BODY	**8 hours**
Absorption, Distribution, Excretion and Metabolism of xenobiotics (biotransformation, Phase-I reactions including oxidations, hydrolysis, reductions and phase II conjugation reactions).Toxic insult to liver, its susceptibility to toxicants with reference to any two hepatotoxicants.	
Unit-4 TOXIC AGENTS	**10 hours**
Human exposure, mechanism of action and resultant toxicities of the following xenobiotics: Metals: lead, arsenic, Pesticides: organophosphates, carbamates, organochlorine, bipyridyl compounds and anticoagulant pesticides.	
Unit-5 ECO-TOXICOLOGY	**10 hours**

Brief introduction to avian and aquatic toxicology, movement and effect of toxic compounds in food chain (DDT, mercury), bioaccumulation, biomagnification, acid rain and its effect on ecosystems, concept of BOD and COD.
Unit 6: Resent advances in Toxicology: Review article/Research paper/MOOC

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**INDUSTRIAL BIOCHEMISTRY**				
Course Code	**MSDB6022**				
Prerequisite	**Graduation life science and applied science from any recognized university or equivalent examination with a minimum of 50 % marks in aggregate.**				
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives:

The students will learn to integrate the knowledge of biochemistry and molecular biology with those of microbiology and biochemical engineering, with emphasis on their application to the biotechnological processes.

Course Outcomes

CO1	**Demonstrate the industrial bioprocesses technology, downstream processing.**
CO2	**Describe the process of fermentation.**
CO3	**Demonstrate the various ways of food processing.**
CO4	**Describe the process of BIOSAFETY, IPR**
CO5	**Discuss the general principles of Quality Control and Good Manufacturing practices in food industry.**
CO6	**Evaluate the significance of industrial biochemistry in production and research**

Text Book (s)

- DobleMukesh and Kumar Anil, Biotreatment of industrial effluents.
- WulfCrueger and Anneliese Crueger, Biotechnology, Panima Publishing company New Delhi.
- Rainbow C. and Rose A.H., A.P., Biochemistry of Industrial micro-organisms.
- P. F. Stanbury, A. Whitaker and S. Hall, Principles of Fermentation Technology.
- Bioethics and Biosafety, 1st edition (2008), M. K Sateesh, I K International Pvt Ltd, ISBN-13: 978-8190675703.
- Bioethics and biosafety in biotechnology, 1st edition (2007), V. Sreekrishna; New Age International (P) Ltd., ISBN-13: 978-8122420852.

Reference Book (s)

3. Biosafety and Bioethics, 1st edition (2006), Rajmohan Joshi; Isha Books ISBN-13: 978-8182053779.
4. Wackett, L.P. and Hershberger, C.D. Biocatalysis and Biodegradation, Microbial Transformation of Organic Compounds, 2001 P.-171-190. ISBN 1-55581-179-5. ASM Press Washington D.C.

Unit-1 INTRODUCTION TO INDUSTRIAL BIOPROCESSESTECHNOLOGY	**10 hours**
Definition and scope of Industrial Biochemistry, A historical overview of Industrial fermentation processes- traditional and modern biotechnology, Organism, processes and products related to modern biotechnology, Types of Bioreactors, Parameters for Bio process, bioprocess monitoring, downstream processing.	
Unit-2 BASICS OF FERMENTATION	**8 hours**
Biochemical Basis and Development of Industrial Fermentation process: screening and selection of the organisms for the production of biologically important compounds, Strain improvements, Detection and production of fermentation products, Fermentation media, Scale up of fermentations.	
Unit-3 FOOD BIOCHEMISTRY	**12 hours**
Introduction to different categories of food; constituents of food products and their functional properties; introduction to food processing; intermediate moisture food; food spoilage; intrinsic and extrinsic factors affecting the quality and life of food material; food storage and preservation techniques; food poisoning and intoxication; by-product utilization and scale up; molasses and alcohol production.	
Unit-4 BIOSAFETY, IPR	**10 hours**
Historical background, introduction to biological safety cabinets, primary containment for biohazards, biosafety levels of specific microorganisms, recommended biosafety levels for infectious agents and infected animals. Intellectual property rights (IPR)	
Unit-5 QC and GMP	**10 hours**
General principles of Quality Control and Good Manufacturing practices in food industry, Determination of shelf – life of food products, Food Adulteration – Common food adulterants, their harmful effects and physical and chemical methods for their detection, Role of ISI Agmark and FDA in food industry.	
Unit 6: Resent advances in Industrial biochemistry: Review article/Research paper/MOOC	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**ADVANCED MICROBIOLOGY**				
Course Code	**MSMB6023**				
Prerequisite	**Graduation life science and applied science from any recognized university or equivalent examination with a minimum of 50 % marks in aggregate.**				
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

Course Objectives:

The students will understand the basic concept of proteomics, nanotechnology and their application in the field of microbiology. It will help to understand the knowledge of how patent will grant.

Course Outcomes

CO1	**Acquire knowledge on microbial proteomics**
CO2	**Understand the fundamentals of nanotechnology**
CO3	**Illustration of the applications of nanobiotechnology**
CO4	**Application of knowledge on grant of patent and patenting authorities**
CO5	**Evaluation of advanced approach in microbiology**
CO6	**Evaluation of significance of Advanced microbiology in treatment of disease and industrial application**

Text Book (s)

- Bare Act, 2007.Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., New Delhi.
- Kankanala C (2007). Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution Pvt. Ltd. New Delhi.
- Pradeep T., "A Textbook of Nanoscience and Nanotechnology", Tata McGraw Hill Education Pvt. Ltd., 2012.
- Singh K K (2015). Biotechnology and Intelectual Property Rights: Legal and Social
- Impliocations, Springer India.
- Goel D &Prashar S (2013). IPR, Biosafety and Bioethics. Pearson
- Senthil Kumar Sadhasivam and Mohammed Jaabir, M. S. 2008. IPR, Biosafety and
- Biotechnology Management. Jasen Publications, Tiruchirappalli, India.

Reference Book (s)

4. Nanobiotechnology: Concepts,Applications and Perspectives (2004), Christof M.Niemeyer (Editor), Chad A. Mirkin (Editor), Wiley VCH.
5. Nanobiotechnology - II more concepts and applications. (2007) - Chad A Mirkin and Christof M. Niemeyer (Eds), Wiley VCH.
6.

Unit-1 MICROBIAL PROTEOMICS	**12 hours**
Introduction to Proteomics, 2D electrophoresis, Proteomics applications. Protein biomarker,surfaceplasmon resonance (SPR), protein microarraysdual polarisation interferometry, microscalethermophoresis Microbial pathogenesis at the proteome level. Proteomics of *Saccharomyces cerevisiae*-cell wall & transport, differential expression in stress. Proteomics of probiotic lactobacilli-intestinal epithelial cells interactions, Lantibiotics and Immunomodulators. Proteomic Identification of *Mycobacterium tuberculosis*	
Unit-2 INTRODUCTION TO NANOTECHNOLOGY	**10 hours**
Historical perspectives, Existence of nanostructures in nature, Nanoscale Properties (Electrical, Optical, Chemical) Nanomaterials - Quantum Dots,Wells and Wires, nanotubes, graphene, nanogold, nanosilver and metal oxides, Nanopolymers. Synthesis using Microorganisms, Synthesis using Biological templates, synthesis using plants and plant extracts.	
Unit-3 APPLICATIONS OF NANOBIOTECHNOLOGY	**8 hours**
Nanobiosensors, molecular imaging using nanoparticles, targeted drug delivery. Applications in health and disease - infectious and chronic. Nanobiotechnological applications in Environment and food - detection and mitigation.	
Unit-4 GRANT OF PATENT, AGREEMENTS AND TREATIES	**12 hours**
Grant of Patent and Patenting Authorities: Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; An introduction to Patent Filing Procedures; Patent licensing and agreement; Patent infringement- meaning, scope, litigation, case studies, Rights and Duties of patent owner. Agreements and Treaties: GATT, TRIPS, WIPO, Budapest Treaty on international recognition of the deposit of microorganisms etc.	

Unit-5 ADVANCE APPROACH IN MICROBIOLOGY 12 hours
Novel approaches for anti-influenza virus therapy. Use of bacteria in cancer therapy, Protein secretion: from mechanism to exploitation, Microbicides, Biofilm-related infections, Fungal infections: novel diagnostic tools and antifungal agents, Epidemiology of respiratory viruses, Tumor-associated viruses, Virus (HIV) entry as therapeutic target, Applications of CRISPR genome editing to microbiology.
Unit 6: Resent advances in Advanced microbiology: Review article/Research paper/MOOC

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	PLANT – PATHOGEN INTERACTION				
Course Code	MSDB6024				
Prerequisite	Graduation life science and applied science from any recognized university or equivalent examination with a minimum of 50 % marks in aggregate.				
Corequisite					
Antirequisite					
		L	T	P	C
		4	0	0	4

Course Objectives:

The students will deeper knowledge of host-pathogen interactions at the molecular to organismal level, with emphasis on several model pathosystems and phenomena whose elucidation will have the most power in explaining disease.

Course Outcomes

CO1	Understanding on microbial infections on plant physiology
CO2	Evaluation of important plant diseases and etiology
CO3	Evaluation of genetics of diseases
CO4	Illustration of plant disease control
CO5	Illustration of diseases forecasting and its relevance
CO6	Evaluate the Application of PLANT – PATHOGEN INTERACTION

Text Book (s)

- .
- Plant pathology by R.S. Mehrotra: Tata McGraw –Hill publishing company limited. New Delhi.
- Bacterial plant pathology, cell and molecular aspects by David C. Sigee, Cambridge University Press, 1993.
- The essentials of Viruses, Vectors and Plant diseases by A.N. Basu & B.K. Giri: Wiley Eastern Limited, 1993.
- Biocontrol of Plant Diseases (Vol. I) by K.G. Mukerji & K.L. Garg: CRC Press, Inc., Boca Raton, Florida, 1988.

- Molecular Biology of Filamentous Fungi by U. Stahl & P. Tudzyski: VCH Verlagsgesellschaft mbH, D-6940 Weinheim (Federal Republic of Germany), 1992.

Reference Book (s)

3. Molecular plant pathology by M. Dickinson: BIOS Scientific Publishers, London, 2003.
4. Plant pathology by George N. Agrios: 4th ed., Academic press, New York, 1969.

Unit-1 CONCEPTS AND PHYSIOLOGY OF PLANT DISEASES 8 hours
What is a disease and what causes disease, pathogenesis, pathogenesis in relation to environment, effect of microbial infections on plant physiology, photosynthesis, respiration, transpiration, translocation. Enzymes and toxins in plant diseases, phytoalexins.
Unit-2 SOME IMPORTANT PLANT DISEASES AND THEIR ETIOLOGICAL STUDIES 10 hours
Crown gall, symptoms of viral diseases and their control, diseases of some important cereals, vegetables and crops. Diseases caused by fungi: *Sclerotium rolfsii* and *Macrophomina phaseolina* (collar rot disease, charcoal rot), bacteria: *Xanthomonas campestris* (black rot), actinomycetes: *Streptomyces scabies* (common scab).
Unit-3 GENETICAL BASIS OF PLANT DISEASES 8 hours
Genetics of host-pathogen interactions, resistance genes, resistance mechanism in plants. Molecular diagnosis, transgenic approach for plant protection, futuristic vision of molecular diagnosis, applications and constraints.
Unit-4 DISEASE CONTROL 10 hours
Principles of plant disease control, physical and chemical methods of disease control, biocontrol, biocontrol agents - concepts and practices, fungal agents, *Trichoderma* as biocontrol agent, biocontrol agents – uses and practical constraints.
Unit-5 DISEASE FORECASTING 10 hours
History and important milestones in disease control, disease forecasting and its relevance in Indian farming.
Unit 6: Resent advances in Plant pathogen interaction: Review article/Research paper/MOOC

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

SCHOOL OF BASIC AND APPLIED SCIENCES

GALGOTIAS UNIVERSITY

(Established under Galgotias University Uttar Pradesh Act No. 14 of 2011)

Program: M.Sc Physics

Scheme: 2020-2021

Vision:

To be recognized globally as a center of excellence in imparting value-based education in Basic and Applied Sciences by creating innovation in fundamental and multidisciplinary research

Mission:

M1. To excel in imparting contemporary knowledge and skills by developing an educational ecosystem with diverse interests and talents.

M2. To perform cutting edge research leading to innovation in sciences through national and international collaborations.

M3. To develop solutions for the emerging challenges in Basic and Applied Science to cater the needs of society.

M4. To attract best quality faculty to facilitate knowledge and develop confidence in our graduates to succeed in the world.

Program Educational Objectives: The graduates shall:

PEO1: Nurture the needs of industries/laboratories related to physics including energy/materials Physics.
PEO2: Demonstrate information literacy skills for acquiring knowledge of Physics, as a physicist/ researcher and also as a life-long learner..
PEO3: Communicate effectively the scientific information and research results in written and oral formats, to both professional scientists and to the public.

Program Specific Objectives TheGraduates shall be able to:

PSO1: Comprehend the need, significance and methodologies of physical process their alignment with nature and conducive in cultivating skills for successful carrier in research, industry and as an entrepreneurship.
PSO2: Explore scientific skills with a sustainable approach to develop a new innovative solutions for emerging problems by providing new knowledge in energy, electronics, materials as well and space physics.

Program Outcomes: After the completion of the program the graduates will be able to

PO1. Apply the knowledge of principles and concepts of Physics to practical problems in industry and academia.

PO2. Identify, formulate, research literature, and analyze physical problems to arrive at substantiated conclusions using principles of physical sciences.

PO3. Create, select, and apply appropriate techniques, resources, and modern analytic tools including prediction and modeling of physics with an understanding of the limitations.

PO4. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional industrial practice.

PO5. Understand the impact of the physics, and demonstrate the knowledge with sustainable manner and commit to professional ethics and responsibilities and norms of the industrial and scientific community, function effectively as an individual, and as a member or leader in multidisciplinary settings.

PO6. Communicate effectively by writing reports and presentation with the scientific community and society at large . Be able to comprehend and documentation by giving and receive clear instructions.

PO7. Demonstrate knowledge and understanding of scientific and management principles and apply these to one's own work, as a member and leader in a team. Manage projects in multidisciplinary environments.

PO8. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological and scientific change.

Curriculum

Program: M.Sc. Physics, SBAS									
Scheme: 2020 – 2022									
Program Structure									
Semester 1									
Sl. No	Course Code	Name of the Course					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MSCP5001	Mathematical Physics-I	3	1	-	4	30	20	50
2	MSCP5002	Classical Mechanics	4	-	-	4	30	20	50
3	MSCP5003	Quantum Mechanics-I	4	-	-	4	30	20	50
4	MSCP5021	Solid State Electronics	4	-	-	4	30	20	50
5	MBS28P2101	Programming language Lab	0	0	4	2	50		50
6	**xxxx**	BEC B1				3			
7	**xxxx**	Soft Skills				0			
			Total			21			
Semester II									
Sl No	Course Code	Name of the Course					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MSCP5006	Mathematical Physics-II	3	1	-	4	30	20	50
2	MSCP5007	Statistical Mechanics	4	-	-	4	30	20	50
3	MSCP5024	Applied Numerical Methods	3	1	-	4	30	20	50
4	MSCP5009	Quantum Mechanics-II	4	-	-	4	30	20	50
5	MSCP5025	Nuclear Physics	4	-	-	4	30	20	50
6	MSCP5026	Applied Numerical Methods Lab	-	-	4	2	50		50
7	MBS28T2111	Research Methodology	2			2	30	20	50
8	**xxxx**	IPR				1			
			Total			25			
Semester III (Track -I)									
Sl No	Course Code	Name of the Course					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE

1	MSCP6001	Electrodynamics	4	-	-	4	30	20	50
2	MSCP6002	Atomic and Molecular Physics	4	-	-	4	30	20	50
3	MBS28T5301	Digital Electronics	4	-	-	4	30	20	50
4	MBS28T5302	Microwaves and Antenna Propagation	4	-	-	4	30	20	50
5	MBS28P3311	Physics Laboratory	-	-	4	2	50		50
6	MSCP9998	Summer Internship	-	-	-	2	50	-	50
7	MBS28P3998	Major Project phase I	-	-		3	-		
8	xxxx	Campus to Corporate				2			
			Total			25			
Semester III (Track -II)									
Sl No	Course Code	Name of the Course					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MSCP6001	Electrodynamics	4	-	-	4	30	20	50
2	MSCP6002	Atomic and Molecular Physics	4	-	-	4	30	20	50
3	MSCP6005	Materials Science	4	-	-	4	30	20	50
4	MBS28T5303	Nanomaterials and Applications	4	-	-	4	30	20	50
5	MBS28P3311	Physics Laboratory	-	-	4	2	50		50
6	MSCP9998	Summer Internship	-	-	-	2	50	-	50
7	MBS28P3998	Major Project phase I	-	-		3	-		
8	xxxx	Campus to Corporate				2			
			total			25			
Semester III (Track -III)									
Sl No	Course Code	Name of the Course					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MSCP6001	Electrodynamics	4	-	-	4	30	20	50
2	MSCP6002	Atomic and Molecular Physics	4	-	-	4	30	20	50
3	MBS28T5305	Solid State Physics	4	-	-	4	30	20	50
4	MBS28T5306	Fiber Optics and optoelectronics	4	-	-	4	30	20	50
5	MBS28P3311	Physics Laboratory	-	-	4	2	50		50
6	MSCP9998	Summer Internship	-	-	-	2	50	-	50
7	MBS28P3998	Major Project phase I	-	-		3	-		
8		Campus to Corporate				2			
			Total			25			
Semester III (Track -IV)									

Sl No	Course Code	Name of the Course					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MSCP6001	Electrodynamics	4	-	-	4	30	20	50
2	MSCP6002	Atomic and Molecular Physics	4	-	-	4	30	20	50
3	MBS28T5307	Nuclear and Particle Physics	4	-	-	4	30	20	50
4	MBS28T5308	Astrophysics and Cosmology	4	-	-	4	30	20	50
5	MBS28P3311	Physics Laboratory	-	-	4	2	50		50
6	MSCP9998	Summer Internship	-	-	-	2	50	-	50
7	MBS28P3998	Major Project phase I	-	-		3	-		
8		Campus to Corporate				2			
			Total			25			
Semester VI									
Sl No	Course Code	Name of the Course					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MBS28P4999	Major Project phase II	**-**	**-**	**-**	**9**	50	-	50
			total			9			
Total Credits of the program=80									

Name of The Course	Mathematical Physics-I				
Course Code	MSCP 5001				
Prerequisite	B.Sc. (3 years) with Physics, Chemistry and Mathematics, Electronics, Instrumentation, with min. 50% marks in each subject and 50% marks in aggregate.				
Corequisite	Students should have fundamental knowledge of subjects like mathematics, physics and chemistry				
Antirequisite					
		L	T	P	C
		3	1	-	4

Course Objectives:

To prepare the students with fundamental knowledge about Mathematical Physics and develop problem-solving skills utilizing mathematical tools.

Course Outcomes

CO1	Discuss the application of Matrix in solving physical problems.
CO2	Demonstrate and practice Complex Analysis in physical problems.
CO3	Appraise the application of Delta and Gamma Functions for the solution of different physical problems.
CO4	Demonstrate the application of Differential Equations applied in the different field of physics.
CO5	Develop the Concept of Elementary Statistics in physical problems.
CO6	Develop the analytical solutions for operationally important problems employing conformal mapping theory

Text Books:

1. Arfken& Weber, Mathematical methods for physicists, 4th ed., Academic Press, San Diego, 1995.
2. P.K. Chattopadhyay, Mathematical Physics, 3rd ed., Wiley Eastern, New Delhi, 2004.
3. J.W. Brown, R.V .Churchill, Complex Variables and Applications,8th ed., Mc-Graw Hill, New York,2009.

Reference Books:

1. E. Kreyszig, Advanced Engineering Mathematics, 7th ed., John Wiley &Sons,USA, 1992.
2. A. W. Joshi, Matrices and Tensors in Physics, New Age International,2nd ed., New Delhi,1995
3. P.K. Chattopadhyay, Mathematical Physics, 3 rd ed., Wiley Eastern, New Delhi, 2004.
4. J.W. Brown, R.V .Churchill, Complex Variables and Applications,8th ed., Mc-Graw Hill, New York,2009.
https://www.sciencedirect.com/science/article/pii/B9780081003282000250

Unit - 1: Matrices (12 Lectures) Definitions, types and properties of matrices; elementary transformations, rank of a marix, Solution of linear algebraic equations; Characteristic equation, Eigen values and Eigen vectors; Cayley - Hamilton theorem; Diagonalization of matrix, Functions of matrices.
Unit-2: Complex Analysis (12 Lectures) Function of complex variables; analytical function, Cauchy-Riemann differential equations; Cauchy's integral theorem, Milnethomson method, Cauchy's integral formula; Zeroes and poles, Singular points of

an analytical function , Taylor's Series, Laurent series; Cauchy residue theorem;; Evaluation of residues & definite integrals.
Unit-3: Delta and Gamma Functions (10 Lectures) Dirac delta function, Delta sequences for one dimensional function, Properties of delta function; Gamma function, factorial notation and applications; Beta function.
Unit-4: Ordinary Differential Equations (10 Lectures) Order and degree of differential equations, solution of linear differential equations (SHM and LCR circuit), Integrating Factor and particular integral, exact and inexact differentials equations,
Unit-5: Partial Differential Equations (10 Lectures) Partial differential equations and applications in theoretical physics, Separation of variables, Singular points, Series solutions.
Unit-6: Application of Mathematical Physics (4 Lectures) Recent advancement in Mathematical Physics I: Fundamental aspects of conformal mapping in advanced mathematical physics, Application of conformal mapping in Mathematical Physics, Recent research trends.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Classical Mechanics				
Course Code	MSCP 5002				
Prerequisite	B.Sc. (3 years) with Physics, Chemistry and Mathematics, Electronics, Instrumentation, with min. 50% marks in each subject and 50% marks in aggregate.				
Co requisite	Students should have fundamental knowledge of subjects like mathematics, physics and chemistry				
		L	T	P	C
		4	0	0	4

Course Objectives:

This course is designed to make the students familiar with Lagrangian equations and Hamilton's equations. They will also learn the motion of the particle and scattering in central force field. The knowledge of small oscillation problem and to find its normal modes of vibration and normal coordinates are also provided. The students will be able to do canonical transformation and Poisson Bracket relation. In recent advanced studies, they can develop nonlinear normal mode initialization for a limited area model

Course Outcomes:

CO1	Solve Lagrange's equation and Hamilton's equation.
CO2	Analyze central force problem.
CO3	Explain scattering in central force field.
CO4	Formulate small oscillation problem and find its normal modes of vibration and normal coordinates.
CO5	Illustrate canonical transformation and Poisson Bracket relation
CO6	Develop nonlinear normal mode initialization for a limited area model

Text Books:

1. H. Goldstein, Poole and Salko, Classical Mechanics, 3rd ed., Narosa Publication, New York,2001.
2. Simon, Classical Mechanics, 4th ed., Addison-Wesley, New York, 1977.

Reference Books:

1. Classical Mechanics, N. C. Rana and P. S. Joag, 4th ed., Tata McGraw Hill, New Delhi,1991 .
2. Landau and Lifshitz, Mechanics, 3rd ed., Butterworth-Heinemann, China,1976,
3. E. A. Deslougue, Classical Mechanics, Vol I and II, John Wiley, 1982
4. Theory and Problems of Lagrangian Dynamics, Schaum Series, McGraw, NewYork, 1967
5. K. C. Gupta, Classical Mechanics of Particles and Rigid Bodies, Wiley Eastern, New Delhi, 2001

"Nonlinear Normal Mode Initialization of a limited area Model', Serge Briere, Monthly Weather Review, Volm 110, 1982, pg 1166- 1186
https://doi.org/10.1175/1520-0493(1982)110<1166:NNMIOA>2.0.CO;2
"Normal-mode function representation of global 3-D data sets: open access software for the atmospheric research community" N Zagar, A Kasahara, K Teraski, Geoscientific Model Development, 8,1169-1195,2015, doi:10.5194/gmd-8-1169-2015

Unit-1: System of particles (12 Lectures) D'Alembert's principle; Lagrange's equations; Velocity-dependent potentials; Simple applications of the Lagrangian formulation; Hamilton's principle; Derivation of Lagrange's equations from Hamilton's principle; Lagrange Multipliers and constraint optimization Problems.
Unit-2: Central force (12 Lectures) Conservation theorems and symmetry properties, Energy Function and the conservation of energy; Two-Body Central Force Problem, Reduction to the equivalent one body problem; Equations of motion and first integrals; Equivalent one-dimensional problem and classification of orbits;
Unit-3: Scattering in a central force field (9 Lectures) Differential equation for the orbit and integrable power-law potentials; Kepler problem, Inverse square law of force; Scattering in a central force field, Transformation of the scattering problem to laboratory coordinates.
Unit-4: Small oscillations (10 Lectures) Small Oscillations, Formulation of the problem, The eigenvalue equation and the principal axis transformation; Frequencies of free vibration and normal coordinates; Legendre transformations and the Hamilton equations of motion, Derivation of Hamilton's equations from a variational principle.
Unit-5: Canonical transformations (9 Lectures s)

Canonical Transformations, Examples of canonical transformations, Symplectic approach to canonical transformations; Poisson brackets and other canonical invariants; Equations of motion, infinitesimal canonical transformations; Conservation theorems in the Poisson bracket formulation; Angular momentum, Poisson bracket relations.
Unit VI Application of Classical Mechanics (4 Lectures) Recent advancement in classical mechanics : Primitive equation model, Initialization, Nonlinear normal mode initialization for a limited area model

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Quantum Mechanics-I				
Course Code	MSCP 5003				
Prerequisite	B.Sc. (3 years) with Physics, Chemistry and Mathematics, Electronics, Instrumentation, with min. 50% marks in each subject and 50% marks in aggregate.				
Corequisite	Students should have fundamental knowledge of subjects like mathematics, physics and chemistry				
Antirequisite	-				
		L	T	P	C
		4	-	-	4

Course Objectives:

Objective of this course is to introduce the basic concepts of quantum mechanics and fundamental concept of operators and solution of initial value problems. Students will learn the formalism of quantum mechanics based on wave mechanics and matrix mechanics. Students will also apply the concepts of quantum mechanics for the solution of SWE in 1D and 3D cases for different quantum systems and solve the related problems.

Course Outcomes

CO1	Describe the wave functions and quantum operators to obtain information about a quantum particle and system
CO2	Interpret the superposition principle and calculate the commutator problems in the quantum mechanics
CO3	Explain the Dirac notations and matrix representation of the operators
CO4	Calculate the Schrödinger equations for 1-D quantum systems (e.g. square well, harmonic oscillator).
CO5	Describe the spherical polar coordinates in 3-D and solve the quantum mechanical problems of Hydrogen atom
CO6	Develop the Quantum communication system by using surface acoustic waves.

Text Books:

1. Richard Liboff, Introductory Quantum Mechanics, 4thed.,Addison Wesley, USA, 2003.
2. DJ Griffiths, Introduction to Quantum Mechanics,5th ,Pearson Prentice Hall, USA,1995.
3. A Ghatak& S Lokanathan, Quantum Mechanics: Theory & Applications. 5th ed., KAP,Netherland, 2004.
Reference Books:
1. W Greiner, Quantum Mechanics: An Introduction, 4th. ed., Springer, Germany, 2004.
2. R Shankar, Principles of Quantum Mechanics, 2nd ed., Springer, USA,1994.
3. Leonard I Schiff, Quantum Mechanics, 3rd Edition, McGraw Hill, New York,1968.
4.EugenMerzbacher, Quantum Mechanics, 2nd edition, Wiley, Japan,1970
5. NouredineZettili, Quantum Mechanics: concepts and applications, 2nd Edition, Wiley, UK, 2009
Reference: Bienfait et al., Science 364, 368–371 (2019)
DOI: 10.1126/science.aaw8415

Unit-1: Theory (10 Lectures) Postulates of QM; Observables and operators, measurements; the state function and expectation values; the time-dependent Schrodinger equation; time development of state functions; solution to the initial value problem.
Unit-2: Superposition (12 Lectures) Dirac notation; superposition principle; commutator relations; their connection to the uncertainty principle; complete sets of commuting observables; Time development of state functions and expectation values; parity.
Unit-3: Formalism (10 Lectures) Hilbert space; Hermitian operators and their properties; Matrix mechanics, Basis and representations, matrix properties; Unitary and similarity transformations; the enery representation.
Unit-4: Schrodinger wave solution (8 Lectures) General properties of one-dimensional Schrodinger equation; Finite potential well, Harmonic oscillator; Unbound states; barrier problems.
Unit-5: Orbital Angular Momentum and applications (12 Lectures) Ladder operators; eigen values and eigen functions of L^2 and L_z using spherical harmonics Radial equation for a spherically symmetric central potential; Hydrogen atom, Eigenvalues and radial eigenfunctions, degeneracy, probability distribution, angular momentum and rotations.
Unit VI Application of Quantum Mechanics I 4 lectures Recent advancement in Quantum Mechanics I: Phonon-mediated quantum state transfer and remote qubit entanglement

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Solid State Electronics				
Course Code	**MSCP5021**				
Prerequisite	B.Sc. (3 years) with Physics, Chemistry and Mathematics, Electronics, Instrumentation, with min. 50% marks in each subject and 50% marks in aggregate.				
Corequisite	Students should have fundamental knowledge of subjects like mathematics, physics and chemistry				
Antirequisite					
		L	T	P	C
		4	0	0	4

Course Objectives:

Objective of this course is:

To gain knowledge of electronicstructure of materials from the band theory of solids.

To study the transport of charges through a metal or a semiconductor.

To learn how solid-state theory is applied to describe the various applications of solid-state electronic devices.

Course Outcomes

CO1	Estimate energy band gaps of solids, density of states and effective mass of electrons using tight binding model, Kronig Penny model, Cellular method and Pseudo-potential method
CO2	Explain carrier transport and thermal conductivity
CO3	Operationalize Junction Theory based Devices
CO4	Demonstrate switching circuits and amplifiers.
CO5	Intemperate characteristics and mathematical operatios using OP-AMP
CO6	Acquire detailed analysis-level and design level knowledge on thermometer and bolometer by Silicon-On-Insulator (SOI) diodes, Silicon carbide (SiC) and p-i-n diodes.

Text books:

1. Kanaan Kano, Semiconductor Devices, PHI, 2005.
2. Samuel V Liao, "Microwave devices and circuit", Prentice Hall of India.
3. M. S. Tyagi, Introduction to semiconductor materials and devices, John Wiley & Sons, 2004.
4. D. A. Neamen, Semiconductor physics and devices. 3rd Edition, McGraw-Hill, 2003.

References:

1. SZE, Physics of semiconductor, John Wiley, 2007.
2. Robert F Pierret, Semiconductor Device Fundamentals, Pearson Education, 2006.
3. Pallab Bhattacharya, Semiconductor Optoelectronic Devices, PHI, 2004.
4. https://doi.org/10.1016/j.sse.2020.107838
5. https://doi.org/10.1016/j.sse.2020.107834

UNIT-I: Semiconductor Fundamentals 10 Lectures Energy band formation, Kronig-Penny model-allowed and forbidden energy band-E-k diagram, one dimensional Brillouin zone, effective mass, direct and indirect band gap, electrons and holes, basic governing equations in semiconductors-Poisson's equation, continuity equation.
UNIT-II: Carrier Transport Phenomena 11 Lectures Carrier concentration and Fermi level of intrinsic and extrinsic semiconductor, Thermal Effect, conductivity and carrier mobility in semiconductor, Drift and diffusion of carriers, Carrier scattering-Ionized Impurity and Phonon Scattering.
UNIT-III: Junction Theory and Devices 11 Lectures I-V relationships, Breakdown phenomena- avalanche and zener processes, Quasi Fermi level, biasing of PN Junctions, Metal-Semiconductor Junction- Metal- Semiconductor contacts-Ohmic and Schottky contacts, Junction capacitance, Schottky Barrier Diode, Tunnel Diode, Photo diode, Photo Conductive cells, LCDs, Solar Cells.
UNIT–IV: Amplifiers and switching 10 Lectures Low frequency and high frequency and Power amplifiers using transistors (Class A, B and C); Negative feedback: Emitter follower, Darlington Amplifier, Switching Transistors: Multi-vibrator circuits (Astable, monostable and Bistable).
Unit V: Operational Amplifiers 12 Lectures Ideal operational amplifier: Characteristics; Feedback types; Applications: Basic scaling circuits, current to voltage and voltage to current conversion; Sum and difference amplifiers; Integrating and differentiating circuits; R.C. Amplifiers; Filters.
UNIT-VI: - Diodes for Bolometric Application **4**lectures Silicon-On-Insulator (SOI) diodes, Silicon carbide (SiC), Lateral diodes, p-i-n diodes Schottky barrier diodes (SBDs), Thermometer, Bolometer

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Programming language Lab**
Course Code	**MBS28P2101**
Prerequisite	B.Sc. (3 years) with Physics, Chemistry and Mathematics, Electronics, Instrumentation, with min. 50% marks in each subject and 50% marks in aggregate.
Corequisite	Students should have fundamental knowledge of subjects like mathematics, physics and chemistry
Antirequisite	

	L	T	P	C
	-		4	2

Course Objectives:

In this course the students will be introduced to the basics of python programming language. They will write and execute codes which shall cover different python objects, packages and their related methods and operations.

Course Outcomes

CO1	Underline and practice the basic syntax of python programming and its applications
CO2	Utilize various control statements effectively in python programming
CO3	Formulate program using python object method and operations
CO4	Demonstrate and devise the basic use of Numpy Array in python
CO5	Utilize the basics knowledge of Matplotlib for plotting in python.

Text Books:
1. John M. Sewart, "Python for Scientist", Cambridge Universities Press
2. ReemaThareja, "Python Programming" Oxford Higher Education
3. Y. Daniel Liang "Introduction to Programming using Python" Pearson

Reference Books:
1. Robert Sedgewick, Kevin Wayne, Robert Dondero, "Introduction to Programming in Python" Pearson
2. MrakLitz, " LearningPython",O' Reilly
3. Mark Pilgrim, "Dive into Python", Apress
4. James L. Young, "Python made Simple and Practical", Kindle Edition (paperback)

List of Experiments
1. Write a python program to read in two numbers, x and n, and then compute the sum of the geometric progression: $1+x+x^2+x^3+\ldots\ldots\ldots\ldots+x^n$: Print x, n, the sum.
2. Write a python program to determine if the given string is a palindrome or not.
3. Write a python program to find all prime numbers within a given range.
4. Write a python program to print 'n terms of Fibonacci series using iteration
5. Write a python program to add 'ing' at the end of a given string (length should be at least 3). If the given string already ends with 'ing' then add 'ly' instead. If the string length of the given string is less than 3, leave it unchanged. Sample String : 'abc' Expected Result : 'abcing' Sample String : 'string' Expected Result : 'stringly'
6. Write a python program that accepts a sequence of whitespace separated words as input and prints the words after removing all duplicate words and sorting them alphanumerically
7. Write a python program that uses functions to perform the following operations:
a) To insert a sub-string/list/dictionary into given main string/list/dictionary from a given position.
b) To delete n characters/elements from a given position in a given string/list/dictionary.
8. Use python numpy array for
a) Matrix summation, subtraction and multiplication.
b) Matrix inversion
9. Use Python Matplotlib for
(a) Graphics: 2D, Printing labels, Grid & Axes box.
10. Use Python for

(a) Random number generations
(b) mean, variance and standard deviation of given data

Continuous Assessment Pattern

Internal Assessment (IA)	**End Term Test (ETE)**	**Total Marks**
50	50	100

Name of The Course	Mathematical Physics-II
Course Code	MSCP 5006
Prerequisite	B.Sc. (3 years) with Physics, Chemistry and Mathematics, Electronics, Instrumentation, with min. 50% marks in each subject and 50% marks in aggregate.
Corequisite	Students should have fundamental knowledge of subjects like mathematics, physics and chemistry
Antirequisite	-

	L	T	P	C
	4	-	-	4

Course Objectives:

Objective of this course is:
To prepare the students with fundamental knowledge about Mathematical Physics & develop necessary problem-
solving skills utilizing mathematical tools.

Course Outcomes

CO1	Discuss the special function and discriminate between different methods of power series solutions for ordinary differential equations.
CO2	Demonstrate and practice the Green's function application in physical problems.
CO3	Appraise the application of Fourier series and Transforms for the solution of differential equations.
CO4	Apply Laplace Transform for the solution of differential equations.
CO5	Develop the Concept of a group in physical problems.
CO6	Organize elementary special functions to solve complex physical problems.

Text Books:
1. Arfken& Weber, Mathematical methods for physicists, 4th ed., Academic Press, San Diego, 1995.
2. A.K. Ghatak, I.C. Goyal and S.J. Chua, Mathematical Physics, MacMillan, Delhi,1986.

Reference Books:
1. M.L. Boas, Mathematical Methods in the Physical Sciences, 3rd edition, Wiley, New York, 2007.
2. E.D. Rainville, Special Functions, MacMillan, New York, 1960.

3. K.F.Riley, M.P.Hobson and S.J. Bence, Mathematical Methods for Physics and Engineering, 3rd ed. Cambridge University Press, Cambridge, 2006.
4. P.K. Chattopadhyay, Mathematical Physics, 3 rd ed., Wiley Eastern, New Delhi, 2004.
5. J.W. Brown, R.V .Churchill, Complex Variables and Applications,8th ed., Mc-Graw Hill, New York,2009.
Research Article link: https://link.springer.com/chapter/10.1007/978-1-4614-7034-2_9

Unit-1: Special Functions (14 Lectures) Bessel functions of first and second kind, Generating function, integral representation and recurrence relations; Legendre functions, generating function, recurrence relations, orthogonality, various definitions of Legendre polynominals; Associated Legendre functions: recurrence relations, parity and orthogonality, Hermite functions, Laguerre functions.
Unit-2: Green's function (10 Lectures) Green's function- Eigenfunction expansion of Green's function; Liouville type equations in one dimension and their Green's function.
Unit-3: Fourier series and Transforms (10 Lectures) Fourier series; Fourier integrals and transform; Properties; Fourier transform of Delta functions; Convolution theorem; Parseral's identity; Applications to the solution of differential equations.
Unit-4: Laplace Transforms (9 Lectures) Laplace Transform and its properties; Applications to the solution of differential equations.
Unit-5: Group Theory (9 Lectures) Concept of a group (additive and multiplicative); Matrix representation of a group; Reducible and irreducible representation of a group; The Great Orthogonality Theorem.
Unit-6: Application of Mathematical Physics-II 4 lectures Recent development in Mathematical Physics-II: Fundamental aspects of special functions in advanced mathematical physics, Applications of special functions in Mathematical Physics, Recent research trends.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Statistical Mechanics				
Course Code	MSCP 5007				
Prerequisite	B.Sc. (3 years) with Physics, Chemistry and Mathematics, Electronics, Instrumentation, with min. 50% marks in each subject and 50% marks in aggregate.				
Corequisite	Students should have fundamental knowledge of subjects like mathematics, physics and chemistry				
Antirequisite	-				
		L	T	P	C
		4	-	-	4

Course Objectives:
To fascinate students about the fundamentals of thermodynamics and statistical mechanics.
To introduce the fundamental concepts relevant to thermodynamic potentials, probability, classical and quantum statistics.
To impart statistical basis of thermodynamics and its applications to magnetism, black body radiation and phase transition.

Course Outcomes

CO1	Apply the ensemble concepts for determination of thermodynamic potentials.
CO2	Distinguish three MB, FD, BE statistics and their application for classical particle, fermions and bosons.
CO3	Discriminate change in characteristics of particle-to wave nature at low temperature.
CO4	Correlate the variation of thermodynamics potentials by changing the phase of materials.
CO5	AnalyzeBrownian motion through Einstein, Landau and Langevin theory.
CO6	Formulate many body problems using density matrix method and their time evolution.

Texts Books:
1. Greiner, Neise and Stocker,Thermodynamics and Statistical Mechanics, Springer,Verlag, 1995.
2. RK Pathria and PD Beale, Statistical Mechanics, 3rd ed., Elsevier, 2011.
3. J. D. Walecka, Fundamentals of Statistical Mechanics, 1sted.,World Scientific Press, 2001.

Reference Books:
1. F Reif, Fundamentals of Statistical and Thermal Physics, McGraw-Hill, NewYork, 2010.
2. Ashley H. Carter, Classical and Statistical Thermodynamics, Prentice Hall, 2001.
3. Teunis C. Dorlas, Statistical Mechanics, IOP Publishing,1999.
4. L. D. Landau and E. M. Lifshitz, Statistical Physics, Addison-Wesley, 1969.
5. Kerson Huang, Introduction to Statistical Physics, Taylor and Francis, London, 2001.
6. Parr, R. G.; Yang, W. (1989). Density-Functional Theory of Atoms and Molecules. New York: Oxford University Press. ISBN 978-0-19-504279-5

Unit -1 : Classical Statistical Mechanics (12 Lectures) Concept of phase space; Statistical definition of entropy; Gibb's paradox; Ensembles: microcanonical, canonical and grand canonical; partition function and derivation of thermodynamics; Entropy as an ensemble average; Classical ideal gas.

