A PROJECT REPORT

ON

HEAT LOAD CALCULATION

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD

OF

DIPLOMA IN MECHANICAL ENGINEERING

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Session (2021-2022)

CERTIFICATE

This is to certify that the project report entitled "Heat Load Calculation" was successfully completed by the student of sixth semester Diploma in Mechanical Engineering.

Abdul Samad

In partial fulfillment of the requirements for the award of the Diploma in Mechanical engineering and submitted to the Department of mechanical engineering of Galgotias University, University Polytechnic, work carried out during a period for the academic year 2021-2022 as per curriculum.

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ABSTRACT

The aim of a heating, ventilation, and air conditioning (HVAC) system is to meet the environmental requirements of occupant comfort and a mechanism. HVAC systems are widely used in a variety of structures, including manufacturing, commercial, domestic, and institutional structures. To manage the operation of a heating and/or air conditioning system, HVAC (Heating, Ventilation, and Air Conditioning) equipment requires a control system. Its effective design is arguably the most complex system installed in a building and is responsible for a substantial component of the total building energy use. A right size and design of HVAC system will provide the desired comfort and will run efficiently. This strategy guideline discusses the information needed to design an energy efficient HVAC system for a commercial building by providing results of Heat load calculations, the right choice of system selection and selection of proper materials. In this project we investigate and review the different Materials, Chiller choices, give a brief about HVAC, outline the process followed, which demonstrates its ability to improve the performance of HVAC systems to reduce energy consumption. The pros and cons of each system type specific to the building layout and climate zone will be discussed in this study. This research has a central theme which focuses on reducing the energy consumption of a Educational Institution with structure in 2D in Auto CAD.

CHAPTER – 1

INTRODUCTION

1.1 History of HVAC System

Air-conditioning dates to prehistory. Ancient Egyptian buildings used a wide variety of passive air-conditioning techniques. These became widespread from the Iberian Peninsula through North Africa, the Middle East, and Northern India. Similar techniques were developed in hot climates elsewhere. Passive techniques remained widespread until the 20th century, when they fell out of fashion, replaced by powered A/C. Using information from engineering studies of traditional buildings, passive techniques are being revived and modified for 21st-century architectural designs. Air conditioners allow the building indoor environment to remain relatively constant largely independent of changes in external weather conditions and internal heat loads. They also allow deep plan buildings to be created and have allowed people to live comfortably in hotter parts of the world.

1.2 Development

In the 1558 Giambattista Della Porta described a method of chilling ice to temperatures far below its freezing point by mixing it with potassium nitrate in his popular science book Natural Magic. In 1620 Cornelis Drebbel demonstrated "Turning Summer into winter" for James I of England, chilling part of the Great Hall of Westminster Abbey with an apparatus of troughs and vats. Drebbel's contemporary Francis Bacon, like della Porta a believer in scientific communication, may not have been present at the demonstration, but in a book published later the same year, he described it as "experiment of artificial freezing" and said that "Nitre (or rather its spirit) is very cold, and hence nitre or salt when added to snow or ice intensifies the cold of the latter, the nitre by adding to its own cold, but the salt by supplying activity to the cold of the snow."

In 1758, Benjamin Franklin and John Hadley, a chemistry professor at Cambridge University, conducted an experiment to explore the principle of evaporation to rapidly cool an object. Franklin and Hadley confirmed that the evaporation of highly volatile liquids (such as alcohol and ether) could be used to drive down the temperature of an object past the freezing point of water. They conducted their experiment with the bulb of a mercury thermometer as their object and with a bellows used to speed up the evaporation. They lowered the temperature of the thermometer bulb down to −14 °C (7 °F) while the ambient temperature was 18 °C (64 °F). Franklin noted that soon after they passed the freezing point of water 0 °C (32 °F), a thin film of ice formed on the surface of the thermometer's bulb and that the ice mass was about 6 mm (1»4 in) thick when they stopped the experiment upon reaching -14 °C (7 °F). Franklin concluded: "From this experiment one may see the possibility of freezing a man to death on a warm summer's day.

The 19th century included several developments in compression technology. In 1820, English scientist and inventor Michael Faraday discovered that compressing and liquefying ammonia could chill air when the liquefied ammonia could evaporate. In 1842, Florida physician John Gorrie used compressor technology to create ice, which he used to cool air for his patients in his hospital in Apalachicola, Florida. He hoped to eventually use his ice-making machine to regulate the temperature of buildings and envisioned centralized air conditioning that could cool entire cities. Gorrie was granted a patent in 1851 but following the death of his main backer he was not able to realize his invention. In 1851 James Harrison's created the first mechanical ice-making machine in Geelong, Australia and was granted a patent for an ether vapour-compression refrigeration system in 1855 that produced three tons of ice per day. In 1860 he established a second ice company and later entered the debate over how to compete against the American advantage of ice-refrigerated beef sales to the United Kingdom.

Electricity made development of effective units possible. In 1901 American inventor Willis H. Carrier built what is considered the first modern electrical air conditioning unit. In 1902 he installed his first air-conditioning system, in the Sackett-Wilhelms Lithographing & Publishing Company in Brooklyn, New York, his invention controlled both the temperature and the humidity which helped maintain consistent paper dimensions and ink alignment at the printing plant. Later, together with six other employees Carrier formed The Carrier Air

Conditioning Company of America, a business which in 2020 employed 53,000 employees and was valued at $18.6 billion.

In 1906, Stuart W. Cramer of Charlotte was exploring ways to add moisture to the air in his textile mill. Cramer coined the term "air conditioning", using it in a patent claim he filed that year as analogous to "water conditioning", then a well-known process for making textiles easier to process. He combined moisture with ventilation to "condition" and changes the air in the factories, controlling the humidity so necessary in textile plants. Willis Carrier adopted the term and incorporated it into the name of his company.

Domestic air conditioning soon took off. In 1914 the first domestic air conditioning was installed in Minneapolis in the home of Charles Gates. Built in 1933, Meadowmont House is believed to be the first private homes in the United States equipped for central air conditioning.

Additionally, car manufacturers began exploring ways to use air conditioning in vehicle. 1933 was also the year in the first automobile air conditioning systems were offered for sale. In 1935 Chrysler Motors introduced the first practical semi-portable air conditioning unit. In 1939, Packard became the first automobile manufacturer to offer an air conditioning unit in its cars.

Innovations in the latter half of the 20th century allowed for much more ubiquitous air conditioner use. In 1945, Robert Sherman of Lynn, Massachusetts invented a portable, inwindow air conditioner that cooled, heated, humidified, dehumidified, and filtered the air. By the late 1960s, most newly built residential homes in the United States had central air conditioning. Box air conditioning units during this time also became more inexpensive which resulted in greater population growth in the states of Florida and Arizona.

As international development has increased wealth across countries, and global warming has increase temperatures, global use of air conditioners has increased. By 2018 an estimated 1.6 billion air conditioning units were installed worldwide, with the International Energy Agency expecting this number to grow to 5.6 billion units by 2050. Between 1995 to 2004 the proportion of urban households in China with air conditioners increased from 8% to 70%. As of 2015, nearly 100 million homes or about 87% of US households had air conditioning systems. In 2019 it was estimated that 90% of new single-family homes constructed in the USA included air conditioning (ranging from 99% in the South to 62% in the West).

1.3 Basics of HVAC System

HVAC stands for Heating, Ventilation and Air-Conditioning. Its goal is to provide the thermal comfort and good indoor air quality. HVAC system designing is the sub-disciple of mechanical engineering, based on the principles of thermodynamics, heat transfer, fluid mechanics and some of architectural. HVAC systems are more often used in several types of buildings such as commercial, residential, institutional and many more. The selection of HVAC systems for buildings will depend on the climate, age of building, the individual preferences of the owner of the buildings and the designer of the buildings, the project budget, and the architectural design of the building.

Many of the situations requiring mechanical ventilation also need a degree of air conditioning. To summarize, those situations most likely to require air conditioning are:

1. Rooms subject to high solar gains, such as south facing rooms especially those with large areas of glazing.

2. Rooms with high equipment densities such as computer rooms and offices which make extensive use of IT.

3. Rooms in which environment (temperature, dust, or humidity) sensitive work is being carried out such as operation theatres and microprocessor manufacturing units.

1.3.1 Some Basic Terms Related to HVAC System

- Dry-bulb temperature

  It is the temperature of air measured by a thermometer freely exposed to the air but shielded from radiation and moisture. Dry bulb temperature is the temperature that is usually thought of as air temperature, and it is the true thermodynamic temperature. It is the temperature measured by a regular thermometer exposed to the airstream. It is the temperature shown by a dry sensing element such as mercury in a glass tube thermometer. The Dry Bulb Temperature refers basically to the ambient air temperature. It is called "Dry Bulb" because the air temperature is indicated by a thermometer not affected by the moisture of the air. It is a type of temperature measurement that reflects the physical properties of a system with a mixture of a gas and a vapour, usually air and water vapour.

- Dew Point Temperature

The dew point is a saturation temperature. The temperature at which the air is saturated (100% RH) and further cooling manifests in condensation from water in the air. The dew point is the temperature at which water vapour starts to condense out of the air (the temperature at which air becomes completely saturated). Above this temperature the moisture will stay in the air. If the dew-point temperature is close to the dry air temperature - the relative humidity is high, If the dew point is well below the dry air temperature - the relative humidity is low Dew point: Latent heat: All pure substances in nature can change their state. Solids can become liquids (ice to water) and liquids can become gases (water to vapour) but changes such as these require the addition or removal of heat. The heat that causes these changes is called latent heat. Heat energy added or removed as a substance changes state, whilst temperature remains constant, E.G. Water changing to steam at $100 f$c and atmospheric pressure (W).

- Absolute humidity

Absolute humidity is the total amount of water vapour present in each volume of air. It does not take temperature into consideration.

- Relative humidity (RH)

Relative Humidity is the ratio of water contained in air at a given dry bulb temperature, as a percentage of the maximum amount of water that could be held in air at that temperature. Thus, the relative humidity of air is a function of both water content and temperature.