Unit- 2 : Maxwell-Boltzmann and Fermi-Dirac Statistics (12 Lectures) Density operator; Liouville theorem, Quantum microcanonical, Canonical and grand canonical ensembles; Specific heat of solids (Einstein and Debye theory), Distribution function (MB, FD and B-E), Ideal Fermi gas, Fermi-Dirac statistics.
Unit 3 : Bose-Einstein Statistics (12 Lectures) Bose-Einstein statistics; Applications of the formalism to Ideal Bose gas; properties of black-body radiation, Bose-Einstein condensation, Examples of BEC, BEC in a harmonic potential.
Unit 4: Non-Equilibrium Statistics (8 Lectures) Brownian motion: as a random walk (Einstein theory), as a diffusion process; Langevin theory of Brownian motion; Fluctuation-dissipation theorem
Unit 5 : Phase transitions 8 Lectures Landau theory of phase transition, Paramagnetism, Ferromagnetism, Ising model in 2-Dimension, Curie temperature.
Unit VI. Many body System. 4 lectures Identical particle, Non-interacting particle, One-body density matrix, Two-body density matrix, time dependent density matrix

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	APPLIED NUMERICAL METHODS				
Course Code	**MSCP5024**				
Prerequisite	B.Sc. (3 years) with Physics, Chemistry and Mathematics, Electronics, Instrumentation, with min. 50% marks in each subject and 50% marks in aggregate.				
Corequisite	Students should have fundamental knowledge of subjects like mathematics, physics and chemistry				
Antirequisite	-				
		L	T	P	C
		4	-	-	4

Course Objectives:
In this course the students will learn various methods to solve numerically thealgebraic and transcendental equations, integral and differential problems.

Course Outcomes:

CO1	Estimate the solution of algebraic and transcendental equations
CO2	Evaluate the Solution of simultaneous equations
CO3	Evaluate the interpolation formula for unequal intervals, Lagrange’s method, Newton’s formula etc.

CO4	Apply Numerical differentiation and integration Methods to solve Newton's forward and backward formula, etc
CO5	Evaluate the Initial value problems
CO6	Able to formulate the numerical methods to solve Non linear equations.

Books

1. Jain and Iyengar , Numerical methods for scientific and engineering computations ,New Age International, 2003.
2. Venkatraman, Numerical methods , The National Publishing Company, Madras (1999).
3. Sastry , Numerical methods , PHI learning,2012 .
Reference :*NUMYa-Xiang Yuan, ERICAL ALGEBRA, doi:10.3934/naco.2011.1.15 CONTROL AND OPTIMIZATION Volume 1, Number 1, March 2011*

Unit I Solution of algebraic and transcendental equations 10 Lectures Iteration method, bisection method, Newton – Raphson method, rate of convergence – solution of polynomial equations – BrigeVieta method – Bairstow method.
Unit II Solution of simultaneous equations 10 Lectures Direct method – Gauss elimination method – Gauss-Jordan method – iterative methods – Gauss seidal iterative method – Eigen values and Eigen vectors of matrices – Jacobi method for symmetric matrices.
Unit III Interpolation 10 Lectures Interpolation formula for unequal intervals – Lagrange's method – Interpolation formula for equal intervals – Newton's forward interpolation formula – Newton's Backward interpolation formula - least squares approximation method.
Unit IV Numerical differentiation and integration Methods 10 Lectures based on interpolation – Newton's forward difference formula – Newton's backward formula – numerical integration – Quadrature formula (Newton's cote's formula) – Trapezoidal rule, Simpson's 1/3rd rule, 3/8th rule – Gauss quadrature formula – Gauss two point formula and three point formula.
Unit V Initial value problems 10 Lectures Solution of first order differential equations – Taylor series method, Euler's method, Runge-Kutta methods (second and fourth order) – Milne's predictor – corrector method – Adam Moulton method.
UNIT-6:Advances in Numerical Methods 4 lectures RECENT ADVANCES IN NUMERICAL METHODS FOR NONLINEAR EQUATIONS AND NONLINEAR LEAST SQUARES

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Quantum Mechanics-II				
Course Code	MSCP 5009				
Prerequisite	B.Sc. (3 years) with Physics, Chemistry and Mathematics, Electronics, Instrumentation, with min. 50% marks in each subject and 50% marks in aggregate.				
Corequisite	Students should have fundamental knowledge of subjects like mathematics, physics and chemistry				
Antirequisite	-				
		L	T	P	C
		4	-	-	4

Course Objectives:
This course is designed to provide advanced knowledge of quantum mechanics. Students will solve the problem based on angular momentum and coupling of angular momentum. They will also apply the concepts of perturbation theory and approximation methods to solve the quantum problems. Students will acquire the deep knowledge of scattering theory and relativistic quantum mechanics.

Course Outcomes:

CO1	Apply the concept of ladder operators to calculate the angular momentum and corresponding eigen functions
CO2	Apply the concept of spin eigen function to solve the problems related to Pauli's spin matrices
CO3	Interpret time- dependent and time- independent perturbation theory and determine the energy of quantum systems.
CO4	Apply various approximation methods and evaluate the various quantum mechanical problems using these methods
CO5	Interpret quantum scattering and can apply for cross section calculation in high speed particle physics.
CO6	Develop the advanced quantum techniques for future gravitational-wave detectors.

Text Books:
1. Richard Liboff, Introductory Quantum Mechanics, 4thed.,Addison Wesley, USA, 2003.
2. DJ Griffiths, Introduction to Quantum Mechanics,5th ,Pearson Prentice Hall, USA,1995.
3. A Ghatak& S Lokanathan, Quantum Mechanics: Theory & Applications. 5th ed., KAP,Netherland, 2004.

Reference Books:
1. W Greiner, Quantum Mechanics: An Introduction, 4th. ed., Springer, Germany, 2004.
2. R Shankar, Principles of Quantum Mechanics, 2nd ed., Springer, USA,1994.
3. Leonard I Schiff, Quantum Mechanics, 3rd Edition, McGraw Hill, New York,1968.
4.EugenMerzbacher, Quantum Mechanics, 2nd edition, Wiley, Japan,1970
5.NouredineZettili, Quantum Mechanics: concepts and applications, 2nd Edition, Wiley, UK, 2009
6. Danilishin et al., Living Reviews in Relativity (2019) 22:2
https://doi.org/10.1007/s41114-019-0018-y

Unit-1: Total Angular Momentum (14 Lectures) Total angular momentum J; eigenvalues of J^2 and J_z; Addition of angular momentum; coupled and uncoupled representation of eigen functions, Clebsch Gordon coefficients for $j_1=j_2=1/2$ and $j_1= 1$, $j_2 =1/2$, Angular momentum matrices; Pauli spin matrices; spin eigen functions; Free particle wave functions including spin, addition of two spins, L-S coupling.	
Unit-2: Perturbation Theory (12 Lectures) Time-independent perturbation theory; First-order and second-order corrections to non-degenerate perturbation theory; Degenerate perturbation theory, First order energies and secular equation; Time-dependent perturbation theory and applications.	
Unit-3: Approximation methods (8 Lectures) Ritz variational method, basic principles, illustration by simple examples; WKB Method.	
Unit-4: Scattering theory (10 Lectures) Introduction, scattering cross section and scattering amplitude; partial wave phase shift, optical theorem, Born approximation.	
Unit-5: Relativistic Quantum Mechanics (8 Lectures) The Klein-Gordon Equation for free relativistic particle, plane wave solution, Energy eigenvalues, discussion of negative energies and currents. The Dirac Hamiltonian for free relativistic particle, properties of alpha and beta matrices, Eigenvalues of free particles, Negative energy solutions, Antiparticles, gamma-matrices.	
Unit VI Application of Quantum Mechanics II 4 lectures Recent advancement in Quantum Mechanics II: Advanced quantum techniques for future gravitational-wave detectors	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Nuclear Physics
Course Code	MSCP 5025

Prerequisite	B.Sc. (3 years) with Physics, Chemistry and Mathematics, Electronics, Instrumentation, with min. 50% marks in each subject and 50% marks in aggregate.				
Corequisite	Students should have fundamental knowledge of subjects like mathematics, physics and chemistry				
Antirequisite					
		L	T	P	C
		4	0	0	4

Course Objectives:

This course introduces modern nuclear physics to the students. They will learn basic nuclear properties, nuclear force, elementary particles and their interactions. This course will also cover various decay modes of nucleus and nuclear reactions.

Course Outcomes:

CO1	Recognize and explain in details of the atomic nucleus
CO2	Apply their knowledge to solve existing problems in nuclear Physics
CO3	Construct the interesting topic for research.
CO4	Do experiment in nuclear reactor and evaluate the result.
CO5	Identify the research field in space science, e.g., cosmology.
CO6	Able to formulate the theoretical fremework to study the nuclear structure

Text Books:
1. Preston and Bhadury, Structure of the Nucleus, Perseus Books Group, 1993.
2. B.L. Cohen, Concepts of Nuclear Physics, McGraw Hill,USA, 1971.
3. Bethe and Morrison, Elementary Nuclear Theory, 2nd ed., John Wiley,USA,2006.

Reference Books:
1. I. Kaplan, Nuclear Physics, 2nd ed., Addison-Wesley,USA,1977.
2. M. K. Pal, Theory of Nuclear Structure ,East West Affiliated Press, New Delhi, 1983.
3. Lewis Richard Benjamin Elton, Introductory Nuclear Theory, Interscience, New York, 1959.

Reference: N.K.Timofeyuk, R.C.Johnson, Progress in Prticle and Nuclear Physics Volume 111

Unit-1 : Basic Nuclear Properties and Forces (12 Lectures) Basic nuclear properties; Size, Shape and charge distribution; Spin and parity; Binding energy, liquid drop model and semi-empirical mass formula, nature of the nuclear force form of nucleon-nucleon potential; Charge independndce and charge-symmetry of nuclear forces; Deuteron problem.
Unit-2 : Nuclear Models (8 Lectures) Basic properties of nuclear shell model, Evidence of shell structure; Single-particle shell model, its validity and limitations; Rotational spectra; Magnetic moments and Schmidt lines; Iso-spins.

Unit-3 : Nuclear Decay (10 Lectures) Decay-range; Particle spectra; Gamow theory; Beta decay; Fermi decay of beta decay; Shape of the beta spectrum; Total decay rate; Angular momentum and parity selection rules; Parity violation; Detection and properties of neutrino; Angular momentum and parity selection rules; Internal conversion; Nuclear isomerism.
Unit-4: Nuclear Reactions (12 Lectures) Reaction dynamics; The Q equation; Theory of Nuclear reaction; Partial wave analysis; Compound nucleus formations and break up; Resonance scattering and reactions; Theory of stripping reactions; The Fission process; Neutron released in the fission process; Fusion process.
Unit-5: Elementary Particle Physics (10 Lectures) Types of interaction between elementary particles; Hadrons and leptons; Symmetry and conservation laws; Elementary ideas of CP and CPT invariance; Classification of hadrons quark model SU(2) SU(3) multiplets; Gell-Mann-Okubo mass formula for octet decuplet hadrons.
UNIT-6:Recent advance in Nuclear Reactions 4 lectures Theory of deuteron stripping and pick-up reactions for nuclear structure studies

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Applied Numerical Methods Lab				
Course Code	MSCP5026				
Prerequisite	B.Sc. (3 years) with Physics, Chemistry and Mathematics, Electronics, Instrumentation, with min. 50% marks in each subject and 50% marks in aggregate.				
Corequisite	Students should have fundamental knowledge of subjects like mathematics, physics and chemistry				
Antirequisite	-				
		L	T	P	C
		-	-	4	2

Course Objectives:

This course aims to utilize the programming skills to develop codes for solving linear algebraic equations, integral and differential problems.

Course Outcomes

CO1	Underline the basics of different computer programming C/SciLab/MatLab.
CO2	Compute the negative root using Newton-Raphson method
CO3	Explain the Newton's forward/ backward interpolation formula.
CO4	Evaluate the integration using trapezoidal rule, Simpson's rule, etc.
CO5	Estimate the integration using Monte Carlo method

Text Book

1. "PROGRAMMING AND DATA STRUCTURES", Ashok N Kamthane, Pearson ed., 2004

References:

l. "Fundamentals of Datastructures in C", Ellis Horowitz, SartajSahni, Susan Anderson Freed, Computer Science Press, 1993

2. "Data Structures - A Pseudocode approach with C" - Richard.F.Gilberg, BehrouzA.Forouzan, Thomson, 2002

3. "Data Structures in C", Aaron M.Tenenbaum, YediayahLangsam, Moshe J.Augenstein, Pearson Ed, 2004

List of Experiments

C/SciLab/MatLab/Python

1. Write a program to read the contents of a file and display it on the screen.
2. Write a program to fit a straight line using the method of least squares.
3. Write a program to find smallest positive/ largest negative root using Bisection method.
4. Write a program to find smallest positive/ largest negative root using Newton-Raphson method.
5. Write a program to find the solution of linear algebraic equations using gauss elimination method.
6. Write a program to find the solution of linear algebraic equations using Croat's method.
7. Write a program to interpolate the values of x and y by Newton's forward/ backward interpolation formula.
8. Write a program to interpolate y using the Langrange's method.
9. Write a program to interpolate y using Newtons Divided Difference formula.
10. Write a program to Evaluate the integration using trapezoidal rule.
11. Write a program to Evaluate the integration using Simpson's rule.
12. Write a program to solve the differential equations using Euler's method.
13. Write a program to solve the differential equations using Runge-Kutta method of the fourth order.
14. Program to evaluate the integration using Monte Carlo method.

Continuous Assessment Pattern

Internal Assessment (IA)	End Term Test (ETE)	Total Marks
50	50	100

Name of The Course	Research Methodology				
Course Code	**MBS28T2111**				
Prerequisite	B.Sc. (3 years) with Physics, Chemistry and Mathematics, Electronics, Instrumentation, with min. 50% marks in each subject and 50% marks in aggregate.				
Corequisite	Students should have fundamental knowledge of subjects like mathematics, physics and chemistry				
Antirequisite					
		L	T	P	C
		2	0	0	2

Course Objectives:

Objective of this course is:

To understand the procedures in research, the different types of procedures to make the experiments viable.

To acquire sound knowledge of the various types of analysis and how to use statistics in analyzing and interpreting the obtained data.

Course Outcomes

CO1	Understand the Principles of Scientific Research and different steps involved in doing research.
CO2	Know how to design research and frame up different steps in design.
CO3	Appraise the application of sampling through statistics.
CO4	Build up the method for data collection and analyse the data.
CO5	Develop the Concept of hypothesis preparation.
CO6	Develop the statistical analysis indulges in modern research for drug designing.

Text Books:

33. K. Ramakant; Elementary Statistics in a world of applications, Goodyear California Pub. Co.,1979.
34. K. D. Broota, Experimental designs in psychological research, Wiley eastern, New York, 1992.
35. Guilford, Statistics in Psychology and Education, McGraw hill, New York, 1986.
36. Katz and Kahn, Research in Behavioural Sciences, Methuen, USA, 1979.

Reference Books:

42. Kerlinger, F., Foundations of Behavioural Research, Surjeet Publications, Delhi, 1983.
43. Rajamanickam, M., Statistical Methods in Psychological and Educational Research, Concept Publishing Co. New Delhi, India, 1983.
44. Smith, Jonathan, A. (Ed.), Qualitative Psychology: A Practical Guide to Research Methods, Sage Publications, 2003.
45. Woodworth and Schlosberg, Experimental Psychology, Methuen and co. ltd, London, 1971.
    46. ChaninNantasenamat, ChartchalermIsarankura-Na-Ayudhya, ThanakornNaenna, VirapongPrachayasittikul, A Practical Overview of Quantitative Structure- Activity Relationship.EXCLI Journal 2009;8:74-88.
    47. WiktorPronobis,AlexandreTkatchenko,and Klaus-Robert Muller, J. Chem. Theory Comput. 2018, 14, 2991−3003
    48. Leo, A., &Hoekman, D. H. (1995). *Exploring QSAR*. American Chemical Society.

Unit – 1: Principles of Scientific Research 6 Lectures Research and research methodology, Procedures in research, Identification of the problem - Literature survey - Reference collection - Familiarity with ideas and concept of investigation - Qualitative and Quantitative analysis - Results - Synopsis writing - Art of writing a Research paper and Thesis.
Unit – 2: Research Design, Sampling & Probability 5-Lectures Research Design: Features of a Good Design, Different Research Designs, Sampling: Principles, methods, types of sampling, rationale for using a particular sampling procedure, Probability: Classical definition of Probability.
Unit – 3: Data collection & analysis 6- Lectures Types of Data, Collection of Data, double blind procedures, incidence and prevalence studies, Data Analysis: Measures of Central Tendency, Measures of Dispersion, Measures of Asymmetry,
Unit-4: Correlation and Regression 5-Lectures Methods of correlation, Types of correlation (Pearson r& Rho); Regression analysis, linear regression, Non-linear regression.
Unit – 5: Hypothesis and Statistics 5-Lectures Hypothesis Testing: Problems and hypothesis, variables and type of variables, Parametric and nonparametric statistics; level of significance, the various nonparametric tests with sample.
Module 6: Recent research advances 4 lectures Descriptors, Quantitative structure-activity relationship (QSAR), Quantitative structure-property relationship(QSPR), Drug designing.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Electrodynamics
Course Code	MSCP 6001
Prerequisite	B.Sc. (3 years) with Physics, Chemistry and Mathematics, Electronics, Instrumentation, with min. 50% marks in each subject and 50% marks in aggregate.
Corequisite	Students should have fundamental knowledge of subjects like mathematics, physics and chemistry

Antirequisite	-				
		L	T	P	C
		4	-	-	4

Course Objectives:

To apprise the students regarding correlated concepts of electrodynamics and relativistic theory. By using they can formulate the problem of time varying EM field, EM field from accelerated charge and EM scattering in various conditions.

Course Outcomes

CO1	Explain the concepts of relativity in 4-D and its application in high speed particle physics.
CO2	Describe the 4-vectors and employ the concept for the formulation of Maxwell's equations in electrodynamics
CO3	Discuss the field produced by moving charges
CO4	Explain the field produced by moving charge particle and apply the concept in relativistic domain.
CO5	Describe the different types of scattering phenomenon
CO6	Propose the concepts of Cherenkov radiation using EM field from uniformly moving charge.

Text books:

1. D.J. Griffiths, Introduction to Electrodynamics,4th ed.,Pearson, USA, 2013.
2. J.D. Jackson, Classical Electrodynamics, 3rd ed.,New Age, New Delhi, 2009.
3. R.K. Patharia ,Theory of Relativity, 2nd ed, Hindustan Pub., Delhi, 1974.

Reference Books:

1. S.P. Puri ,Classical Electrodynamics, 2nd ed., Tata McGraw Hill, 1990.
2. I.R. Kenyon, General Relativity, Oxford Univ. Press, 2001.
3. J.B. Marion and M.A. Heald, Classical Electromagnetic Radiation , 3rd ed., Saunders college Publishing House, 1995.
https://nptel.ac.in/courses/115/101/115101004/

Unit -1: Special Theory of Relativity (10 Lectures) Lorentz transformation as orthogonal transformation in 4- dimension, Relativistic equation of motion, Applications of energy momentum conservation, Disintegration of a particle, C.M. System and reaction thresholds.
Unit -2: Covariant Formulation of Electrodynamics in Vacuum (12 Lectures) Four vectors in Electrodynamics, 4-current density, 4-potential, Covariant continuity equation, Wave equation, Covariance of Maxwell equations, Electromagnetic field tensor, Transformation of EM fields, Invariants of the EM fields, Energy momentum tensor of the EM fields and the conservation laws.

Unit -3: Fields from Accelerated Charges (10 Lectures) Lienard-Wiechert Potentials, Field of a charge in arbitrary motion and uniform motion, Radiated power from an accelerated charge at low velocities.	
Unit -4: Radiation from Accelerated Charges (10 Lectures) Radiation from a charged particle with collinear velocity and acceleration. Radiation from a charged particle in a circular orbit, Radiation from an ultra-relativistic particle, Radiation reaction.	
Unit -5: E M Radiation (10 Lectures) Rayleigh scattering, absorption of radiation by bound electron.	
Unit VI- Application of Cherenkov radiation 4 lectures EM field from uniformly moving charge,Cherenkov radiation	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Atomic & Molecular Physics				
Course Code	MSCP 6002				
Prerequisite	B.Sc. (3 years) with Physics, Chemistry and Mathematics, Electronics, Instrumentation, with min. 50% marks in each subject and 50% marks in aggregate.				
Corequisite	Students should have fundamental knowledge of subjects like mathematics, physics and chemistry				
Antirequisite	-				
		L	**T**	**P**	**C**
		4	**-**	**-**	**4**

Course Objective:

Students will learn atomic, molecular and resonance spectroscopy. Effect of atomic energy in electric and magnetic fields. Students will also learn the electronic spectra, vibrational and rotational spectra, IR spectra and Raman spectroscopy.

Course Outcome:

CO1	Recognize and explain in details of the atomic and molecular spectra.
CO2	Demonstrate and detect the effect of atomic energy in the presence of electric and magnetic fields.

CO3	Estimate and Measure the chemical composition using electronic spectra.
CO4	Estimate and Measure the chemical composition using vibrational and rotational spectra.
CO5	Estimate and Measure the chemical composition using IR spectra.
CO6	Organize the recent technical development of Raman spectroscopy.

Text Books:
1. Raj Kumar, Atomic and molecular spectra and laser, KedarNath Ram Nath Publications Meerut, 2012
2. Harvey Elliott White, Introduction to Atomic Spectra, McGraw Hill, 1963.
3. Arthur Beiser, Concepts of Modern Physics, 6thed.,McGraw Hill, New Delhi, 2008.
4. B. H. Bransden and C. J. Joachain, Physics of Atoms and Molecules,2nd Edition, Wiley, Hong Kong,1990.
Reference Books:
1. ManasChanda, Atomic Structure and Chemical Bond, 2nd ed., Tata McGraw Hill, New Delhi,1979.
2. G .Aruldhas, Molecular Structure and Spectroscopy, 2nd ed., Prentice Hall of India Ltd, New Delhi, 2007.
3. G M Barrow, Introduction to molecular spectroscopy, Tata McGraw Hill,Japan, 1962.
B. H. Bransden and C. J. Joachain, Physics of Atoms and Molecules,2nd Edition, Wiley, Hong Kong,1990.
Research Articles
https://doi.org/10.1016/j.vibspec.2011.08.003

Unit – 1: Atomic Spectra (12 Lectures) Hydrogen atom spectrum; Electron spin; Spin Orbit interaction; Lande interval rule; Two electron systems; LS – JJ coupling Schemes; Fine structure; Spectroscopic terms and selection rules; Hyperfine structure; Exchange symmetry of wave function; Pauli's exclusion principle; Spectrum of Helium and Alkali atom.
Unit – 2: Atoms in External Fields and Resonance Spectroscopy (10 Lectures) Zeeman and Paschen Back Effect of one and two electron systems; Stark effect; X-ray – Auger transitions; Compton Effect; NMR – Basic principles; Classical and Quantum mechanical description; Magnetic dipole coupling; Chemical shift; ESR – Basic principles; Nuclear interaction and Hyperfine Structure.
Unit – 3: Microwave Spectroscopy and IR Spectroscopy (10 Lectures) Rotational spectra of diatomic molecules; Rotation spectra of polyatomic molecules; Linear, symmetric top and asymmetric top molecules; Experimental Techniques; Diatomic vibrating rotator; Linear, Symmetric top molecule; Analysis by infrared techniques.
Unit – 4: Raman Spectroscopy (10 Lectures) Raman Effect; Quantum theory of Raman effect; Electronic, rotational, vibrational and Raman spectra of diatomic molecules; Raman spectra of polyatomic molecules (tentative); Experimental techniques.
Unit – 5: Electronic Spectroscopy (10 Lectures) Electronic spectra of diatomic molecules; Frank-Condon principle; Dissociation energy and dissociation products; Rotational fine structure of electronic vibration transitions.
Unit-6: Techniques and applications of Raman spectroscopy: 4 lectures

Recent advancements of Raman spectroscopy: vibrational spectroscopy, Application of Raman spectroscopy in forensic science, Diagnostics and Materials science.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Digital Electronics				
Course Code	**MBS28T5301**				
Prerequisite	B.Sc. (3 years) with Physics, Chemistry and Mathematics, Electronics, Instrumentation, with min. 50% marks in each subject and 50% marks in aggregate.				
Corequisite	Students should have fundamental knowledge of subjects like mathematics, physics and chemistry				
Antirequisite	-				
		L	T	P	C
		4	-	-	4

Course Objectives:

To understand the concepts of Oscillatory Circuits.
To know the applications of Combinational circuits and sequential circuits.
To acquire the basic knowledge of microprocessors and its architecture.
To use modern tools necessary for Display devices and Instrumentation.

Course Outcomes

CO1	Explain the theory of semiconductor diode and transistor and relate its application in various solid state devices such as- Rectifier, clipper/clamper, transistor as a switch and semiconductor memories.
CO2	Describe the role of operational amplifier in electronic circuit for mathematical operation and interpret the oscillator and multivibrator circuits.
CO3	Differentiate between combinational (Encoder/decoder, Adders and Subtractor) and sequential (Flip-flop and Counters) circuits and realize its various digital electronic circuits.
CO4	Analyze and design Analog to Digital and Digital to Analog Converters.
CO5	Demonstrate the understanding of various instruments such as- transducer, gauges and thermometer.
CO6	Acquire knowledge to develop the sensors by soft materials for wearable devices, foldable displays, implant systems.

Text Books:

1.T.L Floyd, Digital Fundamentals, Charles Menil Publishing Co., Prentice Hall, 1991.
2. R.A. Gayakwad, Op- Amps. and Linear Integrated circuits, 3rd ed., Printice Hall, 1993.
3. R.J .Maddock and D.M. Calcutt, Electronics for engineers, 2nd ed.,Longman Scientific & Technical, 1994.

Reference Books:

1. J. Millman and C.C. Halkias, Integrated Electronics, McGraw Hill, Singapore, 1997.
2. D. Leach,A. P.Malvino and G Saha, Digital Principles and Applications, 7th ed.,Tata McGraw Hill, 2011, New Delhi

3. Alan S. Morris, Principles of measurement and instrumentation, Prentice Hall of India, New Delhi, 1999.
https://doi.org/10.1016/j.matt.2020.03.020
Herbertet. al., Materials (Basel). 2018 Feb; 11(2): 187.
GaokuoZhongJiangyuLi
ttps://doi.org/10.1016/j.jmat.2019.12.004

Unit –1: Oscillators (6 Lectures) Feedback concepts, Oscillatory Circuit, Colpitt's oscillator, Hartley oscillator, Phase shift oscillator, Wien Bridge oscillator, Limitations of LC and RC Oscillators: Crystal oscillator, negative resistance oscillator: tunnel diode oscillator, Unijunction Oscillator.
Unit – 2: Logic circuits (10 Lectures) Digital systems-Boolean algebra and Logic gates, Gate level minimization, K -Map , Combinational Logics- Half adder-sub-tractor (half & full) Comparators; Encoder-Decoders; Multiplexers; De-multiplexers; decimal adders and Subtractors. Sequential circuits, Latches, Flip-flops triggering of flip-flop – D and T type flip-flops - asynchronous, synchronous, Registers , decade and modulo – N counters.
Unit – 3: Analog to Digital and Digital to Analog Converters (10 Lectures) Analog Switches, High speed sample- and- hold Circuits, Types of D/A Converter, Current driven DAC, Switches for DAC, A/D converter-Flash, Single slope, Dual slope, Successive approximation, Delta Sigma Modulation, Voltage to Time converters.
Unit 4: Microprocessor: (10 Lectures) Introduction to 8085, basic concepts of microprocessors CPU, I/O devices, clock, memory, bussed architecture, tristate logic, address bus, data bus and control bus, microprocessor architecture: intel 8085A microprocessor, pin description and internal architecture.
Unit 5: Display devices and Instrumentation (16 Lectures) Introduction to display devices: Electro Luminescence display, Plasma display, Liquid Crystal Display (LCD), LED Display, Organic Light Emitting Devices (OLED), Elements of measuring instruments – capacitive transducer – inductive transducer- electrical strain gauges –resistance thermometer – piezoelectric and photoelectric transducers.
UNIT-VI: - Wearable Sensors and Devices 4 lectures Soft materials, flexible electronics, wearable sensors, electronic skin, digital health, wearable devices, foldable displays, implant systems, brain-machine interfaces

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks

30	20	50	100

Name of The Course	Microwaves and Antenna Propagation				
Course Code	**MBS28T5302**				
Prerequisite	B.Sc. (3 years) with Physics, Chemistry and Mathematics, Electronics, Instrumentation, with min. 50% marks in each subject and 50% marks in aggregate.				
Corequisite	Students should have fundamental knowledge of subjects like mathematics, physics and chemistry				
Antirequisite	-				
		L	T	P	C
		4	-	-	4

Course Objectives:
This course provides the advanced knowledge of microwave transmission lines, different microwave devices and its production. This course is also designed to make the students acquire the deep knowledge of microwave antennas and particularly patch antennas for modern communication system.

Course Outcomes

CO1	Demonstrate the transmission lines, smith chart and its applications.
CO2	Understand the basics of Microwave semiconductor devices.
CO3	Estimate the Microwave generation and amplification
CO4	Demonstrate different antenna characteristics, radiation patterns, directive gain etc.
CO5	Apply the Microwave integrated circuits in different transmission lines
CO6	Propose some new concepts for latest 5G communication technology and its application in various domains

Text Book:

1. Rizzi, P. A., Microwave Engineering, (Prentice-Hall, 1999)
2. Pozar, D. M., Microwave Engineering, 3rd edition, (Wiley India Pvt. Limited, 2009)
3. CA Balanis, Antenna Theory: Analysis and Design, 3rd edition John Wiley & Sons, Inc , 2011

Reference Books:

1. Liao, S. Y., Microwave Devices and Circuits, 3rd edition, (Prentice-Hall of India, 2000)
2. Collin, R. E, Foundations for Microwave Engineering, (McGraw-Hill, 1992)
3. Griffiths, D. J., Introduction to Electrodynamics, (Prentice-Hall, 2009) Jackson, J. D., Classical Electrodynamics, 3rd edition, (John Wiley & Sons, 1998)

4. E. Ayanoglu, "Fifth generation (5G) cellular wireless: Vision, goals, and challenges," 2016 IEEE 35th International Performance Computing and Communications Conference (IPCCC), Las Vegas, NV, 2016, pp. 1-3, doi: 10.1109/PCCC.2016.7820594

Unit I Transmission Line 10 Lectures Transmission lines, smith chart and its applications, rectangular wave guide, rectangular cavity, modes in waveguides and cavities, dielectric filled wave guides, dielectric slab guide, surface guided waves, non-resonant dielectric guide, modal expansion of fields and its applications.	
Unit II Microwave Devices 10 Lectures Microwave semiconductor devices: Microwave transistor, microwave tunnel diode, varactor diode, Schottky diode. MESFET: Principle of operation, MOS structure, MOSFET microwave applications, transferred electron devices: Gunn diode, LSA diode, modes of operation.	
Unit III Microwave Generation 12 Lectures Microwave generation and amplification, avalanche effect devices: Read diode, IMPATT diode, klystron: velocity modulation process, bunching process, output power and beam loading, reflex klystron: power output and efficiency, traveling wave tubes, magnetron.	
Unit IV Microwave Antennas 11 Lectures Antenna characteristics: radiation patterns, directive gain, side lobe, back lobe, polarization, co-polarization and cross polarization level, frequency reuse, beam width, input impedance, bandwidth, efficiency, antenna types: wire, loop and helix antennas, aperture antenna-slot, waveguide and horn antenna; parabolic reflector antenna.	
Unit V Microstrip Patch antennas 11 Lectures Microwave integrated circuits: different planar transmission lines, characteristics of microwave integrated circuits, microstrip antenna: rectangular and circular patch, feed for microstrip antennas: probe feed, microstrip line feed, aperture feed, electromagnetically fed microstrip patch.	
Unit VI Application of Microwaves and Antenna Propagation 4 lectures Recent advancement in Microwaves and Antenna Propagation : Fifth generation (5G) communication, Frequency range, MIMO antennas, Applications	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Physics Laboratory
Course Code	MBS28P3311

Prerequisite	B.Sc. (3 years) with Physics, Chemistry and Mathematics, Electronics, Instrumentation, with min. 50% marks in each subject and 50% marks in aggregate.				
Corequisite	Students should have fundamental knowledge of subjects like mathematics, physics and chemistry				
Antirequisite	-				
		L	T	P	C
			-	4	2

Course Objectives:

Student will perform the various experiments based on electronic and magnetic properties, optical fibre and nanoparticles.

Course Outcomes

CO1	Operate and handle the instruments effectively and safely in the physics laboratory.
CO2	Interpret and determine the magnetic properties and Curie temperature of magnetic materials.
CO3	Demonstrate the functioning of the electronics equipments such as FET, MOSFET, logic gates and operational amplifiers.
CO4	Operate and perform the experiments based on fiber optics.
CO5	Characterize absorption spectra and preparation of nanoparticles.

Text Books:

1. R.A. Dunlap, Experimental Physics: Modern Methods, Oxford University Press,1988.
2. B. K. Jones, Electronics for Experimentation and Research, Prentice-Hall,1986.
3. P.B. Zbar and A.P. Malvino, Basic Electronics: A Text-Lab Manual, 5thed.,TataMc-Graw Hill, New Delhi, 1983.

Reference Books:

1. Wersnop and Flint, Advanced Practical Physics, Asia Publishing House,1994.
2. G.Aruldas ,Molecular structure and Spectroscopy, 2nd Edition, Prentice-hall of India Pvt. Ltd., New Delhi, 2008.
3. G.B.Clayton, Operational Amplifier, 2nd ed., Butterworth&Co. Pvt., England, 1979.

List of Experiments

1. Determination of numerical aperture and bending loss of optical fiber.
2. Four probe band gap.
3. To draw the hysteresis curve (B-H curve) of a given sample of ferromagnetic material and to determine hysteresis loss.
4. Study of Curie temperature of Magnetic Materials with the hysteresis (B-H) curve.
5. To determine the precision and nutation using Gyroscope.
6. To study absorption spectra of Iodine molecule and to determine its dissociation energy using spectrometer.
7. Determination of ultrasonic wave in non-electrolyte medium and determination of the compressibility of liquid.
8. Determination of the wavelength of monochromatic light using Michelson interferometer.
9. Determination of the specific rotation of light in cane suger using half shade polarimeter.
10. Experiments on FET and MOSFET characterization and application as an amplifier.
11. Operational amplifier – Characteristics verifications with the help of breadboard.

12. Study of Op-Amp as Square and Ramp Generator with the help of breadboard and function generator.
13. Study of OP AMP as differentiator and integrator.
14. Study of IC 7400 as Half adder, Half subtractor, Full adder, Full subtractor.
15. Study of Addition, subtraction, multiplication and division using 8086.
16. Preparation of nanoparticles (ex- Nickle Oxide) by optimization conditions and Characterization of Nanoparticles with the help of UV-Vis Spectrophotometer.

Continuous Assessment Pattern

Internal Assessment (IA)	End Term Test (ETE)	Total Marks
50	50	100

Name of The Course	Materials Science				
Course Code	MSCP 6005				
Prerequisite	B.Sc. (3 years) with Physics, Chemistry and Mathematics, Electronics, Instrumentation, with min. 50% marks in each subject and 50% marks in aggregate.				
Corequisite	Students should have fundamental knowledge of subjects like mathematics, physics and chemistry				
Antirequisite	-				
		L	T	P	C
		4	-	-	4

Course Objectives:

To describe the major features of a phase diagram.

To describe the various types of crystal **defects** and dislocations in **solid**s.

To acquire knowledge about dielectrics & ferroelectrics, elasticity and superconductivity.

Course Outcomes

CO1	Explain the basic concept of material science and concept of phase and phase diagram of solids.
CO2	Analyze the Structure and defects in solids.
CO3	Explain the dielectric properties of materials and apply it electronic devices.
CO4	Explain the basic concept of polymeric materials apply it in commercial domain.
CO5	Explain and analyze the superconducting phenomena and its applications.
CO6	Development of various materials for construction purposes

Text Books:

1. Charles Kittel, Introduction to Solid State Physics, 7th edition, John Wiley & sons, USA,1996.
2. A J Dekker, Solid State Physics, Prentice-Hall, New York, 1957.
3. H. V.Keer, Principles of the Solid State, New Age Int, New Delhi, 2005.

Reference Books:

1. M. Ali Omar, Elementary Solid State Physics, 4th ed., Addison Wesley, New York,1994.
2. N. W. Ashcroft and Mermin, Solid State Physics, Cengage Learning India Pvt Lim.,1976.
3. V.Raghavan , Materials Science and Engineering – A First Course, 4th ed., Prentice-Hall of India,1988.

4. Lawrence H. Van Vlack, Elements of Materials Science, 3rd ed., Addison- Wesley, New York, 1964.
5. Silva et al. Carbohydrate PolymersV 240 , 116268 (2020) https://doi.org/10.1016/j.carbpol.2020.116268

Unit -1: Phase Diagram (12 Lectures) Phase Diagram - Basic principle - Simple binary systems - Solid solutions - Eutectic systems - Application. Solid Solution - Interstitial and substitutional solid solutions - Super lattices - Intermediate and interstitial phases - Intermetallic compounds, Elementary ideas of corrosion - Oxidation - Creep and fracture. Liquid crustal ordering, Phases of liquid crystal, Landau-De Gennes theory of nematic liquid crystals.
Unit -2: Defect in solids (10 Lectures) Point defects - Schottky and Frenkel defects - number of defects as a function of temperature - Diffusion in metals - Diffusion and ionic conductivity in inonic crystals - Dislocations - Edge and screw dislocations - Motion of dislocations under uniform shear stress - Stress fields around dislocations - Effect of grain size on dislocation.
Unit -3: Dielectrics & ferroelectrics (10 Lectures) Internal electric field in a dielectric - Clausius - Mossotti and Lorentz - Lorenz equations - Dielectric dispersion and loss, Ferroelectrics - Ferro electricity - General properties - Dipole theory - Ionic displacements and the behaviors of $BaTiO_3$ - Spontaneous polarization of $BaTiO_3$ - Thermodynamics of Ferro electric transitions.
Unit-4: Elasticity (10 Lectures) Atomic model of elastic behaviour - Elastic deformation - Relaxation process - Model for viscoelastic behavior, Polymerization mechanism - Polymer structures - Deformation of polymers - Effect of structure on the behaviour of ceramic phases - composites.
Unit-5: Super conductivity (10 Lectures) Super conductivity —Meissner effect – Type I and II superconductors – thermal properties of superconductors – High frequency phenomenological properties – coherence length – London model – Ginzburg-Landau theory – flux quantisation – BCS theory – Josephson effect (AC and DC) – High temperature superconducting oxides – Technological applications
Unit 6: Application of materials 4 lectures Thermoresponsive systems composed of poloxamer 407 and HPMC or NaCMC: mechanical, rheological and sol-gel transition analysis

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Nanomaterials and Applications				
Course Code	**MBS28T5303**				
Prerequisite	B.Sc. (3 years) with Physics, Chemistry and Mathematics, Electronics, Instrumentation, with min. 50% marks in each subject and 50% marks in aggregate.				
Corequisite	Students should have fundamental knowledge of subjects like mathematics, physics and chemistry				
Antirequisite	-				
		L	T	P	C
		4	-	-	4

Course Objectives:

The objective of the course on nanotechnology is to equip the postgraduate students with the concepts required for understanding various dimension of the nanomaterials, synthesis, characteristics and its versatile applications. With the aim of developing a strong background if he/she chooses to pursue research and industry in various domain of Nano engineering as a career.

Course Outcomes

CO1	Understand the materials propertied around Nano scale in a confined systems.
CO2	Obtain the synthesis of nanomaterials and their applications and the impacts
CO3	Determine the structure of nanoparticle using different methods.
CO4	Estimate the various properties and transport in nanostrcutures
CO5	Discuss and evaluate characterization methods for nanomaterials, and determine nanomaterial safety and handling methods required during characterization.
CO6	Formulate the fundamental knowledge of photovoltaic devices and propose synthesis of quantum dot solar cells.

Text Books:

1. C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (Wiley-Interscience, May 2003).
2. S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publishing Company, 2007),
3. K.K. Chattopadhyay and A. N. Banerjee, Introduction to Nanoscience and Technology (PHI Learning Private Limited, 2009).
4. Richard D. Booker, Earl Boysen, Nanotechnology (John Wiley and Sons, 2005).