- Specific humidity

  It the mass of water vapour present in a unit mass of air. Where temperatures are high and rainfall is excessive, the specific humidity of the air reaches high proportions. This is also called “moisture content”

  .

- Sensible heat gain

  When an object is heated, its temperature rises as heat is added. The increase in heat is called sensible heat. Similarly, when heat is removed from an object and its temperature falls, the heat removed is also called sensible heat. Heat that causes a change in temperature in an object is called sensible heat.

1.3.2 Basic Refrigeration Cycle

- **Compressor**
  An air compressor is a device that converts power (using an electric motor, diesel, or gasoline engine, etc.) into potential energy stored in pressurized air

- **Condenser**
  A condenser is a device or unit used to condense a substance from its gaseous to it liquid state, by cooling it.in so doing, the latent heat is given by the substance, and will transfer to the condenser coolant

- **Expansion Valve**
  A thermal expansion valve is a component in refrigeration and air conditioning systems that control the amount of refrigerant flow into the evaporator thereby controlling the superheating at the outlet of the evaporator.

- **Evaporator**
  An evaporator is a device used to turn liquid form of a chemical into its gaseous form. The liquid is an evaporated, or vaporized, into a gas

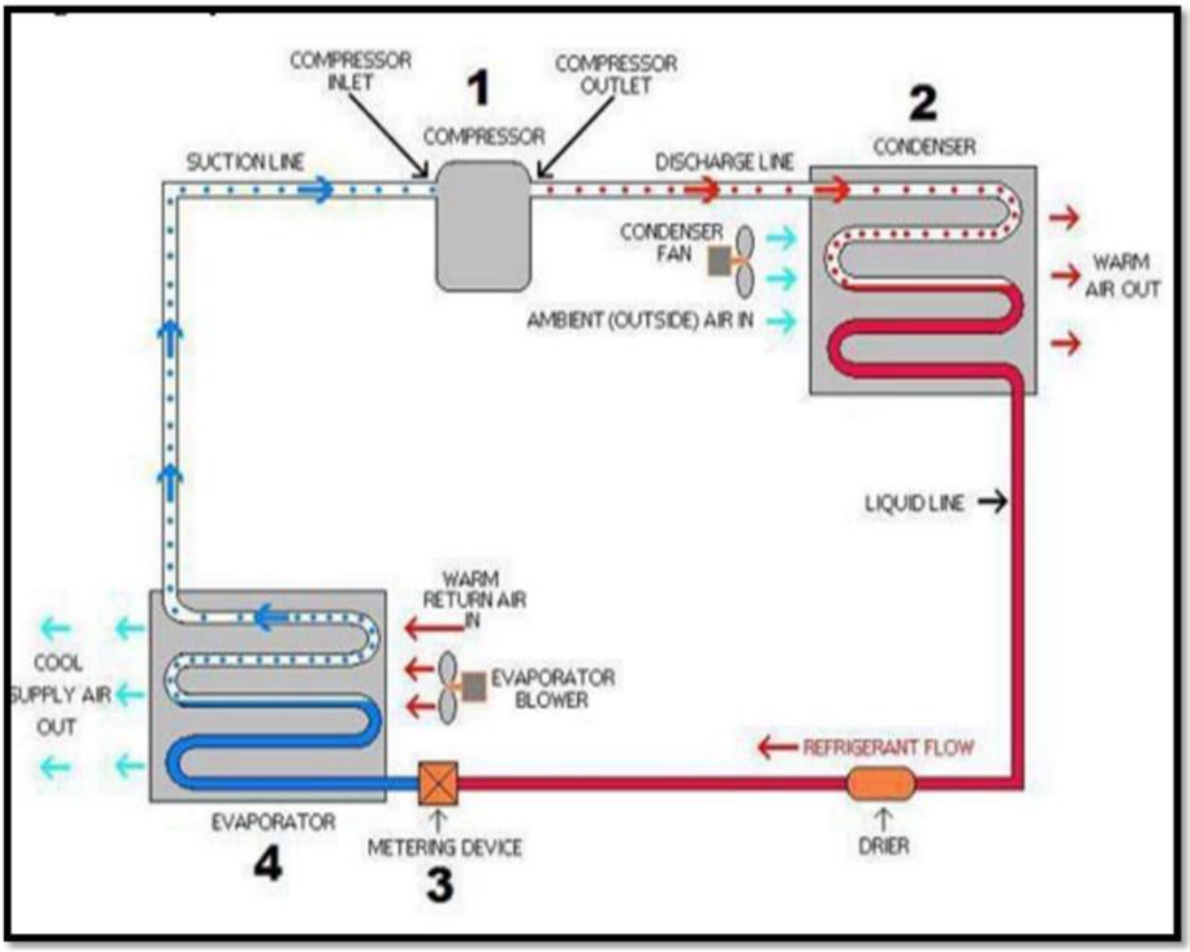

Figure 1: Basic Refrigeration Cycle

1.4 Need for HVAC System

HVAC systems are responsible for the regulation of heat, airflow, ventilation, and air conditioning of an entire building. You will not see the machines when you enter the building, but you will most certainly feel the effects of a comfortable and well-ventilated workplace.

- As we know that 1 TR is amount of heat extracted from the atmosphere for melting one metric ton of ice in 24 hours. One ton of refrigeration (TR) equals to 12000 btu/hr or 3025 kcal/hr.
- Here are some of the top reasons why business owners opt to have reliable HVAC systems in place for their office buildings.

- HVAC systems control the overall climate in the building. They also make the proper adjustments whenever we experience changes in outdoor temperature. During the winter season, the HVAC systems (mainly the boilers or heaters) work to keep the indoor temperature at a comfortable level. In hotter times of the season, the HVAC systems regulate air temperature by providing the necessary cooling to keep the entire building comfortable.

- Having a comfortable office climate increases the level of productivity and increases morale amongst the workers and employees. If you let your people work in settings conducive for work, they will surely be motivated to perform better because they feel good in their work environment.

- No employee will enjoy working in an office where it is freezing, or in an office where you frequently must ignore your perspiration just to focus on your computer screen. Having a proper HVAC system installed is guaranteed to make your employees happy, hence, giving you better work results in return.

- HVAC systems not only regulate the temperature inside the building, but they also improve the quality of air. The quality of air pertains to humidity, and a typical HVAC system will reduce the amount of humidity in the air so your workers and employees can continue enjoying a cosy and pleasant atmosphere at work.

CHAPTER-2
LITERATURE REVIEW

The compressive study of existing information related to HVAC system –

1. Farheen Bano and Vandana Sehgal said Comparison of the thermal performance of energy efficient office buildings in composite climate, India. The aim of this paper is to examine the energy consumption of and determine the energy efficient design strategies for midrise and high rise the building.

2. Yingya Chen, Yanfeng Liu, Jingrui Liu, Jiaping Liu, Yingying Wang Central air conditioning said Energy Consumption of a buildings occupies a large proportion of energy consumption in all over world, to minimise the energy consumption of buildings by using solar energy. Challenges: Photovoltaic (PV) air conditioning is an effective way to solve the problems of energy consumption of office buildings.

3. Sam C. M. Hui describes the Design strategies for effective, green HVAC systems and new emerging HVAC technologies. This paper describes the basic concepts of green buildings and discusses the role of HVAC for ensuring high performance sustainable buildings in design and operation.

4. Daut, M. Adzrie, M. Irwanto, Ibrahim, M. Fitra said the development of renewable energy is on the rise worldwide because of the growing demand on energy, high oil prices therefore to overcome this use of solar energy in HVAC system. This paper focuses on design and construction of a direct current (DC) AC systems integrated with PV systems, solar batteries, chargers, inverter.

5. Critiana Maria Barbosa Riebeiro said the study of retrofit building design to make sustainable. To achieve sustainability in any HVAC system. HVAC retrofit can be very complicated, owner's property manager looks to outside sources for designing retrofit and designing its benefits. HVAC retrofit are generally undertaken to boost a system's cost or energy efficiency. Any retrofit should take both factors, as well as environmental concern into account.

6. W. Goetzler, M. Guernsey, and J. Young said that The U.S. Department of Energy’s (DOE) Building Technologies Office (BTO) within the Office of Energy Efficiency and Renewable Energy (EERE) works with researchers and industry partners to develop and deploy technologies that can substantially reduce energy consumption in residential and commercial buildings. BTO aims to reduce building-related primary energy consumption by 50% by the year 2030, relative to 2010 consumption. Specifically for heating, ventilation, and air conditioning (HVAC), BTO identified primary energy savings targets of 12% by 2020 and 24% by 2030.

7. Guanglin Xu said that Compared to single-variable model, MLR models showed a decrease in coefficient of variation which is between 10 percentage to 60 percentage and with an average decrease of about 33%. a dynamic neural network is proposed to build a dynamic HVAC model and then a multi-objective particle swarm optimization algorithm is applied to solve the model.

CHAPTER- 3

PROBLEM STATEMENT

3.1 Problem Statement

Energy efficiency in heating, ventilating, and air-conditioning (HVAC) systems is a primary concern in process projects, since the energy consumption has the highest percentage in HVAC for all processes.

Without sacrifice of thermal comfort, to reset the suitable operating parameters, such as the humidity and air temperature, would have energy saving with immediate effect. In this paper, the simulation-optimization approach described the effective energy efficiency for HVAC systems which are used in industrial process. Due to the complex relationship of the HVAC system parameters, it is necessary to suggest optimum settings for different operations in response to the dynamic cooling loads and changing weather conditions during a year.

The energy consumed in air conditioning and refrigeration systems is sensitive to load changes, ambient condition etc. The major purpose of air conditioning is to make occupants comfortable with the cooled air in the room.

However, the system of air conditioning in commercial building running inconsistent due to the several factor. This problem is occurred by the unstable supply cooled air to the system. Therefore, the occupants and some locations are not receiving a necessary capacity of cooled air.

Considering various factors into account, to design an energy efficient system, to get an overview 2D model of educational institution in Delhi , do the heat load calculations, and select the right chiller for the operation of the HVAC system.