Reference Books:

1. M. Hosokawa, K. Nogi, M. Naita, T. Yokoyama, Nanoparticle Technology Handbook (Elsevier, 2007).
2. Bharat Bhushan, Springer Handbook of Nanotechnology (Springer-Verlag, Berlin, 2004).
3. Cao Guozhong and Wang Ying, Nanostructures and Nanomaterials –Sysnthesis, Properties and Applications, World Scientific Publishing, 2nd edition, 2011.
4. Dieter Vollath, Nanomaterials: An Introduction to Synthesis, Properties and Applications, , Wiley, 2008
5. Nanoscale Materials in Chemistry, edited by Kenneth J. Klabunde& Ryan Richards, John Wiley & Sons, 2nd edition, 2009.
6. A Wang, Z Jin, M Cheng, F Hao, L Ding - Journal of Energy Chemistry, "Advances in perovskite quantum-dot solar cells", 2020 – Elsevier, Volume 52, January 2021, Pages 351-353

Unit I Nano-structures 12 Lectures Nanoscale systems: Length scales, different nanostructures : nanodots, nanowires, nanorods, Band structure and density of states of materials at nanoscale, Size effects in nano systems, Quantum confinement: Applications of Schrodinger equation- Infinite potential well, potential step, potential box, quantum confinement of carriers in 3D, 2D, 1D nanostructures and its consequences.	
Unit II Synthesis of Nano-materials 10 Lectures Synthesis of nanostructured materials: Top down and Bottom up approach, Photolithography. Ball milling. Gas phase condensation. Vacuum deposition. Physical vapor deposition (PVD): Thermal evaporation, E-beam evaporation, Pulsed Laser deposition. Chemical vapor deposition (CVD). Sol-Gel. Electro deposition. Spray pyrolysis. Hydrothermal synthesis. Preparation through colloidal methods. MBE growth of quantum dots.	
Unit III Characterization techniques 9 Lectures Characterization: X-Ray Diffraction, Optical Microscopy, Scanning Electron Microscopy, Transmission Electron Microscopy, Atomic Force Microscopy, Scanning Tunnelling Microscopy.	
Unit IV Properties of Nanomaterials 12 Lectures Properties of nanomaterials: Dielectric constant for nanostructures. Excitons in direct and indirect band gap semiconductor nanocrystals, absorption, emission and luminescence. Optical properties of heterostrctures and nanostructures. Electron transport in nanostrcutures, thermionic emission, tunneling and hoping conductivity. Defects and impurities: Deep level and surface defects. Mechanical and thermal properties of nanomaterials.	
Unit V Applications of Nanomaterials 11 Lectures Applications: Applications of nanoparticles, quantum dots, nanowires and thin films for photonic devices (LED, solar cells). Single electron devices. CNT based transistors. Micro Electromechanical Systems (MEMS), Nano Electromechanical Systems (NEMS).	
Unit VI- Perovskite quantum-dot solar cells 4 lectures Recent advances in Perovskite quantum-dot solar cells- Perovskite structure, Challenges in synthesis, Efficiency of solar cells, Comparison to others.	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Solid State Physics
Course Code	**MBS28T5305**
Prerequisite	B.Sc. (3 years) with Physics, Chemistry and Mathematics, Electronics, Instrumentation, with min. 50% marks in each subject and 50% marks in aggregate.

Corequisite	Students should have fundamental knowledge of subjects like mathematics, physics and chemistry				
Antirequisite	-				
		L	T	P	C
		4	-	-	4

Course Objectives:

The course aims through a theoretical and experimental approach to give fundamental insights into solid state physics. It includes theoretical description of crystal and electronic structure, lattice dynamics, and magnetic properties of different materials, based on the classical and quantum physics principles.

Course Outcomes

CO1	Analyze X-Ray diffraction data for identifying a crystal structure.
CO2	Estimate energy band gaps of solids, density of states and effective mass of electrons using tight binding model, Kronig Penny model, Cellular method and Pseudo-potential method
CO3	Explain lattice vibrations in one-dimensional monoatomic and diatomic lattices with their dispersion relations.
CO4	Describe Langevin and quantum mechanical formulation of diamagnetism and paramagnetism.
CO5	Discuss ferromagnetic order and anti- ferromagnetic order.
CO6	Plan the construction of Graphene based nanostructured photovoltaic devices such as- solar cells, battery etc.

Text Books:

1. Charles Kittel, Introduction to Solid State Physics, 7th edition, John Wiley & sons, USA,1996.
2. J.RichardChristman, Fundamentals of Solid State Physics, 1sted.,John Wiley & sons, New York, 1988.
3. M.A.Wahab, Solid State Physics –Structure and properties of Materials, Narosa Publications, 1999.

Reference Books:

1. A J Dekker, Solid State Physics, Prentice-Hall, New York, 1957.
2. M. Ali Omar,Elementary Solid State Physics, 4th ed., Addison Wesley, 1994.
3. H. Ibach and H. Lüth, Solid State Physics – An Introduction to Principles of Materials Science, 3rd ed., Springer International Edition, 2004.
4. N. W. Ashcroft and Mermin, Solid State Physics, Cengage Learning India Pvt Lim.,1976.
5. Introduction of Graphene-Based Nanomaterials: Je Min Yoo, January 2020

Unit-1: Crystal Diffraction and Reciprocal Lattice (12 Lectures) Crystal Diffraction Methods for X rays, Laue, Rotating Crystal, Powder Method; Reciprocal Lattice and Brillouin Zones; Reciprocal Lattice to sc, bcc, fcc.; Scattered wave amplitude; Fourier analysis of the basis; Structure Factor of lattices (sc, bcc, fcc); Atomic Form Factor.
Unit-2: Electronic Properties (10 Lectures) Electrons in periodic potential, Band Theory, Kronig Penney model, Tight Binding, Cellular and Pseudo potential methods, Symmetry of energy bands, density of states- Sommerfeld free-electron model, Fermi surface, De Haas von Alfen effect, Elementary ideas of quantum Hall effect.

Unit-3: Lattice Vibrations and thermal properties (12 Lectures) Vibrations of Monoatomic Lattice, normal mode frequencies, dispersion relation; Lattice with two atoms per unit cell; normal mode frequencies, dispersion relation: Quantization of lattice vibrations, phonon momentum; Anharmonic Crystal Interaction; Thermal conductivity, Lattice Thermal Resistivity.
Unit-4: Diamagnetism and Paramagnetism (10 Lectures) Langevin diamagnetic equation; diamagnetic response; Quantum mechanical formulation; core diamagnetism; Quantum Theory of Paramagnetism; Crystal Field Splitting and Quenching of orbital angular momentum; Paramagnetic susceptibility of conduction electrons.
Unit-5: Magnetic Ordering (8 Lectures) Ferromagnetic order, Exchange Integral, Saturation magnetization; Magnons, neutron magnetic scattering; Spinels, Yttrium Iron Garnets; Anti Ferromagnetic order; Anisotropy energy, transition region between domains.
Unit VI- Graphene and its applications 4 lectures Structure of Graphene, synthesis of Graphene and nanostructure, Hybrid structure of Graphene, Applications-solar cells, battery, biomedical etc

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Fiber Optics and optoelectronics				
Course Code	**MBS28T5306**				
Prerequisite	B.Sc. (3 years) with Physics, Chemistry and Mathematics, Electronics, Instrumentation, with min. 50% marks in each subject and 50% marks in aggregate.				
Corequisite	Students should have fundamental knowledge of subjects like mathematics, physics and chemistry				
Antirequisite	-				
		L	T	P	C
		4	-	-	4

Course Objectives:

This course provides the advanced knowledge of microwave transmission lines, different microwave devices and its production. This course is also designed to make the students acquire the deep knowledge of microwave antennas and particularly patch antennas for modern communication system.

Course Outcomes

CO1	Understand the basic concept of optical fiber

CO2	Illustrate the basic characteristics of optical fibers
CO3	Express the modulators for Fiber optic communication system
CO4	Estimate the physical parameters with the help of Fiber optic sensors
CO5	Categories optoelectronic devices such as CCD, Photo transistor, etc.
CO6	Propose the implications of the advancement in the field of optical fibre and optoelectronic devices

Text Books:

1. D.A Krohn. '*Fiber optic Sensors Fundamentals and Applications*', Instrument society of America, 1999.
2. J. Wilson , J.F.B. Hawkes, ' *Optoelectronics an introduction* ', PHI, second edition 2001.
3. William M. Steen, ' *Laser material processing* 'Springer, third edition, 2003.

Reference Books

1. Keiser, '*Optical Fiber Communication system*', McGraw Hill Ltd., Second Edition, 2003.
2. SilvanoDonati, '*Electro-Optical Instrumentation: Sensing and Measurements with lasers'*,Prentice Hall, 2004.
3. William T. Silvast, '*Laser fundamentals*', Canbridge University Press, 1996.
4. Yue, Z., Ren, H., Wei, S. et al. Angular-momentum nanometrology in an ultrathin plasmonic topological insulator film. Nat Commun 9, 4413 (2018). https://doi.org/10.1038/s41467-018-06952-1

Unit-I Optical Fiber (10 Lectures) Optical fibers, Propagation of light through optical fiber, Angle of acceptance and numerical aperture, , Type of fibers : Step index fiber, Single mode and multimode fiber, graded index fiber, Attenuation, Dispersion
Unit-II Fundamentals of Fiber Optics (10 Lectures) Theory and classification of fiber optics - Characteristics –attenuation and dispersion, Optical fiber production -Technology of preformed fabrication - Fiber drawing - bandwidth limiting mechanism
Unit-III Fiber Optics and communication (10 Lectures) Source coupling – Fiber connectors and splices - Splicing techniques. Modulators - Acousto-optic modulators– magneto-optic modulators – Electro-optic modulators Fiber optic communication system setup - types of modulations– Optical receivers.
Unit-iV Optical Instrumentation (10 Lectures) Mach-Zehnder Interferometer, Fiber optic sensors - displacement, pressure, temperature, acceleration, torque, strain, fluid level and flow- Electric and magnetic field sensors based on polarization effect- Fiber optic gyroscope.
Unit-V Optoelectronics (10 Lectures) Photo detectors, Photo transistor, photoconductors, photon devices, PMT, photodiodes, photo transistors, noise characteristics of photo-detectors, PIN diode, APD characteristics, APD Design of detector arrays, CCD, Solar cells, Opto-Isolators.

Unit VI: Application of Fiber Optics and optoelectronics 4 lectures Recent advancement in Fiber Optics and optoelectronics: Twisted' fibre optic, Organic light-emitting diode (OLED)

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Nuclear and Particle Physics				
Course Code	**MBS28T5307**				
Prerequisite	B.Sc. (3 years) with Physics, Chemistry and Mathematics, Electronics, Instrumentation, with min. 50% marks in each subject and 50% marks in aggregate.				
Corequisite	Students should have fundamental knowledge of subjects like mathematics, physics and chemistry				
Antirequisite	-				
		L	**T**	**P**	**C**
		4	-	-	4

Course Objective: This course aims to impart knowledge about the nuclear scattering process and nuclear models for understanding of related reaction dynamics

Course Outcomes:

CO1	Summarize the basic concepts of scattering process of particles.
CO2	Describe the role of residue interaction in the shell structure of atomic nuclei, and predict the wave function of nucleons in unfilled shell.
CO3	Explain the properties of nuclear ground and excited states based on the Collective motion of nucleons.
CO4	Describe the formation and decay of compound nucleus states in nuclear reactions.
CO5	Analyse the nuclear reactions of unstable nuclei.
CO6	Able to formulate the theoretical fremework to study the nuclear structure

Text Books:

1. B.L. Cohen, Concepts of Nuclear Physics, McGraw Hill,USA, 1971.
2. M. K. Pal, Theory of Nuclear Structure ,East West Affiliated Press. New Delhi,1983.

Reference Books:

1. R.G.Sachs, Nuclear Theory, Addison Wesley,1953.
2. M A Preston, Physics of the Nucleus, Addison Wesley, 1962.
3. Bohr and Mottelson, Nuclear Structure, Vols. I and II , World Scientific, 1968.
4. Greiner and Meruhn, Nuclear Models, 1996 ed., Springer Verlag, 1996.

5. Preston and Bhadury, Structure of the Nucleus, Perseus Books Group, 1993.
6. Bethe and Morrison, Elementary Nuclear Theory, 2^{nd} ed., John Wiley,USA,2006.
7. *Reference: N.K.Timofeyuk, R.C.Johnson, Progress in Prticle and Nuclear Physics Volume 111*

Unit-1: Two Body Interactions (12 Lectures) Introduction to scattering, spin dependence of the interaction: singlet and triplet scattering lengths; coherent scattering from ortho and para-hydrogen; singlet state of the deutron; np, pp, nn scattering; exchange forces and saturation.
Unit-2: Nuclear Shell model (12 Lectures) Residual interaction single particle model and individual particle model; justification of Nordheims rule; configuration mixing; anti-symmetrization of wave functions two and three nucleons in unfilled shell; coefficients of fractional parentage; Pairing interaction and its effects.
Unit-3: Collective and Unified Models (12 Lectures) Collective modes of motion vibrational and rotational modes; Hamiltonian for collective model of a deformed nucleus and its separation into vibrational and rotational parts; rotation vibration coupling; collective spectra of nuclei; back-bending; Coupling of collective and individual particle modes; Deformed core and Nilsson model.
Unit-4: Compound Nuclear Reactions (8 Lectures) Compound Nuclear Reactions; Formation and decay; multilevel Breit-Wigner formula; Weiskopff Ewing formula; continuum states;
Unit-5: Dirac Nuclear Reactions (8 Lectures) Evaporation modet; level density Ericksons formula; Nuclear temperature; Hauser Feshbach formalism.
UNIT-6:Recent advance in Nuclear Reactions 4 lectures Theory of deuteron stripping and pick-up reactions for nuclear structure studies

Continuous Assessment Pattern

Internal Assessment (IA)	**Mid Term Test (MTE)**	**End Term Test (ETE)**	**Total Marks**
30	20	50	100

Name of The Course	Astrophysics and Cosmology
Course Code	**MBS28T5308**
Prerequisite	B.Sc. (3 years) with Physics, Chemistry and Mathematics, Electronics, Instrumentation, with min. 50% marks in each subject and 50% marks in aggregate.

Corequisite	Students should have fundamental knowledge of subjects like mathematics, physics and chemistry				
Antirequisite	-				
		L	T	P	C
		4	-	-	4

Course Objectives:

This course aims to develop understanding of physical laws of the universe in the astrophysical and cosmological domains.

Course Outcomes

CO1	Describe and explain the key coordinate systems used in astrophysical observations.
CO2	Identify the various observational techniques and instruments.
CO3	Explain the characteristics and phenomena associated with the Sun.
CO4	Describe the formation and evolution of stars and galaxies systems.
CO5	Explain the structure of the Universe, cosmological parameters and the cosmological standard model
CO6	Able to plan research work on gravitational wave.

Reference Books:

1. An Introduction to Modern Astrophysics and Cosmology (Second Edition), B.W. Carroll & D.A. Ostlie, Addison-Wesley Publishing Co., 2006
2. Introductory Astronomy and Astrophysics (Fourth Edition), M. Zeilik and S. A. Gregory
3. An Introduction to Astronomy and Astrophysics, Pankaj Jain, CRC Press Taylor & Francis Group, 2015
4. Saunders College Publishing, 1998 Fundamental of Astronomy (Fifth Edition), H. Karttunen et al. Springer, 2007
5. Introduction to Cosmology, by J. V. Narlikar (Cambridge University Press, 2002)
6. Cosmology by Steven Weinberg (Oxford University, 2008)
7. Modern Cosmology by Scott Dodelson, Academic Press; 1 edition (March 27, 2003)
8. The early Universe by Kolb and Turner
9. Reference: LIGO Scientific and Virgo Collaborations•B.P. Abbott(Caltech) et al.

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Unit I Astronomical observations and Coordinate systems 10 lectures Astronomical Coordinates- Celestial Sphere, Horizon, Equatorial, Ecliptic and Galactic Systems of Coordinates, Conversion from one system of co-ordinates to another, Magnitude Scale- Apparent and absolute magnitude, distance modulus. Determination of mass, luminosity, radius, temperature and distance of a star, Colour Index, Stellar classification – Henry-Draper and modern M-K Classification schemes, H-R Diagram, H-R Diagram of Clusters, Empirical mass- luminosity relation

Unit II Telescopes and Instrumentation: 10 lectures Different optical configurations for Astronomical telescopes, Mountings, plate scale and diffraction limits, telescopes for gamma ray, X-ray, UV, IR, mm and radio astronomy, Stellar Photometry - solid state, Photo-multplier tube and CCD based photometers, Spectroscopy and Polarimetery using CCD detectors
Unit III The Sun 10 lectures Physical Characteristics of sun- basic data, solar rotation, solar magnetic fields, Photosphere - granulation, sunspots, Babcock model of sunspot formation, solar atmosphere – chromosphere and Corona, Solar activity- flares, prominences, solar wind, activity cycle, Helioseismology
Unit IV Stars and Galaxies systems 10 lectures Binary Stars, Kinematics of a Binary Star System, Classification of Binary Stars, Mass determination, Mass Transfer in Binary Systems, Galaxies, Elliptical Galaxies, spiral galaxies, Milky way galaxy, Galaxy Clusters, Galactic rotation curve, Evidence of dark matter, Extragalactic Distance Scale, pulsars, quasars
Unit V Cosmology and the early Universe 10 lectures Cosmological principle, maximally symmetric spaces, Killing vectors, Robertson- Walker metric. Redshift of galaxies and Hubble's law. Magnitude-red shift relation, Hubble's constant and deceleration parameter. Friedmann equations and standard models. Closed, flat and open universes. Age of the universe, critical density, dark energy. Thermal history of early universe, helium formation, decoupling of matter and radiation, microwave background radiation. Cosmological constant and the late time acceleration.
UNIT-6: Recent Advances in Cosmology 4 lectures Observation of Gravitational Waves from a Binary Black Hole Merger

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

GALGOTIAS UNIVERSITY

(Established under Galgotias University Uttar Pradesh Act No. 14 of 2011)

Program: M.Sc. Environmental Science

Scheme: 2020-2021

Vision:

To be recognized globally as a center of excellence in imparting value-based education in Basic and Applied Sciences by creating innovation in fundamental and multidisciplinary research

Mission:

M1. To excel in imparting contemporary knowledge and skills by developing an educational ecosystem with diverse interests and talents.

M2. To perform cutting edge research leading to innovation in sciences through national and international collaborations.

M3. To develop solutions for the emerging challenges in Basic and Applied Science to cater the needs of society.

M4. To attract best quality faculty to facilitate knowledge and develop confidence in our graduates to succeed in the world.

Program Educational Objectives: The postgraduates shall:

PEO1: Postgraduates shall be nurtured to meet the needs of industries/laboratories related to Environmental Science and other subjects contributing to it

PEO2: Postgraduates shall be equipped with necessary knowledge and skills which would enable them to pursue successful careers in research/academics in institutes of national and international repute

PEO3: Postgraduates shall be able to communicate effectively the scientific information and research results in written and oral formats thereby helping the scientific fraternity as well as the society in general

Program Specific Objectives The Postgraduates shall be able to:

PSO1: Demonstrate efficiency in using modern technical and computational skills in solving common environmental issues like pollution, waste management, environmental toxicology and disaster management

PSO2: Develop research oriented skills like literature review, gap analysis, data collection and result compilation through exposure in industries and R&D labs during internship

Program Outcomes After the completion of the program the postgraduates will be able to

PO1: Apply the knowledge of chemistry, biology, chemical and civil engineering and architecture to find solution of complex environmental problems in industry and academics

PO2: Identify, formulate research literature and analyze environmental problems to arrive at substantiated conclusions using principles of analytical chemistry, biology and chemical engineering and design solutions for environmental problems with a valid conclusion.

PO3: Create, select, and apply appropriate techniques, resources and modern analytical tools including prediction and modelling of environmental issues with an understanding of the limitations.

PO4: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional industrial practice.

PO5: Understand the impact of the environmental issues in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO6: Communicate effectively with the scientific community and society at large. Be able to comprehend and write effective reports documentation. Make effective presentations, and give and receive clear instructions.

PO7: Demonstrate knowledge and understanding of scientific and management principles and apply these to one's own work, as a member and leader in a team. Manage projects in multidisciplinary environments.

PO8: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological and scientific change.

Curriculum

Program: M.Sc. Environmental science, SBAS									
Scheme: 2020 – 2022									
Program Structure									
Semester 1									
Sl. No	Course Code	Name of the Course					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MEV101	Introduction to Environmental Studies	4	0	0	4	30	20	50
2	MEV102	Biodiversity and Conservation Biology	4	0	0	4	30	20	50
3	MEV103	Environmental Hazards and Pollution	4	0	0	4	30	20	50
4	MEV104	Environmental Geology	4	0	0	4	30	20	50
5	MEV105	Disaster management	4	0	0	4	30	20	50
6	MEV131	Environmental Science Lab-I	0	0	4	2	50	-	50
			Total			22			
Semester II									
Sl No	Course Code	Name of the Course					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MEV201	Environmental Impact and Risk Assessment	4	0	0	4	30	20	50
2	MEV202	Environmental Toxicology and Health	4	0	0	4	30	20	50
3	MEV203	Resource Management	4	0	0	4	30	20	50
4	MEV204	Environmental Chemistry	4	0	0	4	30	20	50
5	MEV231	Environmental Science Lab-II	0	0	4	2	50	-	50
6	XXXX	BEC (B1)				3			
7	MBS26T2111	Research Methodology				2	30	20	50
8	XXXX	IPR				1			
			Total			24			
Semester III									
Sl No	Course Code	Name of the Course					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MEV341	Summer Internship*	0	0	0	2	50		50
2	MBS26P2998	Major Project Phase-I	0	0	0	6	50		50
3	XXXX	Campus to Corporate				2			
			Total			10			
Semester IV									

Sl No	Course Code	Name of the Course					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MEV401	Environmental Biotechnology	4	0	0	4	30	20	50
2	MEV402	Green Technology	4	0	0	4	30	20	50
3	MEV431	Environmental Science Lab-III	0	0	4	2	50	-	50
4	MBS26P2999	Major Project Phase-II	0	0	0	6	50		50
5	MBS26T5XXX	*Electives	3	0	0	8	30	20	50
		Total				24			
Total Credits of the program=80									

List of Electives

Elective-1 Methodologies for Environmental Studies

Sl No	Course Code	Name of the Electives					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MBS26T5101	System Analysis and Modelling	3	0	0	3	30	20	50
2	MBS26T5102	Remote Sensing and GIS	3	0	0	3	30	20	50
3	MBS26T5103	Methodolgy Lab I - Practical on System Analysis and Modelling	0	0	2	1	50	-	50
4	MBS26T5104	Methodology Lab II - Practical on Remote Sensisng and GIS	0	0	2	1	50	-	50

Elective-2 Waste management

Sl No	Course Code	Name of the Elective					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MBS26T5105	Solid and Hazardous Waste Management	3	0	0	3	30	20	50
2	MBS26T5106	Waste Water Management	3	0	0	3	30	20	50
3	MBS26T5107	Waste management Lab I - Practicals on Solid Waste	0	0	2	1	50	-	50
4	MBS26T5108	Waste Management Lab II - Practicals on Waste Water Treatment	0	0	2	1	50	-	50

Elective-3 Environment and society

Sl No	Course Code	Name of the Elective					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MBS26T5109	Rural Society and Development	3	0	0	3	30	20	50
2	MBS26T5110	Urban Ecosystem	3	0	0	3	30	20	50

3	MBS26T5111	E&S Lab I - Field Work on Rural Development	0	0	2	1	50	-	50
4	MBS26T5112	E&S Lab II - Field Work on Urban Ecosystem	0	0	2	1	50	-	50

SEMESTER-I

Name of The Course	Introduction to Environmental Studies				
Course Code	MEV101				
Prerequisite	B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry				
Corequisite	Environmental Science				
Antirequisite					
Theory Lectures:		L	T	P	C
		4	0	0	4

Course Objectives:
This course reviews the basic concepts in Environmental Science and gives an overall awareness about the earth, atmosphere, water and the biotic components that constitute our ecosystem

Course Outcomes

CO1	Describe the Environment and concept of ecosystem. K2
CO2	Explain the structure, composition of atmosphere and reasons of air pollution. K2
CO3	Interpret the water quality parameters and standards. K3
CO4	Identify the biodiversity patterns and Hotspots. K4
CO5	Illustrate the reasons of Global warming, climate change and Environmental Impact Assessment. K3
CO6	Identify the recent environmental issues in the world (K4)

Text Book (s)

4. Principles Of Environmental Science. McGraw-Hill Higher Education. Cunningham, W.P., Saigo, B.W. and Cunningham, M.A. 2001.
5. Environmental Science: A Global Concern (Vol. 412). Boston, MA: McGraw-Hill. Glasson, J. and Therivel, R. 2013.
6. Introduction To Environmental Impact Assessment. Routledge.

7. Reference Book (s)
8. Anjaneyulu, Y. 2004. Introduction to Environmental Science. B. S. Publications. Barrett, E.C. 2013.
9. Introduction To Environmental Remote Sensing. Routledge. Botkin, D.B. and Keller, E.A. 1995. 3.Environmental Science Earth as a Living Planet, (9th Ed). Wileyplus. Chiras, D.D. 2001.
10. Environmental Science, 6Ed., Jones and Bartlett Publishers. Cunningham, W. and Cunningham, M.A. 2010.

Unit-1 Introduction to the Environment	10 hours
Introduction to the Environment. Acquisition, transformation and utilization of energy: the geochemical, biogeochemical and hydrological cycles. Concept of ecosystem.	
Unit-2Atmosphere	10 hours
Atmosphere: structure and composition. Air pollutants and their emission sources. Aerosols and Smogs. Air quality standards. Tropospheric ozone. Air pollution in Indian cities.	
Unit-3 Water and hotspots	10 hours
Water: quantity and quality. Parameters and standards; Demands. Rain water chemistry. Surface and subsurface waters in India. Environmental hotspots related to water in India.	
Unit-4 Soil and Land use	8 hours
Soil and Land use: Climate and soil profile, Mineral matters in soil. Soil classification. Soil distribution in India. Land use in India. Impact of soil loss and land cover on biogeochemical cycles. Biodiversity. Problems and issues in biodiversity. Biodiversity status and patterns and hotspots. Conservation and utilization of biodiversity.	

Unit-5 Global warming and climate change 10 hours
Global warming and climate change. Recent records of climate change. Impact of climate change on Indian environment. Measures to cope with climate change. Mineral and energy resources. Impact of mining and other human activities on the environment. Environmental impact assessment and environmental audit: an introduction. Environmental policy matters and law.
Unit-6: Current Environmental Concerns: 6 hours
Overpopulation and urban sprawl. Deforestation and desertification. Pollution. Waste Disposal.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Biodiversity and conservation biology				
Course Code	MEV102				
Prerequisite	Introduction to biodiversity and conservation biology				
Corequisite	Environmental Science and Biology				
Antirequisite					
Theory Lectures:		L	T	P	C
		4	0	0	4

Course Objectives:

The objective of this course is to provide students with an understanding of the problems associated biodiversity conservation worldwide, to give hand-on experience in conservation methods, and their benefits to bring ethical awareness in relation to biodiversity and conservation biology.

Course Outcomes

CO1	Demonstrate importance of diversity at different levels of biological organization. K2
CO2	Explain basic concept of ecological and biological processes that ensures long-term stability of ecosystems. K2
CO3	Illustrate the various biodiversity perameters.K3
CO4	Explain the methods for measurement of species diversity and molecular diversity. K2
CO5	Analyze the values of biodiversity and scientific approaches for conservation that can lead to sustainable development. K4
CO6	Explain the innovative steps and latest trends in biodiversity. K5

Text Book (s)

1. Loreau, M., and Inchausti, P. 2002. Biodiversity and Ecosystem functioning: Synthesis and Perspectives. Oxford University Press, Oxford, UK.
2. Pandit, M.K. 2017. Life in the Himalaya: An Ecosystem at Risk. Harvard University Press.
3. Primack, R.B., 2002, Essentials of Conservation Biology, 3 rdEdn.,Sinauer Associates, Sunderland, Ma. USA.
4. Sodhi, N. S., Gibson, L., and Raven, P. H. 2013. Conservation Biology: Voices from the Tropics. John Wiley and Sons Ltd.: UK.
5. Wilson, E. O. 1993.Diversity of Life. Harvard University Press, Cambridge, MA.

Reference Book (s)

1. Biju, S.D. and Bossuyt, F. 2003. New frog family from India reveals an ancient biogeographical link with the Seychelles. Nature, 425: 711-714.
2. Daily, G.C., Ed. 1997. Nature's Services: Societal Dependence on Natural Ecosystems. Island Press, Washington.
3. Dobson, D.C. 1996. Conservation and Biodiversity. Scientific American Library, New York, NY.
4. Groombridge, B., and Jenkins, M. 2000. Global Biodiversity: Earth's Living Resources in the 21 st Century. World Conservation Press, Cambridge, UK.
5. IUCN. 2004. Red list of threatened species. A global species assessment. IUCN, Gland, Switzerland.

Unit-1 Biodiversity	10 hours
Concepts: Organic evolution through geological time scale. Levels of organisation in the biological world – molecules to ecosystems, biomes to the biosphere. Levels of Biodiversity: Community diversity (alpha, beta and gamma biodiversity), Gradients of Biodiversity (latitudinal, insular), ecosystems diversity: biomes, mangroves, coral reefs, wetlands and terrestrial diversity (equilibrium mix of G and W). Species diversity: richness and evenness; magnitude of biodiversity (Global and Indian); global biodiversity hot spots; geography of species; species richness gradients and their drivers; mountain biodiversity and richness gradients; drivers of species richness through ages with specific reference to India.	
Unit-2 Benefits of Biodiversity	12 hours
Direct and indirect benefits from biodiversity including ecosystem services, bio-prospecting (molecular techniques like RAPD, RFLP, AFLP, DNA sequencing etc). Genetic diversity: sub species, breeds, race, varieties and forms. Variation in genes and alleles at DNA sequence levels (selected case studies). Microbial diversity and useful prokaryotic genes. Speciation (amount of genetic variation is the basis of speciation). Consequences of monotypic agricultural practice (Detailed case studies). Threats to Biodiversity: Species extinctions and their drivers – deforestation, landuse changes, overexploitation, biological invasions; habitat loss; projection of species extinction using species area relationship model. Human intervention and Biodiversity loss: Global Environmental changes, land in water use changes.	
Unit-3 Biodiversity conservation	8 hours
History of Conservation movements: International and National. Ecologically relevant parameters(viable population, minimum dynamic area, effective population size, metapopulations); reproductive parameters in conservation (breeding habitats, mating systems, inbreeding depression, genetic bottlenecks, genetic constraints).	
Unit-4 Conservation methods	10 hours
IUCN categorized-endangered, threatened, vulnerable species. Red data book and related documentation. Methods of conservation. In situ (Biosphere reserves, National Parks, Sanctuaries, Sacred groves, etc.) &ex situ (Botanical gardens, Zoological gardens, Gene banks, Pollen, seed and seedling banks, tissue culture and DNA banks etc) modes of conservation.hotspots. Conservation and utilization of biodiversity.	
Unit-5 Benefits of conservation	10 hours

Biodiversity as a source of food and improved varieties; source of drugs and medicines; Aesthetics and cultural benefits. Sustainable development. Ecosystems services (maintenance of gaseous composition of the atmosphere, climate control by forests and oceanic systems, Natural pest control, pollination of plants by insects and birds, formation and protection of soil, conservation and purification of water, nutrient cycling).
UNIT-6: Latest advances in biodiversity and conservation: (6Lectures)
Innovative steps in conserving biodiversity, hotspots of research activities over the past several decades, social awareness, planning, and advancement in conservation tools and techniques, Gathering and monitoring information about biodiversity, modern tools and technologies to monitor the biodiversity.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

	Environmental Hazards and Pollution				
Course Code	MEV 103				
Prerequisite	B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry				
Corequisite	Environmental Science and Chemistry				
Antirequisite					
Theory Lectures:		L	T	P	C
		4	0	0	4

Course Objectives:

This course gives an overview of the different types of pollution affecting the different components of the ecosystem and discusses ways of managing such environmental hazards

Course Outcomes

CO1	Describe the Environment and hydrological hazards
CO2	Identify global climate change driven environmental hazards and manmade hazards.
CO3	Explain the disasters and hazard management
CO4	Explain the air and water pollution causes and monitoring and control of air and water pollution.
CO5	Interpret the soil quality analysis. Illustrate the reasons of soil, noise and marine pollution.
CO6	Choose the advance techniques to solve the environmental problems.

Text Book (s)

1. Principles Of Environmental Science. McGraw-Hill Higher Education. Cunningham, W.P., Saigo, B.W. and Cunningham, M.A. 2001.
2. *Milnes, R. (2014). Environmental engineering: principles and practice. Hoboken: Wiley.*
3. Introduction To Environmental Impact Assessment. Routledge.

Reference Book (s)

1. Anjaneyulu, Y. 2004. Introduction to Environmental Science. B. S. Publications. Barrett, E.C. 2013.
2. Introduction To Environmental Remote Sensing. Routledge. Botkin, D.B. and Keller, E.A. 1995.
3. Environmental Science Earth as a Living Planet, (9th Ed). Wileyplus. Chiras, D.D. 2001.
4. Environmental Science, 6Ed., Jones and Bartlett Publishers. Cunningham, W. and Cunningham, M.A. 2010.

Unit-1 Introduction	10hours
Floods, droughts, Water contamination, melting of snow, Arsenic problem, Tsunamis, cyclones, hurricanes, Ice sheets, global lake outburst floods.	
Unit-2	10 hours
Global climate change driven environmental hazards, Cloud bursts, landslides, Lake or dam break, Man made hazards, Bhopal gas tragedy, Chernobyl disasters., Frost hazards in agriculture, Epidemics , wildfires.	
Unit-3	10 hours

Risk assessment, Vulnerability analysis, Hazards policies and agencies, Land use classification, Role of GIS and remote sensing in surveillance, monitoring and risk assessment, Hazardous waste control, Hazardous waste treatment.	
Unit-4	10 hours
Natural and anthropogenic sources of air pollution, Gas laws governing the behaviour of pollutants, Methods of monitoring and control of air pollution, SO_2, NO_X, CO, Methods of monitoring and control of air pollution, SO_2, NO_X, CO, Analysis of water quality, standards , sewage, Waste water treatment and recycling, Water quality standards.	
Unit-5	10 hours
Soil pollution: Chemical and bacteriological sampling as analysis of soil quality, Soil pollution control, industrial waste effluents and heavy metals and their interactions with soil components, Noise pollution – sources of noise pollution. Marine pollution: Sources of marine pollution and its control, Effects of pollutants on human beings, plants. Air quality standards, measurement and indices of noise pollution.	
Unit 6 Advances in Environmental Hazards and Pollution	4 hours
In the unit recent developments and research will be discussed in the areas of Environmental Hazards and Pollution.	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Environmental Geology				
Course Code	MEV104				
Prerequisite	B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry				
Corequisite	Environmental Science, Chemistry, Geology				
Antirequisite					
Theory Lectures:		L	T	P	C
		4	0	0	4

Course Objectives:

This course introduces whole-Earth materials & processes with a focus on the formation of & human interaction with superficial environments. It discusses phenomena such as volcanoes, earthquakes, wasting, flooding, desertification, & climate change.

Course Outcomes

CO1	Explain the utilization of all natural resources and minimization of their degradation.
CO2	Explain different geological methods to minimize the destructive potential of natural processes and to sustain a healthy biosphere on earth.
CO3	Discuss the concept of resources, their availability and methods of recycling.
CO4	Identify the impact of urbanization on natural hazards and discuss the methods to cope with natural processes.
CO5	Explain the significant usage of land for construction and waste disposal.
CO6	Aware about the natural hazards and how to take preventive measures.

Text Book (s)

1. Keller, E.A. 1996. Introduction to Environmental Geology, Prentice Hall, Upper Saddle River, New Jersey.
2. Kesler, S. F. 1994. Mineral resources economics and the environment. Upper Saddle River, NJ: Prentice Hall.

Reference Book (s)

1. Owen, O.S., Chiras, D.D., Reganold. John P. 2002. Natural Resource Conservation, 7th Ed., Prentice Hall, Upper Saddle River, New Jersey
2. Skinner, Brian J., Porter, Stephen C. 1995. The Dynamic Earth: An Introduction to Physical Geology, Casebook, 3rd Edition (Paperback), John Wiley, New York
3. Slaymake, Olav, (Ed). 2000. Geomorphology, Human Activity and Global Environmental Change. John Wiley, New York.

Unit-1Planet Earth	8 hours
Earth in the solar system; differentiation of the earth into core, mantle, crust, hydrosphere and atmosphere; rock-forming, ore-forming and soil-forming minerals; energy, mineral, water and soil resources.	
Unit-2Earth processes	10 hours
Earth quakes, Landslides and Floods ,Geological cycle,Rock cycle, Hydrological cycle, Biogeochemical cycles, Rivers and their relation to geology and climate; erosional, transportational and depositional processes of water, air, waves and glaciers.	
Unit-3 Resources	12 hours
Renewable and Alternative Energy Sources: Solar energy, solar power, photovoltaic cells; Wind power; Geothermal energy; Ocean energy; Fuel cells. Fossil Fuel. Bio Energy: Biomass conversion processes; Biodiesel; Environmental consequences of biomass resource harnessing. mineral and water resources; geological constraints in their availability and use; environmental consequences of their exploitation to air, water, soil, climate and life. EIA of mineral development, recycling of mineral resources.	
Unit-4 Natural hazards	12 hours
Floods, landslides, earthquakes-tsunami and volcanism, cyclones, coastal erosion and sea level changes; impact of urbanization on the rate of these processes; general methods to identify the hazard potential, to mitigate and to cope with natural processes.	
Unit-5 Land use 8 hours	
Land evaluation and land use planning for construction and waste disposal; Methods of site selection and evaluation, global imperatives, soil erosion,; Desertification and its associated problems and control.	
Unit-6 Recent Advancements in Environmental Geology	4 hours
Prediction of Natural hazards, Advance technology for Dissemination of forecast to end users, Disaster management policy during Natural hazards, Post disaster Health impact	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Disaster Management				
Course Code	MEV105				
Prerequisite	B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry				
Corequisite	Environmental Science, Chemistry, Geology				
Antirequisite					
Theory Lectures:		L	T	P	C
		4	0	0	4

Course Objectives: This course introduces whole-Earth materials & processes with a focus on the formation of & human interaction with superficial environments. It discusses phenomena such as volcanoes, earthquakes, wasting, flooding, desertification, & climate change.

Course Outcomes

CO1	Describe the concept of hazard and disaster and its impacts.
CO2	Relate the implication of different form of natural disaster such as geological, hydrological and Climatic.
CO3	Illustrate and interpret man-made disaster and gain insights about it.
CO4	Determine the various ways of disaster, assistance and relief camps, mitigation and preparedness, programme planning and management.
CO5	Estimate impact and risk analysis, role of GIS and remote sensing in surveillance, monitoring, risk assessment, estimation of losses and planning.
CO6	Combine the concepts for new trends and developments in disaster research and preparedness.

Text Books:

1. G. F. White (Ed). 1974. Natural Hazards – Local, National, Global. Oxford University Press.
2. V.T. Chow. 1964. Handbook of Applied Hydrology. McGraw-Hill.
3. A. N. Strahler and A. H. Strahler. 1973. Environmental Geoscience – InteractionBetween Natural Systems and Man. Santa Barbara, California: Hamilton Publishing.
4. P. Reining. 1978. Handbook of Desertification Indicators. Washington D.C.: AmericanAssociation for the Advancement of Science.
5. K. S. Valdiya. 1987. Environmental Geology. Tata McGraw-Hill.

References:

1. VibhasSukhwani,V., Shaw R. 2020, Operationalizing crowdsourcing through mobile applications for disaster management in India, Progress in Disaster Science, 5 (1-9).
2. Wang, C., Wu, J , He X,Ye M, Liu W and Tang R. (2019) Emerging Trends and New Developments in Disaster, Research after the 2008Wenchuan Earthquake Internationl Journal of Environmental Research and Public Health; 16 (29).
3. Blaikie, P., Cannon, T., Davis, I. and Wisner, B. 2003. At Risk: Natural Hazards, People's Vulnerability and Disasters (2nd Ed.). Abington: Routledge.
4. Bell, F.G. 2003. Geological Hazards: Their Assessment, Avoidance and Mitigation. CRC Press.
5. Bilham, R. 2004. Earthquakes in India and the Himalaya: tectonics, geodesy and history. *Annals of GEOPHYSICS*, *47*(2-3).
6. Blaikie, P., Cannon, T., Davis, I. and Wisner, B. 2014. At Risk: Natural Hazards, People's Vulnerability and Disasters. Routledge.

7. Burton, I. 1993. The Environment as Hazard. Guilford Press.
8. Margottini, C. and Casale, R. 2004. Natural disasters and sustainable development. Environmental Science Series, Springer.
9. Henrry J.G. and Heinke , G.W. 2004, Environmental Science and engineering, Pearson education, Delhi, India.
10. Shroder, J. & Wyss, M. (eds). 2014. Earthquake Hazard, Risk and Disasters (1st Edition). Elsevier.
11. Smith, K. 2003. Environmental Hazards: Assessing Risk and Reducing Disaster. Routledge.
12. Watts, M. 2017. On the poverty of theory: natural hazards research in context. In Environment (pp. 57-88), Routledge.
13. Allen, S.K., Linsbauer, A., Randhawa, S.S., Huggel, C., Rana, P. and Kumari, A. 2016. Glacial lake outburst flood risk in Himachal Pradesh, India: an integrative and anticipatory approach considering current and future threats. *Natural Hazards*, 84: 1741-1763.
14. Hewitt. K. 1997. Regions of Risk, Longman Press.
15. Henrry J.G. and Heinke , G.W. 2004, Environmental Science and engineering, Pearson education, Delhi, India.
16. Shroder, J. & Wyss, M. (eds). 2014. Earthquake Hazard, Risk and Disasters (1st Edition). Elsevier.
17. Smith, K. 2003. Environmental Hazards: Assessing Risk and Reducing Disaster. Routledge.
18. Watts, M. 2017. On the poverty of theory: natural hazards research in context. In Environment (pp. 57-88), Routledge.