3.2 Project Objective

The main objective in this project is to design energy efficient HVAC system for a commercial building. This study will be focused on 3 parts:

1. Proper selection of efficient material
2. To minimize the Heat Load
3. Duct Designing

CHAPTER-04

METHODOLOGY

4.1 Study of location and surrounding.

HVAC systems are of great importance to architectural design efforts for four main reasons. First, these systems often require substantial floor space and/or building volume for Equipment and distribution elements that must be accommodated during the design process.

Second, HVAC systems constitute a major budget item for numerous common building types. Third, the success or failure of thermal comfort efforts is usually directly related to the success or failure of a building's HVAC systems. Last, maintaining appropriate thermal conditions through HVAC system operation is a major driver of building energy consumption.

4.1.1 HVAC System Evolution

The first step in selecting a HVAC system is to determine and document constraints dictated by performance, capacity, available space, budgets, and any other factors important to the project. This usually starts with a formal meeting with an architect/owner and understanding his or her requirements.

4.1.2 Owner's Needs

If the architect is a creator, the customer is a king, and his needs and requirements must be met.

Depending on the customer goals, the building and its HVAC requirements have to be designed accordingly. For example, take an example of multi-storey office building. The complete building may have either a single owner or multiple owners. A single owner normally prefers a central plant, as the quality of air conditioning is far superior and life expectancy is higher. The operation and maintenance costs are also lower than a floor-by-floor system. In addition, the owners can opt for an intelligent building by incorporating a building management system (BMS).

This will enable the owner to derive benefits of optimal utilization of the air conditioning plant. A multiple owner facility requires a system, which provides individual ownership and energy billing for which a floor-by-floor air conditioning system using packaged units or split units is most suited subject to economics of space and aesthetics.

Another important requirement is the normal working hours of the user/users. Some users may have different working hours or different timings. Some areas such as computer rooms may need 24-hour air conditioning. Other areas may have special design requirements. Due to such multiple requirements many engineers prefer a "hybrid system" which is a combination of a central plant and packaged units/split units. For example, a hotel may use packaged unitary air conditioners (or fan coil units served with air-water central system) for the individual guest rooms, roof top units for meeting rooms/restaurants, and a central plant system for the lobby, corridors and other common spaces. Such systems offer high flexibility in meeting the requirement of different working hours and special design conditions.

While HVAC engineer manages the system design the architect retains control of the complete building product. The type of system selected is determined by HVAC designer's knowledge of systems. Architect must also understand the basics, system objectives, the role of key system components, the type of systems that are available and what such systems can and cannot accomplish. Most customers may not understand HVAC design aspects; their benefits and limitations and it is the architect's/ HVAC engineer's responsibility to guide and advise the best option. For HVAC engineer the customer may be an architect whose customer may be the building owner.

- What Influences HVAC design?

  Investment in a building project entails significant capital investment and associated costs over the economic life of the project. It is a mistaken notion that the buildings costs must be expensed once. The buildings like any other industry have running expenses in a way that they consume lot of energy and require water & disposal facilities that accounts for significant recurring costs. The HVAC systems often are very large and are responsible for a large portion of a building's first cost and operating cost.

Every building is unique. For instance, residential apartments, shopping complex, office complex, hospital, hotel, airport, or industry; all have different functional requirements, occupancy pattern and usage criteria. The geographical location of the building, ambient conditions, indoor requirements, building materials, dimensional parameters, aesthetic requirements, noise, and environment issues need careful evaluation. The HVAC design and selection must be customized to meet all these requirements.

Each solution begins with an assessment of the owner's business needs for HVAC, architect's vision, requirements of the facilities manager, combined with a review of the HVAC system itself, be it existing or planned.

4.1.3 Design aspects for HVAC System

HVAC systems is an important part of the building construction budget, account for a major portion of a building's annual energy consumption, often require substantial space allocations and contribute to interior environment that is critically evaluated by the building occupants and the users.

Everyone cares about cost! But the wise customer lays down a list of minimum requirements and then negotiates. Mostly customer goes for price only and skips on right equipment and design specific cations.

The selection process could be chilled water system or direct expansion system, the design of HVAC systems is mainly related to various parameters, including but not limited to the factors listed below.

4.1.4 Details of architecture

- Structure, orientation, geographical location, altitude, shape, modules size & height
- Purpose of the building, area classification, occupancy, and usage patterns
- Ratio of internal to external zones, glazing, plant room sitting, space for service distribution.
- Climate and shading, thermal insulation, passive climate control, relationship with adjacent buildings

- New or existing building, renovation, or extension project, retrofitting or new equipment.
- Plant and system design to match the characteristic of the building and the need to meet the needs (known and unknown) of the ultimate occupants.

4.1.5 Details of Space allocation

- Floor space and clear heights to accommodate HVAC plant, equipment, distribution, and room elements.
- Shaft spaces available for routing ducts/pipes
- Location and size of structural columns and beams, clearance through steelwork, position of reinforcing rods
- Ceiling height, clearance between suspended ceilings and beams
- Foundation and supports requirement, permissible loadings.
- Location of obstructions that may be in the route of air-conditioning services, particularly ductwork.

As our Educational institute is in Delhi the co-ordinates for Delhi are 28.7041°N, 77.1025°E. The city is surrounded by plain area on all directions. Delhi features a monsoon influenced humid subtropical under the Köppen climate classification.

Annual mean temperatures range from 10 to 40 °C, with the most comfortable time to visit in the winter – November to February. The highest maximum temperature ever recorded was 45.6 °C on 29 April 1941. The lowest recorded temperature was 9.8 °C on 3 January 2013. In the cold season, the state is sometimes affected by cold waves in association with the north range from hills.

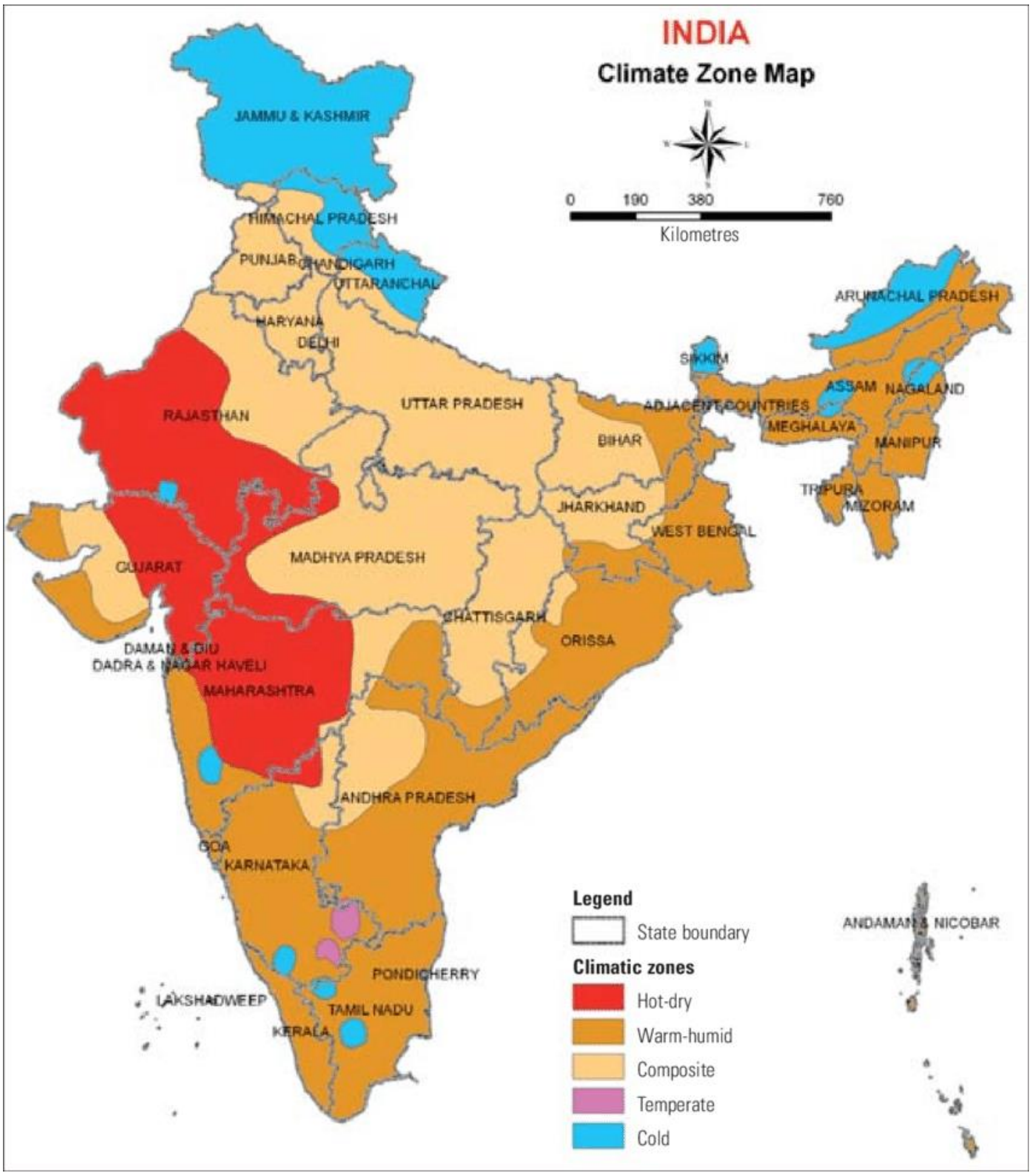

Figure 2 : Climate Zone , Source : NBC Standards

Educational institute Building located in New Delhi with Latitude and longitude the following value were chosen

:

Table - 1 Outside Design Data

State & Station	Lat Deg. N	Alt Mts.	Daily Range °F	Summer °F DB. WB. RH %	Monsoon °F DB. WB. RH %	Winter °F DB. WB. RH %	Summer °C DB. WB.	Monsoon °C DB. WB.	Winter °C DB. WB.