Unit-I: Concept of Hazard and Disaster	(8 Lectures)
Concept of Hazard, disaster, risk, vulnerability, exposure and response. Distinction between natural disaster and anthropogenic environmental disturbances and Hybrid disaster.	
Unit-II: Natural Disaster	(10 Lectures).
Geological Disaster: Earthquakes – a plate tectonic perspective and seismic zonation, Volcanoes – types and geographical distribution, Mass-movement. *Hydrological* Disaster: Floods, Droughts, Tsunami; Cyclones, Hurricanes; Cryosphere – distribution, melting of snow, ice and ice-sheets, avalanches, Glacial Lake Outburst Floods (GLOF), case study of disasters. *Atmospheric/Climatic* Disaster: Extreme weather events, Cloud-bursts, Landslides; Lake or Dam break/ breach; Global Climatic Change driven environmental hazards	
Unit-III: Anthropogenic Disasters	(8 Lectures)
Impacts of anthropogenic activities such as rapid urbanization, injudicious ground water extraction, sand mining from river bank, deforestation, Biophysical Hazards: Frost Hazards in agriculture, epidemics, wildfires, Technological Hazards: Nature and significance. Lessons from Bhopal and Chernobyl disasters.	
Unit-IV: Disaster Assistance and Relief Camps	(10 Lectures)
Disaster assistance technological assistance, relief camps, organization, camp layout, food requirement, water needs, sanitation, security, information administration, firefighting camping and tent pitching, rope, knots and their use, rescue, emergency rescue, disaster education, alternatives and new directions: conceptualizing disaster recovery, mitigation and preparedness, programme planning and management.	
Unit- V: Impact and Risk Analysis of Disasters	(10 Lectures)

Human and ecological impacts; Risk assessment and vulnerability analysis; National preparedness and adaptation strategies; policies and agencies; role of GIS and remote sensing in surveillance, monitoring, risk assessment, estimation of losses and planning. Role of government bodies such as NDMC and IMD; role of armed forces and media in disaster management; role of space technology in disaster management; case study.
Unit-VI: Recent New Advancement in Disaster Management (4 Lectures)
Emerging Trends and New Developments in Disaster Research, Operationalizing crowd sourcing through mobile applications for disaster management in India.

Continuous assessment

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	ENVIRONMENTAL SCIENCE LAB-I				
Course Code	MEV131				
Prerequisite	B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry				
Corequisite	Analytical Chemistry				
Antirequisite					
Practical Lectures:		L	T	P	C
		0	0	4	2

Course Objectives: In this course the students will learn experimental techniques to determine the concentration of pollutants in the environment.

Course Outcomes:

CO1	Collect and store the effluent samples.
CO2	Estimate the strength of Dissolved Oxygen, BOD, COD, Heavy metals in water sample.
CO3	Determine the sound level.
CO4	Analyze the air quality.
CO5	Plan to visit sites for in-situ or ex-situ studies.

Text Book (s):

4. V.P. Kudesia. 1997. Air Pollution. PragatiPrakashan.
5. M.H. Rao and H.V.H. Rao. 1998. Air Pollution. Tata McGraw Hill Publication.
6. B.R. Gurjar, L. T. Molina and C. S. P. Ojha. 2010. Air Pollution. CRC Press. Preparation of coordination compounds

Reference Book (s):

2. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.

Unit-1 3 hours
Collection, processing and storage of effluent samples.
Unit-2 5 hours
Estimation of total dissolved solids, Hardness, dissolved oxygen, BOD and COD in waste water sample, heavy metals analysis in sludge and waste water sample.
Unit-3 3 hours
Determination of sound level and air analysis for particulate matter.
Unit-4 5 hours

Estimation of species abundance of plants, Measurement of chlorophyll, Transpiration and water balance in plants under polluted conditions.	
Unit-5	2 hours
Visit to a local polluted site, in-situ or ex-situ conservation centre/Environmental Education Centre/ Social Service Organization, ICT in Environmental Science.	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
50	-	50	100

SEMESTER-II

Name of The Course	Environmental Impact and Risk Assessment				
Course Code	MEV201				
Prerequisite	B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry				
Corequisite	Environmental Science				
Antirequisite					
Theory Lectures:		L	T	P	C
		4	0	0	4

Course Objectives:This course reviews the environmental impact and risk assessment and studies thoroughly different methods involved in EIA and the types of assessment processes.

Course Outcomes

CO1	Define the environmental risks and to describe the concept and components of EIA. (K2)
CO2	Explain the EIA processes and management techniques and analyze the EIA methods in advance. (K2)
CO3	Interpret the processes of environmental auditing and document planning. (K3)
CO4	Categorize the assessment techniques and describe the role of control boards. (K4)
CO5	Describe the environment protection laws and illustration of environment legislations in various countries. (K2)
CO6	Aware about the advance methods of the EIA (K6)

1. Text Book (s)
2. Blaikie, P., Cannon, T., Davis, I. and Wisner, B. 2003. At Risk: Natural Hazards, People's Vulnerability and Disasters(2nd Ed.).
3. Abington: Routledge. Brown, K. 2015. Resilience, Development and Global Change. London: Routledge Glasson, J. and Therivel, R. 2013.
4. Introduction To Environmental Impact Assessment. Routledge.
5. Morris. P. &Therivel. R., 2001, Methods of environmental impact assessment.
6. Reference Book (s)
7. Ed. Spon Press, New York, With a chapter on GIS and EIA by A.R. Bachiller& G. Wood, p. 381-401.
8. Grumbine, R.E. and Pandit, M.K., 2013. Threats from India's Himalaya dams. Science, 339:36-37.
9. Pandit, M.K. and Grumbine, R.E., 2012. Potential effects of ongoing and proposed hydropower development on terrestrial biological diversity in the Indian Himalaya. Conservation Biology, 26: 1061-1071.
10. Petts, J. 1999. Handbook of Environmental Impact Assessment. Vol. 1, Blackwell Science

Unit-1Introduction to environmental risks and impact analysis	8 hours

Defining environmental risk in different perspectives, Risk Assessment v/s Environmental Impact Assessment, Environmental education programmes and public awareness, Environmental management system (EMS): ISO-14000, Basic concept and principles and purpose of EIA, origin and development of EIA, short term and long term objectives of EIA, EIA 2006 Notification (GOI). Components of EIA, screening, notification, public participation, impact statement, review of EIA Analysis and alternatives, Environmental Impact Statement and Environmental Management Plan.
Unit-2 Process and Methods of EIA 8 hours
Stages, Scoping, Alternatives, Impact Identification, Establishing the Environmental base line, Impact prediction, evaluation and mitigation, Criteria and standards for assessing significant Impact, Cost- Benefit Analysis and valuation of Environmental impacts, Public Participation, EIA monitoring and auditing, EIA Method: ADHOC Method, Check list, Matrix and network method, merits and demerits of EIA.
Unit-3Environmental monitoring and audit 10 hours
Environmental clearance for establishing industries, Environmental Audit: General approaches to environmental auditing, audit methods, benefits of environmental auditing. On-site and post – audit activities, Guidelines and policies, Document planning and Environmental documentation, environmental monitoring, post project audit, recent trends in environmental monitoring, environmental ethics, Environmental audit of river valley projects, mines, cement industry, nuclear power, thermal power, wind energy, dams and highway construction.
Unit-4Types of Assessment processes 10 hours
Air quality Assessment; Water Impact Assessment; Social Impact Assessment; Ecological Impact Assessment; Landscape and visual Impact Assessment; Environmental Impact of surface and underground mining of metals, minerals and fossil fuels, Environment impact assessment: State environmental appraisal committee and state, environmental Assessment authority and their role in environmental clearance of projects, Powers and functions of central and state pollution control boards.
Unit-5Current issues in EIA and Environment Laws 14 hours
Environmental taxes, Worldwide spread of EIA, EIA regulations in India, Life cycles Assessment, Strategic Environmental Assessment, Environmental organization and agencies, Environmental Law I: International Environmental protection laws. 6 Environmental Law II: Environmental protection laws in India and their enforcement, Recent National and International efforts for Environmental management, International trade and environment; Trade Related Intellectual Properties (TRIPs), Intellectual Property Rights (IPRs), Corporate environmental ethics.
Unit-6 Recent advancement in the process of EIA 4hours
In this unit discuss the recent research in the area of Environmental impact assessment.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Environmental Toxicology and Health			
Course Code	MEV202			
Prerequisite	Introduction to toxicants and their effect on human health			
Corequisite	Biochemistry, Chemistry and Environmental science			
Antirequisite				
Theory Lectures:	L	T	P	C
	4	0	0	4

Course Objectives:

The objective of this course is to provide students with an understanding of the problems associated with indiscriminative use of chemicals worldwide, to give hand-on experience in toxicity testing, and to bring ethical awareness in relation to environmental pollution and degradation.

Course Outcomes

CO1	Discuss the sources, origins of various toxic materials and heavy metals present in environment. (K2)
CO2	Explain the adverse effect of toxic chemicals on Environment. (K2)
CO3	Develop perspective on the movement of toxicants in different components of environment, in different levels of biological organization and in trophic transfer across the food chain (K2).
CO4	Demonstrates the relationship between types of contaminants and effect on human health (K3).
CO5	Trains on the methods used to assess the ecotoxicological impact and human health issues due to increase in the levels of contaminants in environment (K3).
CO6	Aware about the new remediation techniques for toxic elements (K6)

Text Book (s)

1. Toxicology
2. Colin, W. 2014. Ecotoxicology: Effects of Pollutants on the Natural Environment, 1st (ed), CRC Press
3. Sparling,D.W.2017. Basics of Ecotoxicology, 1stEdn CRC Press.
4. Newman, M.C. 2015. Fundamentals of Ecotoxicology: The Science of Pollution, 4thEdn. CRC Press.
5. *Environmental Health*
6. Centeno, J.A., Finkelman, R.B., Fuge, R., Lindh, U. and Smedley, P. eds., 2013. Essentials of Medical Geology (p. 820). New York, NY, USA, Springer.

Reference Book (s)

7. Hauser-Davis, R.A. and Parente, T.E. eds., 2018. *Ecotoxicology: Perspectives on Key Issues*. CRC Press.
8. Walker, C.H., Sibly, R.M., Hopkin, S.P., Peakall, D.B. 2017. Principles of Ecotoxicology. 4thEdn. Taylor & Francis, London.
9. Moore, G.S. 2002. Living with the Earth: concepts in Environmental Health Science (2nded.), Lewis publishers, Michigan

Unit-1Major classes of Toxic Chemicals and their toxicity Potential 10 hours
Toxic chemicals in the environment – air, water & their effects, Pesticides in water, Biochemicals aspects of arsenic, cadmium, lead mercury, carbon monoxide, ozone, PAN pesticide, Organics, Organometallics, Gases, Nano-materials, Ecotoxicity challenges of selected contaminants of recent origin.

Unit-2Entry and Movement of Toxicants into Ecosystems and Environment	12 hours
Mode of entry of toxic substance (surface waters, land, atmosphere), Fate of Toxicants in Ecosystems and Environment: Biotransformation, Bioaccumulation & Bio-magnification; Role of biotic and abiotic interactions, biotransformation of xenobiotics detoxification, Carcinogens in air, chemical carcinogenicity, mechanism of carcinogenicity, Environmental carcinogenicity testing.	
Unit-3Toxicant Effects8 hours	
Cellular, organismic, population & ecosystem-level effects; Global Effects – Acid rain, Insecticides, MIC effects. Concept of major, trace and Rare Earth Element (REE)- possible effects of imbalance of some trace elements, Epidemiological issues goitre, fluorosis, arsenic poisoning.	
Unit-4Biochemical and Molecular Toxicology10 hours	
Metabolism of selected ecotoxicants; Role of enzymes, genes and growth regulators, Quantitative and qualitative assessment of biochemical and molecular ecotoxicity. Toxicity Testing and Bio-monitoring: Concept of dosimetry: lethal, sub-lethal & chronic tests, dose response curves, LC50, MATC-NOEC, Brief statistical methodology. Test organisms used in bioassays, Types of bio-monitoring and significance of biomarkers and bio-indicators	
Unit-5Environmental Health10 hours	
Toxicology & Epidemiology and occupational health. Sources: Solid & Hazardous wastes, untreated sewage, Automobile exhausts, Industrial Effluents, Industrial emissions into atmosphere, Agricultural run-off of Pesticides. Carcinogens, Mutagens, Asbestos issues. Human adaptation to cold and hot climates, high altitude environment and man-made environments. Water pollution – Caused diseases (Gastroenteritis, Hepatitis, etc.). Air pollution caused diseases (allergies, respiratory diseases). Food-borne diseases (Food poisoning, parasites etc).	
Unit-6 Recent advancement in the remediation of toxic elements	4 hours
In this unit discuss the new techniques for the remediation of toxic elements.	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Resource Management				
Course Code	MEV203				
Prerequisite	B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry				
Corequisite	Environmental Science and Chemistry				
Antirequisite					
Theory lectures:		L	T	P	C
		4	0	0	4

Course Objectives:

Natural resource management refers to the management of natural resources such as land, water, soil, forest, wildlife, mineral and energy, with a focus on how management affects the quality of life for both present and future generation.

Course Outcomes

CO1	Explain Natural resources and types of natural resources.
CO2	Discuss how and where the Earth's resources are generated, how they are extracted and used, and how these activities impact Earth's environment.
CO3	Explain broadly about the conservation and management of different types of Natural resources.
CO4	Develop the ability to conserve and manage natural resources in day to day life.
CO5	Develop perspectives on sustainability of natural resources.
CO6	Aware about the resources management. K6

1. Text Book (s)
2. Craig, J.R., Vaughan, D.J. Skinner, B.J. 1996. Resources of the Earth: Origin, Use, And Environmental Impact, (2nd Ed). Prentice Hall, New Jersey.
3. Klee, G.A. 1991. Conservation of Natural Resources. Prentice Hall Publ. Co., New Jersey.
4. Owen, O.S, Chiras, D.D. &Reganold, J.P. 1998. Natural Resource Conservation – Management For Sustainable Future, (7thEdn.), Prentice Hall.

Reference Book (s)

1. Agarwal, B. 2010. Gender and Green Governance, Oxford and Delhi: Oxford University Press.
2. Brosius, P.J., Tsing, A.L. and Zerner, C. (eds.). 2005. Communities and Conservation: Histories and Politics of Community-Based Natural Resource Management. Rowman Altamira.

Unit-1Natural Resources and Management	8 hours
Introduction to natural resources and their consumption patterns .Supply and demand of natural resources. Types of natural resources: renewable and non-renewable resources. Resource management meaning & concept, Time frame. Approaches to natural resource management.	
Unit-2Water and Forest Resource Management	10 hours
Management of fresh water ecosystem conservation strategies for non-renewable energy resourses, Water Management, Ganga Action Plan, Yamuna Action Plan, Environmental priorities in India, Watershed development, rainwater harvesting , Management of waste resources, Management of forests, effects of deforestation and it's control.	
Unit-3Land and Wildlife Management	12 hours
The nature of soil, characteristics and value. Soil formation, soil profile and soil classification. Soil fertility. Soil conservation and sustainable agriculture: nature of soil erosion; factors affecting soil erosion by water and its control. Alternative agriculture, sustainable agriculture. Land use and environmental problems of soil. Soil surveys and Land use planning. Wildlife Management & conservation efforts for threatened species.	
Unit-4Minerals Resource Management	8 hours
Minerals resources, their use, mining and sustainability. Genesis of mineral deposits: endogenous and exogenous processes and their time frame. Environmental impact of mineral production. Mineral conservation strategies: the resource cycle.	
Unit-5Energy Resource Management	12 hours
Non-renewable energy resources: patterns of consumption, issues and options. Global energy source: an overview. Fossil fuels: reserves of coal, its classification and basic geology. Environmental impact of coal mining. Reserves of oil and gas, basic geology. Environmental impact of their production and consumption. Nuclear energy, its sources. Nuclear power plants. Nuclear waste disposal. Geothermal	

energy: water dominated and vapour dominated systems.Types of renewable energy source and their environmental significance. Sustainable development of energy resources.
Unit-6 Recent advancement in resource management 4 hours
Discuss about the recent research work done to save resources.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Environmental Chemistry				
Course Code	MEV204				
Prerequisite	B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry				
Corequisite	Organic Chemistry, Bio-chemistry, Analytical Chemistry, Geology				
Antirequisite					
Theory Lectures:		L	T	P	C
		4	0	0	4

Course Objectives: The course encompasses basic knowledge of organic and analytical chemistry and basic bio-chemistry required in the thorough study of Environmental Science. It also reviews different aspects of Geochemistry and chemistry of environmental pollutants required to understand the environmental issues.

Course Outcomes

CO1	Describe and recognize the fundamentals of environmental chemistry. (K2)
CO2	Identify the concepts of geochemistry and correlate its environmental aspects. (K2)
CO3	Generalize and illustrate the properties of environmental chemistry. (K3)
CO4	Interpret the various aspects of pollution chemistry and waste management techniques. (K2 and K3)
CO5	Develop the understanding of various environment instrumentation techniques and analyze their principles for environment assessments. (K4)
CO6	Adapt new techniques in area of geochemistry and pollutant chemistry. K6

Text Book (s):

1. Environmental Instrumentation and Analysis Handbook – R.D. Down and J.H. Lehr
2. Environmental Analysis and Instrumentation – N. Rajvaidya and D. K. Markande
3. Environmental Monitoring and Analysis – Dr. Aradhana Salpekar.
4. A Text book of Environmental Science – Prabhat Patnaik

Reference Book (s):

1. Elements of Environmental Chemistry – J. Hussain.
2. Grumbine, R.E. and Pandit, M.K., 2013. Threats from India’s Himalaya dams. Science, 339:36-37.
3. Manahan, S. E. 2000. Environmental Chemistry 7thEdn. Lewis Publishers. Stumm, W. and Morgan, J.J. 2012. Aquatic Chemistry: Chemical Equilibria and Rates in Natural Waters, John Wiley & Sons.
4. Williams, I. 2001. Environmental Chemistry –a modular approach, Willey John & Sons.

Unit-1: Fundamentals of Environmental Chemistry10 hours Definition of various terms: standard solution preparation and various concentration terms, stoichiometry, Gibbs energy, fundamentals of chemical thermodynamics and solution formation; basic organic chemistry and biochemistry, solubility product, solubility of gases in water, the carbonate system, unsaturated and saturated hydrocarbons, radionuclides.
Unit-2: Geochemistry 8 hours Structure and chemistry of silicate and ore minerals; bulk composition of the earth, crust, & oceans; rock weathering, clay minerals and soil formation; cycling of chemical elements in the earth system, Physico-chemical characteristics of soil, soil humus, mineralization, acidic and alkaline soils, micro and macro nutrients of soil and nitrogen, phosphorus and potassium pathways in the soi.l
Unit-3: Atmospheric Chemistry and properties of environmental elements 8 hours Ions and radicals, thermo and photochemical reactions, physical and chemical properties of water, concept of oxygen demand: BOD, COD, TDS, TSS, hydrologic cycle; concepts of pH, aquatic life and water chemistry; organic and inorganic including radioactive water pollutants and their removal methods. Atmospheric Chemistry: Physical and chemical properties of atmospheric air and their variation with latitude and altitude; chemical reactions in air and the residence time of CO2 and the greenhouse gases aerosols, their chemistry, sources and transport; organic compounds in air and their sources; physical and health effects of air chemistry changes, global warming and acid rain.
Unit-4: Pollutant chemistry 10 hours Chemistry of various organic and hydrocarbon decay, environmental effects of surfactants, pesticides and heavy metals on micro and macro organisms, chemical processes for formation of inorganic and organic particulate matter, thermo chemical and photochemical reactions in the atmosphere, toxic chemicals in the environment, Chemistry of waste substances: Nature and types of various wastes such as mining, industrial, agricultural, municipal, medical and nuclear; chemical and biological treatment of wastes before disposal; chemistry of toxic inorganic and organic compounds in the environment and their interactions with living system.
Unit-5: Environmental Instrumentation 10 hours Spectrometry, UV-Vis and IR spectrophotometer and AAS, flame spectrometry and fluorimetry; Chromatographic techniques: Paper, Thin Layer, Gas and Gas – Liquid Chromatography, HPLC, X-ray fluorescence, x-ray diffraction, Electrophoresis, NMR and MassSpectrometry.
Unit-6: Application of Environmental chemistry 4 hours
Discuss recent advancement in the technologies geochemistry and pollutant chemistry.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Technology, Environment and Sustainability				
Course Code	MEV205				
Prerequisite	B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry				
Corequisite	Organic Chemistry, Bio-chemistry, Analytical Chemistry, Geology				
Antirequisite					
Theory Lectures:		L	T	P	C
		4	0	0	4

Course Objectives: This course gives an overview about environmental sustainability and policies and technologies that define it.

Course Outcomes

CO1	Develop evolutionary perspective on the relationship between and evolution of technology and environment. (K2)
CO2	Develop in-depth understanding on the role and contribution of different types of economic problems of Environment. (K2)
CO3	Generalise social mechanisms in the contemporary societies shaping the structure and function of Environment. (K2)
CO4	Demonstrate the technological changes in the direction of sustainable development, which will help to achieve ecological and social justice.(K3)
CO5	Aware about the new environmental policies K6

Text Book (s):

4. Manahan, S.E. 1997. Environmental Science and Technology. Lewis, New York. Charles, H. 2011. Environment and Society: Human Perspectives on Environmental Issues, 5th Edition Routledge.

Reference Book (s):

1. Manahan, S.E. 1997. Environmental Science and Technology. Lewis, New York. Charles, H. 2011. Environment and Society: Human Perspectives on Environmental Issues, 5th Edition Routledge.

2. Agarwal, B. 1986. Cold Hearths and Barren Slopes: The Wood-fuel Crisis in the Third World. London: Zed Books.

3. Elliot, D. 2003. Energy, Society and Environment, Technology for a Sustainable Future, Routledge

Unit-1: Technology for Energy Resources 10 hours Bioenergy, ethanol fermentation.Liquid waste treatment; Biofilters, activated sludge systems; membrane bioreactors.Biotechnological approaches for solid waste management, Phytotechnology-terrestrial and aquatic phytosystems, metal phytoremediation, nutrient film techniques, algal treatment systems.
Unit-2: Sustainable Development and its different constituents 12 hours Concept of Sustainability, Sustainable Development and its different constituents. Growth and Development, Technology, Affluence and the Environmental Kuznets' Curve. Principles of Ecological and Environmental Economics, their scope and usefulness.Basic Market process, Market

Failure and Externality, case of environmental problems. Solutions to Environmental Problems: Command and Control, Economic solutions.
Unit-3: Environmental policy and its environmental costs 14 hours Technology transitions and environmental technology innovations for ecological and socialjustice; Policy tools for integrated technologies and technology innovations for sustainable development. Impacts of social movements on ecological and social justice in India; Corporate responsibility movement; Appropriate technology movement, industrialization, urbanization, and globalization, Estimation of Environmental Costs and Benefits, Cost Benefit Analysis. Valuation of ecosystem services and impact of intervention (malign and benign). Best practices in ecosystem services and sustainability of society.
Unit-4: Environmental Sustainability 14 hours Sustainability, issues of development and environmental protection and conflicts over resources discussed in context of Environmental Movements by taking up well known Indian and international case Studies . Inter-connection and linkages of environment destruction on a global scale. Select topics (Impacts of development and habitat destruction on pollution, biodiversity, human health, etc).
Unit-5 Recent advancement in the environmental policies 4 hours
Discuss new environmental policies

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Environmental Science-II Lab				
Course Code	MEV 231				
Prerequisite	B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry				
Corequisite	Environmental Science, Analytical Chemistry				
Antirequisite					
Practical Lectures:		L	T	P	C
		0	0	4	2

Course Objective:

5. Analysis of different properties of a given sample of soil.
6. Employ the volumetric titrations techniques used in Environmental Science Laboratory for analysis
7. Estimate the percentage of NPK in a given soil sample with the help of Flame Photometer.
8. Identify basic techniques used in Environmental Science Laboratory for preparation and identification.

Course Outcomes

CO1	Analyze the Physio-chemical properties of soil
CO2	Estimate the Nitrite content of the soil
CO3	Estimate the acidity, alkalinity and Porosity of soil
CO4	Analyze the NPK of soil by flame photometer

CO5	Plan to visit various ecosystems to study the ecological variations

Text Book (s)

1. V.P. Kudesia. 1997. Air Pollution. Pragati Prakashan.
2. M.H. Rao and H.V.H. Rao. 1998. Air Pollution. Tata McGraw Hill Publication.
3. B.R. Gurjar, L. T. Molina and C. S. P. Ojha. 2010. Air Pollution. CRC Press. Preparation of coordination compounds

Reference book

1. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.

Unit-1	3 hours
To determine the soil pH of a given Soil Sample To determine the Organic matter in a given sample of soil. To estimate the humidity/moisture content of a given Soil Sample.	
Unit-2	2 hours
To determine the Nitrate and phosphate content in a given sample of soil.	
Unit-3	3 hours
To determine the Porosity of a given sample of soil. To determine the soil acidity and alkalinity of a given sample of soil.	
Unit-4	2 hours
To estimate the NPK percentage in soil using flame photometer.	
Unit-5 To study and enlist various biotic and abiotic components of forest Ecosystem. To study and enlist various biotic and abiotic components of Desert Ecosystem. To study and enlist various biotic and abiotic components of Grassland Ecosystem To study and enlist various biotic and abiotic components of Aquatic Ecosystem To study ecology of some major invasive weeds	7 hours

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
50	-	50	100

Name of The Course	Research Methodology				
Course Code	MBS28T2111				
Prerequisite	B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry				
Corequisite					
Antirequisite					
Theory Lectures:		L	T	P	C
		3	0	0	3

Course Objectives:

1. To provide the advance knowledge in the field of Physics.
2. To enhance the capability and grasp the concepts of Mathematics more clearly involving specific examples and in-depth knowledge.

Course Outcomes

CO1	Understand the Principles of Scientific Research and different steps involved in doing research.
CO2	Know how to design research and frame up different steps in design.
CO3	Appraise the application of sampling through statistics.
CO4	Build up the method for data collection and analyse the data.
CO5	Develop the Concept of hypothesis preparation.
CO6	Develop the statistical analysis indulges in modern research for drug designing.

1. Text Book (s):
2. K. Ramakant; Elementary Statistics in a world of applications, Goodyear California Pub. Co.,1979.
3. K. D. Broota, Experimental designs in psychological research, Wiley eastern, New York, 1992.
4. Guilford, Statistics in Psychology and Education, McGraw hill, New York, 1986.
5. Katz and Kahn, Research in Behavioural Sciences, Methuen, USA, 1979.

Reference Book (s):
1. Kerlinger, F., Foundations of Behavioural Research, Surjeet Publications, Delhi, 1983.
2. Rajamanickam, M., Statistical Methods in Psychological and Educational Research, Concept Publishing Co. New Delhi, India, 1983.
3. Smith, Jonathan, A. (Ed.), Qualitative Psychology: A Practical Guide to Research Methods, Sage Publications, 2003.
4. Woodworth and Schlosberg, Experimental Psychology, Methuen and co. ltd, London, 1971.

Refrerneces: for unit 6
1. Leo, A., &Hoekman, D. H. (1995). *Exploring QSAR*. American Chemical Society.
2. ChaninNantasenamat, ChartchalermIsarankura-Na-Ayudhya, ThanakornNaenna, VirapongPrachayasittikul, A Practical Overview of Quantitative Structure- Activity Relationship. EXCLI Journal 2009;8:74-88.
3.
4. WiktorPronobis, AlexandreTkatchenko, and Klaus-Robert Muller, J. Chem. Theory Comput. 2018, 14, 2991−3003

Unit-I:Principles of Scientific Research	8 hours

Meaning of Research, Objectives of Research, Motivation in Research,Types of Research, Procedures in research, Identification of the problem - Literature survey - Reference collection - Familiarity with ideas and concept of investigation - Qualitative and Quantitative analysis - Results - Synopsis writing - Art of writing a Research paper and Thesis.
Unit-II:Research Design, Sampling & Probability 10 hours Research Design: Need for Research Design, Features of a Good Design, Different Research Designs, Sampling: Principles, methods, types of sampling, rationale for using a particular sampling procedure, Probability: Classical definition of Probability, Basic terms - Events, Trials, Mutually exclusive events, Favourable events, Exhaustive events etc.
Unit-III: Data collection & analysis 8 hours Types of data, Collection of Data, double blind procedures, incidence and prevalence studies, Data Analysis: Measures of Central Tendency, Measures of Dispersion, Measures of Asymmetry
Unit-IV: Correlation and Regression 8 hours Methods of correlation, Types of correlation (Pearson r& Rho); Regression analysis, linear regression, Non-linear regression.
Unit-V: Hypothesis and Statistics 8 hours Hypothesis Testing: Problems and hypothesis, variables and type of variables, Parametric and nonparametric statistics; level of significance, the various nonparametric tests with one sample, two samples and k-samples, chi square analysis, Analysis of Variance (ANOVA).
Unit 6: Recent research advances 4 hours
Descriptors, Quantitative structure-activity relationship (QSAR) , Quantitative structure-property relationship(QSPR), Drug designing.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

SEMESTER-III

Name of The Course	Minor Project/Summer Internship				
Course Code	MEV341				
Prerequisite	B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry				
Corequisite					
Antirequisite					
		L	T	P	C
		0	0	0	2

Course Objectives: The minor project is aimed at training students in field areas and to prepare them for their major project in the upcoming semester.

Course Outcomes

At the end of the course, the student will be able to:

1. Review the literature for the topic of the project.(K2)
2. Operate instruments neatly for analysis and discuss their experimental results.(K3)
3. Validate the specification of instrumental techniques and interpretation of data.(K5)
4. Used ICT tools to prepare project reports and present it using Power point presentation.(K6)
5. Develop the skills to work within a small team to achieve a common research goal.(K6)

Continuous Assessment Pattern

Internal Viva (IA)	Mid Term Test (MTE)	External Exam (ETE)	Total Marks
50	-	50	100

Name of The Course	MAJOR PROJECT Phase I				
Course Code	MBS26P2998				
Prerequisite	B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry				
Corequisite	Knowledge of research methodology				
Antirequisite					
		L	T	P	C
		0	0	0	6

Course Objectives:

The major project will help the students to have a hand on experience and practical knowledge of the theory papers studied so far. It will enable them to tackle practical problems and expose them to industrial experience.

Course Outcomes

CO1	Survey literature for the topic of the project.(K4)
CO2	Correctly interpret the literature review before starting any individual experiment (K3)
CO3	Propose novel methods and pathways to understand the environmental issues (K6)
CO4	Interpret the results and data obtained from any experiment clearly, interpret the results and data obtained; records experiments orderly for future reference and draw clear and logical conclusions & assemble in presentations and reports.(K4)
CO5	Demonstrate leadership skills and effective teamwork while working and prepare themselves for their future career in environmental ares, industries or academics (K6)

SEMESTER-IV

Name of The Course	Environmental Biotechnology				
Course Code	MEV401				
Prerequisite	B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry				
Corequisite	Organic Chemistry, Bio-chemistry, Analytical Chemistry, Geology				
Antirequisite					
Theory Lectures:		L	T	P	C
		4	0	0	4

Course Objectives: The course is aimed at providing comprehensive training in investigating the natural environment and to develop potential solutions to remedy its damage using chemical, biochemical and molecular technologies.

Course Outcomes

CO1	Determine the nature of genetic information and gene expression.(K4)
CO2	Analyse the recombinant DNA technology.(K4)
CO3	Determine the various processes of waste water treatment.(K4)
CO4	Illustrate the different methods of solid waste treatment. (K3)
CO5	Discuss various bioremedial methods of degraded ecosystems. (K2)
CO6	Choose the advance technique to solve the environmental issues. K6

Text Book (s):

3. Gardner, E.J., Simmons, M.J. and Snustad, D.P. 2006. Principles of Genetics. John Wiley, 8th Edition.
4. Mohapatra, P. K. 2006. Text Book of Environmental Biotechnology. I K International.

Reference Book (s):

5. Olguin, E., Sanchez, G. and Hernandez, E. 1999. Environmental Biotechnology and Cleaner Bioprocesses, Taylor & Francis, London.
6. Rittman, B. E., and McCarty, P. L. 2001. Environmental Biotechnology. Principles and applications. McGraw-Hill, New York.
7. Scragg, A. H. 2005. Environmental Biotechnology. Oxford University of Press.
8. Wainwright, M. 1999. An introduction to environmental biotechnology. Springer Verlag, New York.

Unit-1: Structure and perpetuation of nucleic acids	12 hours
Pioneering experiments leading to development of molecular genetics, Fine structure of gene. DNA replication models, mechanism of replication, enzymes involved in replication. Introduction to nature of genetic information and gene expression: Transcription of DNA; RNA polymerase, initiation, chain elongation, termination, post-transcriptional modifications. The genetic code; protein synthesis: tRNA as adaptor molecule, ribosome structure, ribosomal genes, initiation, elongation and termination of protein synthesis. Inhibition of protein synthesis.	

Unit-2: Recombinant DNA technology	10 hours
Recombinant DNA technology: Early discoveries, restriction endonucleases, ligases modification enzymes, DNA and RNA markers, cloning and expression vectors (plasmids, bacteriophage, phagmids, cosmids, artificial chromosomes), selection of recombinant clones, DNA sequencing, gene probes. CDNA synthesis and cloning (mRNA enrichment, reverse transcription, DNA promers, linkers, adaptors and their chemical synthesis, library construction and screening). Nucleic acid microarrays.	
Unit-3: Wastewater Treatment	10 hours
Water as a scarce natural resource, Measurement of water pollution, sources of water pollution. Wastewater treatment: anaerobic, aerobic process, methanogenesis, bioreactors, cell and protein (enzyme) immobilization techniques. Treatment schemes for waste water, dairy, distillery, tannery, sugar, antibiotic industries.	
Unit-4: Solid Waste Treatment	8 hours
Sources and management (composting, wormiculture and methane production, landfill. Hazardous waste treatment, bio-fuels.	
Unit-5: Bioremediation	10 hours
Remediation of degraded ecosystems, degradation of xenobiotics in environment, decay behaviour& degradative plasmids, hydrocarbons, substituted hydrocarbons, oil pollution, surfactants, pesticides, heavy metals degradative pathways.	
Unit 6 Unit-6: Recent advancement in Environmental Biotechnology	4 hours

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Green Technology				
Course Code	MEV402				
Prerequisite	B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry				
Corequisite	Organic Chemistry, Bio-chemistry, Analytical Chemistry, Geology				
Antirequisite					
Theory Lectures:		L	T	P	C
		4	0	0	4

Course Objective: This course aims at teaching students the basic concepts of Green Chemistry and Technology. Students will be able to understand the importance of Green resources, methodologies and applications of Green Technology and appreciate how Green is better than the conventional methods

Course outcome

CO1	Demonstrate the fundamental concepts of Green Chemistry and Sustainable Development (K2)

CO2	Examine the different Renewable energy resources and systems (K4)
CO3	Demonstrate methods for converting different wastes into energy (K2)
CO4	Apply the concept of Nanotechnology in Green Technology (K3)
CO5	Demonstrate different applications of Green Technology (K2)
CO6	Adapt new green methods to conserve environment. (K6)

ReferenceBooks:

6. The Sustainability Revolution: Portrait of a Paradigm Shift by Edwards, Andres R.,New Society Publishers, 2005.
7. Sustainable development in India: Stocktaking in the run up to Rio+20: Report prepared by TERI for MoEF,2011.
8. Report of the Department for Policy Coordination and Sustainable Development (DPCSD), United Nations Division for Sustainable Development.
9. Environmental Studies, Anubha Kaushik, C P Kaushik, New Age International Publishers, 2008, ISBN:978-81-224-2159-0
10. M. H. Fulekar (2010) Nanotechnology Importance and applications, I K international publishing house Pvt.Ltd.

Unit-1: Fundamentals of Green Chemistry and Sustainable Development	10 hours
Green Chemistry: Concept of Green Chemistry, Atom Economy, Twelve basic Principles of Green Chemistry and their discussions, Tools of Green Chemistry; Sustainable Development: Principles of Sustainable Development, History and emergence of Sustainable development, Socio-economic policies for sustainable development, Strategies for implementing eco-development programmes, International agreements/conventions on energy and sustainability - United Nations Framework Convention on Climate Change (UNFCC)	
Unit-2: Renewable Energy Resources and Systems	10 hours
Current energy requirements, growth in future energy requirements, *Solar Energy:*Solar radiation: measurements and prediction, solar heating of buildings, solar water heaters, Solar Photovoltaic: Principle of photovoltaic conversion of solar energy, types of solar cells and fabrication. Photovoltaic applications : battery charger, domestic lighting, street lighting, water pumping, power generation schemes, *Wind Energy:*Atmospheric circulations, classification, factors influencing wind, turbulence, wind speed monitoring, applications, *Ocean Energy:*Ocean energy resources-ocean energy routes - Principles of ocean	

thermal energy conversion systems- ocean thermal power plants- Principles of ocean wave energy conversion and tidal energy conversion, Hydropower and Geothermal energy
Unit-3: Waste to Energy Conversion 10 hours *Introduction to Waste & Waste processing:* Definitions, sources, types and composition of various types of wastes; characterisation of Municipal Solid Waste (MSW) , Industrial waste and Biomedical Waste (BMW); *Energy from waste-thermo chemical conversion:*Sources of energy generation, incineration, pyrolysis,gasification of waste using gasifiers, briquetting, environmental and health impacts of incineration and methods to mitigate them; *Energy from waste- Bio-chemical Conversion:* Anaerobic digestion of sewage and municipal wastes, direct combustion of MSW-refuse derived solid fuel, industrial waste, agro residues, anaerobic digestion biogas production, land fill gas generation and utilization, present status of technologies for conversion of waste into energy, design of waste to energy plants for cities, small townships and villages
Unit-4: Green Nanotechnology 10 hours *Nanomaterials for "Green" Systems:*Green materials, including biomaterials, biopolymers, and bioplastics, for Truly Sustainable Construction: Windows, Skylights, and Lighting. Paints, Roofs, Walls, and Cooling. Multifunctional Gas Sensors; *Nanomaterials for Alternative Energy:*Nanomaterials for Fuel Cells and Hydrogen Generation and storage, Nanostrcutures for efficient solar hydrogen production, *Nanomedical applications of green Nanotechnologies:* use of nanotechnologies and materials impact on biodiversity, resource conservation, ecosystems and human.
UNIT-5 Green Technology Application 10 hours
Biocatalysis, green chemistry in industries, fuel cell and electric vehicles, solar energy and hydrogen production, energy from alternate sources; Solar photovoltaic technology, Biofuel production (bio-ethanol and biodiesel), Biomass, prevention/minimization of hazardous/toxic products. Agricultural related practices and food processing, Production of biodegradable materials, concept of green building, Pollution free engineering processes.
Unit-6 Recent advancement in green technology 4 hours
Discuss the new advance methods and green synthesis to conserve environment.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Environmental Science Lab-III				
Course Code	MEV431				
Prerequisite	B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry				
Corequisite	Environmental Science, Analytical Chemistry, Botany				
Antirequisite					
Practical Lectures:		L	T	P	C
		0	0	4	2

Course Objectives: The course aims at studying different eco-systems and biodiversity present in the environment and also deals with an in-depth study of waste water treatment.

Course Outcomes

CO1	Demonstrate index of diversity and dominance of species (K2)
CO2	Demonstrate biotic and abiotic components of ecosystems (K2)
CO3	Estimate chlorophyll, carbohydrate & protein content in plant samples (K5)
CO4	Analyze hardness, chloride content, TSS, BOD ,COD and TDS of water sample (K4)
CO5	Calculate Na and K metals in water by flame photometer (K4)

Text Book (s):

1. Anjaneyalu, Y. 2004. Introduction to Environmental Science. BS Publications, Hyderabad, A.P. India.
2. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.

Unit-1: 2 hours 1.To study ecology of some more exotic invasive weeds.
Unit-2: 2 hours 1.To study and enlist various biotic and abiotic components of pond and forest ecosystem.
Unit-3: 3 hours 1. To estimate carbohydrate content in given plant sample. 2. To estimate protein content in the given sample.
Unit-4: 8 hours 1. Determination of chloride of a given water sample. (Precipitation titration) 2. Determination of TS, TSS and TDS of a given water sample by alternative method. 3. Determination of turbidity of different drinking water samples 4. Potentiometric determination of pH of water/wastewater samples. 5. Determination of BOD of a wastewater sample
Unit-5: 2 hours 1.Determination of pH and electrical conductivity of different drinking water samples.

Continuous Assessment Pattern

Internal Viva (IA)	Mid Term Test (MTE)	External Exam (ETE)	Total Marks
50	-	50	100

SEMESTER-IV/List of ELECTIVES

Elective-I Methodologies for Environmental Studies

Name of The Course	System Analysis and Modelling				
Course Code	MBS26T5101				
Prerequisite	B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry				
Corequisite	Environmental Science, Mathematics, Physics and Computer Science				
Antirequisite					
Theory Lectures:		L	T	P	C
		3	0	0	3

Course Objectives:

The paper introduces the student to the concept of systems and sub-systems, and modelling and simulations as well as computational techniques. These concepts are used to model various environmental systems, particularly those dealing with ecology and ecosystems and study of environmental pollution in modelling air and water quality.

Course Outcomes

CO1	Develop the concept of systems and sub-systems, and modelling and simulations as well as computational techniques. (K6)
CO2	Create various environmental systems, particularly those dealing with ecology and ecosystems and study of environmental pollution in modelling air and water quality. (K6)
CO3	Collect major approaches towards natural resource issues and enables to think creatively about conflict and concord in general, with special emphasis on the roles of ideas and institutions in environmental politics. (K6)
CO4	Formulate on the simulation models to analyze environmental processes. (K6)
CO5	Analyse computational techniques for environmental processes (K4).
CO6	Choose the advance techniques for system analysis and modelling. (K6)

Text Book (s)

4. Bennett, J. and Blamey, R. (eds). 2001. The choice modelling approach to environmental valuation. Edward Elgar Publishing.
5. Beven, K. 2007. Environmental Modelling: An Uncertain Future? CRC press.
6. Fotheringham, S. and Rogerson, P. (eds). 2014. Spatial analysis and GIS. CRC Press.

Reference Book (s)

8. Gallager R. 1996. Discrete Stochastic Processes, Kluwer Academic Publishers.
9. Grant, W.E., Pederson, E.K. and Sendra, L.M., 1997, Ecology and Natural Resource Management: Systems Analysis and Simulation, John Wiley, New York.
10. Illian, J., Penttinen, A., Stoyan, H. and Stoyan, D. 2008. Statistical Analysis and Modelling of Spatial Point Patterns (Vol. 70). John Wiley & Sons.
11. Recknagal, F., (Ed.), 2003, Ecological Informatics, chapters I, II, III and IV. Springer, Germany.
12. Refsgaard, J.C., van der Sluijs, J.P., Højberg, A.L. and Vanrolleghem, P.A. 2007. Uncertainty in the environmental modelling process–a framework and guidance. Environmental Modelling &Software, 22:1543-1556.

13. Wainwright, J., Mulligan, M. (Eds). 2004. Environmental Modelling: Finding Simplicity in Complexity. John Wiley, New York
14. Zannetti, P. 1990. Air pollution modeling, theories computational methods and available softwares. Van NostrandRheinhold, New York.

Unit-1 Introduction	12 hours
Definitions and concepts of system, sub-system, variables and parameters, systems analysis, modelling and simulation. Linear vs. non-linear models; Non-linear forecasting. Prey-predator systems, Environmental systems. Time series analysis.	
Unit-2Types of Systems	10 hours
Open and cybernetic systems; feedback; Ecosystem as a cybernetic system; Critical points of a system; stability of critical points. Limitations of modelling.	
Unit-3 Models in Ecology	10 hours
Stochastic and Deterministic model; Development of Ecological models. Fundamental interactions in ecology: predator-prey, competition, mutualism and interference.	
Unit-4 Models in Ecosystem	10 hours
Analysis, Synthesis and forecasting: statistical regression approach, differential equation approach and computational approaches, Lotka-Voltera model. Air and water quality modelling.	
Unit-5 Introduction to computational technology	10 hours
Fuzzy logic; artificial neural networks; Genetic algorithms; Evolutionary algorithm, Natural Distribution functions.	
Unit-6 Recent advancement in system analysis and modeling	4hours
Application of advanced techniques for system analysis and modelling.	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Remote Sensing and GIS				
Course Code	MBS26T5102				
Prerequisite	B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry				
Corequisite	Environmental Science, Mathematics, Physics and Computer Science				
Antirequisite					
Theory Lectures:		L	T	P	C
		3	0	0	3

Course outcome

CO1	Demonstrate different mechanism and characteristics of Remote Sensing process
CO2	Analyze different aspects of Remote Sensing Data
CO3	Demonstrate the different applications of Remote Sensing data
CO4	Analyze the different concepts and applications of GIS
CO5	Adapt new techniques for remote sensing

1. Text Books and References:

2. Burough, P.A. and McDonnel, R. 1998. Principles of Geographical Information Systems. Oxford University Press, NY.
3. Campbell, J.B. (2nd Ed), 1996. Introduction to Remote Sensing. Taylor and Francis.
4. Christopher, J. 1997. Geographical Information Systems and Computer Cartography. Longman.
5. Reeves, Robert G. 1999. Manual of Remote Sensing, (Vols. I & II). American Society of Photogrammetry and Remote Sensing, USA.
6. Rencz, A.N. (3rd Ed.) Remote Sensing for the Earth Sciences: Manual of Remote Sensing. John Wiley & Sons, Inc., New York.
7. Sabins, F. F. Jr. (2nd Ed). 1986. Remote Sensing: Principles and Interpretation. W.H. Freeman & Co.

UNIT-1:	10 hours
Electromagnetic Radiation as Remote Sensing Medium; General Mechanism of Remote Sensing Data Recording; General Characteristics of Remote Sensing Platforms; General Characteristics of Remote Sensing Sensors; Indian Remote Sensing Satellites and Sensors.	
Unit-2	10 hours
Spectral Characteristics of Common Natural Objects; Atmospheric Effects on Remote Sensing Data; Spectral Signatures and Spectral Response Patterns; Resolution of Remote Sensing Data; Characteristics of Raw Remote Sensing Data	
Unnit-3	10 hours
Nature of Qualitative Information and Sequence in Interpretation; Elements of Image Patterns-Landforms, Drainage, Erosion Details; Applications of Remote Sensing; Remote Sensing Applications in Environmental Studies; Digital Image enhancement and classification methods; Principles of Microwave Remote Sensing; Characteristics of Microwave remote sensing Data; Radar and Lidar: Applications of Microwave Remote Sensing Data.	
Unit-4	10 hours
Geograpical Data and GIS; Coordinate Systems and Datums; Digital representation of geographical data-Raster and Vector models; GIS Data Standards-Concepts and Components; Conceptual and Logical Data Modeling; Applications of GIS	
Unit-5 Recent advancement in remote sensing and GIS	8hours
Application of advanced techniques for remote sensing and GIS	

Continuous assessment

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Methodolgy Lab I - Practical on System Analysis and Modelling				
Course Code	MBS26T5103				
Prerequisite	B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry				
Corequisite	Environmental Science, Mathematics, Physics and Computer Science				
Antirequisite					
Practical Lectures:		L	T	P	C
		0	0	2	1

Course outcome

CO1	Generate the random numbers
CO2	Analyse the random numbers generators
CO3	Build Chi-square goodness-of-fit test
CO4	Classify Simulation of single/two server queuing system

List of experiment

1. Generation of Random Numbers
2. Testing for Random Number Generators and Standard Normal Distribution
3. Chi-square goodness-of-fit test
4. Monte-Carlo Simulation
5. Simulation of single/two server queuing system

Reference Books:

3. Illian, J., Penttinen, A., Stoyan, H. and Stoyan, D. 2008. Statistical Analysis and Modelling of Spatial Point Patterns (Vol. 70). John Wiley & Sons.
4. Wainwright, J., Mulligan, M. (Eds). 2004. Environmental Modelling: Finding Simplicity in Complexity. John Wiley, New York

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
50		50	100

Name of The Course	Methodology Lab II - Practical on Remote Sensisng and GIS				
Course Code	MBS26T5104				
Prerequisite	B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry				
Corequisite	Environmental Science, Mathematics, Physics and Computer Science				
Antirequisite					
Theory Lectures:		L	T	P	C
		0	0	2	1

Course Outcomes

CO1	Classify aerial photos and satellite image
CO2	Explain the remote sensing data
CO3	Analyzethe spectral response pattern of different landforms
CO4	AnalyseGPS & GIS data integration and output preparation

1. Fundamentals of aerial photos and satellite image interpretation
2. Techniques of Visual interpretation; Generations of Thematic maps
3. Features extractions from remote sensing data
4. Image interpretation and Analysis of spectral response pattern of different landforms
5. Familiarization with digital image processing & image processing software
6. Importing raw data, Displaying image data, Image Rectification & Registration, Image Enhancement & Transformation.
7. GPS & GIS data integration and output preparation

Reference Books:

5. Integrating GIS and the Global Positioning System Karen Steede-Terry
6. Remote Sensing and Image Interpretation Thomas M. Lillesand &Palph W. Kiefer
7. Elements of Photogrammetry with application in GIS Paul R. Wolf & Bon A. Dewitt
8. Remote Sensing Geology Ravi P. Gupta

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
50		50	100

Elective-II Waste management

Name of The Course	Solid and Hazardous Waste Management				
Course Code	MBS26T5105				
Prerequisite	B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry				
Corequisite	Environmental Science, Mathematics, Physics and Computer Science and Bio-statistics				
Antirequisite					
Theory Lectures:		L	T	P	C
		3	0	0	3

Course Objective:

4. To provide comprehensive overview of solid, biomedical and hazardous waste management.
5. To provide knowledge on solid waste management design aspects.

6. To learn about the different methods of solid waste management.

Course Outcomes

CO1	Identify different types of solid wastes and methods of collection K3
CO2	Analyze different treatment methods of solid wastes K4
CO3	Identify different techniques for biomedical waste management K3
CO4	Interpret different thermal treatment processes of solid wastes K3
CO5	Adapt new techniques to treat waste K6

Text Books and References:

1. Tchobanoglous G., Theissen H., and EIiassenR.(1991), "Solid Waste Engineering - Principles and Management Issues", McGraw Hill, New York.

2. Pavoni J.L(1973)., "Handbook of Solid Waste Disposal".

3. Peavy, Rowe and Tchobanoglous (1985), "Environmental Engineering", McGraw Hill Co. 4th Edition

4. Mantell C.L., (1975), "Solid Waste Management", John Wiley.

5. CPHEEO, Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organisation, Government of India, New Delhi, 2000.

6. WHO Manual on Solid Waste Management.

7. VesilandA.(2002), "Solid Waste Engineering", Thompson Books.

8. Hazardous waste (management and handling) rules, 2001

9. Biomedical (Handling and Management) Rules 2008

Unit-1Solid waste	8 hours
sources and engineering classification, characterization, generation and quantification. Transport - collection systems, collection equipment, transfer stations, collection route optimization.	
Unit-2 Treatment methods -	10 hours
various methods of refuse processing, recovery, recycle and reuse, composting – aerobic and anaerobic, incineration, pyrolysis and energy recovery, Disposal methods – Impacts of open dumping, site selection, sanitary land filling – design criteria and design examples, leachate and gas collection systems, leachate treatment.	
Unit-3 Biomedical Waste management	10 hours
sources, treatment and disposal Hazardous Waste Management- Introduction, Sources, Classification, Physico-chemical, Chemical and Biological Treatment of hazardous waste, regulations	
Unit-4 Thermal treatment	10 hours
Incineration and pyrolysis. Soil contamination and site remediation – bioremediation processes, monitoring of disposal sites.	
Unit-5 Recent Advancement in Waste Management and treatment	6 hours
Discuss the new techniques to treat variety of waste.	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Waste Water Management				
Course Code	MBS26T5106				
Prerequisite	B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry				
Corequisite	Environmental Science, Mathematics, Physics and Computer Science and Bio-statistics				
Antirequisite					
Theory Lectures:		L	T	P	C
		3	0	0	3

Course Objectives:

3. To learn about the methods used for the treatment of wastewater biologically.
4. To make the students understand modeling and design aspects of biological techniques available.

CO1	CO1: Analyze the objectives of Waste Water treatment (K4)
CO2	Interpret the kinetics of biological treatment systems (K2)
CO3	Organize the theoretical principles and design of Water treatment process (K3)
CO4	Identify different advanced Water treatment processes (K3)
CO5	Adapt new methods to treat waste water K6

Text Books and References:

1. Peavy, H.S., Rowe and Tchobonoglous,G., (1985), “Environmental Engineering”, McGraw Hill

2. Metcalf and Eddy Inc., (2003), “Wastewater Engineering - Treatment and Reuse”, 4th Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi.

3. Benefield R.D.,and Randal C.W., (1980), “Biological Process Design for Wastewater Treatment”, Prentice Hall, Englewood Chiffs, New Jersey.

4. Karia G.L., and Christian R.A., (2001), “Wastewater Treatment Concepts and Design Approach”, Prentice Hall of India Pvt. Ltd., New Delhi.

5. Lee C.C., and Lin S.D., (1999), “Handbook of Environmental Engineering Calculations”, McGraw Hill, New York.

Unit-1	12 hours
Objectives of wastewater treatment: flow variations , characteristics, analysis of BOD, COD, solids and volatile solids & their significance, BOD progression & its formulation, types of reactors and reactors analysis. Study of Wastewater Treatment, Flow Diagrams and Hydraulic Profile. Theoretical principles and design - screens, equalization basin, grit chamber, primary and secondary settling tanks.	
Unit-2	10 hours
Kinetics of biological treatment systems: bio-kinetic constants and their determination, batch and continuous systems.	
Unit-3	10 hours
Theoretical principles and design: Suspended growth system - conventional activated sludge process and its modifications. Theoretical principles and design – attached growth system – trickling filter, bio-towers and rotating biological contactors. Principles and design of stabilization ponds	
Unit-4	10 hours
Sludge Processing: Separation, sludge thickeners, volume reduction, conditioning and digestion – aerobic and anaerobic. Advanced Wastewater Treatment – Need and technologies used. Nitrification and Denitrification Processes, Phosphorous removal, Wastewater disinfection.	
Unit-5	8 hours
Discuss the new techniques to treat waste water.	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Waste management Lab I - Practicals on Solid Waste				
Course Code	MBS26T5107				
Prerequisite	B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry				
Corequisite	Environmental Science, Mathematics, Physics and Computer Science and Bio-statistics				
Antirequisite					
Theory Lectures:		L	T	P	C
		0	0	2	1

Course Outcomes

CO1	Determine the pH of MSW and total solids
CO2	Analyze the nutrient value (NPK) .
CO3	Illustrate vermicomposting in lab.
CO4	Survey report of disposal site and handling of hazardous materials.
CO5	Illustrate the working of incinerators

1. Reference Books:

2. J. Glynn Henry and Gary. W. Heinke, “Environmental Science and Engineering”, Pretice Hall of India, 2004.
3. A. D.Bhide and B.B.Sundaresan, “Solid Waste Management – Collection, Processing and disposal” Mudrashilpa Offset Printers, Nagpur, 2001.
4. Biomedical waste (Management and Handling) Rules, 1998.

1. List of experiments
2. Determination of pH of MSW
3. Determination of Total Solids, fixed solids and volatile solids
4. Determination of nutrient value (NPK)
5. Lab scale study on vermin-composting
6. Lab scale study of aerobic and anaerobic digesting of solid wastes (Both industrial & Municipal)
7. A Visit to the Hazardous waste Generation or disposal site.
8. Practical knowledge and working of incinerators
9. Visit to Industrial area, study the handling of Hazardous materials

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
50		50	100

Name of The Course	Waste Management Lab II - Practicals on Waste Water Treatment				
Course Code	MBS26T5108				
Prerequisite	B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry				
Corequisite	Environmental Science, Mathematics, Physics and Computer Science and Bio-statistics				
Antirequisite					
Practical Lectures:		L	T	P	C
		0	0	2	1

Course Outcomes

CO1	Differentiate bacteria and fungi.
CO2	Test forGram staining, capsule staining, differential staining and motility and microbes in lab .
CO3	Summarize the preservation of culture and Batch and Fed culture i.
CO4	Determine DO,BOD and COD in lab.
CO5	Analyse Fats, oils, greases in lab.

Reference Books:

1. Prescott and Dunn, “Industrial Microbiology”, Macmillian.
2. Dany Spencer Adams, “Lab Methodologies”, IK Intl.Pub house.
3. L.M. Prescott, Harley, Klein, (2002), “Microbiology” 5th edition, McGraw-Hill Higher Education.

4.Chemistry for Environment Engineering. Sawyer and Mc Carty.

List of experiments

1. Isolation of bacteria and fungi from wastewater.
2. Gram staining, capsule staining, differential staining and motility test.
3. Biochemical Tests for characterization of microbes.
4. Preservation of cultures.
5. Batch and Fed batch culture studies.
6. Determination of Solids in wastewater: Total Solids, Suspended Solids, Dissolved Solids, Volatile Solids, Fixed Solids, Settleable Solids.
7. Determination of DO, BOD and COD
8. Determination of Fats, oils and greases.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
50		50	100

Elective-III Environment and society

Name of The Course	Rural Society and Development				
Course Code	MBS26T5109				
Prerequisite	B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry				
Corequisite	Environmental Science, Mathematics, Physics and Computer Science and Bio-statistics				
Antirequisite					
Theory Lectures:		L	T	P	C
		3	0	0	3

Course Objectives:

a) To make the students to understand some basic concepts and theoretical approaches related towards Rural Social Structure.

b) To expose the students to the critical / analysis and evaluation of those programmes aiming to bring desired change in Indian Society.

c) To make the students aware of changed prospective of Rural Society in India.

d) To create practical approach among the students.

CO1	Identify the components of Rural Society and the different institutions associated with it
CO2	Interpret the different concept and theories of Rural Social Change
CO3	Analyze methods of agricultural development
CO4	Identify the various sources of Rural Employment
CO5	Adapt new processes for development of rural society.

Text Books and References:

1. Vasant Desai: A Study of rural economics; Himalaya Publishing Company; New Delhi.

2. Sharma K.C. (1997): Rural Sociology in India; Rural Publication; New Delhi.

3. Jain S.C: Rural Development; Concept Publishing.

4. S.R.Mehta: Sociology of Rural Development; Sage. Publications; New Delhi.

5. Sreenivas M. N.: Social Change in Modern India; Orient Black Swan.

6. A. R. Desai: Rural Sociology; Popular Prakashan.

Unit-1 : Rural Society and Institutions	10 hours
Indian Rural society – Nature and Characteristics, Factors of Indian Society- Tribal- Rural- Urban- Rural Urban continuum, Problems of Weaker Sections- Schedule Casts, Schedule Tribes and, Women, Caste and Class, Caste and Economic Inequalities Institutions: Religious- Concept, Nature, Function and its Changing Structure, Education- Objectives, Functions and Importance, Co-operation- Concept, Nature, Scope, Role and Significance in Rural Development.	
Unit-2 Rural Social Change	10 hours
Concept of Social Change; Factors of Social Change: Cyclical Theories; Linear Theories; Conflict Theories, Sanskritization, Westernization, Modernization, Diffusion of Innovation; Resistance to Change; Socio-Cultural Barriers for Rural Development, Role of Leadership in Promoting Social Change.	
Unit-3 Development of Agriculture	12 hours
National Agricultural Policy 2000 and Food Security, Irrigation and Water Management, Methods of Irrigation, Conventionaland Modern Methods, Role of Agricultural Universities and Krishi Vigyan Kendra- Needs andEstablishment	
Unit-4 Sources of Rural Employment	10 hours
Self Help Group- Concept, Characteristics and Functions, Swarnajayanti Gram Swarojgar Yojana (SGSY)- Salient features of SGSY, Nature and Scope, Agro Based Industries- Concept, Types, Functions and Importance in Rural Employment Generation	
Unit-5 Recent development in rural society	8 hours
Discuss the new development in rural society, agriculture tech. and employment.	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	Urban Ecosystem				
Course Code	MBS26T5110				
Prerequisite	B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry				
Corequisite	Environmental Science, Mathematics, Physics and Computer Science and Bio-statistics				
Antirequisite					
Theory Lectures:		L	T	P	C
		3	0	0	3

Course Outcomes

CO1	Describe the concept of urbanization; urban sprawl and associated environmental issues.
CO2	Generalize emerging importance of the urban setting as the locus of environmental conflict and governance.
CO3	Relate and examine town planning, acts and their environmental aspects presence of slums as a specific environmental issue in urban contexts.
CO4	Determine the major forms of urban pollution - air, water, noise and land are explored.
CO5	Adapt new processes for sustainable development in urban areas

Course Objectives:
This paper introduces the students to the concept of urbanization, urban sprawl and environmental issues.

Text Books/References

- Berkowitz, A.R., Nilon, C.H. and Hollweg, K.S. (eds.). 2003. *Understanding urban ecosystems: a new frontier for science and education*. Springer Science & Business Media.
- D'Monte D. 1985. Industry versus Environment Temples or Tombs. Three Controversies, Delhi, CSE.
- Douglas, I. 2012. Peri-urban ecosystems and societies: transitional zones and contrasting values. In The Peri-urban Interface (pp. 41-52). Routledge.
- Kopecká, M., Nagendra, H. and Millington, A. 2018. Urban Land Systems: An Ecosystems Perspective.
- Kumar, P. 2009. Assessment of economic drivers of land use change in urban ecosystems of Delhi, India. AMBIO:A Journal of the Human Environment, 38: 35-39.
- Nagendra, H., Sudhira, H.S., Katti, M., Tengö, M. and Schewenius, M. 2014. Urbanization and its impacts on land use, biodiversity and ecosystems in India. INTERdisciplina, 2.
- Pelling, M. and S. Blackburn (eds.). 2003. Megacities and the Coast: Risk, Resilience and Transformation, Abington: Routledge.
- Singh, V.S., Pandey, D.N. and Chaudhry, P. 2010. Urban forests and open green spaces: lessons for Jaipur, Rajasthan India. Jaipur: Rajasthan State Pollution Control Board.
- Oldenburg, V.T. 2014. The Making Of Colonial Lucknow, 1856-1877. Princeton University Press.
- Verma, G.D. 2002. Slumming India: A Chronicle Of Slums And Their Saviours. Penguin Books, New Delhi.

Unit-1Environment inan urban setting-City, region and modernity 10 hours	
Urban ecosystem, meaning and concept, introduction to urbanization; Man as the driver of urban ecosystem, increasing challenges posed by modernity for the environment. Nature in the city: Parks, Gardens and Public spaces. Examines the principles and techniques through which green spaces are organized in the city to produce 'controlled nature' Infrastructure:A variety of infrastructure from sewage and water to transport and communication are studied from an environmental perspective.	
Unit-2 Urban Planning and environment	12 hours
Town planning Acts and their environmental aspects are studied across a range of Indian cities. Historical and contemporary developments in urban planning and environmental management are addressed. Slums and neighborhoods: Examines the housing scenario across large-medium-small cities and the presence of slums as a specific environmental issue in urban contexts.	
Unit-3 Occupational environment of Urban Areas	12 hours
Environmental aspects of a variety of informal and formal work spaces are examined. Pollution and waste, Major forms of urban pollution - air, water, noise and land - are explored historically and across various urban sites. Spatial dimensions of waste circulation are explored.	
Unit-4 Consuming nature and environmental impacts	12hours
Introduce the issue of consumption from a variety of perspectives - materials, symbolic and aesthetic. Energy and environment Examines the major techniques for providing energy in urban contexts - generation, transportation, usage, alternatives and environmental impacts. Insight into some key challenges facing urban sustainability in the 21st century; Urban futures.	
Unit-5 Recent advancement in urban ecosystem	4 hours
Discuss about the new processes applicable for sustainable development of urban ecosystem	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	E&S Lab I - Field Work on Rural Development				
Course Code	MBS26T5111				
Prerequisite	B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry				
Corequisite	Environmental Science, Mathematics, Physics and Computer Science and Bio-statistics				
Antirequisite					
Lectures:		L	T	P	C
		0	0	2	1

Course objective

Students will get exposure the rural societies understand their development issues.

Course Outcomes:

CO1	Identify rural societies in an area and plan visits to study about them (K3)
CO2	Analyze structure, agriculture and recent developments in rural societies (K4)
CO3	Organizing visits in the sector in which students choose to develop policy concentration and specialization (K3)
CO4	Compile data collected from field work for report writing (K6)

List:

1. Understanding Rural Societies and Development in Rural Areas (understanding of rural society, structure, agriculture etc.)

2. Policy Area Concentration Aligned Experiential Learning (acquiring practical, political and administrative experience in the sector in which students choose to develop policy concentration/specialisation)

3. Primary data collection from the field work carried out and report writing on the same.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
50		50	100

Name of The Course	E&S Lab II - Field Work on Urban Ecosystem				
Course Code	MBS26T5112				
Prerequisite	B.Sc.(H) Zoology, Chemistry, Botany, Microbiology, Bio-chemistry				
Corequisite	Environmental Science, Mathematics, Physics and Computer Science and Bio-statistics				
Antirequisite					
Lectures:		L	T	P	C
		0	0	2	1

Course Outcomes

CO1	Illustrate formation and Community Planning exercise
CO2	Identify the problems of special area (slum / new town / rural area)
CO3	Simplify the interaction studies of a small urban area and its environment.
CO4	Illustrate the Heritage and the roots of our modern concepts in urban design.
CO5	Analyse theories and principles of urban development plan and preparation for survey and data collection.

Course objective

Students develop the skill to solve the issues related to urbanization.

Reference Books:

1. Urban Design: The architecture of towns & cities / SPREIREGEN, PAUL. D.

2. The urban pattern: city planning and design / GALLION, A B.

3. Water supply, waste disposal & Environmental Engineering / CHATTERJEE, AK

List of experiments:

1. Skill formation and Community Planning exercise.
2. Housing cluster and residential sector studies – layout, density, utility net-work and community facilities locations
3. Introduction to special area problems (slum / new town / rural area) and preparation of their plan program.
4. Land use interaction studies of a small urban area and its environment.
5. Early examples of Urban Design in classical and pre-industrial cities – Heritage and the roots of our modern concepts in urban design.
6. Objectives and scope of urban design, Basic functions, principles and techniques, Value enhancement, aesthetics and conservation aspects.
7. Theories and principles of urban development plan and preparation for survey and data collection.
8. Field survey of the study area and Analysis of data and information
9. Planning for urban area and its region (structure plan / Development plan) with emphasis on:

• Land use and transportation network
• Infrastructure plan
• Action area programs and urban renewal plan
• Capital budget and financing

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
50		50	100

GALGOTIAS UNIVERSITY

(Established under Galgotias University Uttar Pradesh Act No. 14 of 2011)

Program: M.Sc. Chemistry

Scheme: 2020-2021

Vision:

To be recognized globally as a center of excellence in imparting value-based education in Basic and Applied Sciences by creating innovation in fundamental and multidisciplinary research

Mission:

M1. To excel in imparting contemporary knowledge and skills by developing an educational ecosystem with diverse interests and talents.

M2. To perform cutting edge research leading to innovation in sciences through national and international collaborations.

M3. To develop solutions for the emerging challenges in Basic and Applied Science to cater the needs of society.

M4. To attract best quality faculty to facilitate knowledge and develop confidence in our graduates to succeed in the world.

Program Educational Objectives:

PEO1: Nurture the needs of industries/laboratories related to chemistry including pharmaceutical/analytical chemistry.

PEO2: Demonstrate information literacy skills for acquiring knowledge of chemistry, as a chemist/researcher and also as a life-long learner.

PEO3: Communicate effectively the scientific information and research results in written and oral formats, to both professional scientists and to the public.

Program Specific Objectives:

PSO1: Comprehend the need, significance and methodologies of chemical process their alignment with nature and conducive in cultivating skills for successful carrier in research, industry and as an entrepreneurship.

PSO2: Explore scientific skills with a sustainable approach to develop a new innovative solutions for emerging problems by providing new knowledge in organic, inorganic, physical and analytical chemistry.

Program Outcomes

1. Apply the knowledge of organic, inorganic, physical, and analytical chemistry to the solution of complex chemical problems in industry and academia.
2. Identify, formulate, research literature, and analyze chemical problems to arrive at substantiated conclusions using principles of chemical and physical sciences and design solutions for complex chemical synthesis and new reaction pathways with valid conclusions.
3. Create, select, and apply appropriate techniques, resources, and modern analytic tools including prediction and modeling of chemical reactions with an understanding of the limitations.
4. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional industrial practice.

5. Understand the impact of the chemical solutions in societal and environmental contexts, and demonstrate the knowledge with sustainable manner and commit to professional ethics and responsibilities and norms of the industrial and scientific community, function effectively as an individual, and as a member or leader in multidisciplinary settings.
6. Communicate effectively with the scientific community and with society at large. Be able to comprehend and write effective reports documentation. Make effective presentations, and give and receive clear instructions.
7. Demonstrate knowledge and understanding of scientific and management principles and apply these to one's own work, as a member and leader in a team. Manage projects in multidisciplinary environments.
8. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological and scientific change.

Curriculum

Semester 1									
Sl. No	**Course Code**	**Name of the Course**					**Assessment Pattern**		
			L	**T**	**P**	**C**	**IA**	**MTE**	**ETE**
1	MSCH 5001	Stereochemistry & Reaction mechanisms	4	0	0	4	30	20	50
2	MSCH5002	Basic concepts and principles of Inorganic chemistry	4	0	0	4	30	20	50
3	MBS24T1101	Basic Concepts of Physical Chemistry	3	0	0	3	30	20	50
4	MBS24T1102	Basic Analytical Chemistry	3	0	0	3	30	20	50
5	MSCH 5005	Computer Applications for chemistry	2	0	0	2	30	20	50
6	MSCH 5006	Organic chemistry Lab – I	0	0	4	2	50	-	50
7	MSCH 5007	Inorganic chemistry Lab – I	0	0	4	2	50	-	50
8	MSCH5031	Computer Applications for chemistry Lab	0	0	2	1	50	-	50
9		Soft Skills				0			
10		Computer Awareness				0			
		Total	18	0	12	21			
Semester II									
Sl No	**Course Code**	**Name of the Course**					**Assessment Pattern**		
			L	**T**	**P**	**C**	**IA**	**MTE**	**ETE**
1	MSCH 5008	Organic Spectroscopy	4	0	0	4	30	20	50
2	MBS24T1103	Reaction mechanism and Basics of group theory	3	0	0	3	30	20	50
3	MSCH 5024	Physical Chemistry-II	4	0	0	4	30	20	50
4	MBS24T1104	Techniques in Analytical Chemistry	3	0	0	3	30	20	50
5	MSCH 5012	Physical chemistry Lab – I	0	0	4	2	50	-	50
6	MSCH 5013	Analytical chemistry Lab – I	0	0	4	2	50	-	50
7		BEC (B1)				3			
8	MBS28T2111	Research Methodology	2	0	0	2	30	20	50
9		IPR				1			
		Total	16	0	12	24			
Semester III									
Sl No	**Course Code**	**Name of the Course**			**Assessment Pattern**				
			L	**T**	**P**	**C**	**IA**	**MTE**	**ETE**
1	MSCH 6040	Summer Internship*	0	0	0	2	50		50
2	MBS24P2998	Major Project- Phase I	0	0	0	6	50		50
3		Campus to Corporate				2			

Sl No	Course Code	Name of the Course	L	T	P	C	IA	MTE	ETE
	Total		0	0	0	10			
Semester IV (Organic Specialization)									
Sl No	**Course Code**	**Name of the Course**					**Assessment Pattern**		
			L	**T**	**P**	**C**	**IA**	**MTE**	**ETE**
1	MSCH6001	Photo chemistry & Pericyclic reaction	4	0	0	4	30	20	50
2	MSCH6002	Reagents and Heterocyclic Chemistry	4	0	0	4	30	20	50
3	MSCH6003	Chemistry of Natural Products and Retrosynthesis	4	0	0	4	30	20	50
4	MBS24TXXX	(Elective)	3	0	0	3	30	20	50
5	MSCH 6005	Organic chemistry Lab – II	0	0	8	4	50		50
6	MBS24P2999	Major Project-Phase II	0	0	0	6	50		50
		Total	15	0	8	25			
Semester IV (Inorganic Specialization)									
Sl No	**Course Code**	**Name of the Course**					**Assessment Pattern**		
			L	**T**	**P**	**C**	**IA**	**MTE**	**ETE**
1	MSCH 6006	Organometallic Chemistry	4	0	0	4	30	20	50
2	MSCH 6012	Spectroscopic techniques in Inorganic Chemistry	4	0	0	4	30	20	50
3	MSCH 6009	Bio-Inorganic Chemistry	4	0	0	4	30	20	50
4	MSCHEXXX	(elective)	3	0	0	3	30	20	50
5	MSCH 6010	Inorganic chemistry Lab – II	0	0	8	4	50		50
6	MBS24P2999	Major Project-Phase II	0	0	0	6	50		50
		Total	15	0	8	25			
Semester IV (Physical Specialization)									
Sl No	**Course Code**	**Name of the Course**					**Assessment Pattern**		
			L	**T**	**P**	**C**	**IA**	**MTE**	**ETE**
1	MSCH6021	Applied Electrochemistry	4	0	0	4	30	20	50
2	MSCH6022	Chemical Kinetics and Surface Chemistry	4	0	0	4	30	20	50
3	MSCH6023	Molecular Spectroscopy	4	0	0	4	30	20	50
4	MSCHEXXX	(Elective)	3	0	0	3	30	20	50
5	MSCH6025	Physical chemistry Lab –II	0	0	8	4	50	-	50
6	MBS24P2999	Major Project-Phase II	0	0	0	6	50		50
		Total	15	0	8	25			
Semester IV (Analytical Specialization)									
Sl No	**Course Code**	**Name of the Course**	**L**	**T**	**P**	**C**	**IA**	**MTE**	**ETE**

1	MSCH6031	Electroanalytical methods	4	0	0	4	30	20	50
2	MSCH6032	Quality control and quality assurance	4	0	0	4	30	20	50
3	MSCH6033	Advanced Instrumentation methods	4	0	0	4	30	20	50
4	MSCH EXXX	(Elective)	3	0	0	3	30	20	50
7	MSCH6034	Analytical chemistry Lab -II	0	0	8	4	50		50
6	MBS24P2999	Major Project-Phase II	0	0	0	6	50		50
		Total	15	0	8	25			

List of Electives

Sl No	Course Code	Name of the Electives					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MBS24T5101	Polymer chemistry	3	0	0	3	30	20	50
2	MBS24T5102	Industrial chemistry	3	0	0	3	30	20	50
3	MBS24T5103	Solid State chemistry	3	0	0	3	30	20	50
4	MBS24T5104	Environmental analytical chemistry	3	0	0	3	30	20	50
5	MBS24T5105	Bio-organic Chemistry	3	0	0	3	30	20	50
6	MBS24T5106	Advanced Green Chemistry	3	0	0	3	30	20	50
7	MBS24T5107	Carbon Materials	3	0	0	3	30	20	50
8	MBS24T5108	Advance Metallurgical Sciences	3	0	0	3	30	20	50
9	MBS24T5109	Industrial Biochemistry	3	0	0	3	30	20	50

SEMESTER-I

Name of The Course	**Stereochemistry and Reaction Mechanisms**				
Course Code	**MSCH5001**				
Prerequisite	B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects.				
Corequisite	To be having basics of stereochemistry and reaction mechanisms				
Antirequisite					
		L	T	P	C
		4	0	0	4

Course Objectives:The course introduces about the organic chemistry and students would be acquainted with the basics of organic chemistry, stereochemistry and reaction mechanism. Demonstrate and practice the mechanism of various name reactions and will be able to construct a mechanism for applications in various fields of organic chemistry. This course will further helps to carry out carrier in the field of research and development in the core areas of organic chemistry.

Course Outcomes

CO1	Interpret and discuss stereo chemical concepts including type of projections, CIP system enantiomeric relationship R and S, E and Z and nomenclature and stereochemistry in allenes, spiranes and biphenyls. (K4)
CO2	Illustrate conformational analysis in cyclohexanes, compare the stereospecific and stereoselective reactions. (K3)
CO3	Determine the mechanism and role of reaction intermediates in organic reaction including classical and nonclassical carbocation, neighbouring group participation, carbanion, carbene, niterne and benzyne. (K4)
CO4	Compare and differentiate between types of addition, elimination and substitution reaction and describe SN1, SN2 and SNi mechanism with stereochemistry. (K5)
CO5	Distinguish various name reaction with example and interpret major and minor product of variety of organic reaction.(K4)
CO6	Combine the concepts for new trends and developments in stereochemistry and reaction mechanism.(K6)

Text Book (s)

3. L.Finar, Organic Chemistry. Vol.2, 6thedition, PearsonIndia, New Delhi, 2002.
4. Peter Sykes, A Guidebook to Mechanisms in Organic Chemistry, 6thedition, PearsonIndia, New Delhi, 2009.

Reference Book (s)

12. P.S. Kalsi, Stereochemistry – Conformation and Mechanism, 6th edition, New Age International Ltd.,India, 2005.
13. S.N.Sanyal., Reactions, Rearrangement and Reagents, BharatiBhawan Publisher, India, 2014.
14. E.L. Eliel, Stereochemistry of carbon compounds, Wiley India (P) Ltd., India, 2008.
15. J. March, M. B. Smith, March’s Advanced Organic Chemistry: Reactions, Mechanisms and Structure, 6th edition, John Wiley&Sons, New York, 2007.
16. S.M. Mukherji and S.P Singh., Reaction Mechanism in Organic Chemistry, Macmillan Publishers India, 3rd Edition, 1990.
17. Solomons&Fryhle, Organic Chemistry; 10th edition, Wiley & Sons, 2009.
18. J. Clayden, N. GreevesandS. Warren, Organic Chemistry, Oxford University Press, 2nd edition, 2012.

Unit-1 General Chemistry	8 hours
Stereoisomerism: concept of chirality and symmetry elements. Projections: Newman, Sawhorse and Fischer projection - formulae and inter conversions, Nomenclature: Cahn - Ingold - Prelog system of nomenclature (DL, RS and EZ system), Numerical problems based on specific optical rotation, racemic modification, molecules with one, two or more chiral centres.	
Unit-2 Stereochemistry	10 hours
Stereochemistry of ring system: Stereochemistry of allenes, spiranes, biphenyls, and bridged biphenyls. Conformational analysis: Conformations and stability of cyclohexanes and some substituted cyclohexanes, cyclohexenes, cyclohexanones, decalins. Stereospecific and stereoselective synthesis (elementary examples), Cram's rule, Chiral separation and asymmetric synthesis.	
Unit-3 Reaction Intermediates	7 hours
Carbanions: Generation, structure and stability, Radicals: Generation, structure, stability and reactions, radical cations and radical anions. Carbenes: Formation and structure, reactions involving carbine. Nitrenes: Generation, structure and reactions of nitrenes. Benzynes: Generation, structure and reactions (SNAr).	
Unit-4 Types of Organic Reactions	15 hours
Aliphatic & Aromatic Nucleophilic Substitution: • The SN_1 and SN_2 mechanism, reactivity effects of substrate structure, attacking nucleophile, leaving group and reaction medium. • The SNAr and benzyne mechanism, Reactivity effect of substrate, structure, leaving group and attacking nucleophile. Aliphatic & Aromatic Electrophilic Substitution: • Bimolecular mechanisms - SE_2 and SE_1, The SE_1 mechanism, electrophilic substution accompanied by double bond shifts. • The arenium ion mechanism, orientation and reactivity, energy profile diagrams. Elimination Reactions & Addition Reactions: • The E_2, E_1 and E1cb mechanisms, Orientation of the double bond. • Reactivity-effects of substrate structures, attacking base, the leaving group and the medium. • Mechanism and orientation in pyrolytic elimination. Addition to Carbon-Carbon & Carbon-Hetero Multiple Bonds: • Hydrogenation of aromatic rings hydroboration, Michael reaction. • Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acid esters and nitriles. • Mechanism of condensation reactions involving enolates - Aldol, Claisen, Mannich, Benzoin, Perkin Stobbe reactions. • Mechanism of rearrangement reactions - Hofmann; Schmidt; Lossen; Curtius; Beckmann reactions	
Unit-5: Name Reactions and Mechanism	08 hours
Favorskii reaction; Stork enamine reactions; Sharpless asymmetric epoxidation; Ene reaction; Barton reaction; Hofmann- Loffler-Freytag reaction; Shapiro reaction; Baeyer villager reaction; Chichibabin reaction	
Unit-6: Recent Advances in Stereochemistry and Reaction Mechanisms	04 hours

Recent Advances in the Stereoselective Synthesis, and advances in Catalytic enantioselective fluorination and reaction mechanism.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Basic Concepts and Principles of Inorganic Chemistry**				
Course Code	**MSCH 5002**				
Prerequisite	B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects.				
Co-requisite	To be aware of basics of inorganic chemistry, periodic element and bonding.				
Anti-requisite					
		L	T	P	C
		4	0	0	4

Course Objectives:The course introduces about the inorganic chemistry and students would be acquainted with the basics of transition metals, organometallic compounds, transition metal complexes and metal-ligand bonding and their applications in various fields of inorganic chemistry. This course will further helps to carry out carrier in the field of research and development in the core areas of Inorganic chemistry.

Course Outcomes

CO1	Apply knowledge of chemistry of s and p block group elements and synthesis, properties and applications of few main group compounds in many fields. (K3)
CO2	Explain the properties of aqueous solutions systems and the theories describing the behaviour of acids and bases in aqueous systems. (K2)
CO3	Analyze general properties, separation techniques of lanthanides and actinides and applications of rare earth elements in industries. (K4)
CO4	Develop an understanding of stereochemistry and nomenclature of co-ordination compounds.(K3)
CO5	Apply the knowledge of crystal field theory, molecular orbital theory and its great importance in inorganic chemistry.(K3)
CO6	Elaborate the knowledge of recent advancement in the field of Inorganic chemistry. (K6)

Text Book (s)

1. F. A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, 6th Edn., (1999), John-Wiley & Sons, New York.

2. James E. Huheey, Inorganic Chemistry, 4th Edn., (1993), Addison Wesley Pub. Co., New York

Reference Book (s)

8. Inorganic Chemistry, James E House, 2008, Elsevier.

Unit-1 Introduction	12 hours

Unit I: Compounds of s and p block elements Lithium chloride, Lithium carbonate, Boranes , Carboranes, Carbazide , Borazine, Silicates and Aluminosilicates, Peroxo compounds of Boron ,Carbon and Sulphur, compounds of Sulphur and Nitrogen, Interhalogen compounds of Pseudohelogen and polyhalide ions, Noble gas compounds (Xe)
Unit-2 10 hours
Unit II: HSAB Theory Classification of acids and bases as hard and soft; HSAB principle, theoretical basis of hardness and softness; Lewis-acid base reactivity approximation; donor and acceptor numbers, E and C equation; applications of HSAB concept.
Unit-3 10 hours
Unit III: Inner transition elements Chemistry of Lanthanides and actinides: Occurrence, periodicity, general properties, causes and consequences of lanthanide contraction, applications of rare earth elements. Comparison of general characteristics of lanthanides and actinides.
Unit-4 10 hours
Unit IV: Basic concepts of co-ordination Classification of ligands, chelation, co-ordination number, stereochemistry and nomenclature of co-ordination compounds, polynuclear or bridged complexes , inner- metallic complexes, Werner's theory , EAN concept
Unit-5 10 hours
Unit V: Metal Ligand Bonding Limitations of crystal field theory, molecular orbital theory: octahedral, tetrahedral and square planer complexes, π- bonding and molecular orbital theory, explanation of position of the ligands in spectrochemical series using MOT, Comparision with CFT.
Unit-6 Recent Advancement in Inorganic Chemistry 4 hours
Water treatment materials, Toxic chemicals in wastewater

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Basic Concepts of Physical Chemistry**				
Course Code	**MBS24T1101**				
Prerequisite	B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects.				
Corequisite	Knowledge of basic physical chemistry				
Antirequisite					
		L	T	P	C
		3	0	0	3

Course Objectives:

The course introduces about the physical chemistry and students would be acquainted with the concepts of quantum chemistry, phase rule, kinetics and surface chemistry and their applications in various fields of chemistry.