U.P & Delhi																	
New Delhi	28.35	216	25	110	75	20	95	83	60	45	41	70	43.3	23.9	35.0	28.3	7.2	5.0
Lucknow	26.52	111	30	109	79	26	94	83	64	48	43	67	42.8	26.1	34.4	28.3	8.9	6.1
Deharadun	30.19	682	26	105	75	25	90	80	65	42	38	70	40.6	23.9	32.2	26.7	5.6	3.3
Kanpur	26.26	126	29	109	77	23	97	83	58	45	42	80	42.8	25.0	36.1	28.3	7.2	5.6
Agra & Aligarh	27.1	169	26	108	75	21	96	83	58	48	43	67	42	23.9	35.6	28.3	8.9	6.1
Varanasi	25.2	76	29	109	76	21	94	83	64	50	47	80	43	24.4	34.4	28.3	10	8.3
Allahabad	25.3	98	26	110	76	22	96	83	58	48	46	87	43	24.4	35.6	28.3	8.9	7.8

Figure 3 sources: ISHRAE Handbook (NEW DELHI)

4.2 Building Orientation

4.2.1 Form and Orientation

Form and orientation constitute two of the most important passive design strategies for reducing energy consumption and improving thermal comfort for occupants of institute. It affects the amount of sun falling on surfaces, day lighting, and direction of winds. Towards net zero energy goals; form and orientation have a significant impact on institute energy efficiency, by harnessing sun and prevailing winds to our advantage. Thus, they play a pivotal role design approach as these strategies are one-time interventions and their potential benefits should not be missed.

Institute designs vary according to context of its location and climate. However, the underlying principle remains the same, maximizing the amount of solar radiation in winter and minimizing the amount in summers. In predominantly hot regions, institute should be ideally oriented to minimize solar gains; the reverse is applicable for cold regions. Orientation also plays an important role about wind direction.

The institute form determines the volume of space inside a institute that needs to be heated or cooled. Thus, more compact the shape, the less wasteful it is in gaining/losing heat. In hot & dry regions and cold climates, a building’s shape needs to be compact to reduce heat gain and losses, respectively.

4.2.2 Sun Path

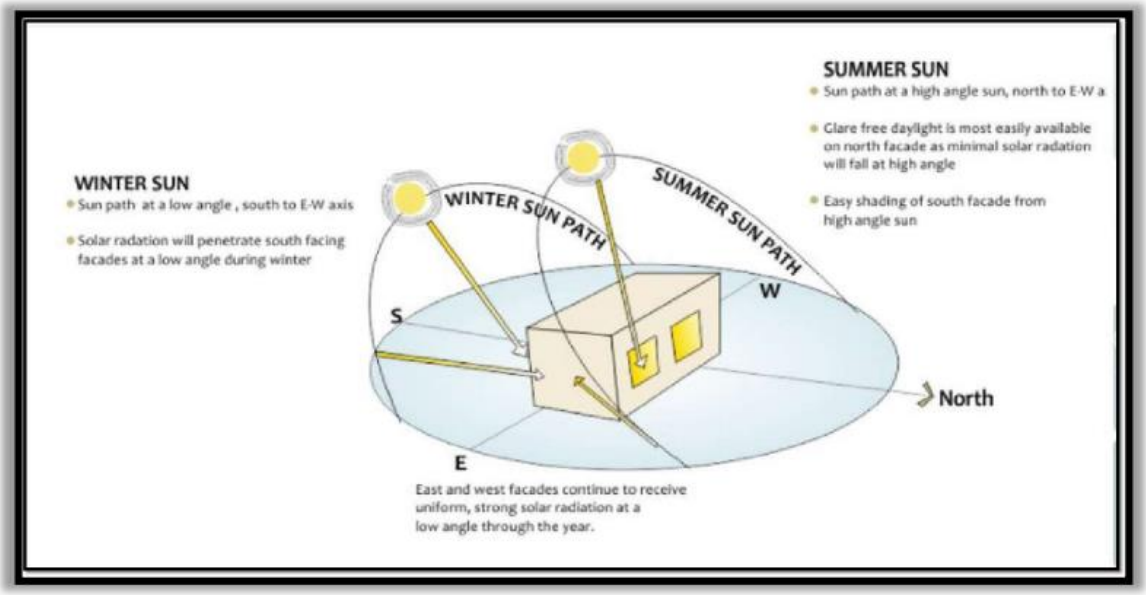

Figure 4: Sun path for HVAC System

The building orientation is generally used to refer solar orientation while planning of house with respect to sun path. The orientation can refer to a particular room or most important, the building facade. The word ‘building orientation’ is basically the positioning of a building with respect to the sun, usually done to maximize solar gain at the appropriate time of the year when required in cold climate and to minimize solar gain in a hot climate. Best house orientation can increase the energy efficiency of your home by making it more comfortable to live in and cheaper to run from energy consumption point of view. The fact is that the sun is lower in the sky in winter than in summer allows us to plan and construct buildings that capture that free heat in winter and reject the heat in summer. The building orientation of the whole building plays an important part in designing a good home.

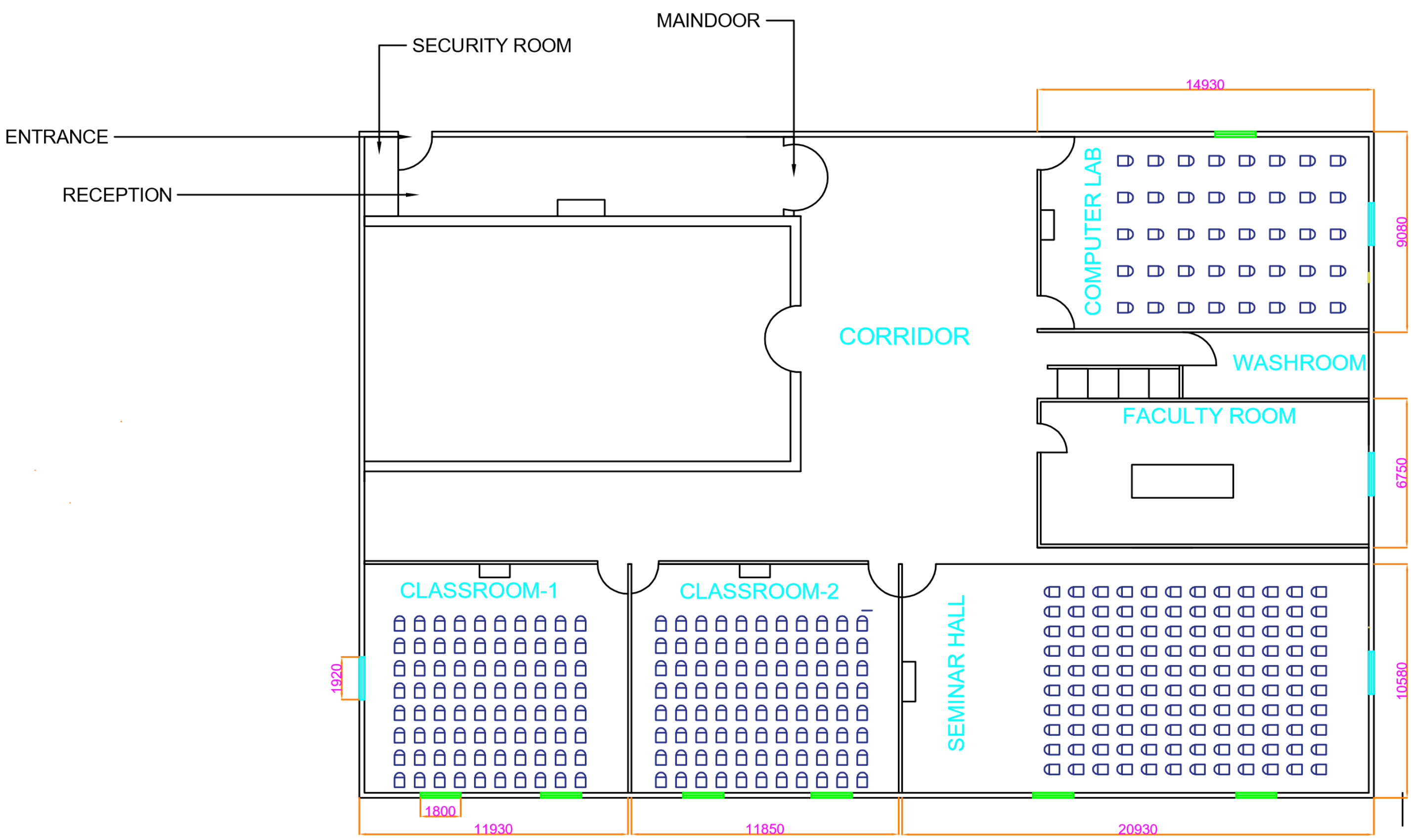

Figure 5: Floor Plan

4.2.3 Objectives of Building Orientation.

The orientation of a building is done for the following purposes:

1. To give the correct direction to the building according to the surroundings.

2. To provide natural light and air to the inhabitants.

3. To save the inhabitants from dust and smoke.

4. To save the inhabitants from noise.

5. To provide privacy to the inhabitants.

6. To save the building from damages due to rain.

7. To save the inhabitants from the bad effects of the worst weather.

8. To add beauty to the building

4.3 Heat Load

- Load Estimation

The importance of accurate load calculations for air conditions design can never be over emphasized. In fact, it is the precision and care exercised by the designer in the calculation of the cooling. load for summer and the heating load for winter that a trouble free, successful operation of air conditioning plant after installation would depend