This course will further helps to carry out carrier in the field of research and development in the core areas of chemistry.

Course Outcomes

CO1	Interpret and discuss the basic concepts of quantum chemistry including Schrodinger wave equation, particle in 1D box, particle in 3D box, concept of degeneracy, hydrogen atom etc. (K4)
CO2	Illustrate partial molar quantities and phase rule and compare excess functions of non ideal solutions.(K3)
CO3	Determine different rate laws and role of collision theory and transition theory (K4)
CO4	Compare and differentiate between types of sols, surfactants and macromolecules and describe methods of determining molecular weights.(K5)
CO5	Distinguish various Type of radioactive decay, Decay Kinetics,and interpret Critical size of thermal reactor.(K4)
CO6	Discuss recent advancements in different fields of physical chemistry (K6)

Text Books:

5. Physical Chemistry - P.W. Atkin, ELBS fourth edition.
6. Chemicals Kinetics, K.J. Laidler (Tata Mc. Graw Hill) 1998
7. Basic Chemical Thermodynamics, E. Brian Smith (ELBS) 1990
8. Elements of Nuclear chemistry – H.J. Arnikar, fourth edition Wiley Eastern Ltd.

Unit-1 Introduction	10 Lectures
Quantum Mechanics Historical development of quantum theory principle of quantum mechanics, wave particle duality, uncertainty principles, Schrödinger equation, operators simple system – free particle, Particle in a box, Two dimensional, Three dimensional box, Hydrogen like atoms, atomic orbital.	
Unit-2	10 Lectures
Thermodynamics - I Chemical potential and Entropies, Partial molar quantities: Partial molar free energy, Partial molar volume and Partial molar heat content and their significances. Determinations of the partial molar quantities. Phase Rule: Derivation of phase rule from the concept of chemical potential. Application of Phase Rule to three components system.	
Unit-3	08 Lectures
Chemical Kinetics - I Methods of determining rate laws, collision theory of reaction rates, steric factor, Arrhenius equation and activated complex theory, kinetic and thermodynamic control of reactions, ionic reactions, kinetic salt effects, steady state kinetics, unimolecular reactions and their treatments.	
Unit-4	11 Lectures
Colloids and Macromolecules Sols, Lyophilic and lyophobic sols, properties of sols, coagulation.Sols of surface active reagents, surface tension and surfactants, critical micelle concentration. Macromolecules: Mechanism of polymerization, Degree of polymerization and molecular weight, methods of determining molecular weights	
Unit-5	09 Lectures
Nuclear and Radiation Chemistry	

Type of radioactive decay, Decay Kinetics, Detection & measurement of radiation Elements of radiation chemistry, interaction of radiation with matter, Nuclear Reactor: Natural uranium reactor, thermal reactor, the Breeder reactor, nuclear waste management.
Unit VI: Recent Advancement in Physical Chemistry 04 Lectures
Comparative study of classical, statistical and quantum mechanics, applications of thermodynamic principles in ecology, applications of chemical kinetics, applications of nuclear energy in sustainable development

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**BASIC ANALYTICAL CHEMISTRY**			
Course Code	**MBS24T1102**			
Prerequisite	B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects			
Co-requisite	A course that covers gravimetric and volumetric techniques, pH metric titrations, centrifugation techniques and spectrophotometric analysis. Knowledge related to the introductory instrumental analysis with a focus on precision and accuracy of experimental data.			
Anti-requisite				
	L	T	P	C
	3	0	0	3

Course Objectives:

The course introduces about the analytical chemistry and students would be acquainted with the concepts of its theory, chemical methods including techniques of gravimetric, volumetric and separation instrumental analysis with a focus on precision and accuracy of experimental data.This course will further helps to carry out carrier in the field of research and development in the core areas of chemistry.

Course Outcomes

CO1	Assess analytical method for a specific purpose, and evaluate sensitivity, important sources of interferences and errors.
CO2	Explain the theoretical principles and important applications of classical analytical methods within titration (acid/base titration, complexometric titration, redox titration).
CO3	Acquire the various techniques of quantitative and qualitative analysis such as voltammetry, high frequency titration.
CO4	Calculate titration errors for method evaluation, and perform statistical evaluation of results from classical and instrumental chemical experiments and analyses.
CO5	Make scientific reports from chemical experiments and present the results in a transparent manner.
CO6	Elaborate the knowledge of recent advancement in the field of Analytical Chemistry.

Text Book (s)

4. 1Day R.A. and Underwood A.L., " quantitative analysis," 1999, 6th edition, prentice hall of India
5. Christian G.D., :Analytical Chemistry", 2004, 6th ed., John Wiley & Sons Inc
6. Skoog D.A., West D.M, Holler F.J. and Crouch S.R., Fundamentals of analytical chemistry", 2004, 8th Ed., Thomson Brooks/Cole.

Reference Book (s)

Vogel's textbook of quantitative chemical analysis, 6th edition.

Vogel's textbook of quantitative chemical analysis, 7th edition

Unit I: INTRODUCTION TO ANALYTICAL CHEMISTRY	10 hours
Scope and objectives, General steps in chemical analysis, Introduction to methods of detecting analytes (Physical, Electromagnetic radiations, Electric charge), Propagation of measurement uncertainties (in accuracy and precision). Useful statistical test: test of significance, the F test, the student's test, the chi-test, the correlation coefficient, confidence limit of the mean, comparison of two standard values, comparison of standard deviation with average deviation, comparison of mean with true values, significant figures, regression analysis (least square method for linear and non-linear plots), statistics of sampling and detection limit evaluation and Calibration.	
Unit II: Volumetric analysis	08 hours
Definitions: Titrimetry, Volumetric titrimetry, Gravimetric titrimetry, The equivalence point, the end point, Classification of volumetric methods, theory of indicators and buffers, Equilibria, Principles, Aqueous and non-aqueous acid-base titration, Redox titrations, Complexometric titrations, Precipitation titration, Typical problems in volumetric titrimetry, Sigmoidal Titration Curves, The Henderson-Hasselbalch Equation.	
Unit III Gravimetric analysis	10 hours
A. Precipitation methods, B. Volatilization methods. (The analyte or its decomposition products are volatilized at a suitable temperature. The volatile product is then collected and weighed, or, alternatively, the mass of the product is determined indirectly from the loss in mass of the sample. e.g., Determination of the sodium hydrogen carbonates content of antacid tablets) C. Properties of precipitates and precipitating reagents: Particle size, Filterability of Precipitates (factors that determine particle size). Colloidal Precipitates (coagulation of colloids, peptization of colloids, treatment of colloidal precipitates). Crystalline Precipitates (particle size and filterability). Co-precipitation (surface adsorption, mixed-crystal formation, occlusion, and mechanical entrapment, co precipitation errors). Precipitation from Homogeneous Solution (The use of the technique of Homogeneous solutions to effect precipitation). D. Drying and Ignition of precipitates. E. Practical gravimetric procedures.	
Unit IV: Measurement of pH and pH metry	7 hours
Introduction, Determination of pH, Introduction to Ion Selective Electrodes, Instrumentation, The pH scale, Buffer solutions, calculation of pH values of buffer mixtures, Hydrolysis of slats. pH of hydrolysed salt solution, Degree of hydrolysis, Determination of degree of hydrolysis, The theory of indicators, Application of pH Measurement, Ionic equilibria involving complex ions.	
Unit V: CENTRIFUGATION METHODS	6 hours
A. Introduction B. Sedimentation and relative centrifugal force C. Different types of rotors. D. Density gradient E. Types of centrifugation techniques.	
Unit VI. Recent developments in the analytical techniques	4 hours
This unit will cover the latest development in the area of volumetric and gravimetric analysis , pH metry and centrifugation methods as per latest literatures	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Computer Applications for Chemistry**				
Course Code	**MSCH5005**				
Prerequisite	B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects				
Corequisite					
Antirequisite					
		L	T	P	C

	2	0	0	2

Course Objectives:Introduce the basic concepts computer science and application areas to explore both theoretical and practical knowledge of programming such as Fortan, C and MATLAB.Understand the concepts of data analysis and chemical application fields.

Course Outcomes

CO1	Grapes the knowledge of computer science in chemical applications filed. (K2)
CO2	Apply the knowledge of FORTRAN and C+ programming to write down short codes for finding chemical reaction.(K3)
CO3	Apply software's like Gaussian and MATLAB for real time data analysis of chemical problems.(K3)
CO4	Perform programming for finding various chemical reasons and energies calculation.(K4)
CO5	Apply data analysis in various chemical application fields.(K3)
CO6	Discuss recent software used in chemical research. (K6)

Text Book (s)

9. The Art of Scientific Computing. W. H. Press, S. A. Teukolsky
10. V. Rajaraman, *Fortran 90*, Prentice Hall (India), New Delhi (1997)
11. C. Xavier, Fortran 77 and Numerical Methods, New Age International Pvt. Ltd. Publishers, New Delhi (1994)

Reference Book (s)

19. S. Lipschutz and A. Poe, Schaum's Outline Series – Theory and Problems of Programming with Fortran including structured Fortran, Mc Graw Hill Book Company, Singapore (1982)
20. K. V. Raman, *Computers in Chemistry*, Tata McGraw Hill (1993).

Unit-1Basic about the computers and programming 6hours
Introduction of software and hardware, basic about the operating systems, introduction of programming languages, flow chart, algorithms , Chemical Applications of computers – Computational Chemistry-Chemometrics.
Unit-2 FORTRAN or C Programming 6 hours
Types of Constants and Variables in Fortran, Dimension, Data Type, COMMON and EQUIVALENCE statements, Arithmetic and Logical IF, IF-THEN- ELSE constructs, 'DO' statement, Various types of 'I/O' statements, Library functions, Statement functions, Function subprograms and subroutine subprograms. Or Introduction; style of C language ,character and key words, variables and constants in C, arithmetic , relational , logical and bitwise operators in C, ternary, cast, & and * pointer operators, Size of operator input and output in C : content , conditional and switch statement in C; break and continue statement in loop. Storage classes in C functions array and pointers C, structure and unions, types of statement , preprocessor- define and includes simple programming in C.
Unit-3MATLAB 6 hours
Features of MATLAB –Basics of MATLAB programming – Array operations in MATLAB – Loops and execution control- Working with files: Scripts and Functions-Plotting and programming input and output.

Unit-4Drawing Tools	6 hours
CHEMDRAW: Introduction –installation –Tools-Structure types – Drawing Structure –Drawing Bonds of Different Types – Drawing Schemes	
Unit-5 Data Analysis	6 hours
Bioinformatics: Introduction to Bioinformatics – Bioinformatics tools are emerging for describing DNA genomics, etc.	
Unit-6 Recent Software in chemical research	3 hours
Chemdraw, python, ADMET, pKCSM	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**ORGANIC CHEMISTRY LAB-1**			
Course Code	**MSCH 5006**			
Prerequisite	B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects			
Corequisite				
Antirequisite				
	L	T	P	C
	0	0	4	2

Course Objectives:

To introduce different experiments to test basic understanding of Organic Chemistryconcepts.

Course Outcomes

CO1	Safe laboratory practices by handling laboratory glassware, equipment, and chemical reagents.
CO2	Separate organic compounds in different phases.
CO3	Perform single and two stage preparation.
CO4	Make use of soxhlet extractor and steam distillation assembly for Purification of organic compound.
CO5	Synthesis, purification and characterization of aspirin, Diels-Alder adduct.

Text/Reference Books

5. A. I. Vogel - A Textbook of Practical Organic Chemistry, 5th Edition, 1989
6. W.L. Jolly, Synthesis and Characterization of Organic Compounds, Prentice Hall.
7. John Leonard, Barry Lygo, Garry Procter, Advanced Practical Organic Chemistry, CRC Press Published January 8, 2013.
8. N K Vishnoi, Advanced Practical Organic Chemistry, Vikas Publishing, 3rd edition.

Separation, purification and identification of organic compounds: • Separation of mixtures of organic compounds: 6. Separation of liquid mixture of liquid mixture of toluene and o-toluidine. 7. Separation of a mixture of o-cresol and benzoic acid. 8. Separation of a mixture of anthracene and p-bromobenzoic acid.

Separation by Chromatographic Techniques: 9. To separate mixture of methyl orange and methylene blue by TLC. 10. Separation of mixture of sugars by paper chromatography. ● Purification by appropriate methods ● Identification of organic compounds

Continuous Assessment Pattern

Internal Assessment (IA)	End Term Test (ETE)	Total Marks
50	50	100

Name of The Course	**INORGANIC CHEMISTRY LAB-1**				
Course Code	**MSCH 5007**				
Prerequisite	B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects				
Co-requisite	This lab course covers the synthesis and characterization of inorganic compounds and quantitative analysis of elements in mixtures and the inorganic synthesis, purification and study of various chromatographic techniques.				
Anti-requisite					
		L	T	P	C
		0	0	4	2

Course Objectives:To introduce different experiments to test basic understanding of Inorganic Chemistryconcepts.

Course Outcomes

CO1	Recognize basic laboratory rules and basic principles of lab safety.(K2)
CO2	Carry out qualitative analysis to identify acidic and basic radicals.(K4)
CO3	Estimate ions in binary mixtures of metal ions involving volumetric and gravimetric methods. (K4)
CO4	Prepare and determine percent purity of various inorganic complexes. (K3)
CO5	Perform chromatographic technique (paper chromatography). (K3)

Text Book (s)

4. Vogel's Textbook of Quantitative Analysis, Revised, J. Bassett, R.C. Denney, G.H.H. Jeffery and J. Mendham, elbs.

5. Synthesis and Characterization of Inorganic Compounds, W.L. Jolly, Prentice Hall

Reference Book (s)

2. Synthesis and Characterization of Inorganic Compounds, W.L. Jolly, Prentice Hall

Unit-1 Qualitative analysis
Qualitative estimation of the inorganic mixture for eight radicals including interfering acid radicals, their combinations and insoluble oxides, sulphates and halides.
Unit-2 Quantitative analysis of mixtures
Separation and determination of binary mixture of metal ions: Cu-Ni, Ni-Zn, Cu- Ag etc, involving volumetric and gravimetric methods.
Unit-3 Chromatographic techniques
Separation of cations and anions by: I) Paper Chromatography
Unit-4 Synthesis of Inorganic compounds Part-1
Preparation of selected inorganic compounds and their studies by I.R, electronic, Mossbauer (wherever applicable) and their physical and chemical properties . a. Sodium trioxalateferrate(III) $Na_3[Fe(C_2O_4)_3]$ b. Potassium Chlorochromate ($KCrO_3Cl$) c. Iron(III) hexacyanidoferrate(II) $Fe_4[Fe(CN)_6]$
Unit-5 Synthesis of Inorganic compounds Part-2
Preparation of selected inorganic compounds and their studies by I.R, electronic, Mossbauer (where ever applicable) and their physical and chemical properties. d. HexaamineNickel(II)Chloride $[Ni(NH_3)_6]\ C_{l2}$ e. Pottasium tri oxalate Chromate (III) ($K_3[Cr(C_2O_4)_3].3H_2O$)

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
50		50	100

Name of The Course	**Computer Applications for Chemistry Lab**				
Course Code	**MSCH5031**				
Prerequisite	B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects				
Corequisite					
Antirequisite					
		L	T	P	C
		0	0	2	2

Course Objectives: Perform basic concepts computer science and related experiments. To explore both theoretical and practical knowledge of programming such as Fortan, C and MATLAB. Understand the concepts of data analysis and chemical application fields using CHEMDRAN.

Course Outcomes

CO1	Grapes the knowledge of computer science in chemical applications filed. (K2)
CO2	Apply the knowledge of FORTRAN and C+ programming to write down short codes for finding chemical reaction.(K3)
CO3	Apply software's like Gaussian and MATLAB for real time data analysis of chemical problems.(K3)
CO4	Perform programming for finding various chemical reasons and energies calculation.(K4)
CO5	Apply data analysis in various chemical application fields.(K3)

Text Book (s)

12. The Art of Scientific Computing. W. H. Press, S. A. Teukolsky
13. V. Rajaraman, *Fortran 90*, Prentice Hall (India), New Delhi (1997)
14. C. Xavier, Fortran 77 and Numerical Methods, New Age International Pvt. Ltd. Publishers, New Delhi (1994)

Reference Book (s)

21. S. Lipschutz and A. Poe, Schaum's Outline Series - Theory and Problems of Programming with Fortran including structured Fortran, Mc Graw Hill Book Company, Singapore (1982)
22. K. V. Raman, *Computers in Chemistry,* Tata McGraw Hill (1993).

Basic Programming
Types of Constants and Variables in Fortran, Dimension, Data Type, COMMON and EQUIVALENCE statements, Arithmetic and Logical IF, IF-THEN- ELSE constructs, 'DO' statement, Various types of 'I/O' statements, Library functions, Statement functions, Function subprograms and subroutine subprograms. Or Introduction; style of C language ,character and key words, variables and constants in C, arithmetic , relational , logical and bitwise operators in C, ternary, cast, & and * pointer operators, Size of operator input and output in C : content , conditional and switch statement in C; break and continue statement in loop. Storage classes in C functions array and pointers C, structure and unions, types of statement , preprocessor- define and includes simple programming in C.
MATLAB Features of MATLAB -Basics of MATLAB programming - Array operations in MATLAB - Loops and execution control- Working with files: Scripts and Functions-Plotting and programming input and output.
Drawing Tools
CHEMDRAW: Introduction –installation –Tools-Structure types – Drawing Structure -Drawing Bonds of Different Types - Drawing Schemes

Continuous Assessment Pattern

Internal Assessment (IA)	End Term Test (ETE)	Total Marks
50	50	100

SEMESTER-II

Name of The Course	**Organic Spectroscopy**				
Course Code	**MSCH5008**				
Prerequisite	B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects				
Corequisite	Basic knowledge of organic Chemistry.				
Antirequisite					
		L	T	P	C
		4	0	0	4

Course Objectives:To introduceabout the organic spectroscopy and students would be acquainted with the basics of UV, IR, NMR, Mass, ESR and Raman spectroscopy. Demonstrate and Practice the method of spectroscopic techniques, and will be able to construct a relational comparison of method, techniques for analysis & characterization of organic molecules. This course will further helps to carry out carrier in the field of research and development.

Course Outcomes

CO1	Generalize the basic concepts of electromagnetic radiation, Apply & characterize samples by UV spectroscopic techniques. (K3)
CO2	Demonstrate and Practice the method of IR spectroscopic techniques and sample recording for analysis. (K3)
CO3	Correlate the method of NMR spectroscopic technique for characterization and analysis. (K4)
CO4	Apply the method of mass spectroscopic technique, recording samples & appraise the recent developments in the field of characterization. Construct a relational comparison of method, techniques for analysis & characterization. (K6)
CO5	Conclude and Practice the method of ESR spectroscopic techniques, collection and their recording for analysis.(K4)
CO6	Compile modern spectroscopic techniques (K6)

Text Book (s)

4. D.L. Pavia, G.M. Lampman, G. S. Kriz, Introduction to Spectroscopy third edition,Thomson, India, 2007.
5. P.S. Kalsi, Spectroscopy of Organic Compounds, 6th edition, New Age International, India, 2014.
6. Y.R. Sharma, Elementary organic spectroscopy: principle and chemical applications, S.Chand, India, 2010

Reference Book (s)

8. W. Kemp, Organic Spectroscopy, 3rd edition, Palgrave Macmillan, London, 1991.
9. D.H. Williams, I. Fleming, Spectroscopic Methods in Organic Chemistry, 6th edition, McGraw-Hill Education, U.K., 2007.
10. L.D.S. Yadav, Organic Spectroscopy, Anamaya Publishers, India, 2009.
11. B.R. Puri, L.R Sharma, M.S. Pathania, Principles of Physical Chemistry, Vishal Publishing co. India, 2006.
12. B.K. Sharma, Spectroscopy, Krishna Prakashan Media(P) Ltd. India, 1999.

13. R.M., Silverstein, F.X. Webster, Spectroscopic identification of organic compounds, 6th edition, Wiley India (P) Ltd., India, 2009.
14. R. V. Parish, NMR, NQR, EPR and Mössbauer Spectroscopy in Inorganic Chemistry, Ellis Harwood.

Unit-1 General Introduction of Spectroscopy andUV-Visible Spectroscopy 10 hours
General spectroscopic introduction, basic principle and Instrumentation of UV-vis, absorption law, absorption bands, theory of electronic spectroscopy, types of electronic transitions, chromophore auxochromeeffect,Redandblueshifts,hypoandhyperchromiceffect,woodwardrulesforconjugated dienes and □-□ unsaturated carbonyl groups, extended conjugated and automatic sterically hindered systems and heterocyclic compounds.
Unit-2 Infra Red(IR)Spectroscopy 10 hours
Introduction, basic principle and instrumentation, selection rules, normal modes of vibration, group frequencies, overtones, hot bands, factors affecting the bond positions and intensities, characteristic vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols, amines and carbonyl compounds (ketones, aldehydes, esters ,amides, acids anhydrides , lactones , lactams and conjugated carbonyl compounds) effect of hydrogen bonding, solvent effect, linear harmonic oscillator, vibrational energies of diatomic molecules, zero point energy, force constant and bond strength.
Unit-3 NuclearMagneticResonance(NMR)Spectroscopy 12 hours
^{1}HNMR, basic principle and instrumentation, relaxation process (spin-spin relaxation and spin-lattice relaxation), shielding and deshielding effects, chemical shift, factors influencing chemical shift (inductive effect, anisotropic effect, van der wall's deshielding and hydrogen bonding), peak area, splitting of signals, spin-spin coupling, calculating he ratio in the height of the signals, coupling constant, nulcear overhauser effect (NOE), heteronuclear coupling, shift reagent in NMR spectroscopy and, ^{13}C NMR, two dimensional fourier-transform NMR, magnetic resonance imaging (MRI).
Unit-4 Mass Spectroscopy 12 hours
Basic principle and Instrumentation, unit mass and molecular ions; metastable ions or peaks,importance of metastable peaks, nitrogen rule, base peak, isotopic mass peaks, McLafferty rearrangement, fragmentation mode (hemolytic cleavage, hydrolytic cleavage,

Retro Diel's-Alder reaction and hydrogen transfer rearrangement), mass spectra of hydrocarbon, alkenes, cycloalkanes, alkynes, aromatic compounds, phenols, ethers, acetals, ketals, aliphatic aldehydes, ketones, esters and halogenated compounds. Combined problems on UV, IR, NMR and Mass.
Unit-5 Electron Spin Resonance (ESR) and Raman Spectroscopy 8 hours
Introduction, limitation of ESR, difference between ESR and NMR, instrumentation, hyperfine interactions and analysis, sensitivity, choice of solvent, study of free radicals, electronic structure and hyperfine splitting, applications. Raman spectroscopy: Introduction and basic principle.
Unit-6 Recent Advances of Spectroscopy In Chemical Applications 3 hours
Modern Spectroscopy techniques for the analysis of organic or inorganic compounds

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Reaction Mechanism and Basics of Group Theory**				
Course Code	**MBS24T1103**				
Prerequisite	B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects				
Corequisite	Basic knowledge of Inorganic Chemistry				
Antirequisite					
		L	T	P	C
		3	0	0	3

Course Objectives

3. To impart the knowledge of key concepts to understand reaction mechanism.
4. To present a comprehensive introduction to important inorganic theories with a focus on inorganic concepts.

Course Outcomes

CO1	Explain the various structural properties, preparation methods and vibrational spectra of Carbonyl and Nitrosyl complexes. (K2)
CO2	Interpret the different types of substitution reaction mechanism and factors associated with these. (K3)
CO3	Describe the concept of 'Trans effect' and the various types of electron transfer mechanisms. (K2)
CO4	Differentiate between various metal clusters and study their applications.(K4)
CO5	Identify and distinguish between different symmetry elements and symmetry operations. (K4)
CO6	Compile recent advances in the field of symmetry elements and their applications. (K6)

Text Book (s)

- F. A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, 6th Edn., (1999), John-Wiley & Sons, New York.
- James E. Huheey, Inorganic Chemistry, 4th Edn., (1993), Addison Wesley Pub. Co.,New York.

Reference Book (s)

- N.N.Green Wood and A. Eafnshow: Chemistry of the element, Pergamon.

Unit-1 : Metal π-complexes	8 Lecture
Metal carbonyls. Preparation, structure and bonding in metal carbonyls, vibrational spectra of metal carbonyls for bonding and structural elucidation. Metal nitrosyls. Preparation, bonding, structure and important reactions of transition metal nitrosyl.	
Unit-2Reaction mechanism of Transitions metal complexes	8 Lecture
Energy profile of a reaction (transition state or activated complex) nucleophilic and electrophilic substitution, factors responsible for including SN_1 and SN_2 reaction, Lability and inertness of octahedral complexes according to VBT and CFT. Acid and base hydrolysis: factor affecting hydrolysis, base hydrolysis, conjugate base mechanism (SN1 cB) Evidences in favour of conjugate base mechanism, anation reactions, Substitution reaction without metal-ligand bond cleavage with Special reference to Co(III) complexes.	
Unit-3Substitution in square planar complexes	8 Lecture
Trans effect, mechanism of substitution reaction, polarization and π bonding theory. Redox reaction.Electron transfer reaction, mechanism of one electron transfer reaction, outer sphere reaction, Inner sphere reaction, bridge intermediate mechanism.	
Unit-4Metal clusters	8 Lecture
Definition, types :Carbonyl cluster of low nuclearity (M= Co, Ru, Os), high nuclearity (M= Rh, Ru, Ni) and Carbon encapsulated clusters (M=Fe, Ru, Os). Carbonyl cluster: synthesis and reactions (reduction, oxidation and legand substitution) Halide type Cluster: di, tri, tetra &hexa nuclear halide cluster. Chevrel cluster and zitl ion (cluster without ligand).	
Unit-5Basics of Group Theory	8 Lecture
Molecular symmetry:Symmetry elements and symmetry operations, definition of group and .its characteristics, subgroups, classes, similarity transformation. Products of symmetry operations, equivalent atoms and equivalent symmetry elements, relations between symmetry elements and operations, classes of symmetry operations, point groups and classification. Symmetry:Optical activity and dipole moment.	
Unit 6 Recent Applications in group theory	3 Lecture
Modern application of group theory in various metal clusters	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Physical Chemistry II**				
Course Code	**MSCH5024**				
Prerequisite	B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects				
Corequisite	Basic Knowledge of thermodynamics, kinetics and spectroscopy				
Antirequisite					
		L	T	P	C
		4	0	0	4

Course Objectives: To impart the knowledge of key concepts ofstatistical thermodynamics, reaction mechanism,electrochemistry,spectroscopic techniques and photochemical phenomenon to explain its applications.

Course Outcomes

CO1	Determine advanced studies of statistical thermodynamics.
CO2	Illustrate different methods of reaction mechanism and discuss various factors affecting rate of the reaction
CO3	Interpret basic equations of electrochemistry and predict the reaction mechanism based on surface charge.
CO4	Analyze and solve problems in chemistry through spectroscopic techniques
CO5	Explain photochemical phenomenon and apply knowledge to explain applications in photochemical energy conversion.
CO6	Compile recent applications in photochemical energy conversion.(K6)

Text Books:

1. Physical Chemistry - P.W. Atkin, ELBS fourth edition.
2. Chemicals Kinetics, K.J. Laidler (Tata Mc. Graw Hill) 1998
3. Fundamentals of Photochemistry- K. K. Rohatgi-Mukharjii, Wiley Eastern
4. Fundamentals of molecular spectroscopy: C.N. Banewell and E.Mc. Cash

References:

1. Electrochemistry- S. Glasstone, D
2. Statistical Thermodynamics, L.K. Nash
3. Basic Chemical Thermodynamics, E. Brian Smith (ELBS) 1990
4. Physical Chemistry molecular approach, D.Mcquarie and J. Simom(Viva) 2000
5. Electrochemistry by Carl H. Hamann, Andrew Hamnett and Wolf Vielstich, Wiley 1998
6. Photochemistry – J. G. Calverts and J. N. Pitts, John-Wiley & Sons

Unit-1 Introduction	10 Lectures
Statistical Thermodynamics Statistical Thermodynamics: Concepts of distribution, thermodynamic probability and most probable distribution. Ensemble averaging, postulates of ensemble averaging. Canonical and microcanonical ensembles, Boltzmann distribution of particles. Partition function: translational, rotational, vibrational partition functions, thermodynamic properties of ideal gases in terms of partition function.	

Unit-2	10 Lectures
Catalysis Acid - Base catalysis - mechanism of acid - base catalyzed reactions - Bronsted catalysis law. Catalysis by enzymes - rate of enzyme catalyzed reactions - effect of substrate concentration, pH and temperature on enzyme catalyzed reactions - inhibition of enzyme catalyzed reactions. Study of surfaces - Langmuir and BET adsorption isotherms.	
Unit-3	10 Lectures
Electrochemistry Metal/Electrolyte interface : OHP and IHP, potential profile across double layer region, potential difference across electrified interface; Structure of the double layer : Helmholtz-Perrin, Gouy-Chapman, and Stern models. Butler-Volmer equation under near equilibrium and non-equilibrium conditions, exchange current density, Tafel plot. Polarizable and non-polarizable interfaces.	
Unit-4	10 Lectures
Molecular Spectroscopy Width and intensity of spectral transitions, Fourier transform. Microwave spectroscopy, rotation spectra of di – and poly- atomic molecules, Stark effect. Infra-red spectroscopy: Harmonic and an-harmonic oscillator, vibrational spectra of di – and poly - atomic molecules, nuclear spin effect, application. Raman Spectroscopy: polarization of light and Raman effect, Electronic spectroscopy of molecules: Born–Oppenheimer approximation.	
Unit-5	10 Lectures
Photochemistry Absorption of light and nature of electronic spectra, electronic transition, Frank-Condon principle, selection rules, photochemical reactions, Photo physical phenomena: Electronic structure of molecules, electronically excited singlet states, construction of Jablonski diagram, photo-physical pathways of excited molecular system (radiative and non-radiative), fluorescence, and phosphorescence, fluorescence quenching, Stern-Volmer relation.	
Unit 6 Latest trends in Photochemical reactions	3 Lectures
Recent advances in applications in photochemical energy conversion.	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Techniques in Analytical Chemistry**			
Course Code	**MBS24T1104**			
Prerequisite	B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects			
Co-requisite	This course covers data analysis, extraction and separation techniques, various industrial techniques such as sample preparation and analysis. Separation and identification techniques: extraction, chromatography, and spectroscopy			
Anti-requisite				
	L	T	P	C
	3	0	0	3

Course Objectives:To introduce and make them able to interpret and analyse about the various methodologies for solvent extraction, chromatographic techniques, spectroscopic data, thermometric titration methods.

Course Outcomes

CO1	Determine various methodologies for solvent extraction. (K2)
CO2	Illustrate different chromatographic techniques for analysis of reaction mixtures.(K3)
CO3	Interpret various spectroscopic data for sample analysis. (K3)
CO4	Analyze the constituents of a reaction mixture by thermometric titration methods. (K4)
CO5	Compile the recent developments in the analytical techniques (K6)

Text Book (s)

D.A. Skoog, *Principles of Instrumental Analysis*, 5th Edition (1998), Saunders CollegePublishing, Philadelphia, London.

2. G.W. Ewing, *Instrumental Methods of Chemical Analysis*, 5th Edition (1978), McGraw HillBooks Co., New York.

3. R.L. Pecsok, L. D. Shields, T. Cairns and L.C. Mc William, *Modern Methods of ChemicalAnalysis*, 2nd Edition (1976), John Wiley, New York.

4. Gurdeep R. Chatwal, Sham K. Anand, Instrumental Methods of Chemical Analysis, 5 th edition (2013),Himalaya Publications, ISBN: 978-93-5051-531-0

Reference Book (s)

3. Gael Sofer, Laris Hagel, Handbook of Process Chromatography, I st Edition, ISBN-13: 978-0126542660, Academic Press
4. J.H. Kennedy, *Analytical Chemistry: Principles*, 2nd Edition (1990), Saunders Holt, London

Unit-1 Introduction	10 hours
Unit I: Analytical Separation Involving Solvent Extraction: Introduction, Nature of the separation process, Separation by precipitation, Separation based on control of Activity, Inorganic precipitant, Organic Precipitant, Separation of Constituents present in trace amounts, Separation by Electrolytic precipitation, Application of Extraction procedures	
Unit-2	10 hours
Unit II: Chromatographic Techniques: Principle of chromatography, Classifications of chromatography,Techniques of Paper, Column and Thin layer Chromatography, Gas chromatography, High- performanceliquid chromatography.	
Unit-3	14 hours
Unit III: Spectroscopy Theory, Instrumentation and applications of X-rays (emission, absorption, diffraction and fluorescence methods), Atomic absorptionSpectroscopy, Atomic fluorescence spectrometry, Atomic emission spectrometry, UV-visible molecular absorption spectrometry (instrumentation and application), Molecular luminescence spectroscopy (fluorescence,phosphorescence, chemiluminescence).	
Unit-4	10 hours
Unit IV: Thermal Analysis	

Theory, methodology and applications of thermogravimetric analysis(TGA), Differential Thermal Analysis (DTA), and Differential scanning calorimetry (DSC).Principles, techniques and applications of thermometric titration methods.
Unit 5 Recent developments in the analytical techniques 4 hours
This unit will cover the latest development in the area of chromatography , spectroscopy , thermal techniques and polarography as per latest literatures

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Physical Chemistry II Lab**				
Course Code	**MSCH5012**				
Prerequisite	B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects				
Corequisite					
Antirequisite					
		L	T	P	C
		0	0	4	2

Course Objectives:To introduce and make them aware about quantitative analysis, potentiometric, conductometric,solubility product of reactants by pH metric method and kinetic analysis of chemical reactions.

Course Outcomes

CO1	Recognize basic laboratory rules and basic principles of lab safety.
CO2	Carry out quantitative analysis to identify strength of acids and bases in a reaction mixture.
CO3	Perform potentiometric and conductometric studies of reaction mixtures
CO4	Estimate dissociation constant and solubility product of reactants by pH metric method.
CO5	Perform kinetic analysis of chemical reactions

Text Books

2. Experimental Physical Chemistry –R.C. Das, B. Behera

Experiment -1
Determination of the strength of strong and weak acids in a givenmixture using a conductometer
Experiment -2
Kinetic study of acid hydrolysis of an ester
Experiment -3
Kinetic study of Saponification of ethyl acetate with sodium hydroxide
Experiment -4
Determination of solubility and solubility product of sparingly soluble salt (e.g. PbSO4, BaSO4) conductometrically
Experiment -6
Determination of the dissociation constant of a weak acid by pH metric method
Experiment -7
Determination of strength of halides in a mixture potentiometrically
Experiment -8
Determination of order and rate constant for autocatalytic reaction between Potassium permanganate and Oxalic acid
Experiment -9 Phase Diagram and critical solute temperature of phenol water system

Continuous Assessment Pattern

Internal Assessment (IA)	End Term Test (ETE)	Total Marks
50	50	100

Name of The Course	**Analytical CHEMISTRY LAB-1**				
Course Code	**MSCH 5013**				
Prerequisite	B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects				
Co-requisite	Experimental work in related areas of chemical analysis and instrumentation; acid/base titrations, pH measurements, complexometric titrations, ion-selective electrodes; spectrophotometric analysis.				
Anti-requisite					
		L	T	P	C
		0	0	4	2

Course Objectives:To introduce and make them aware about analysis techniques, analysis, and interpretation.

Course Outcomes

CO1	Recognize basic laboratory rules and able to perform Complexometric K2
CO2	Analyse Na and K from binary mixture vs flame photometry (K4)
CO3	Perform gravimetric analysis of reaction mixtures. (K3)
CO4	Estimate functional groups in organic compounds using IR spectroscopy. (K4)
CO5	Perform colorimetric analysis of dyes using UV spectrophotometer. (K3)

Text Book (s)
Experimental Physical Chemistry –R.C. Das, B. Behera.

Vogel's Textbook of Quantitative Analysis, Revised, J. Bassett, R.C. Denney, G.H.H. Jeffery and J. Mendham, elbs.

Reference Book (s)

6. Synthesis and Characterization of Inorganic Compounds, W.L. Jolly, Prentice Hall.

Unit-1 Complexometric titrations and flame photometry
• Estimation of glucose by complexometric titration. • Estimation of Na and K from binary mixture vs flame photometry
Unit-2 Gravimetric analysis
• Estimation of Ni-DMG by gravimetric analysis
Unit-3 Spectrophotometric analysis Part-1

• Determination of functional groups in organic compounds using IR spectroscopy • Determination of iron in iron tablet using extractive spectrophotometry
Unit-4 Spectrophotometric analysis Part-2
• Verify Beer-Lamberts Law and determine concentration of given dye colorimetrically
Unit-5 Water Analysis
• Estimation of hardness of the given water sample. • Estimation of the amount of 'DO' in the given water sample.

Continuous Assessment Pattern

Internal Assessment (IA)	End Term Test (ETE)	Total Marks
50	50	100

Course Code	Course Name	L	T	P	C
MBS28T2111	**RESEARCH METHODOLOGY**	2	0	0	2

Course Objective:

To understand the procedures in research, the different types of procedures to make the experiments viable. To acquire sound knowledge of the various types of analysis and how to use statistics in analyzing and interpreting the obtained data.

Course Outcome:

On completion of this course the students will be able to understand the procedures in research, the different types of procedures to make the experiments viable. They get a good knowledge of the various types of analysis and how to use statistics in analyzing and interpreting the obtained data.

CO1	Understand the Principles of Scientific Research and different steps involved in doing research.
CO2	Know how to design research and frame up different steps in design.
CO3	Appraise the application of sampling through statistics.
CO4	Build up the method for data collection and analyse the data.
CO5	Develop the Concept of hypothesis preparation.
CO6	Develop the statistical analysis indulges in modern research for drug designing.

Course Contents:

Unit – 1: Principles of Scientific Research 6 Lectures

Research and research methodology, Procedures in research, Identification of the problem - Literature survey - Reference collection - Familiarity with ideas and concept of investigation - Qualitative and Quantitative analysis - Results - Synopsis writing - Art of writing a Research paper and Thesis.

Unit – 2: Research Design, Sampling & Probability 5-Lectures

Research Design: Features of a Good Design, Different Research Designs, Sampling: Principles, methods, types of sampling, rationale for using a particular sampling procedure, Probability: Classical definition of Probability.

Unit – 3: Data collection & analysis 6- Lectures

Types of Data, Collection of Data, double blind procedures, incidence and prevalence studies, Data Analysis: Measures of Central Tendency, Measures of Dispersion, Measures of Asymmetry,

Unit-4: Correlation and Regression 5-Lectures

Methods of correlation, Types of correlation (Pearson r& Rho); Regression analysis, linear regression, Non-linear regression.

Unit – 5: Hypothesis and Statistics 5-Lectures

Hypothesis Testing: Problems and hypothesis, variables and type of variables, Parametric and nonparametric statistics; level of significance, the various nonparametric tests with sample.

Unit 6: Recent research advances 3 lectures

Descriptors, Quantitative structure-activity relationship (QSAR) , Quantitative structure-property relationship(QSPR), Drug designing.

Text Books:

37. K. Ramakant; Elementary Statistics in a world of applications, Goodyear California Pub. Co.,1979.
38. K. D. Broota, Experimental designs in psychological research, Wiley eastern, New York, 1992.
39. Guilford, Statistics in Psychology and Education, McGraw hill, New York, 1986.
40. Katz and Kahn, Research in Behavioural Sciences, Methuen, USA, 1979.

Reference Books:

49. Kerlinger, F., Foundations of Behavioural Research, Surjeet Publications, Delhi, 1983.
50. Rajamanickam, M., Statistical Methods in Psychological and Educational Research, Concept Publishing Co. New Delhi, India, 1983.
51. Smith, Jonathan, A. (Ed.), Qualitative Psychology: A Practical Guide to Research Methods, Sage Publications, 2003.
52. Woodworth and Schlosberg, Experimental Psychology, Methuen and co. ltd, London, 1971.

Mode of Evaluation

Quiz, Assignment, Seminar and Written Examination

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Minor Project/Summer Internship**				
Course Code	**MSCH 6040**				
Prerequisite	B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects				
Corequisite	Basic knowledge of research aptitude				
Antirequisite					
		L	T	P	C
		0	0	0	2

Course Objectives: The minor project is aimed at training students in practical workshops and to prepare them for their major project in the upcoming semester.

Course Outcomes

At the end of the course, the student will be able to:

11. Review the literature for the topic of the project.(K2)
12. Operate instruments neatly for analysis and discuss their experimental results.(K3)
13. Validate the specification of instrumental techniques and interpretation of data.(K5)
14. Used ICT tools to prepare project reports and present it using Powerpoint presentation.(K6)
15. Develop the skills to work within a small team to achieve a common research goal.(K6)

Continuous Assessment Pattern

Internal Viva (IA)	External Exam (ETE)	Total Marks
50	50	100

SEMESTER-III

Major Project- Phase I

Name of The Course	**MAJOR PROJECT**				
Course Code	**MBS24P2998**				
Prerequisite	B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects				
Corequisite	Knowledge of research methodology				
Antirequisite					
		L	T	P	C
		0	0	0	16

Course Objectives:

The major project will help the students to have a hand on experience and practical knowledge of the theory papers studied so far. It will enable them to tackle practical problems and expose them to industrial experience.

Course Outcomes

CO1	Survey literature for the topic of the project.(K4)
CO2	Correctly interpret the literature review before starting any individual experiment (K3)
CO3	Propose novel reaction routes and pathways for an chemical reaction(K6)

CO4	Interpret the results and data obtained from any experiment clearly, interpret the results and data obtained;records experiments orderly for future reference and draw clear and logical conclusions&assemblein presentations and reports.(K4)
CO5	Demonstrate leadership skills and effective teamwork while working and prepare themselves for their future career in industry or academics (K6)

Continuous Assessment Pattern

Internal Assessment (IA)	External Assessment (ETE)	Total Marks
50	50	100

SEMESTER-IV
(ORGANIC SPECIALIZATION)

Name of The Course	**Photochemistry and Pericyclic reaction**				
Course Code	**MSCH6001**				
Prerequisite	B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects				
Corequisite	Students should have the basic knowledge of various chemical reactions				
Antirequisite					
		L	T	P	C
		4	0	0	4

Course Objectives:To introduce and make them aware about photochemistry various photochemical reactions, pericyclic reactions, its typeand applications in chemical reactions.

Course Outcomes

CO1	Deduce thedifferent principles of photochemistry, with illustration of the absorption, emission processes andjabolonski diagram. (K4)
CO2	Determine the photochemical reactions of carbonyl compounds in presence of light.(K4)
CO3	Identify and explain the photochemical reactions of alkenes and aromatic compounds.(K4)
CO4	Illustrate the pericyclic reactions, its type and frontier orbital, orbital symmetry correlation approaches used in pericyclic reactions. (K3)
CO5	Employ the knowledge in the field of chemical synthesis. (K3)
CO6	Analyze the recent applications of photochemical reactions in organic synthesis (K6)

Text Book (s)

T1. D. John Coyle, Introduction to Organic Photochemistry, John Wiley & Sons, Chichester, 1998.
T2. J. Singh and J. Singh, Photochemistry and pericyclic Reactions, New Age International (P) Ltd. New Delhi, 2nd edition, 2006.

Reference Book (s)

5. C.H. Depuy and O.L Chapman, Molecular Reactions and Photochemistry, 2ndEdition, Prentice-Hall of India (P) Ltd., New Delhi, 1988.
6. F.A. Carey and R.J. Sundberg, Advanced Organic Chemistry:Part A, 5thEdition, Springer US, 2007.
7. I. Fleming, Pericyclic Reactions, 1ST edition, Oxford University Press, Oxford, 1998.
8. S. Sankaraman, Pericyclic Reactions- A Textbook, Wiley-VCH, Weinheim, 2005.

Unit-1Basics of Photochemistry 8 hours
Absorption, excitation, photochemical laws, quantum yield, quantum efficiency, spin multiplicity, excited state (Jablonski diagram), Photolytic cleavage, Frank-Condon principle, photochemical stages-primary and secondary processes/effects.
Unit-2Photochemistry of Carbonyl Compounds 12 hours
Norrish type-I cleavage of acyclic, cyclic and β, γ-unsaturated carbonyl compounds, Norrish type-II cleavage. Hydrogen abstraction: Intramolecular and intermolecular hydrogen abstraction, photoenolization. Photocyclo-addition of ketones with unsaturated compounds: Paterno-Buchi reaction, photodimerisation of α, β-unsaturated ketones, rearrangement of enones and dienones, Photo-Fries rearrangement.
Unit-3Photochemistry of Alkenes and Aromatic Compounds 10 hours
Photochemistry of alkenes and related compounds, isomerization, Di-π-methane rearrangement and cycloadditions. Photochemistry of aromatic compounds, ring isomerization and cyclization reactions.
Unit-4 Pericyclic Reactions14 hours
Classification, electrocyclic, sigmatropic, cycloaddition, chelotropic and ene reactions, Woodward Hoffmann rules, frontier orbital and orbital symmetry correlation approaches.
Unit-5 Pericyclic reactions in organic synthesis8 hours
Pericyclic reactions in organic synthesis such as Claisen, Cope, Diels-Alder and Ene reactions (with stereochemical aspects), introductory dipolar cyclo-addition reactions.
Unit VI: Application of photochemical reactions in recent organic synthesis 4 lecture hours
Recent advances in the photochemical and pericyclic reactions in organic synthesis.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Reagents and Heterocyclic Chemistry**			
Course Code	**MSCH6002**			
Prerequisite	B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects			
Corequisite	Knowledge of basic of reaction mechanisms			
Antirequisite				
	L	T	P	C
	4	0	0	4

Course Objectives: This course offers extensive study of various reagents used in the organic synthesis.

Course Outcomes

CO1	Illustrate the mechanism and stereochemistry of reduction reactions in Organic Chemistry using various reducing reagents. (K3)
CO2	Discuss about the mechanism and stereochemistry of oxidation reactions in Organic Chemistry using various oxidising reagents and use them in organic synthesis. (K3)
CO3	Analyze the utility of various organic reagents in the areas of organic, pharmaceutical, analytical, and medicinal chemistry. (K4)
CO4	Discuss the nomenclature, synthesis and reactions of various five and six-membered heterocyclic compounds. (K2)
CO5	Determine the mechanism, structure and synthesis of different medicinal drugs and discuss their side effects. (K4)
CO6	Compile the green reagents used for Organic synthesis as well as for pharmaceutical industry. (K6)

Text Book (s)

1. W. Carruthers, Some Modern Methods of Organic Synthesis, 3 rd edition, Cambridge UniversityPress, New York, 1998.
2. I.L. Finar, Organic Chemistry, Vol. I, 6 th Edition, Pearson India, New Delhi, 2002.
3. L.F. Fieser and M. Fieser, Reagents for Organic Synthesis, Vol. 1-16, Wiley-Interscience, New York and London.
4. J. March, M. B. Smith, March’s Advanced Organic Chemistry: Reactions, Mechanisms and Structure, 6 th edition, John Wiley & Sons, New York, 2007.
5. H.O. House, Modern Synthetic Reactions, 2 nd edition, W.A. Benjamin, U.S.A., 1972.
6. J. Clayden, N. Greeves and S. Warren, Organic Chemistry, Oxford University Press, 2 nd edition, 2012.

Reference Book (s)

7. T.L. Gilchrist, Heterocyclic Chemistry, 3 rd edition, Addison-Wesley Longman Ltd., England, 1997.
8. R.K. Bansal, Heterocyclic Chemistry, 5 th edition, New Age International Publisher, New Delhi, 2015.
9. Ashutoshkar, Medicinal Chemistry, 4 th edition, New Age International Publisher, New Delhi, 2013.

Unit I: Reducing Reagents 10 lecture hours Complex metal hydride reductions: LiAlH4 and NaBH4; reduction of aldehydes and ketones,stereochemistry of ketone reduction, Reduction of conjugated systems: Birch reduction.Hydroboration, Miscellaneous: Tributyltin hydride, Wilkinson’s catalyst, Wolf Kishner reduction.

Unit II: Oxidising Reagents 10 lecture hours

Oxidation with peracids: Oxidation of carbon-carbon double bonds (Sharpless epoxidation),carbonyl compounds, allylic carbon-hydrogen bonds.Oxidation with selenium dioxide and Osmium tetraoxide, Woodward and Prevost, hydroxylation.

Unit III: Reagents and Reactions 8 lecture hours

- Gilman's reagent – Lithium dimethylcuprate
- Lithiumdiisopropylamide (LDA)
- Dicyclohexyl carbodiimide (DDC)
- 1,3-Dithiane (Umpolung reagent)
- Peterson's synthesis
- Bakers yeast
- DDQ

Unit IV: Heterocyclic compounds 14 lecture hours

Nomenclature, five membered rings (furan, thiophene, pyrrole and its derivatives, condensed pyrroles(Indole), azoles (Five membered rings with two or more hetero atoms).
Pyridine: Synthesis, structure and reactions (Chichibabin reaction and Hofmann exhaustive degradation reaction).
Quinoline : Synthesis and reactions (Skraup, Friedlander, ConardLimpach and Knorr quinoline synthesis, Pfitzinger reaction).

Unit V: Medicinal Chemistry 10 lecture hours

Mechanism of action at molecular level, Structure and Synthesis and side effects of following types ofdrugs:
Sulphonamides : Sulphanilamide, Sulphadiazine
Antiseptics : Chloramine-T, Dettol
Anticancer agents : Taxol
Anesthetics : Benzocaine
Tranquillizers : Chloropromazine,
Antipyretics & Analgesics : Novalgin, Paracetamol,
Antimalarials : Chloroquine, Mepacrine

Unit VI: Recent Advancement in Organic Reagents and Medicinal Chemistry 04 lecture hours

Reagents used for Green Chemical Processes, Green Synthesis approach of analgesic, antibiotic and anticancer drugs.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**CHEMISTRY OF NATURAL PRODUCTS**				
Course Code	**MSCH6003**				
Prerequisite	B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects				
Corequisite	Basic knowledge of functional group reactions and their different mechanism.				
Antirequisite					
		L	T	P	C
		4	0	0	4

Course Objectives: This course offers extensive study of various methods for structure determination, synthesis and properties of natural products.

Course Outcomes

CO1	Determine the structure, stereochemistry, spectroscopic techniques and synthesis of terpenoids. (K4)
CO2	Analyse the structure, stereochemistry, spectroscopic techniques, synthesis and biosynthesis of alkaloids. (K4)
CO3	Deduce the structure and synthesis of various steroids. (K4)
CO4	Illustrate the structure determination and synthetic methods for the preparation of different flavonoids. (K3)
CO5	Compile the advance therapeutic uses of different natural products (K6)

Text Books

3. N.R. Krishnaswamy, Chemistry of Natural Products: A unified Approach, 2nd edition, Universities Press, Hyderabad, 2010.
4. S.G. Warren and P. Wyatt, Organic Synthesis: The Disconnection approach, 2nd edition, Wiley, Chichester, 2010

Reference Books

6. J. H. Furhop and G. Penzillin, Organic Synthesis-concept, methods and starting materials VerlagChemie, Weinheim, 1983.
7. A.Rahman and M.I. Choudhary, New Trends in Natural Product Chemistry, Harwood Academic Publishers, Amsterdam, 1998.
8. R.O.C.Norman and J. M. Coxon, Principles of Organic Synthesis, Blackie Academic and professional, New York, 1993.
9. F. A. Carey and R. J. Sundberg, Advanced Organic Chemistry: Part B Reactions and Synthesis, 5th edition, Springer, New York, 2007.
10. S. V. Bhat, B.A. Nagasampagi, M. Sivakumar, Chemistry of Natural Products, Revised edition, Narosa publishing house, New Delhi, 2014.

Unit I: Terpenoids	10 lecture hours
Classification, nomenclature, occurrence, isolation, general methods of structure determination, isoprene rule. Structure determination, stereochemistry and synthesis of the following representative molecules: Camphor and Longifolene.	
Unit II: Alkaloids	14 lecture hours
Definition, nomenclature and physiological action, occurrence, isolation, general methods of structure elucidation, classification, role of alkaloids in plants.Structure, stereochemistry, synthesis and biosynthesis of Morphine Reserpine and Quinine.	
Unit III: Steroids	13 lecture hours
Occurrence, nomenclature, basic skeleton, diel's hydrocarbon and stereochemistry. Isolation, structure determination synthesis and biosynthesis of Cholesterol, Testosterone and Estrone.	
Unit IV: Flavonoids	9 lecture hours
Biosynthesis of flavonoids and related polyphenols, Acetate and schikimic acid pathways, structure and synthesis of apigenin, luteolin, quarcetin and diadzen.	
Unit V: Applications of Natural Products as therapeutic agents	4 lecture hours

Recent advances in the isolation, synthesis and bio-medical aspects of different natural products

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Organic chemistry Lab – II**				
Course Code	**MSCH6005**				
Prerequisite	B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects				
Corequisite	Knowledge of fundamental of reaction mechanism of organic Chemistry				
Antirequisite					
		L	T	P	C
		0	0	8	4

Course Objectives:

To make the student to acquire practical skills in the determination of organic compound preparations. To acquaint the students with the determination Isolation of organic compound from natural sources.

Course Outcomes

CO1	Students will achieve knowledge regarding fundamentals of organic compounds and the methods used to identify organic compounds.
CO2	Illustrate and extract and characterize different organic compounds from plant products.
CO3	Analyze and perform the reactions like acetylation, benzoylation and bromination for synthesis of organic compounds.
CO4	Design new synthetic route and synthesize organic molecules.
CO5	Operate the instruments handled in the laboratory efficiently and safely.

Text Book (s)

Text: Arthur, I. V. *Quantitative Organic Analysis*, Pearson

- Organic preparations
    4. Acetylation (Preparation of Aspirin from salicylic acid)
    5. Alkylation (Preparation of Anisole from sodium phenoxide)
    6. Benzoylation (Preparation of phenyl benzoate)
- Isolation of organic compound from natural sources:
    8. Isolation of Caffeine from tea leaves
    9. Lactose and Casein from milk
    10. Glucose from cane sugar.
- Two step preparations
- Three steps preparation
- Separation, identification and derivatization of organic compounds
- Polymeric synthesis

Continuous Assessment Pattern

Internal Assessment (IA)	End Term Test (ETE)	Total Marks
50	50	100

Major Project-Phase II

Name of The Course	**MAJOR PROJECT**				
Course Code	**MBS24P2999**				
Prerequisite	B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects				
Corequisite	Knowledge of research methodology				
Antirequisite					
		L	T	P	C
		0	0	0	6

Course Objectives:

The major project will help the students to have a hand on experience and practical knowledge of the theory papers studied so far. It will enable them to tackle practical problems and expose them to industrial experience.

Course Outcomes

CO1	Survey literature for the topic of the project.(K4)
CO2	Correctly interpret the literature review before starting any individual experiment (K3)
CO3	Propose novel reaction routes and pathways for an chemical reaction(K6)
CO4	Interpret the results and data obtained from any experiment clearly, interpret the results and data obtained; records experiments orderly for future reference and draw clear and logical conclusions & assemble in presentations and reports.(K4)
CO5	Demonstrate leadership skills and effective teamwork while working and prepare themselves for their future career in industry or academics (K6)

Continuous Assessment Pattern

Internal Assessment (IA)	External Assessment (ETE)	Total Marks
50	50	100

SEMESTER-IV
(INORGANIC SPECIALIZATION)

Name of The Course	**Organometallic Chemistry**				
Course Code	**MSCH6006**				
Prerequisite	B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects				
Corequisite	Advance knowledge of Inorganic Chemistry				
Antirequisite					
		L	T	P	C
		4	0	0	4

Course Objectives:

3. To impart the knowledge of key concepts of Organometallic chemistry.
4. To present a comprehensive introduction to inorganic chemistry.

Course Outcomes

CO1	Differentiate the Organometallic compounds with different ligands. (K2)
CO2	Describe the preparation and structure of metal complexes having unsaturated groups. (K2)
CO3	Illustrate the synthesis methods of trasition metal complexes having metal hydrogen bond. (K3)
CO4	Interpret the structure and reaction of the cyclopentadienyle and related metal complexes (K3)
CO5	Compare the methods to prepare the various metal complexes. (K4)
CO6	Compile recent advances in organometallic chemistry (K6)

Text Book (s)

- F. A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, 6^{th} Edn., (1999), John-Wiley & Sons, New York.
- James E. Huheey, Inorganic Chemistry, 4^{th} Edn., (1993), Addison Wesley Pub. Co., New York.

Reference Book (s)

- . R.H. Crabtree, The Organometallic Chemistry of the Transition Metals, 1^{st} Edn.(1988), John-Wiley & Sons, New York.
- J. P. Collman, L. S. Hegedus, J. R. Norton and Richard G. Finke, Principles and Applications of Organotransition Metal Chemistry, 1^{st} Edn.(1987), University Science Books, Mill Valley, California.

Unit-1 : Metal Carbonyls 10 Lecture
Semibridging carbonyl group; metal nitrosyl carbonyls; tertiary phosphines and arsines as ligands; carbenes and carbynes.
Unit-2 Complexes of Unsaturated Molecules 10 Lecture
Preparation, bonding and structures of alkene, alkyne, allyl, dienyl and trienyl complexes; reactions with special reference to organic synthesis.
Unit-3 Transition Metal Compounds with M-H bonds 10 Lecture
Synthesis methods , Hydridospecies, terminal metal hydride bonds , hydrogen bridge bonding.
Unit-4 Chemistry of cyclopentadienyle and related complexes 10 Lecture
Ferrocene –Structure and reactions, complexes of Benzene with Chromium and Molibdenum.
Unit-5 Transition Metal Compounds in Homogeneous Catalysis 10 Lecture

Hydrogenation , hydroformylation and polymerization; Waker process.
Unit-6 Recent advances in organometallic chemistry 3 lectures
Latest trends and applications in the field of organometallic chemistry

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Spectroscopic Techniques In Inorganic Chemistry**			
Course Code	**MSCH 6012**			
Prerequisite	B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects			
Corequisite				
Antirequisite				
	L	T	P	C
	4	0	0	4

Course Objectives:To impart the knowledge of key concepts of Spectroscopic Techniques in Inorganic Chemistry

Course Outcomes

CO1	Analyze the structure and magnetic behaviour of metal complexes using NMR spectroscopy. (K4)
CO2	Learn and interpret about the various concepts and structural applications of ESR spectroscopy with respect to metal complexes. (K3)
CO3	Illustrate the role of Mossbauer spectroscopy and to employ them for structural interpretation of Iron and Tin complexes. (K3)
CO4	Describe the structure and symmetry of the various inorganic molecules using IR spectroscopy. (K2)
CO5	Interpret the concept of Mass spectroscopy in structural elucidation of various complex compounds. (K3)
CO6	Compile the modern Spectroscopic Techniques in Inorganic Chemistry (K6)

Text Book (s)

- F E. A. V. Ebsworth, D. W. H. Rankin and S. Cradock, Structural Methods in Inorganic Chemistry, 1st Edn.(1987), Blackwell Scientific Publications, Oxford, London.
- R. S. Drago, Physical Methods for Chemists, (1992), Saunders College Publishing, Philadelphia.
- R. S. Drago, Physical Methods in Inorganic Chemistry, 1st Edn.(1971), Affiliated East-West Press, New Delhi.
- K. Nakamoto, Infrared and Raman Spectra of Inorganic and Coordination Compounds, 4th Edn. (1986), John Wiley & Sons, New York.
- W. Kemp, Organic Spectroscopy, 3rd Edn. (1991), MacMillan, London.

Reference Book (s)

1.K. Nakamoto, Infrared and Raman Spectra of Inorganic and Coordination Compounds, 4th Edn. (1986), John Wiley & Sons, New York.

2.W. Kemp, Organic Spectroscopy, 3rd Edn. (1991), MacMillan, London.

Unit I:NMR Spectroscopy	(12 Lecture)
(i) Use of Chemical shifts and spin-spin couplings for structural determination, (ii) Double resonance, and Dynamic processes in NMR, (iii) Decoupling phenomenon, Nuclear Overhauser Effect, DEPT spectra and structural applications in ^{13}C NMR, (iv) Lanthanide shift reagents, (v) ^{1}H NMR of paramagnetic substances.	
Unit II:Electron Spin Resonance Spectroscopy	(10 Lecture)
Basic principle, Hyperfine splittings (isotropic systems); the g-value and the factors affecting thereof; interactions affecting electron energies in paramagnetic complexes (Zero-field splitting and Kramer's degeneracy); Anisotropic effects (the g-value and the hyperfine couplings); The EPR of triplet states; Structural applications to transition metal complexes.	
Unit III: Mössbauer Spectroscopy	(10 Lecture)
Basic principle, conditions for Mossbauer spectroscopy, Spectral parameters (Isomer shift, electric quadrupole interactions, magnetic interactions), temperature-dependent effects, structural deductions for Iron and Tin complexes, miscellaneous applications.	
Unit IV: Infrared Spectroscopy	(10 Lecture)
Basic principles and advantages of IR spectroscopy, applications of vibrational (IR) spectroscopy in investigating (i) symmetry and shapes of simple AB_2, AB_3 and AB_4 molecules on the basis of spectral data, (ii) mode of bonding of ambidentate ligands (Thiocyanate, Nitrate, Sulfate and Urea).	
Unit V: Mass Spectrometry	(10 Lecture)
Fingerprint applications and the interpretation of Mass spectra, effect of isotopes on the appearance of mass spectrum, recognition of the molecular ion peak; Ionization techniques (EI and FAB).	
Unit VI: Recent advances in Spectroscopic Techniques in Inorganic Chemistry	(4 Lecture)
Modern Spectroscopic Techniques in Inorganic Chemistry	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Bio inorganic chemistry**				
Course Code	**MSCH6009**				
Prerequisite	B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects				
Corequisite					
Antirequisite					
		L	T	P	C
		4	0	0	4

Course Objectives:To impart the knowledge of key concepts of biomolecules and interaction with inorganic elements, complex formation and their biological importance.

Course Outcomes

CO1	Understand the role of metals in biochemical reactions ,Catalysis of phosphate transfer& muscle contraction in biological system.(K2)
CO2	Discuss and demonstrate the activity of Iron, copper and molybdenum proteins in biological activities.(K3)
CO3	Analyzeand demonstrate the activity of metaloenzyme in biological activities. (K4)
CO4	Analyze and demonstrate the properties ofIron storage and transport of proteins.(K4)
CO5	Estimate the Interaction of metal complexes with DNA & chemotherapeutic agents. (K5)
CO6	Compile recent advances in Bio-inorganic Chemistry (K6)

Text Book (s)

1. M. N. Hughes, Inorganic Chemistry of Biological Processes, 2nd Ed.(1981), John-Wiley & Sons, New York.
2. W. Kaim and B. Schwederski, Bioinorganic Chemistry: Inorganic Elements in the Chemistry of Life, An Introduction and Guide, (1995) Wiley, New York.

Reference Book (s)

1. S. J. Lippard and J. M. Berg, Principles of Bioinorganic Chemistry, (1994) University Science Books.
2. I. Bertini, H. B. Grey, S. J. Lippard and J. S. Valentine, Bioinorganic Chemistry, (1998) Viva Books Pvt. Ltd., New Delhi.

Unit I: Alkaline earth metal ions and biological systems 12 lecture hours
General introduction of the role of metals in biochemical reaction,Catalysis of phosphate transfer by Mg^{2+} ion, Ubiquitous regulatory role of Ca^{2+} - muscle contraction.
Unit II:Iron, copper and molybdenum proteins : 10 lecture hours
Anti-oxidative functions (cytochrome P-450, catalases and peroxidases), Nitrate and nitrite reduction (NO_3^- and NO_2^- reductase), Electron transfer (cytochromes, blue copper proteins and iron-sulfur proteins), Synthetic models of iron-sulfur proteins, molybdo-enzymes – molybdenum cofactors (molybdenum-pterin complexes), nitrogen fixation through metal complexation–nitrogenase, Photosynthesis (PS-I and PS-II).
Unit III: Metalloenzymes 10 lecture hours
Functions and significance of following metalloenzymes :urease, hydrogenase, and cyanocobalamine .
Unit IV: Interaction of metal complexes with DNA 10 lecturehours
Biological function and importance of DNA probe and chemotherapeutic agents.
Unit V: Iron storage and transport proteins 10 lecture hours

Detailed Structure , biological function and significance of following proteins : Ferritin, transferritin and hemosiderin.
Unit VI Recent trends in Bio-inorganic Chemistry 4 lectures hours
Advancement in bio-inorganic chemistry

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of the Course	**Inorganic Chemistry lab-II**				
Course Code	**MSCH6010**				
Prerequisite	B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects				
Corequisite					
Antirequisite					
		L	T	P	C
		0	0	8	4

Course Objectives:

3. To impart the knowledge of key concepts of preparation of co-ordination compounds.
4. To present a comprehensive introduction to inorganic chemistry.

Course Outcomes

CO1	Learn and recognize the basic laboratory safety rules and to practice them properly while performing experiments. (K2)
CO2	Synthesize inorganic coordination compounds. (K6)
CO3	Inspect the mixture of rare earth elements. (K3)
CO4	Distinguish and estimate the constituents of a mixture by gravimetric and volumetric techniques. (K5)
CO5	Examine the stability constant and composition of complex. (K4)

Text Book (s)

- Vogel's Textbook of Quantitative Analysis, Revised, J. Bassett, R.C. Denney, G.H.H.Jeffery and J. Mendham, elbs.
- Synthesis and Characterization of Inorganic Compounds, W.L. Jolly, Prentice Hall

Reference Book (s)

- . Synthesis and Characterization of Inorganic Compounds, W.L. Jolly, Prentice Hall

Unit-1 :
Part-1 Preparation of some Inorganic coordination compounds d. Potassium trioxalatochromate(III). e. Cuprous tetraiodomercurate(II). f. Tetraamminecarbonatocobalt(III) nitrate.
Unit-2
Part-2

Preparation of some Inorganic coordination compounds e. Pentaamminechloridocobalt(III) chloride. f. Tris(acetylacetonato)manganese(III) ion g. Cis& trans potassium diaquodioxalatochromate(III) h. Prussian Blue($Fe_4[Fe(CN)_6]$)
Unit-3
Analyze the given mixture for four rare elements.
Unit-4
Estimation of three constituent in the given mixture (Two gravimetrically and one volumetrically).
Unit-5
Determination of stability constant and composition of complex by Job's method

Continuous Assessment Pattern

Internal Assessment (IA)	End Term Test (ETE)	Total Marks
50	50	100

Major Project-Phase II

Name of The Course	**MAJOR PROJECT**			
Course Code	**MBS24P2999**			
Prerequisite	B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects			
Corequisite	Knowledge of research methodology			
Antirequisite				
	L	T	P	C
	0	0	0	6

Course Objectives:

The major project will help the students to have a hand on experience and practical knowledge of the theory papers studied so far. It will enable them to tackle practical problems and expose them to industrial experience.

Course Outcomes

CO1	Survey literature for the topic of the project.(K4)
CO2	Correctly interpret the literature review before starting any individual experiment (K3)
CO3	Propose novel reaction routes and pathways for an chemical reaction(K6)
CO4	Interpret the results and data obtained from any experiment clearly, interpret the results and data obtained; records experiments orderly for future reference and draw clear and logical conclusions & assemble in presentations and reports.(K4)
CO5	Demonstrate leadership skills and effective teamwork while working and prepare themselves for their future career in industry or academics (K6)

Continuous Assessment Pattern

Internal Assessment (IA)	External Assessment (ETE)	Total Marks
50	50	100

SEMESTER-IV
(PHYSICAL SPECIALIZATION)

Name of The Course	**Applied Electrochemistry**				
Course Code	**MSCH6021**				
Prerequisite	B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects				
Corequisite					
Antirequisite					
		L	T	P	C
		4	0	0	4

Course Objectives:To impart the knowledge of key concepts, importance and role ofelectrochemistry and their role in energy generation, energy devices and kinetics.

Course Outcomes

CO1	Describe the working of fuel cells, hydrogen cells and other electrochemical cells. (K2).
CO2	Explain about battery performance and energy density of various batteries .(K2)
CO3	Compare the properties of electrical double layer and its effect on electrical properties (K2)
CO4	Assess the corrosion and stability of metals(K4)
CO5	Develop knowledge about the working of fuel cells, hydrogen cells and other electrochemical cells. (K5)
CO6	Compile the recent applications of electrochemistry. (K6)

Text Books

2. J.O'M. Bockris and A.K.N. Reddy, Modern Electrochemistry, Vol. 1 & 2A and 2 B, (1998) Plenum Press, New York.

Reference Books

5. "Fuel Cells : Their electrochemistry". McGraw Hill Book Company, New York.
6. An Introduction to Electrochemistry by S. Glasstone.
7. Electrolytic Solutions by R. A. Robinson and R. H. Strokes
8. Physical Chemistry by P. W. Atkins. ELBS.

Unit I:Electrochemical Energy Generation 12 lecture hours History of fuel cells, Direct energy conversion by electrochemical means. Maximum intrinsic efficiency of an electrochemical converter. Physical interpretation of the Carnot efficiency factor in electrochemical energy converters. Power outputs. Electrochemical Generators (Fuel Cells): Hydrogen oxygen cells, Hydrogen Air cell, Hydrocarbon air cell, Alkaline fuel cell, Phosphoric and fuel cell, direct NaOH fuel cells, applications of fuel cells.
Unit II: Electrochemical Energy Storage 10 lecture hours Properties of Electrochemical energy storers: Measure of battery performance, Charging and discharging of a battery, Storage Density, Energy Density. Classical Batteries : (i) Lead Acid (ii) Nickel-Cadmium, (iii) Zinc manganese dioxide. Modern Batteries : (i) Zinc-Air (ii) Nickel-Metal Hydride, (iii) Lithium Battery, Future Electricity storers : Storage in (i) Hydrogen, (ii) Alkali Metals, (iii) Non aqueous solutions.
Unit III: Corrosion and Stability of Metals 10 lecture hours

Surface mechanism of the corrosion of the metals; Thermodynamics and the stability of metals, Corrosion current and corrosion potential –Evans diagrams. Inhibiting Corrosion: Cathodic and Anodic Protection. (i) Inhibition by addition of substrates to the electrolyte environment, (ii) by charging the corroding method from external source, anodic Protection, Organic inhibitors, Passivation: Structure of Passivation films, Mechanism of Passivation
Unit IV :Electrode Kinetics 10 lecture hours Review of Butler-Volmer treatment. Polarizable and non-polarizable interfaces. Multistep reactions- a near equilibrium relation between current density and over potential, Concept of rate determining step. Determination of reaction order. Stoichiometric number, and transfer coefficient. Electrocatalysis–comparison of electrocatalytic activity. Importance of oxygen reduction and hydrogen evolution reactions and their mechanisms.
Unit V: Electrical Double Layer 10 lecture hours Thermodynamics of double layer, Electrocapillary equation, Determination of surface excess and other electrical parameters- electrocapillarity, excess charge capacitance, and relative surface excesses. Metal/ water interaction- Contact adsorption, Complete capacity potential curve, Specific adsorption, Adsorption isotherm, rate of adsorption, Semiconductor/ electrolyte interface, Capacity of space charge, Mott-Schottky plot.
Unit VI: Recent applications of electrochemistry 4 lecture hours Advances in recent trends in electrochemistry

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**CHEMICAL KINETICS AND SURFACE CHEMISTRY**				
Course Code	**MSCH6022**				
Prerequisite	B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects				
Corequisite					
Antirequisite					
		L	T	P	C
		4	0	0	4

Course Objectives:To impart the knowledge of keytechniques of fast reaction kinetics, catalytic activity micelles and theories of emulsions.

Course Outcomes

CO1	Illustrate the techniques of fast reactions kinetics.(K3)
CO2	Discuss the reactions taking place in solutions and generalize the effect of different factors on the rate of these reactions.(K2)
CO3	Generalize the significance of different types of adsorption: derivation, experimental verification and catalytic activity of surfaces.(K3)
CO4	Discuss the classification and different characteristics of micelles. (K2)
CO5	Generalize the theories and applications related with emulsions. (K3)
CO6	Compile the recent advances in chemical kinetics and surface chemistry (K6)

Suggested Reading

1. K.J. Laidler, Chemical Kinetics, 3rd Edition (1967), Harper & Row Publishers, New York.
2. Introduction to colloid and surface chemistry by D. J. Shaw.
3. M. J. Pilling and A.P.W, Seakins, Reaction Kinetics, (1998) Oxford Science Publication, New York.
4. **J. Rajaram and J.C. Kuriacose, Kinetics and Mechanism of Chemical Transformation, Ist** Edition (1993), MacMillan India Ltd., New Delhi.
5. B. G. Cox, Modern Liquid Phase Kinetics, (1994) Oxford University Press, Oxford.
6. Kinetics and Mechanism by A. A. Frost and R. G. Pearson
7. Physical chemistry of surfaces: A. W. Adamson.
8. Theory of adsorption and catalysis by Alfred Clark.

Unit I: Fast Reactions Techniques 10 lecture hours Kinetics of fast reactions-Study of reactions by relaxation method: Temperature and pressure jump, flow method: Plug flow method and Stopped flow method, Flash photolysis and Shock tube method.
Unit II: Reactions in Solutions 12 lecture hours Reaction between ions; Effect of solvent (single & double sphere models), interpretation of frequency factor and entropy of activation, influence of ionic strength, salt effect and reaction mechanisms. Reactions involving dipoles. Influence of pressure on reaction rates in solution. Significance of value of activation. Influence of substituents on reaction rates. Electronic theories of organic reactivity. Linear free energy relationships. The Hammett equation, significance of σ and ρ. The Taft equation
Unit III: Adsorption and Surface Phenomenon 12 lecture hours Physisorption and chemisorption, adsorption isotherms, Langmuir and B. E. T. equation and significance in surface area determination, surface films, states of insoluble films, L. B. films and their application, adsorption from solution, adsorption types, surface excess concentration, Gibb's adsorption equation : derivation, significance and experimental verification , catalytic activity of surfaces.
Unit IV : Micelles 10 lecture hours Surface activity, surface active agents and their classification, micellisation, critical micelle concentration thermodynamics of micellisation , factors affecting cmc, methods of determination of cmc, reverse micelle , solubisation of water insoluble organic substances , use of surfactants in oil recovery.
Unit V: Emulsions 8 lecture hours Types of emulsion, theories of emulsion and emulsion stability, identification of emulsion types, inversion emulsion, microemulsion: theory and application
UnitVI: Recent trends in chemical kinetics and surface chemistry 4 lecture hours Recent Advances in the field of chemical kinetics and surface chemistry

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Molecular Spectroscopy**				
Course Code	**MSCH6023**				
Prerequisite	B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects				
Corequisite					
Antirequisite					
		L	T	P	C
		4	0	0	4

Course Objectives:To impart the advanced knowledge of instrumentation by different spectroscopic techniques for molecular structure determination and their real time applications.

Course Outcomes

CO1	Illustrate molecular spectroscopy as an important tool to understanding molecular structure and its characteristics.(K3)
CO2	Categorize different electromagnetic regions and instrumentation of various modern spectrometers. (K4)
CO3	Evaluate the theoretical knowledge of the various spectroscopic methods on the basis of the examples.(K5)
CO4	Acquire the skill to determine the functional groups present in unknown molecules.(K4)
CO5	Solve and interpret the results obtained from different spectroscopic methods.(K4)
CO6	Compile recent trends in Molecular Spectroscopy (K6).

Suggested Reading

6. Fundamentals of molecular spectroscopy : C.N. Banewell and E.Mc. Cash.
7. Vibrational Spectroscopy: Theory and Applications, D.N. Sathyanarayana, New Age International Publishers, New Delhi (2000).
8. Electronic Absorption Spectroscopy and Related Techniques, D.N. Sathyanarayana, Universities Press, Bangalore (2001).
9. Organic spectroscopy, W. Kemp, ELBS London, 2000.
10. Mass spectroscopy a foundation course. K Downard, RSC, Cambridge, 2004.

Unit I: Ultraviolet and Visible Spectroscopy 10 lecture hours Classification of electronic transitions, Terminology, Fourier transform, Substituent and solvent effects, UV spectral study of alkenes, polyenes, enones and aromatic compounds. Emperical rules for calculating λ max.
Unit II: IR- Spectroscopy 12 lecture hours Sampling techniques, Group frequencies, factors affecting group frequencies, Bond order, Mass effect, Conjugation, Inductive, resonance, steric effects, intramolecular interactions. Application of IR in the study of H-bonding and tautomerism. Complimentarity of IR and Raman. Identification of the following organic compounds by IR: Alkanes, Alkenes, Alkynes, Aromatic compounds, Aldhydes, Ketones, Alcohols, Acids and its derivatives; Amines, Esters, Alkyl halides and Nitro compounds; Problems using UV and IR.
Unit III: Raman and Electronic Spectroscopy 12 lecture hours Raman Spectroscopy: Introduction, Rotational Raman spectra, Vibrational Raman Spectra, polarization of light and Raman effect, structure elucidation from combined Raman and IR spectroscopy, applications in structure elucidation.

Electronic spectroscopy of molecules: Born – Oppenheimer approximation, electronic spectra of diatomic molecules, vibrational coarse structure, rotational fine structure dissociation energy and dissociation products, electronic structure of diatomic molecules, molecular photoelectron spectroscopy, application.
Unit IV : Nuclear Magnetic Resonance Spectroscopy 10 lecture hours Introduction, Magnetic properties of nuclei-Resonance condition, Nuclear spin, population of nuclear spin levels and NMR isotopes, Relaxation methods, Instrumentation and sample handling; Classical approach and FT-NMR. Chemical shift, Factors influencing chemical shifts : electronegativity and electrostatic effects; Mechanism of shielding and deshielding in alkanes, alkyl halides, alkenes, aromatic compounds, carbonyl compounds and annulenes. Equivalence of protons-chemical and magnetic equivalence; Spin-spin interactions.
Unit V: ESR, Mossbauer and Mass Spectroscopy 8 lecture hours Basic principles and applications of ESR, Mossbauer and Mass Spectroscopy.
Unit VI: Recent trends in Molecular Spectroscopy 4 lecture hours Recent advances in molecular structure determination and their real time applications

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Physical Chemistry lab-II**				
Course Code	**MSCH6025**				
Prerequisite	B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects				
Corequisite					
Antirequisite					
		L	T	P	C
		0	0	8	4

Course Objectives:To impart the knowledge and concepts ofphase diagram of binary system, rate constant and distribution coefficient by performing experiments.

Course Outcomes

CO1	Understand the of acid catalyzed hydrolysis. (K2)
CO2	Interpret different techniques as potentiometric titration, spectrophotometry, pH metery.(K3)
CO3	Validate adsorption isotherms and determine degree of hydrolysis, rate constant, saponification number and comparison of acid strengths. (K5)
CO4	Evaluate physical parameters like distribution coefficient, molecular weight by cryoscopy method and equilibrium constant by distribution method.(K4)
CO5	Determination of the solubility of salts. (K4)

Suggested Reading

Advanced Practical Physical Chemistry; Twenty-second Edition; J.B.Yadav; Goel Publishing House, Merrut, 2005.

Course Contents:

1. Phase diagram of a binary organic system (Naphthalene and Diphenyl).
2. Rate constant of acid catalyzed hydrolysis of sucrose by polarimetric method.
3. Potentiometric titrations
4. Spectrophotometry (Jobs method)
5. pHmetry.

15. Adsorption of acetic acid on charcoal to verify Freundlich adsorption isotherm.
16. Degree of hydrolysis of urea hydrochloride by kinetics method.
17. Rate constant of acid catalyzed hydrolysis of sucrose by chemical method.
18. Saponification of ethyl acetate with sodium hydroxide by chemical method.
19. Comparison of acid strengths through acid catalyzed methyl acetate hydrolysis
20. Distribution coefficient of I2 between two immiscible solvents.
21. Molecular weight of a non-electrolyte by cryoscopy method.
22. Equilibrium constant of KI + I2 ⇌KI3 by distribution method.
23. Determination of solubility and solubility product of sparingly soluble salt conductometrically.

Continuous Assessment Pattern

Internal Assessment (IA)	End Term Test (ETE)	Total Marks
50	50	100

Major Project-Phase II

Name of The Course	**MAJOR PROJECT**				
Course Code	**MBS24P2999**				
Prerequisite	B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects				
Corequisite	Knowledge of research methodology				
Antirequisite					
		L	T	P	C
		0	0	0	6

Course Objectives:
The major project will help the students to have a hand on experience and practical knowledge of the theory papers studied so far. It will enable them to tackle practical problems and expose them to industrial experience.
Course Outcomes

CO1	Survey literature for the topic of the project.(K4)
CO2	Correctly interpret the literature review before starting any individual experiment (K3)
CO3	Propose novel reaction routes and pathways for an chemical reaction(K6)
CO4	Interpret the results and data obtained from any experiment clearly, interpret the results and data obtained;records experiments orderly for future reference and draw clear and logical conclusions&assemblein presentations and reports.(K4)
CO5	Demonstrate leadership skills and effective teamwork while working and prepare themselves for their future career in industry or academics (K6)

Continuous Assessment Pattern

Internal Assessment (IA)	External Assessment (ETE)	Total Marks
50	50	100

SEMESTER-IV
(ANALYTICAL SPECIALIZATION)

Name of The Course	**Electroanalytical methods**				
Course Code	**MSCH6031**				
Prerequisite	B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects				
Corequisite	Knowledge of basic Analytical Chemistry				
Antirequisite					
		L	T	P	C
		4	0	0	4

Course Objectives:To impart the knowledge about the biosensors, electrophoresis, various electrochemical phenomenon and their industrial importance.
Course Outcomes

CO1	Employ some understanding of the professional and safety responsibilities in pollution monitoring, trace metal estimation etc.(K3)
CO2	Define the theoretical skills used in the field of biosensors.(K1)
CO3	Develop some basic understanding of electrophoresis.(K2)

CO4	Apply their knowledge in electrochemistry and related areas in industry as well as in research.(K3)
CO5	Understand some basic techniques used in electrochromatography and electrogravimetry.(K1)
CO6	Compile recent advances in Electroanalytical methods (K6)

Text Books

1 .D.A. Skoog, F.J. Holler and T. A. Nieman, Principles of Instrumental Analysis, Thomson Asia Pvt Ltd., Singapore, Sixth reprint, 2005.