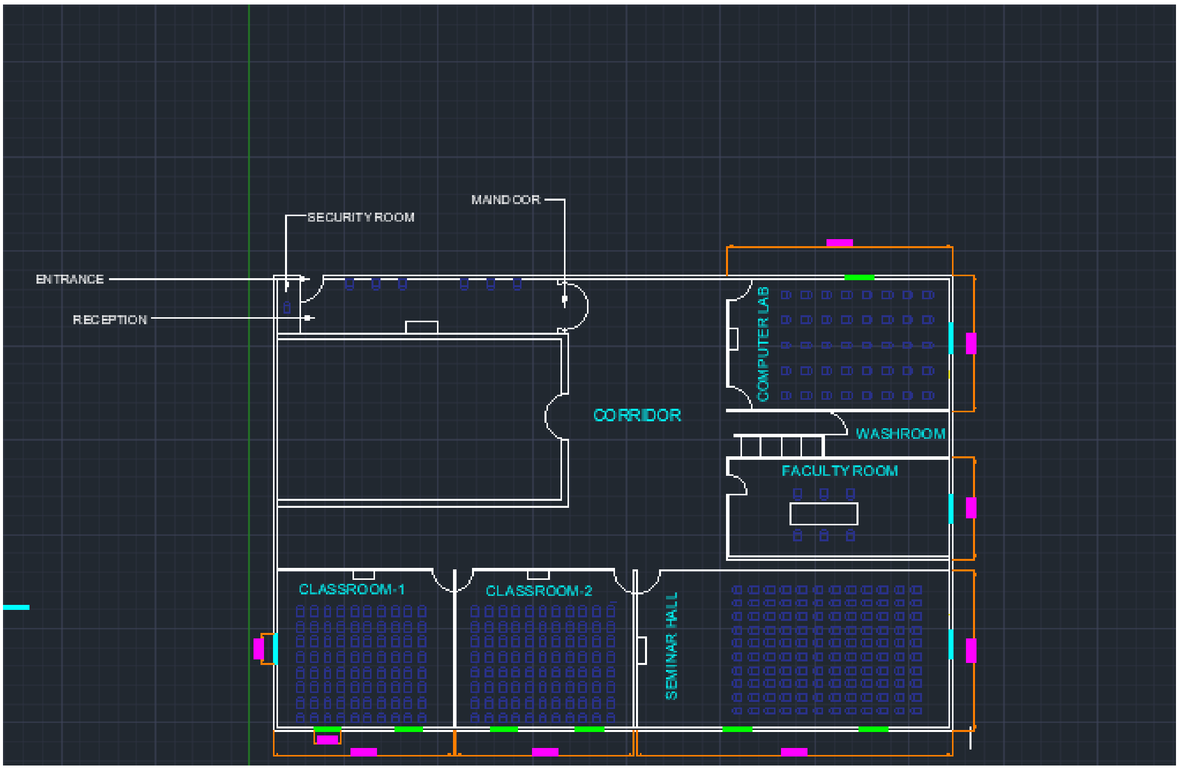

Figure 6 : Floor Pla

- Solar Heat Gain Through Glass

Glass, which is transparent, allows the sunrays to pass through it. This results in heat dissipation inside the room. The amount of heat dissipated into room depends upon the glass area that is exposed to sun.

1.8 ISHRAE Handbook

Table 5 - Over-All Factors for Solar Heat Gain Thru Glass
With and without Shading Devices

Apply Factors to Table 3
Outdoor wind velocity, 5 mph - Angle of incidence, 30° - Shading devices fully covering window

TYPE OF GLASS	GLASS FACTOR NO SHADE	INSIDE VENETIAN BLIND* 45° horz. or vertical or ROLLER SHADE			OUTSIDE VENETIAN BLIND 45° horz. slats		OUTSIDE SHADING SCREEN 17° horz. slats		OUTSIDE AWNING vent. sides & top	
		Light Colour	Medium Colour	Dark Colour	Light Colour	Light on Outside Dark on inside	Medium Colour	Dark Colour	Light Colour	Med. or Dark
ORDINARY GLASS	1.00	.56	.65	.75	.15	.13	.22	.15	.20	.25
REGULAR PLATE (1/4 inch)	.94	.56	.65	.74	.14	.12	.21	.14	.19	.24
HEAT ABSORBING GLASS										
40 to 48% Absorbing	.80	.56	.62	.72	.12	.11	.18	.12	.16	.20
48 to 56% Absorbing	.73	.53	.59	.62	.11	.10	.16	.11	.15	.18
56 to 70% Absorbing	.62	.51	.54	.56	.10	.10	.14	.10	.12	.16
DOUBLE PANE										
Ordinary Glass	.90	.54	.61	.67	.14	.12	.20	.14	.18	.22
Regular Plate	.80	.52	.59	.65	.12	.11	.18	.12	.16	.20
48 to 56% Absorbing outside; Ordinary Glass inside	.52	.36	.39	.43	.10	.10	.11	.10	.10	.13
48 to 56% Absorbing outside; Regular Plate inside.	.50	.36	.39	.43	.10	.10	.11	.10	.10	.12
TRIPLE PANE										
Ordinary Glass	.83	.48	.56	.64	.12	.11	.18	.12	.16	.20
Regular Plate	.69	.47	.52	.57	.10	.10	.15	.10	.14	.17
PAINTED GLASS										
Light Colour	.28									
Medium Colour	.39									
Dark Colour	.50									
STAINED GLASS										
Amber Colour	.70									
Dark Red	.56									
Dark Blue	.60									
Dark Green	.32									
Greyed Green	.46									
Light Opalescent	.43									
Dark Opalescent	.37									

Figure 7: Table of solar heat gain thru glass

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20° Table 7 - Solar Heat Gain Thru Ordinary Glass *(Contd.)* 20°

Btu / (hr) (sq ft sash area)

20° NORTH LATITUDE		AM					SUN TIME						PM		20° SOUTH LATITUDE	
Time of Year	Exposure	6	7	8	9	10	11	Noon	1	2	3	4	5	6	Exposure	Time of Year
	North	28	41	33	25	19	17	15	17	19	25	33	41	28	South	
	Northeast	81	154	144	122	83	38	15	14	14	14	12	9	3	Southeast	
	East	81	148	160	143	96	41	14	14	14	14	12	9	3	East	
	Southeast	20	62	73	60	44	21	14	14	14	14	12	9	3	Northeast	
JUNE 21	South	3	9	12	14	14	14	14	14	14	14	12	9	3	North	DEC 22
	Southwest	3	9	12	14	14	14	14	21	44	66	73	62	28	Northwest	
	West	3	9	12	14	14	14	14	41	96	143	160	148	61	West	
	Northwest	3	9	12	14	14	14	15	38	83	122	144	154	81	Southwest	
	Horizontal	11	60	121	176	216	232	250	232	216	176	121	60	11	Horizontal	
	North	20	28	23	17	15	14	14	14	15	17	23	28	20	South	
	Northeast	71	132	138	111	73	31	14	14	14	13	12	8	3	Southeast	
JULY 23	East	75	148	163	145	99	46	14	14	14	13	12	8	3	East	JAN 21
	Southeast	31	70	85	79	57	29	14	14	14	13	12	8	3	Northeast	
&	South	3	8	12	13	14	14	14	14	14	13	12	8	3	North	&
	Southwest	3	8	12	13	14	14	14	29	57	79	85	70	31	Northwest	
MAY 21	West	3	8	12	13	14	14	14	46	99	145	163	148	75	West	NOV 21
	Northwest	3	8	12	13	14	14	14	31	73	111	138	132	71	Southwest	
	Horizontal	8	55	118	175	216	240	251	240	216	175	118	55	8	Horizontal	
	North	6	10	11	13	14	14	14	14	14	13	11	10	6	South	
	Northeast	45	111	118	89	50	18	14	14	14	13	11	7	2	Southeast	
AUG 24	East	53	142	165	149	106	51	14	14	14	13	11	7	2	East	FEB 20
	Southeast	29	89	113	108	98	55	20	14	14	13	11	7	2	Northeast	
&	South	2	7	11	14	20	24	26	24	20	14	11	7	2	North	&
	Southwest	2	7	11	13	14	14	20	56	98	108	113	89	29	Northwest	
APR 20	West	2	7	11	13	14	14	14	51	106	149	165	142	53	West	OCT 23
	Northwest	2	7	11	13	14	14	14	18	50	89	118	111	45	Southwest	
	Horizontal	5	48	107	167	210	235	247	235	210	167	107	48	5	Horizontal	
	North	0	6	11	13	14	14	14	14	14	13	11	6	0	South	
	Northeast	0	83	87	59	22	14	14	14	14	13	11	6	0	Southeast	
SEPT 22	East	0	130	163	149	104	45	14	14	14	13	11	6	0	Eest	MAR 22
	Southeast	0	99	136	140	120	84	41	15	14	13	11	6	0	Northeast	
&	South	0	8	22	38	52	63	65	63	52	38	22	8	0	North	&
	Southwest	0	6	11	13	14	15	41	84	120	140	136	99	0	Southwest	
MAR 22	West	0	6	11	13	14	14	14	45	104	149	163	130	0	West	SEPT 22
	Northwest	0	6	11	13	14	14	14	14	22	59	87	83	0	Southwest	
	Horizontal	0	30	93	153	198	225	233	225	198	153	93	30	0	Horizontal	
	North	0	4	9	12	13	14	14	14	13	12	9	4	0	South	
OCT 23	North East	0	44	52	29	13	14	14	14	13	12	9	4	0	Southeast	
	East	0	99	147	141	100	49	14	14	13	12	9	4	0	Eest	APR 20
	Southeast	0	91	146	160	149	119	74	27	13	12	9	4	0	Northeast	
&	South	0	21	80	76	93	106	111	106	93	76	50	21	0	North	&
	Southwest	0	4	9	12	13	27	74	119	149	160	146	91	0	Northwest	
FEB 20	West	0	4	9	12	13	14	14	40	100	141	147	99	0	West	AUG 24
	Northwest	0	4	9	12	13	14	14	14	13	29	52	44	0	Southwest	
	Horizontal	0	18	68	127	171	196	208	196	171	127	68	18	0	Horizontal	
	North	0	3	8	11	13	13	13	13	13	11	8	3	0	South	
	Northeast	0	24	26	14	13	13	13	13	13	11	8	3	0	Southeast	
NOV 21	East	0	71	128	127	91	43	13	13	13	11	8	3	0	East	MAY 21
	Southeast	0	73	144	164	158	135	91	46	16	11	8	3	0	Northeast	
&	South	0	28	69	100	123	136	141	136	123	100	69	28	0	North	&
	Southwest	0	3	8	11	16	46	91	135	158	164	144	73	0	Northwest	
JAN 21	West	0	3	8	11	12	13	13	43	91	127	128	71	0	West	JULY 23
	Northwest	0	3	8	11	12	13	13	13	13	14	26	24	0	Southwest	
	Horizontal	0	5	48	101	146	172	180	172	146	101	48	5	0	Horizontal	
	North	0	2	7	11	12	13	13	13	12	11	7	2	0	South	
	Northeast	0	14	18	12	12	13	13	13	12	11	7	2	0	Southeast	
	East	0	56	118	121	85	34	13	13	12	11	7	2	0	East	
	Southeast	0	59	139	167	159	134	97	60	20	11	7	2	0	Northeast	
DEC 22	South	0	25	74	111	132	146	149	146	132	111	74	25	0	North	JUNE 21
	Southwest	0	2	7	11	20	60	97	134	159	167	139	59	0	Northwest	
	West	0	2	7	11	12	13	13	34	85	121	118	56	0	West	
	Northwest	0	2	7	11	12	13	13	13	12	12	18	14	0	Southwest	
	Horizontal	0	4	36	92	135	161	170	161	135	92	36	4	0	Horizontal	