1. .A.J. Bard and L.R. Faulkner, Electrochemical Methods, John Wiley and Sons, 2nd Edition, 2004.

Reference Books

3. S.M. Khopkar, Basic Concept of Analytical Chemistry, Wiley Easter, 2nd Edition, 2000.
4. L. Barret et al, Vogel's Textbook of Quantitative Inorganic Analysis, ELBS (Longmann's Ed.), 1998

Unit I:Ion-selective electrodes 12 lecture hours Working principles and applications– Theoretical considerations – Types of ion-selective electrodes – Properties of ion-selective electrodes – Sources of errors – Construction and working of cation specific electrodes for analysis of cadmium, lead, arsenic and anion specific electrodes for fluoride, chloride and sulphide ions; Application of ion selective electrodes in different fields such as pollution monitoring, trace metal estimation, agriculture and food and pharmaceuticals.
Unit II: Bio-sensors in analysis 10 lecture hours Introduction – basic components – bio-sensors – bio-sensors based on chemoreceptors - biocatalytic bio-sensors – immunological bio-sensors – building blocks for bio-sensors – base devices for metabolism bio-sensors – amperometric and potentiometric bio-sensors – calorimetric bio-sensors.
Unit III: Electrophoresis8 lecture hours Principle of electrophoresis; Principles and applications of Paper electrophoresis or zone electrophoresis, Capillary electrophoresis, capillary zone electrophoresis.
Unit IV: Voltammetry 14 lecture hours Introduction to voltammetry –Three electrode potentiostat – circuit diagram and working of potentiostat – Single sweep voltammetry, cyclic 583oltammetry – Randles-Sevcik equation, Criteria for reversible and irreversible processes – methodology and applications Description and general principles involved in stripping techniques – Anodic Stripping, Cathodic Stripping and Adsorptive stripping voltammetry – processes and applications.
Unit V: Electrochromatography and Electrogravimetry 8 lecture hours Micellar electrokinetic chromatography and capillary electrochromatography, principle ,theory and applications of electrogravimetry.
Unit VI: Recent advances in Electroanalytical methods 4 lecture hours Applications of different Electroanalytical methods

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Quality Control and Quality Assurance**				
Course Code	**MSCH6032**				
Prerequisite	B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects				
Corequisite	Knowledge of basic Analytical Chemistry				
Antirequisite					
		L	T	P	C
		4	0	0	4

Course Objectives:To impart the knowledge about the principle and laws of quality control, quality assurance and quality management and to develop the skills of process selection and unit operation in chemical industry.

Course Outcomes

CO1	Describe basic principles and laws related to quality control, quality assurance and quality management. (K2)
CO2	Illustrate the standard operating procedures for quality control .(K3)
CO3	Develop knowledge of the working principles of automated quality control.(K4)
CO4	Describe the principles of process selection and unit operation in chemical industry.(K2)
CO5	Employ their knowledge of Green chemistry to modify existing industrial methodologies.(K3)
CO6	Compile recent advances in skills for quality assurance (K6)

Text Books

1. Statistical Quality Control, D.C. Montgomery, John Wiley & Sons, 5th edition, 2005.
2. Production and Operations Management, M. K. Starr, Biztantra, Delhi, 2004.

Reference Books

1. QA Manual, D.H. Shah, Business Horizons, 2000
2. Total Quality Management, D.H. Besterfield, C. Besterfield-Michna, G.H. Besterfield, M. Besterfield -Sacre, Pearson Education, Inc., 3rd Edition, 2003.

Unit I:An Introduction to Quality Management system - 10 lecture hours Concept of quality, Quality control and quality assurance; Quality dimensions and costs of quality; Economics of quality Control; Materials management; Current trends in quality management – ISO 9000 and its series, Laws related to quality control; Product development and project management.
Unit II:Quality assurance and Control 10 lecture hours Standard operating procedure (SOP), Good laboratory practice (GLP), Concept of six sigma and overview of TQM; Basics of sampling, sampling procedure, sampling based on physical state and hazards in sampling pre-concentration methods; Introduction to statistical quality control (SQC), Process capability assessing methods, techniques in SQC, roles of SQC in QCQA of process industry.
Unit III: Automation in Analytical Chemistry - 10 lecture hours Instrumental parameters for automated instruments, sample conditioning. Automated process control, automated instruments in process control systems, automation in chemical industry, flow injection analysis, automation in process quality control and quality assurance;
Unit IV:Quality control/Quality Assurance in Process Industry 12 lecture hours Outlines of QA in chemical industries; Flow sheet preparations, principles of process selection and unit operation; Basic raw materials and route for the manufacture of important organic and inorganic products; Flow sheets, engineering aspects and QC/QA measures of manufacture of ammonium

nitrate, DDT, Bulk drugs Paracetamol/Asprin. Case studies on QC/QA in industries manufacturing plastics, petrochemicals and dyes.
Unit V:Green Chemistry 10 lecture hours Principles and concepts of green Chemistry; Sustainable Development and green chemistry, Atom Economy, examples of atom economic and atom uneconomic reactions, reducing toxicity, Organic solvents: environmentally benign solutions, solvent free systems, supercritical fluids (only introduction) Ionic liquids as catalysts and solvents, Emerging green technologies, photochemical reactions (advantages and challenges) examples, Chemistry using microwaves, sonochemistry, electrochemical synthesis
Unit VI: Advancement in skills for quality assurance 4 lectures hours Recent trends in the field of quality assurance and green chemistry

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**ADVANCE INSTRUMENTATION METHODS**				
Course Code	**MSCH6033**				
Prerequisite	B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects				
Corequisite	Knowledge of spectroscopy				
Antirequisite					
		L	T	P	C
		4	0	0	4

Course Objectives: To impart advanced knowledge in instrumentations methods for chemical analysis.

Course Outcomes

CO1	Determine various spectroscopic techniques for quantitative and qualitative analysis. (K2)
CO2	Describe principle and instrumentation of Infra-Red, Electron, 1H NMR, 13C NMR and Mass spectroscopy. (K3)
CO3	Investigate structures on these techniques. (K5)
CO4	Identify structure of organic compounds by NMR techniques. (K4)
CO5	Analyze reaction sequences by using spectroscopic technique. (K4)
CO6	Compile the recent instrumentations methods for chemical analysis. (K6)

Text Books

(3) Gary D. Christian, Analytical chemistry, 6^{th} edition, John Wiley & Sons, Inc New York, 2004.
(4) H.A. Willard, L.L. Merrit, J.A. Dean, Von Nostrand, Instrumental methods of analysis, 7^{th} Edition, CBS Publishers, 1986.

Reference Books

1. D.A Skoog, D.M. West, Holt Rinahart Winston, Principles of Instrumental Analysis, New York, 1988.

2.D.A. Skoog, F.J. Holler and T. A. Nieman, Principles of Instrumental Analysis, Thomson

Asia Pvt Ltd., Singapore, Sixth reprint, 2005.
3.D. A. Skoog, D. M. West and F. J. Holler, Nieman, Analytical Chemistry, Third reprint,

Thomson Asia Pte ltd., Singapore, 2005.

Unit I: Infra-red spectroscopy	10 lecture hours
Introduction, Theory of Infrared Absorption Spectroscopy , Linear Molecules, Symmetric Top Molecules, Asymmetric Molecules, Instrumentation, Single beam and double beam spectrophotometers, Modes of vibrations of Atoms in Polyatomic molecules, Factors which influence vibrational frequencies, Selection Rules, Finger print region, Applications of IR, Limitations of Infrared Spectroscopy.	
Unit II:Electron spectroscopy	8 lecture hours
X-ray photoelectron spectroscopy (XPS), Ultra-Violet photoelectron spectroscopy (UPS), Atomic emission spectroscopy (AES)Principle, Theory, Instrumentation, Measurements, Surface sensitivity, Chemical states and chemical shifts, Detection limits, Sample size, Sample preparations, Advanced instrumentation aspects, Industry use, applications	
Unit III: Electron Microscopy	8 lecture hours
TEM (Transmission electron microscopy), SEM, STM and AFM Introduction, Theory, Instrumentation, Imaging methods, sample preparation, modifications, resolution limits, typical applications.	
Unit IV:Nuclear Magnetic Resonance Spectroscopy	10 lecture hours
Theory, Instrumentation, chemical shifts, solvents used in NMR, Interpretation, Limitations of NMR spectroscopy, Applications of ^{1}H and ^{13}C NMR technique for structure determination of typical organic molecules, Solid state NMR (MAS)	
Unit V: Mass Spectrometry	14 lecture hours
Introduction – instrumentation – ion production -EI, CI, FD and FAB – factors affecting fragmentation – ion analysis – ion abundance – mass spectral fragmentation of organic compounds – common functional groups – molecular ion peak – meta stable peak – base peak – Mc Lafferty rearrangement, nitrogen rule, high resolution mass spectrometry.	
Unit VI: Recent instrumentations methods	4 lecture hours
Advancement in recent instrumentations methods for chemical analysis	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**ANALYTICAL CHEMISTRY LAB – II**				
Course Code	**MSCH6034**				
Prerequisite	B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects				
Corequisite	Knowledge of spectroscopy				
Antirequisite					
		L	T	P	C
		0	0	8	4

Course Objectives:To impart advanced practical knowledge in analytical methods for various chemical analysis.

Course Outcomes

CO1	Use instruments and suitable analytical techniques for the identification of various compounds (K3).
CO2	Determine the values of BOD, COD, TDS and alkalinity of water samples collected from different areas (K4).
CO3	Analyze different ions accurately using spectrophotometry, potentiometric, thermogravimetric and voltametric methods (K4).
CO4	Operate the instruments efficiently and safely (K3).
CO5	Validate the various spectroscopic techniques (K5).

Suggested Reading

1. Qualitative Analysis by Vogel

Course Contents:

13. Inorganic quantitative Analysis: Experiments based on
   - Redox Titrations
   - Iodometric Titrations
   - Complexometric titration
   - Gravimetric analysis
14. Conductometry for the Analysis of Aminoacids
15. Differential Pulse Polarography
16. Multiple Analytes by Stripping Voltammetry
17. Automobile Exhausts by FTIR Spectrophotometry
18. Thermogravimetric Studies of Zeolites
19. Determination of metal ions by spectrophotometric and potentiometric methods
20. Determination of total alkalinity, BOD, COD and Total solids
21. Determination of requirement of coagulants
22. Determination of anions and silicates using spectrophotometric and ion analyzer potentiometric methods.
23. Bioassaying and Environmental Analysis by Potentiometric and Voltammetric Methods
24. Amperometric Titrations

Continuous Assessment Pattern

Internal Assessment (IA)	End Term Test (ETE)	Total Marks
50	50	100

Major Project-Phase II

Name of The Course	**MAJOR PROJECT**				
Course Code	**MBS24P2999**				
Prerequisite	B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects				
Corequisite	Knowledge of research methodology				
Antirequisite					
		L	T	P	C
		0	0	0	16

Course Objectives:
The major project will help the students to have a hand on experience and practical knowledge of the theory papers studied so far. It will enable them to tackle practical problems and expose them to industrial experience.
Course Outcomes

CO1	Survey literature for the topic of the project.(K4)
CO2	Correctly interpret the literature review before starting any individual experiment (K3)
CO3	Propose novel reaction routes and pathways for an chemical reaction(K6)
CO4	Interpret the results and data obtained from any experiment clearly, interpret the results and data obtained;records experiments orderly for future reference and draw clear and logical conclusions&assemblein presentations and reports.(K4)
CO5	Demonstrate leadership skills and effective teamwork while working and prepare themselves for their future career in industry or academics (K6)

Continuous Assessment Pattern

Internal Assessment (IA)	External Assessment (ETE)	Total Marks
50	50	100

List of ELECTIVES

Name of The Course	**Polymer chemistry(Elective)**				
Course Code	**MBS24T5101**				
Prerequisite	B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects				
Corequisite					
Antirequisite					
		L	T	P	C
		3	0	0	3

Course Objectives:

- To introduce the student to polymers, their synthesis, reaction mechanism and kinetics.
- To introduce the student to the methods of molecular weight determination of polymers and their properties.
- To introduce the students to synthesize, compare the properties and application of various resins /polymers.

Course Outcomes

CO1	Understand the basic concepts about polymers & mechanism of polymerization.
CO2	Analyze the Kinetics and metallic mechanism of co-ordination polymers.
CO3	Analyze and evaluate molecular weight of polymers, properties by various techniques and methods.
CO4	Synthesize, compare the properties and application of various resins /polymers.
CO5	Develop & compare the properties ofvarious newly developed conducting & bio polymers.
CO6	Compile the recent advances in polymer chemistry

Text Book (s)

3. F.W.Billmeyer, TextBook of Polymer Science, 3rd edition, Wiley, Singapore 2009.
4. V.R.Gowariker, N.V.Viswanathan and J.Sreedhar, Polymer Science, Wiley Eastern, New Delhi, 1988.

Reference Book (s)

4. H.F. Mark, Encyclopedia of polymer science and technology, 4th edition, John Wiley & Sons, New York, 2014.
5. Paul. G. Flory, Principle of Polymer chemistry, Ist edition, Cornell university press, U.S.A., 1995.
6. Joel R. Fried, Polymer science and Technology, 3rd edition, Prentice Hall, New Jersey, 2014.

Unit I: Addition and Condensation Polymerization10 Lectures 8 lectures Monomers, repeat units, degree of polymerization, linear, branched and network polymers. Condensation polymerization: Mechanism of stepwise polymerization. Kinetics and statistics of linear stepwise polymerization. Addition polymerization: Free radical, cationic and anionic polymerization.
Unit II: Co-ordination Polymerization 10 lectures Kinetics, mono and bimetallic mechanism of co-ordination polymers, co-polymerization: block and graft co-polymers, kinetics of copolymerization, types of co-polymerization, evaluation of monomer.
Unit III: Molecular Weight and Properties 10 Lectures Polydispersion: Average molecular weight concept, number, weight and viscosity average molecular weights, measurement of molecular weights, gel permeation chromatography, viscosity, light scattering, osmotic and ultracentrifugation methods. Polymer structure and physical properties, crystalline melting point T_m, glass transition temperature, determination of T_g, relationship between T_m and T_g .
Unit IV: Properties of Polymers 6 lectures Polyethylene, polyvinyl chloride, polyamides, polyesters, phenolic resins, epoxy resins and silicone polymers. Functional polymers

Unit V: Application of Polymers 6 lectures Applications of Fire retarding polymers and electrically conducting polymers. Biomedical polymers – contact lens, dental polymers, artificial heart, kidney, skin and blood cells.	
Unit VI: Recent advances in polymer chemistry 4 lectures Recent applications in the field of polymer chemistry	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Industrial chemistry(Elective)**				
Course Code	**MBS24T5102**				
Prerequisite	B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects				
Corequisite	Advance knowledge of Inorganic Chemistry				
Antirequisite					
		L	T	P	C
		3	0	0	3

Course Objectives:

- To introduce the student about various water treatment processes
- To introduce the student about various petroleum and petrochemical products
- To introduce the student about various mineral processing and metal finish technologies.
- To introduce the student about refractories, cement, glass and protective coatings.

Course Outcomes

CO1	Utilize their knowledge in treatment of hard water and waste water through sewage treatment plant (STP), Effluent treatment plant (ETP) etc.
CO2	Understand the petroleum resources, petroleum composition, nature of crude oil, types of crude oil, and its general processing.
CO3	Explain the types of minerals in India, mineral processing and the types of metal finish technology.
CO4	Understand the classification, properties, raw material composition of refractories.
CO5	Recognize the types of coating and differentiate paints, varnishes and lacquers.
CO6	Compile recent advances in industrial chemistry

Text Book (s)

1. P. C. Jain, M. Jain: Engineering Chemistry, Dhanpat Rai & Sons, Delhi.
2. S. S. Dara: A Textbook of Engineering Chemistry, S. Chand & Company Ltd. New Delhi.

Reference Book (s)

1. Industrial Chemistry by B.K. Sharma, GOEL Publishing House, Meerut

Unit I: Water treatment 8 lectures

Hardness of water, softening methods: lime soda method and ion exchange method, demineralization, desalting (electrodialysis and reverse osmosis method) primary, secondary and tertiary treatment of waste water. Estimation of biological and chemical oxygen demand. Design and functioning of sewage treatment plant (STP), Effluent treatment plant (ETP).
Unit II: Petroleum and Petrochemical products 8 lectures Petroleum resources, petroleum composition, different types of crude oil, general processing of crude oil- fractionation and stripping, thermal decomposition process, Cracking process- thermal and catalytic, Aviation fuel, gasoline, Diesel, Kerosene, LPG, Synthetic petrol. Petrochemicals – Types of petrochemicals. Manufacture, properties and uses of acetone, acetylene, ethylene, ethyl hexanol and 591sopropanol.
Unit III: Metallurgical processes and metals 10 lectures Minerals in India, mineral processing. Manufacture and applications of metal alloys, iron and steel, (Iron, steel alloy, tool steel and stainless steel), copper and its alloys. Metal finish technology: Eletro refining of metals, electroplating, surface treatment technology, surface coats. Electrodeposition, electroplating, hot dipping, metal cladding, immersion plating, metal spraying, vapour deposition, chemical and organic coating.
Unit IV: Cement and Glass 8 lectures Cement. Types and composition of cement, raw material, manufacture chemistry of setting cement, additives, and reinforced cement concrete, high performance concrete. Glass. Introduction, chemical and Physical properties of glass, raw materials and manufacture annealing and finishing, types of glasses – optical glass, borosilicate glass, high silica glass, safety glass, fiber glass, glass laminates, glass wool.
Unit V: Protective coatings 10 lectures Metallic coatings metal cladding, organic coating- Paints,Varnishes- oleoresinous and spirit varnishes, lacquers, difference between Paints, Varnishes and Lacquers, classification, formulation and preparation of paints, raw materials for paints: resinous binders, pigments- their classification, white, coloured, metallic and luminous pigments, drying oils, solvents, plasticizers and other additives, paint and film properties.
Unit VI: Recent Advances in industrial chemistry 4 lectures Recent Applications of industrial chemistry

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Environmental analytical chemistry (Elective)**				
Course Code	**MBS24T5104**				
Prerequisite	B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects				
Corequisite	Knowledge of Analytical Chemistry and toxicology				
Antirequisite					
		L	T	P	C
		3	0	0	3

Course Objectives:

- To introduce students about toxicology and associated terms, exposure types and factors influencing toxicity, toxicity tests in animals
- Provide knowledge about water pollution, water quality parameters, analysis and treatment methods
- Knowledge about different phases, factors affecting and chemical analysis of soil
- To impart knowledge about various food ingredients with food adulteration and analysis. .
- learn how to evaluate laboratory and pathologic testing.

Course Outcomes

CO1	Recognize different types of toxic substances, their responses and analyse toxicological information
CO2	Recognize the origin of wastewater and water pollution, quality requirement of water, analysis and treatment methods.
CO3	Acquire the knowledge of phases of soil, factors affecting the composition and concentration of salts in soils, Soil Sampling, Physical Analysis of various soil parameters.
CO4	Acquire the knowledge of various food ingredients and Pesticide analysis in water and food products.
CO5	Discuss various parameters of body fluids, and get an idea about the analysis in concerned field of clinical chemistry with various products.
CO6	Compile recent trends in Environmental analytical chemistry

Text Books

3. S.M. Khopkar, Basic concepts of analytical chemistry, Wiley Eastern, 2nd Edition, 2000.
4. Ayodhya Singh, A textbook of Environmental Chemistry, 1st Edition, Campus Books International, New Delhi, 2000.

Reference Books

1. Sajeev, Moorthy and Kaliappan, Food and Bioprocess engineering, Anamaya Publishers, New Delhi, 1st Edition, 2005.

Unit I: Environmental toxicology 8 Lectures Classification of Toxic agents, Acute and Chronic exposure-Route, site, duration and frequency of exposure. Toxico Kinetics-absorption, distribution, metabolism, excretion and influencing factors. Ld50, Ed50, Mechanism of action, Factors influencing toxicity, toxicity tests in animals-Acute, sub acute and chronic tests, mutagenicity, 592eratogenicity and carcinogenicity tests
Unit II: Water Analysis 8 Lectures Types & Effects of water pollution,. Objectives of analysis- parameters for analysis- colour, turbidity, total solids, conductivity, acidity, alkalinity, hardness, chloride, sulphate, fluoride, silica, phosphates and different forms of nitrogen. Measurements of DO, BOD and COD.
Unit III: Soil Analysis: 8 Lectures Introduction of phases of soil, Factors affecting the composition and concentration of salts in soils. Relation of particle size and texture with the nutrients present in the soil, Soil Sampling, Physical Analysis (porous nature, water absorbing capacity, pH, conductivity, cation exchange capacity and its determination)

Unit IV: Food Analysis 10 Lectures Food Ingredients:Moisture, ash, crude protein, fat, fibre, carbohydrates crude, Food adulteration & Analysis: Common adulterants in food, contamination of food stuffs. Microscopic examination of foods for adulterants. Pesticide analysis in water and food products.Extraction and purification of samples. HPLC, Gas chromatography for organophosphates. Chromatographic techniques for identification of chlorinated pesticides in food products
Unit V:Pathological Analysis 6 Lectures Clinical Chemistry – Composition of blood-collection and preservation of samples.Serum electrolytes, blood glucose, blood urea nitrogen, uric acid, albumin, globulins, Cannabinoids, barbiturates, acid and alkaline phosphatases.
Unit VI: Recent trends in Environmental analytical chemistry 4 lectures Recent Applications in Environmental analytical chemistry

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Solid State Chemistry (Elective)**				
Course Code	**MBS24T5103**				
Prerequisite	B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects				
Corequisite					
Antirequisite					
		L	T	P	C
		3	0	0	3

Course Objectives: To impart advanced knowledge in solid state chemistry covering crystal growth, preparation, properties and kinetics for their major applications.

Course Outcomes

CO1	Categorize various crystal structures and predict their properties.
CO2	Describe the various preparative routes of crystal structure.
CO3	Determine the factors affecting kinetics of reactions.
CO4	Determine the optical and conducting properties of metals, insulators and semi-conductors.
CO5	Interpret the magnetic properties of different crystal structures.
CO6	Compile recent advances in Solid State Chemistry

Text Books

1. 1. Principals of solid state, H. V. Keer, Wiley Eastern.
2. A.R. West, Solid State Chemistry and its Applications, (1984) John Wiley and Sons, Singapore.
3. Puri, Sharma and Pathania, Principles of Physical Chemistry, Vishal Publishing Co.

Reference Books

1. A guide to laser in chemistry by Gerald R., Van Hecke, Keny K. Karokitis
2. Solid state chemistry, N. B. Hannay
3. Solid state chemistry , D. K. Chakrabarty , New Age International
4. An Introduction to Crystallography : F. G. Philips
5. Crystal Structure Analysis: M. J. Buerger
6. Electronic processes in materials : L. U. Azroff and J. J. Brophy, Elements of X-ray Diffraction by B. D. Cullity, Addison- Weily

Unit-1 Introduction	08 Lectures
The Solid State Types of solids, isomorphism and polymorphism, laws of crystallography, lattice types, X-ray diffraction, Bragg's equation, Miller indices, Bragg Method, identification of unit cells from systematic absence in diffraction pattern, structure of simple lattice and X-Ray intensities	
Unit-2	08 Lectures
Preparation of Materials Purification and crystal growth, zone refining, growth from solution, growth from melt and preparation of organic semiconductors for device applications.	
Unit-3	08 Lectures
Solid State Reactions General principle, types of reactions: Additive, structure sensitive, decomposition and phase transition reactions, tarnish reactions, kinetics of solid state reactions, factors affecting the reactivity of solid state reactions.	
Unit-4	08 Lectures
Electronic Properties and Band Theory Metals, insulators and semi-conductors, free electron theory and its applications, electronic structure of solids, band theory, doping in semiconductors, p-n junction, super conductors, optical properties, photo-conduction and photoelectric effects	
Unit-5	08 Lectures
Magnetic Properties Basic magnetic properties: Diamagnetism, paramagnetism, ferromagnetism and antiferromagnetism, ferrimagnetism, hysteresis, magnetic symmetry and structures, magnetic resonance	
Unit-6 Recent trends in Solid State Chemistry	04 lectures
Recent advances and applications of solid state chemistry	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Bio-organic Chemistry**				
Course Code	**MBS24T5105**				
Prerequisite	Students should qualify B.Sc. and advanced knowledge of Chemistry				
Corequisite	Students should have fundamental knowledge of Organic Chemistry.				
Antirequisite					
		L	T	P	C
		3	0	0	3

Course Objectives:The course reviews to understand the organic chemistry of biomolecules like amino acids, peptides, nucleic acids and carbohydrates and enzyme action.

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Course Outcomes:

CO1	Interpret the organic chemistry of carbohydrates (K5)
CO2	Illustrate the organic chemistry of amino acids and peptides (K2)
CO3	Identify the mechanism of action of enzymes (K3)
CO4	Analyse the organic chemistry of coenzymes (K4)
CO5	Assess the bio-organic chemistry of lipids and nucleic acids (K5)
CO6	Compile the recent applications of Bio-organic Chemistry (K6)

Text Book (s)

- P. Y. Bruice, Organic Chemistry, 5thEd., Pearson, 2014.
- D.V.Vranken and G.A. Weiss, Introduction to Bioorganic Chemistry and Chemical Biology, 1st Ed., Garland Science, 2012.

Reference Book (s)

- T. K. Lindhorst, Essentials of Carbohydrate Chemistry and Biochemistry, 3rdEd., Wiley 2007.
- N. Sewald and H.D Jakubke, Peptides: Chemistry and Biology, 2ndEd. Wiley, 2009.

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Unit-1: Carbohydrates 8hrs Classification of carbohydrates, configuration, redox reactions of monosaccharides, KilianiFischer synthesis, Ruff degradation, hemiacetals and cyclic structure of monosaccharides, glycosides, anomeric effect, reducing and non-reducing sugars, disaccharides and polysaccharides.
Unit-2: Aminoacids, peptides and proteins 10hrs Amino acids: acid base properties, isoelectric point, separation, resolution of racemic mixtures of amino acids, asymmetric synthesis Peptide bonds,peptide synthesis. Proteins: primary, secondary, tertiary and quaternary structures, protein denaturation, natural β-amino acids and β-peptides; β-turn peptidomimetics, β-lactam based peptidomimetics.
Unit-3: Enzymes 7hrs Classification of enzymes, enzyme catalysis and kinetics, nucleophilic, acid, base and metal-ion catalysis, the catalytic triad, mechanisms of carboxypeptidase A, serine proteases and lysozyme, enzyme inhibition, Industrial biocatalysts.
Unit-4:Organic chemistry of coenzymes 7hrs

Niacin and its role in redox reactions, mechanisms for pyridine nucleotide coenzymes, flavin adenine dinucleotide and flavin mononucleotide, pyridoxal phosphate and its role in decarboxylation, transamination and racemization of amino acids.
Unit-5: Bioorganic Chemistry of lipids &Nucleic Acids 8hrs Fatty acids structure and classification, structure andfunction of prostaglandins, tri-acyl glycerol, structure and functions of phospholipids,spingomyelin, plasmologens and glycolipids. Nucleic acids: nucleosides and nucleotides, conformation of sugar-phosphate backbone, hydrogen bonding by bases, the double helix,A, B, and Z double helices, stability of double helix, replication, transcription and translation, DNA intercalators, chemical synthesis of DNA, catalytic RNA, siRNA, micro RNA, synthesis and applications of unnatural nucleosides. Structure of Peptide Nucleic Acid.
Unit VI: Recent applications of Bio-organic Chemistry 4hrs
Recent trends and applications of Bio-organic Chemistry

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Advanced Green Chemistry**				
Course Code	**MBS24T5106**				
Prerequisite	Students should have the basic and advanced knowledge of green chemistry needs and the limitations pursuing green chemistry and also the existing problems faced by our environment.				
Co-requisite	This part of course provides introduction to green chemistry aspects and the approaches to be adopted for greener synthesis. Students will understand the significance of green chemistry in industries specially to provide cleaner energy				
Anti-requisite					
		L	T	P	C
		3	0	0	3

Course Objectives:

Course Outcomes

CO1	Explain the basic concepts and need of green chemistry. (K2)
CO2	Utilize green chemistry tools and its principles for sustainable development. (K3)
CO3	Identify the role of catalysis in green chemistry. (K3)
CO4	Discover the application of green chemistry in real world.(K4)
CO5	Explain the various green technologies in academics and industries
CO6	Compile the recent developments in Advanced Green Chemistry

Text Book (s)

6. Anastas, P.T. & Warner, J.C. Green Chemistry- Theory and Practical, Oxford University Press (1998).
7. Matlack, A.S. Introduction to Green Chemistry, Marcel Dekker (2001).
8. Cann, M.C. &Connely, M.E. Real-World cases in Green Chemistry, American Chemical Society, Washington (2000).

9. Sharma, R.K. &Bandichhor, R. Hazardous Reagent Substitution, Royal Society of Chemistry, Green Chemistry Series (2018).
10. Ryan, M.A. &Tinnes, M. Introduction to Green Chemistry, American Chemical Society, Washington (2002).

Reference Book (s)

3. Sharma, R.K., Sidhwani, I.T. & Chaudhari, M.K. Green Chemistry Experiments: A Monograph I.K. International Publishing House Pvt. Ltd. New Delhi, Bangalore ISBN 978-93-81141-55-7 (2013). 7.

4. Lancaster, M. Green Chemistry: An Introductory Text RSC publishing, 2nd Edition ISBN 978-1-84755-873-2 (2010).

Unit-1	8 hours
Unit I:Green Chemistry: An introduction History of emergence of Green Chemistry through some industrial disasters, Environmental movements for public awareness and some important environmental laws, Definition of Green Chemistry, Need for Green Chemistry, Goals of Green Chemistry.	
Unit-2	8 hours
Unit II: Green Chemistry: An interdisciplinary approach towards sustainable development Green Chemistry advances towards a sustainable future, Green Chemistry v/s Environmental Chemistry, Green Chemistry and its interdisciplinary nature, Twelve Principles of Green Chemistry and their illustrations with examples. Green energy and sustainability.	
Unit-3	8 hours
Unit III: Role of Catalysis in Green Chemistry Catalysis for Green Chemistry with examples. Catalytic oxidation using H_2O_2, Bio-catalysis, Photocatalysis, Green reagents, Green solvents including solvent free synthesis of some organic compounds and inorganic complexes, alternative sources of energy, atom economy concept.	
Unit-4	10 hours
Unit IV: Application of Green Chemistry in real world cases Wealth from waste, Industrial case studies Green Nanotechnology, Greener approaches for nanoparticle synthesis Pharmaceutical industries: The largest waste producer problems and solutions through Green Chemistry benefits of greening industries, Next generation catalyst design, Microwave assisted synthesis etc.	
Unit-5	6 hours
Unit V: Green Chemistry: Emerging Trend Need for Academia-Industry collaborations, study of biomimetic catalysts, zero waste technology.	
Unit-6	4 hours
Recent developments and applications of Advanced Green Chemistry	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Carbon Materials**				
Course Code	**MBS24T5107**				
Prerequisite	Chemistry as major or one of the subjects along with Physics, Mathematics and Biology/any branch of biosciences as minor subjects at B.Sc. level.				
Corequisite					
Antirequisite					
		L	T	P	C
		3	0	0	3

Course Objectives: To give in-depth insight of carbon nano materials about preparation, synthesis, methods of purification and its major applications.

Course Outcomes

CO1	Simplify and discuss basic science behind the properties of materials at the 598anometer scale. (K4)
CO2	Interpret different methods of preparation, methods of purification and applications fullerenes.(K5)
CO3	Conclude the various preparation, purification methods and applications of carbon nano tube.(K5)
CO4	Compare various methods of DLC synthesis its properties, application in the field of polymer metical and lubricants science. (K4)
CO5	Distinguish the methods of preparation, purification and applications of graphene and its oxide. K4)
CO6	Compile recent applications of carbon materials (K6)

Text Book (s)

4. The Chemistry of Nanomaterials, C.N.R. Rao, A. K. Cheetham, Achim Muller Anthony K. Cheetham , John Wiley & Sons Inc, 2004, ISBN: 978-3-527-30686-2.
5. In Introduction to Nanotechnology C P Poole, Frank J. Owens, John Wiley & Sons, 2011, ISBN 978-81-265-1099-3.
6. Introduction to Nanoscience and Nanotechnology, KK Chattopadhyay, A N Banerjee, Phi Learning Pvt Ltd., New Delhi, 2012, ISBN-978-81-203-3608-7.

Reference Book (s)

3. Carbon Materials and Nanotechnology, Anke Krueger, Wiley –VCH Verlag GmbH & Co., 2010, ISBN-10: 3527318038.
4. Gold nanoparticles in biomedical applications: recent advances and perspectives Lev Dykmana and Nikolai Khlebtsov, Chem. Soc. Rev., 2012, 41, 2256–2282.

Nanotechnology Science Innovation & Opportunity, Lynn E Foster, Pearson publication, 2008, ISBN-9788131711187.

Unit-1: Introduction	08 hours
Definition of Nano, Scientific revolution-atomic structure and atomic size, emergence and challenges of nanoscience and nanotechnology, size, shape effects, large surface to volume ratio, surface and size effects on the properties.	
Unit-2 Fullerenes	08 hours
Introduction of fullerenes, structures of C60, C70 and higher fullerenes, synthesis, purification, properties, characterization and applications of fullerenes.	
Unit-3 Carbon Nano tubes (CNT)	10 hours
Introduction of Carbon nanotube (CNT), structure, synthesis and functionalization, single- and multi- wall CNT,characterizationpurification and major properties; applications of CNT for energy storage (such as Hydrogen), Use of nanoscale catalysts to save energy and increase the industrial productivity.	

Unit-4 Diamond like Carbon (DLC)	08 hours
Introduction of DLC, structure of DLC, synthesis, purification, properties, characterization and applications, and use in polymer coatings, lubricants, and medical applications.	
Unit-5 Graphenes	08 hours
Introduction of Graphene, structure, synthesis and functionalization of Graphene, properties and applications such as in the field of electronics, electrochemical deposition, and use as graphene Oxide.	
Unit-6 Recent advances in carbon materials	4 hours
Recent advances and applications of carbon materials	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Advanced Metallurgical Sciences**				
Course Code	**MBS24T5108**				
Prerequisite	B.Sc. Chemistry (H) or in B.Sc. having chemistry as one of the main subjects				
Co-requisite	Basic knowledge of Physical Chemistry and some portions of important metallurgical terms				
Antirequisite					
		L	T	P	C
		3	0	0	3

Course Objectives

1. Provides an overview of Materials Science and Engineering as a basis for understanding how structure/property/processing relationships are developed.
2. Illustrates the role of materials in modern society by case studies of advances in new materials and processes.

Course Outcomes

CO1	Explain the basic thermodynamics concepts and various rules related to the metallurgical concepts.(K2)
CO2	Identify the relationship between various solution models and thermodynamics of multicomponent systems.(K3)
CO3	Interpret the concepts of multicomponent systems and phase diagrams.(K2)
CO4	Analyse the thermodynamics of transformations and all the related terminologies. (K4)
CO5	Analyse the concepts of heterogeneous thermodynamic systems and factors involved. (K4)
CO6	Compile recent advances in Metallurgical Sciences (K6)

Text Book (s)

- Physical Chemistry of Metals: L.S. Darken and R.W. Gurry
- Thermodynamics of Solids: R.A. Swalin
- Principles of Extractive Metallurgy: H.S. Ray

Reference Book (s)

- Phase Transformations in Metals and Alloys: D.A. Porter and K.E. Easterling.

- W.D. Callister, Jr., "Materials Science and Engineering, An Introduction" Wiley – 7th Edition.

Unit-1 : Basic Introduction	10 Lecture
Basics: First, second and third laws of thermodynamics, free energy, Maxwell's relations, Clausius Clayperon equation, phase diagram, phase equilibrium, phase rule.	
Unit-2 : Solution and equilibrium concepts	12 Lecture
Free energy of solutions, Chemical potential, solution models, quasichemical theory, Solution models, regular, sub-regular, cluster variation models, multi-parameter models, quasi-chemical theory, multicomponent systems, Unary, binary and multicomponent systems, phase equilibrium, evolution of phase diagrams, metastable phase diagrams, calculation of phase diagrams, thermodynamics of defects.	
Unit-3 : Thermodynamics of Transformations	12 Lecture
Melting and solidification, precipitation, eutectoid, massive, spinodal, martensitic, order disorder transformations and glass transition. First and second order transitions, glass formation, Peritectic solidification and metastable equilibrium.	
Unit-4 : Heterogeneous Systems	8 Lectures
Thermodynamics of heterogeneous systems, Equilibrium constant, Ellingham diagrams and their application to commercially important reactions.	
Unit-5: Recent advances in Metallurgical Sciences	4 lectures
Advanced Metallurgical Sciences with recent applications	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100

Name of The Course	**Industrial Biochemistry**				
Course Code	**MBS24T5109**				
Prerequisite	Candidate should have passed graduation in relevant subject with 50% or equivalent CGPA from any recognized university.				
Corequisite	Students should have understanding of general biology, including a basic knowledge of the biological molecules, the cell, genetics, regulation, structure/function, interaction with the environment, and evolution.				
Antirequisite					
		L	T	P	C
		3	0	0	3

Course Objectives:

The course aims to integrate the knowledge of biochemistry and molecular biology with those of microbiology and biochemical engineering, with emphasis on their application to the biotechnological processes.

Course Outcomes

CO1	Demonstrate the industrial bioprocesses technology, downstream processing.
CO2	Describe the process of fermentation.
CO3	Demonstrate the various ways of food processing.
CO4	Describe the process of BIOSAFETY, IPR
CO5	Discuss the general principles of Quality Control and Good Manufacturing practices in food industry.
CO6	Compile recent advances in Industrial Biochemistry

Text Book (s)

- DobleMukesh and Kumar Anil, Biotreatment of industrial effluents.
- Wackett, L.P. and Hershberger, C.D. Biocatalysis and Biodegradation, Microbial Transformation of Organic Compounds, 2001 P.-171-190. ISBN 1-55581-179-5. ASM Press Washington D.C.
- WulfCrueger and AnnelieseCrueger, Biotechnology, Panima Publishing company New Delhi.
- Rainbow C. and Rose A.H., A.P., Biochemistry of Industrial micro-organisms.
- P. F. Stanbury, A. Whitaker and S. Hall, Principles of Fermentation Technology.

Reference Book (s)

- Bioethics and Biosafety, 1st edition (2008), M. K Sateesh, I K International Pvt Ltd, ISBN-13: 978-8190675703.
- Biosafety and Bioethics, 1st edition (2006), Rajmohan Joshi; Isha Books ISBN-13: 978-8182053779.
- Bioethics and biosafety in biotechnology, 1st edition (2007), V. Sreekrishna; New Age International (P) Ltd., ISBN-13: 978-8122420852.
- P. F. Stanbury, A. Whitaker and S. Hall, Principles of Fermentation Technology.

Unit-1Introduction to industrial bioprocesses technology (10 hours)

Definition and scope of Industrial Biochemistry,A historical overview of Industrial fermentation processes- traditional and modern biotechnology, Organism, processes and products related to modern biotechnology, Types of Bioreactors, Parameters for Bio process, bioprocess monitoring, downstream processing.

Unit-2Basics of fermentation (08 hours)

Biochemical Basis and Development of Industrial Fermentation process: screening and selection of the organisms for the production of biologically important compounds, Strain improvements, Detection and production of fermentation products, Fermentation media, Scale up of fermentations

Unit-3 Food biochemistry (12 hours)

Introduction to different categories of food; constituents of food products and their functional properties; introduction to food processing; intermediate moisture food; food spoilage; intrinsic and extrinsic factors affecting the quality and life of food material; food storage and preservation techniques; food poisoning and intoxication; by-product utilization and scale up; molasses and alcohol production.

Unit-4Biosafety, IPR (10 hours)

Historical background, introduction to biological safety cabinets, primary containment for biohazards, biosafety levels of specific microorganisms, recommended biosafety levels for infectious agents and infected animals. Intellectual property rights (IPR)

Unit-5QC and GMP (10 hours)

General principles of Quality Control and Good Manufacturing practices in food industry, Determination of shelf – life of food products, Food Adulteration – Common food adulterants, their harmful effects and physical and chemical methods for their detection, Role of ISI Agmark and FDA in food industry.

Unit-VI Recent advances in Industrial Biochemistry (4 hours)

Recent trends and applications of Industrial Biochemistry

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
30	20	50	100