Solar Gain correction	Steel Sash, or No Sash	Haze	Altitude	Dew point Decrease From 67 F	Dew point Increase From 67 F	South Lat. Dec. or Jan
	x 1/.85 or 1.17	- 15% (Max)	+ 0.7% per 1000 Ft	+ 7% per 10 F	- 7% per 10 F	+ 7%

Figure 8: Heat gain thru ordinary glass

- Solar Heat Gain Through Walls And Roofs:

Heat gain through the exterior construction (walls and roof) is normally calculated at the time of greatest heat flow. It is caused by the solar heat being absorbed at the exterior surface and by the temperature difference between the outdoor and indoor air. The heat flow through the structure may then be calculated, using the steady state heat flow equation with equivalent temperature difference (ETD)

Q= U*A*ETD where Q is heat flow rate in (KJ/Sec)

U = transmission rate (W/Sq. M K)

A= Area of surface (Sq m)

ETD= Equivalent Temperature Difference (K)

Heat loss through the exterior construction is normally calculated at the time of greatest heat flow.

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Table 9 - Equivalent Temperature Difference (Deg F)
For Dark Colored †, Sunlit and Shaded Walls*

Based on Dark Colored Walls; 95 F db Outdoor Design Temp; Constant 80 F db Room Temp; 20 deg F Daily Range; 24 hour Operation; July and 40° N. Lat.†

Exposure	Weight of Wall (lb/sq.ft)	SUN TIME AM							PM												AM				
		6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5
Northeast	20 4"	5	15	22	23	24	19	14	13	12	13	14	14	14	12	10	8	6	4	2	0	−2	−3	−4	−2
	60 6"	−1	−2	−2	5	24	22	20	15	10	11	12	13	14	13	12	11	10	8	6	4	2	1	0	−1
	100 8"	4	3	4	4	4	10	16	15	14	12	10	11	12	12	12	11	10	9	8	7	6	6	5	5
	140 12"	5	5	6	6	6	6	6	10	14	16	14	12	10	10	10	10	10	10	10	9	9	8	7	7
East	20	1	17	30	33	36	35	32	20	12	13	14	14	14	12	10	8	6	4	2	0	−1	−2	−3	−3
	60	−1	−1	0	21	30	31	31	19	14	13	12	13	14	13	12	11	10	8	5	4	3	1	1	0
	100	5	5	6	8	14	20	24	25	24	20	18	16	14	14	14	13	12	11	10	9	8	7	7	6
	140	11	10	10	9	8	9	10	15	18	19	16	17	16	14	12	13	14	14	14	13	13	12	12	12
Southeast	20	10	6	13	19	26	27	28	26	24	19	16	15	14	12	10	8	6	4	2	0	−1	−1	−2	−2
	60	1	1	0	13	20	24	28	26	25	21	18	15	14	13	12	11	10	8	6	5	4	3	3	2
	100	7	7	6	6	6	11	16	17	18	19	18	16	14	13	12	11	10	10	10	9	9	8	8	7
	140	9	8	8	8	8	7	6	11	14	15	16	18	16	15	14	13	12	12	12	11	11	10	10	9
South	20	−1	−2	−4	1	4	14	22	27	30	28	26	20	16	12	10	7	6	3	2	1	1	0	0	−1
	60	−1	−3	−4	−3	−2	7	12	20	24	25	26	23	20	15	12	10	8	6	4	2	1	1	0	−1
	100	4	4	2	2	2	3	4	8	12	15	16	18	18	15	14	11	10	9	8	8	7	6	6	5
	140	7	6	5	5	4	4	4	4	4	7	10	13	14	15	16	16	14	12	10	10	9	9	8	7
Southwest	20	−2	−4	−4	−2	0	4	6	19	26	34	40	41	42	30	24	12	6	4	2	1	1	0	−1	−1
	60	2	1	0	0	0	1	2	8	12	24	32	35	36	35	34	20	10	7	6	5	4	4	3	3
	100	7	5	6	5	4	5	6	7	8	12	14	19	22	23	24	23	22	15	10	10	9	9	8	7
	140	8	8	8	8	8	7	6	6	6	7	8	9	10	15	18	19	20	13	8	8	8	8	8	8
West	20	−2	−3	−4	−2	0	3	6	14	20	32	40	45	48	34	22	14	8	5	2	1	0	0	−1	−1
	60	2	1	0	0	0	2	4	7	10	19	26	34	40	41	36	28	16	10	6	5	4	3	3	2
	100	7	7	6	6	6	6	6	7	8	10	12	17	20	25	28	27	26	19	14	12	11	10	9	8
	140	12	11	10	9	8	8	8	9	10	10	10	11	12	14	16	21	22	23	22	20	18	16	15	13
Northwest	20	−3	−4	−4	−2	0	3	6	10	12	19	24	33	40	37	34	18	6	4	2	0	−1	−1	−2	−2
	60	−2	−3	−4	−3	−2	0	2	6	8	10	12	21	30	31	32	21	12	8	6	4	3	1	0	−1
	100	5	4	4	4	4	4	4	4	4	5	6	9	12	17	20	21	22	14	8	7	7	6	6	5
	140	8	7	6	6	6	6	6	6	6	5	6	7	8	9	10	14	18	19	20	16	13	11	10	9
North (Shade)	20	−3	−3	−4	−3	−2	1	4	8	10	12	14	13	12	10	8	6	4	2	0	0	−1	−1	−2	−2
	60	−3	−3	−4	−3	−2	−1	0	3	6	8	10	11	12	12	12	10	8	6	4	2	1	0	−1	−2
	100	1	1	0	0	0	0	0	1	2	3	4	5	5	5	8	7	6	5	4	3	3	2	2	1
	140	1	1	0	0	0	0	0	0	0	1	2	3	4	5	6	7	8	7	6	4	3	2	2	1
		6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5
		AM							PM												AM				
		SUN TIME																							

Equation: Heat Gain through Walls, Btu/hr = (Area, sq.ft) X (equivalent temp diff) X (transmission coefficient U.

* All values are for both insulated and uninsulated walls.

† For other conditions, refer to corrections on page 1.15.

For wall constructions less than 20 lb/sq ft, use listed values of 20 lb/sq ft.

Figure 9: Equivalent Temperature Difference

• Transmission Heat Gain through Glass

This is heat gain that is obtained due to the difference in outside and inside conditions. The amount of heat that is transmitted through the glass into the room depends upon the glass area, temperature difference and transmission coefficient of glass. Here total glass irrespective of the direction is taken into consideration in total glass area

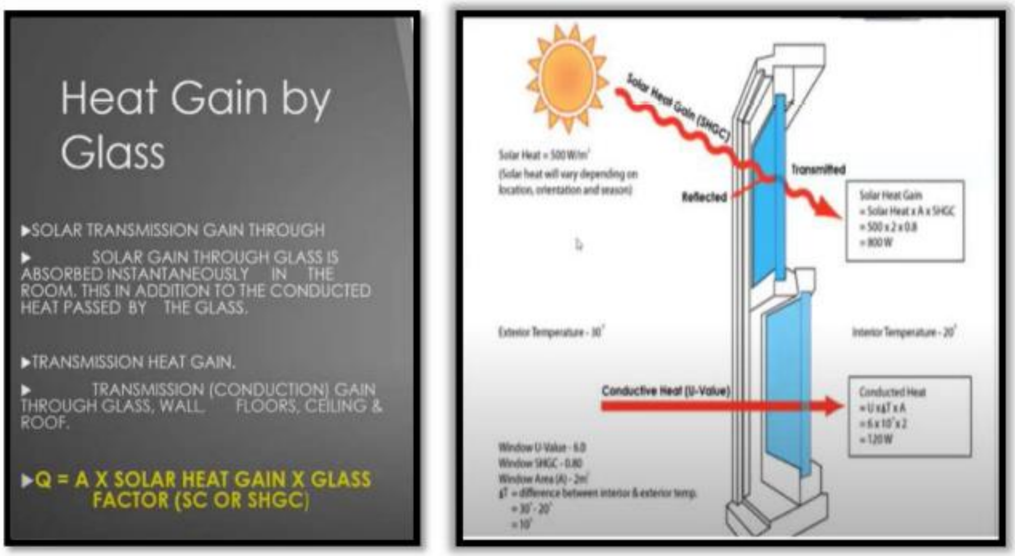

Figure10: Heat gain by glass

- Transmission Through Partitions and Walls:

Heat gain here also depends upon the temperature difference between the outside and inside conditions, transmission coefficient and wall area exposed or partition wall area. Here the total area of the wall is taken irrespective of its direction. The temperature taken is generally 2℃ less than the temperature gradient that is existing. Equivalent temperature difference is taken in these calculations.

- Occupancy Load

Heat is generated within the human body by oxidation commonly called metabolic rate. The metabolic rate varies with the individuals and with his activity level. The amount of heat dissipated by the human body by radiation and convection is determined by the difference in temperature between the body surface and its surrounding. The heat dissipated by evaporation is determined by the difference in vapor. Pressure between body and the air. The metabolic rate is 85% for the male, and for children it is about 75%. The excess heat and moisture brought in by people, where short time occupancy is occurring may increase heat gain from people by as much as 10%.

Table 12 - Heat Gain from People

DEGREE OF ACTIVITY	TYPICAL APPLICATION	Metabolic Rate (Adult Male) Btu/hr	Average Adjusted Metabolic Rate* Btu/hr	ROOM DRY - BULBTEMPERATURE									
				82F Btu/hr		80F Btu/hr		78F Btu/hr		75F Btu/hr		70F Btu/hr	
				Sensible	Latent	Sensible	Latent	Sensible	Latent	Sensible	Latent	Sensible	Laten
Seated at rest	Theater, Grade School	390	350	175	175	195	155	210	140	230	120	260	90
Seated, very light work	High School	450	400	180	220	195	205	215	185	240	160	275	125
Office worker	Offices, Hotels, Apts., College	475	450	180	270	200	250	215	235	245	205	285	165
Standing, walking slowly	Dept., Retail, or Variety Store	550											
Walking, seated	Drug Store	550	500	180	320	200	300	220	280	255	245	290	210
Standing, walking slowly	Bank	550											
Sedentary work	Restaurant†	500	220	190	360	220	330	240	310	280	270	320	230
Light bench work	Factory, light work	800	750	190	560.	220	530	245	505	295	455	365	385
Moderate dancing	Dance Hall	900	850	220	630	245	605	275	575	325	525	400	450
Walking, 3 mph	Factory, fairly heavy work	1000	1000	270	730	300	700	330	670	380	620	460	540
Heavy work	Bowling Alley‡ Factory	1500	1450	450	1000	465	985	485	965	525	925	605	845

*Adjusted Metabolic Rate is the metabolic rate to be applied to a †Restaurant - Values for this application include ...

Figure 11: Heat Gain from People

- Lighting

Lights generate sensible heat by the conversion of the electrical power input into light and heat. The heat is dissipated by radiation to the surrounding surfaces, by conduction into the adjacent materials and by convection to the surrounding air.

Fluorescent= total light watts 1.25
Incandescent= total light watts

Figure 12: Heat Gain through Equipment

- Appliances:

Most applications contribute both sensible and latent heat to a space. Electric appliances contribute latent heat, only by virtue of the function they perform that is, drying, cooking, etc., whereas gas burning appliances, contribute additional moisture as a product of combustion. A properly designed hood with a positive exhaust system removes a considerable amount id the generated heat and moisture from most types of appliances.

- Electric Motors:

Electric motors contribute sensible heat to the space by converting the electrical power input to heat. Some of this power is dissipated as heat in the motor frame and can be evaluated as: Input*(1-motor efficiency)

- System Heat Gain:

The system heat gain is considered as the heat added to or lost by the system components, such as the ducts, piping, air conditioning fan and pump etc. this heat gain must be estimated and included in the load estimate but can be accurately evaluated only after the system has been designed.

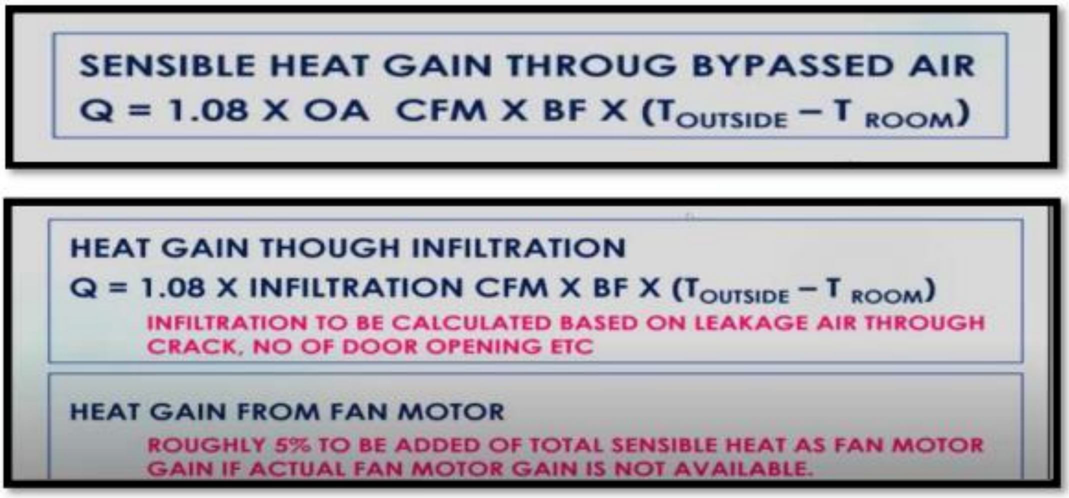

Figure 13: Sensible Heat Gain

- Heat Gain from Outside Air:

To estimate the infiltration of air into the conditioned space, the crack method is considered to become more accurate. The leakage of air is a function of wind pressure difference P, which is determined by the equation:

dp = 0.00470C2

Where dp is in the cm of WG and C is in Km/hr is the local wind velocity. Tables are available for infiltration in m/hr/m of crack for different dp values. After the calculation of all these components of room loads, the room sensible heat and the room latent heat are determined.

- Determination of U factor:

  The conduction heat transfer through the walls or roof will depend on its thickness and the thermal conductivity of the material used. In addition, there will be convection and radiation from both the outside and inside surfaces. Hence, the steady state heat transfer is expressed in terms of an overall heat transfer coefficient U and the overall temperature difference between the outside and inside. Also, a wall may be composite, consisting of many sections of different construction and insulating materials. For this purpose, all the layers of different materials of varying thickness ‘X’ and thermal conductivity ‘K’ are to be taken into consideration. The cross section of the wall, considered for this building with thickness.

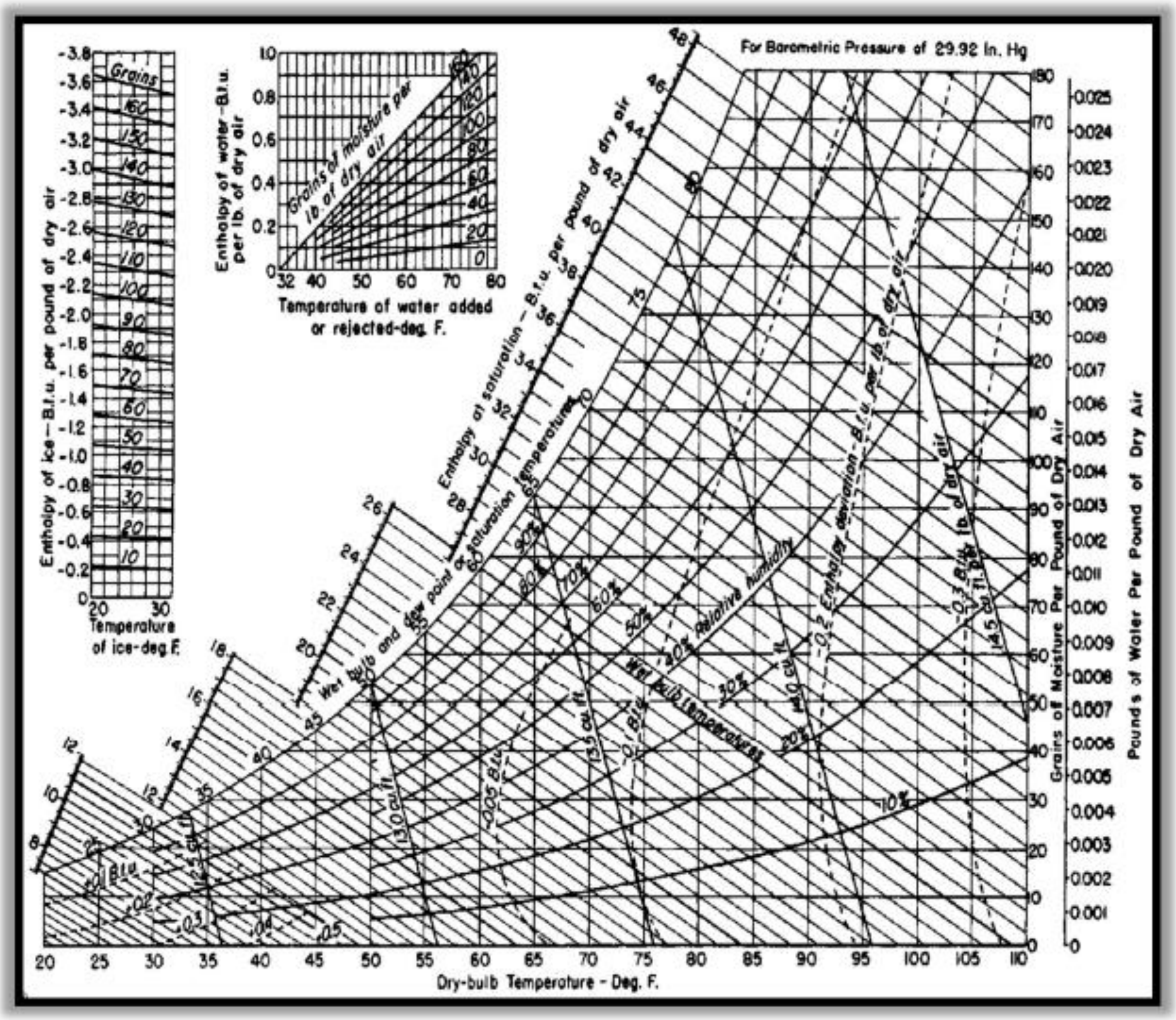

Figure 14: Pshychometry Chart

- Design Parameters

This is the following Plan of HVAC installation Plan where we have to plan and install HVAC system. The following is institute Plan. In following Plan we Have 2class room, Computer Lab, Faculty Room, Seminar Hall.

- **Application** : Educational Institute
- **Location** : New Delhi
- **Room Condition** : DBT – 75 Deg F & RH = 50 %
- **Floor** : 1st Floor (Assuming Ground Floor & 2nd Floor is air conditioned)
- **Height of Building** :12 Feet
- **Height of Window** : 5 Feet
- **Type of Glass** : Ordinary glass - Inside Venetian blind type of light colour, without storm type single layer
- **Type of wall** : 15 mm thick - **Inner & outer plaster** of sand aggregate
  230 mm thick **- masonry unit** – Cinder aggregate

  Weight of wall = 100 lb/sqft

  Weight of roof = 80 lb/sqft
- **U factor of Roof** = 0.5 BTU/hr sqft Deg F
- **U factor of Ceiling** **: 0.4** BTU/hr sqft Deg F
- **U factor of Floor** **: 0.4** BTU/hr sqft Deg F
- **Occupancy** : As per architectural Layout
- **Type of Cooling Coil** : 4 row deep , without spray type with 12 fins/inch
- **Lighting Load** : As per application

Equipment Load :

1. **Class Room 1**
   Laptop – 17 Inch with 2 gb RAM (Consider every student using 1 laptop)
   Projector (1000 W) - 1 Nos
2. **Class Room 2 :** Same as class room
3. **Faculty Room :**

Laptop – 17 Inch with 2 gb RAM – 6 Nos Multi Function Printer (Print, scan,copy) – 1 Nos

4. COMPUTER **LAB**: Computer 3Ghz with 2 gb RAM 40 STUDENTS 690 W-
   1 PROJECTOR 1000W

5. **Entrance Lobby & Reception :**
   - Desktop – 17 Inch with 2 gb RAM – 1 Nos
   - 1 PROJECTOR 1000W
   - 4 LED – 1200

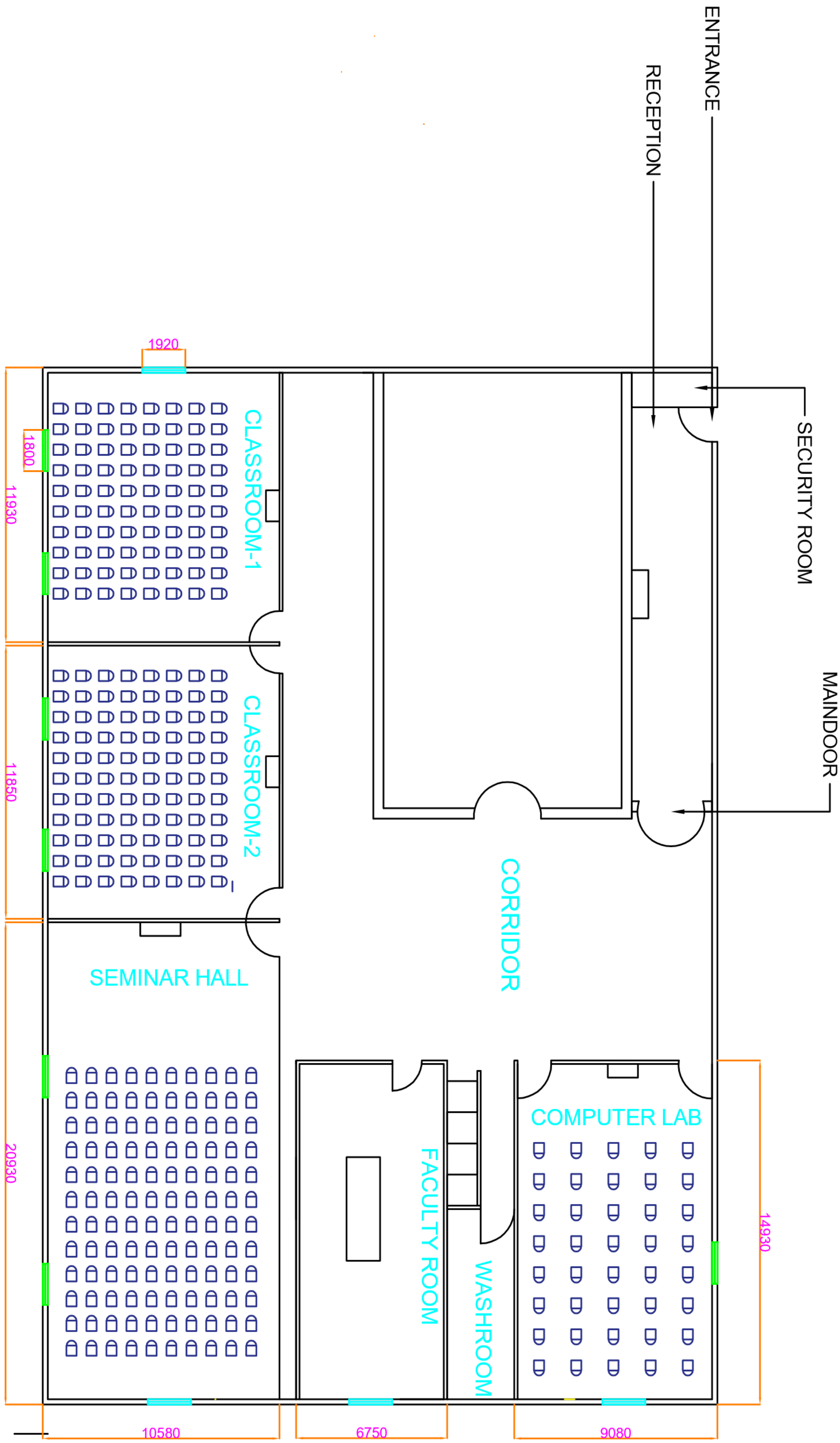

Figure 15 - Institute Plan

- E20 Sheet(Class 1)

HEAT LOAD SHEET - E 20

JOB NAME:	MAJOR PROJECT							DATE:	03-04-2022	
SPACE FOR:	Classs Room 1							Estimated By		
SIZE:	1358.61	Sq ft	16303	Cu ft	ESTIMATE FOR : SUMMER					
	SOLAR GAIN GLASS			HEAT GAIN	CONDITION	DB (°F)	WB (°F)	% RH	DP (°F)	GR/LB
ITEM	Area	Sun Gain	Factor	Btu/hour	OUTSIDE	110	0	20	0	77.4
	(Sq ft)	(Btu/h.sq ft)			ROOM	75	0	50	0	64.9
N - Glass	0.0	14	0.56	0	DIFFERENCE	35	XXXX	70	0	12.5
NE - Glass	0.0	12	0.56	0						
E - Glass	0.0	12	0.56	0	OUTSIDE AIR (VENTILATION)					
SE - Glass	0.0	14	0.56	0	88	People X	7.5	CFM/Person		660
S - Glass	59.1	12	0.56	397	16303	Cu ft X	1	Air change per hour		272
SW - Glass	0.0	100	0.56	0				CFM VENTILATION		660
W - Glass	31.5	164	0.56	2893						
NW - Glass	0.0	123	0.56	0	EFF. SENSIBLE HEAT FACTOR (ESHF) =					
Sky light										
	SOLAR & TRANS. GAIN WALLS & ROOF							Selected ADP =	54	°F
ITEM	Area	Eq. temp. diff.	U					Dehum. temp rise =	18.48	°F
	(Sq ft)	(°F)	(Btu/h.sq ft)					DEHUMIDIFIED CFM =	5518	CFM
N - Wall	0.0	21.5	0.34	0	NOTES					
NE - Wall	0.0	27.5	0.34	0	Occupancy =	88	Nos			
E - Wall	0.0	35.5	0.34	0	Lighting =	1.24	W/Sq ft			
SE - Wall	558.3	35.5	0.34	6764	Eq. Load =	12.44	KW			
S - Wall	410.6	33.5	0.34	4695	Height =	12.00	FT			
SW - Wall	0.0	31.5	0.34	0				*Load Summary*		
W - Wall	385.0	29.5	0.34	3877						
NW - Wall	0.0	23.5	0.34	0				*Summer Load:*		
Roof Sun	0.0	49.5	0.34	0	*TR*		=	*13.63*	*TR*	
Roof Shaded					*DEHUMIDIFIED CFM*		=	*5518*	*CFM*	
	TRANS. GAIN EXCEPT WALLS & ROOF									
ITEM	Area	Temp. diff.	U							
	(Sq ft)	(°F)	(Btu/h.sq ft)							
All Glass	129.10	35	1.13	5106						
Partition	469.69	30	0.30	4194						
Ceiling	0	25	0.4	0						
Floor	0	25	0.4	0						
	INTERNAL HEAT GAIN									
People	80	Nos X	245	19600						
Light	1684.68	W X 1.25	3.41	7181						
Eq. Load	12440	W X	3.41	42420						
								CHECK FIGURES		
OUTSIDE AIR							*Btu/h/ Sq ft =*	*120.4*		
CFM	°F	BF	FACTOR				*CFM / Sq ft =*	*4.06*		
660	35	0.12	1.08	2994			*Sq ft / TR =*	*100*		
		ROOM SENSIBLE HEAT (RSH)		100120			*CFM/ TR =*	*405*		
Supply duct heat gain +	Supply duct leak. loss +	Heat gain from fan HP(%)	0							
		Safety factor (%	10.0	10012						
	EFFECTIVE ROOM SENSIBLE HEAT (ERSH)			110132						
	LATENT HEAT									
People	80	Nos X	205	16400						
OUTSIDE AIR										
CFM	GR/LB	BF	FACTOR		Sensible Heat Per Person		245	btu/hr		
660	12.5	0.12	0.68	673	Latent Heat Per Person		205	btu/hr		
			RLH	17073						
Supply duct leakage l		Safety factor %	10.0	1707						
	EFFECTIVE ROOM LATENT HEAT (ERLH)			18781						
	EFFECTIVE ROOM TOTAL HEAT (ERTH)			128912						
OUTSIDE AIR HEAT (SENSIBLE)										
CFM	°F	1 - BF	FACTOR							
660	35	0.88	1.08	21954						
OUTSIDE AIR HEAT (LATENT)										
CFM	GR/LB	1 - BF	FACTOR							
660	12.5	0.88	0.68	4937						
			HEAT SUB TOTA	155803						
Return duct heat gain &	HP Pump +	Dehum. & Pipe loss (%)	5.0	7790						
TR	13.63	GRAND TOTAL HEAT		163593						

Figure 16:E20 sheet of classroom 1

- Class1 summary

SUMMARY SHEET

NAME	MAJOR PROJECT
DATE	03-04-2022

ESTIMATE FOR : SUMMER					
CONDITION	DB (°F)	WB (°F)	% RH	DP (°F)	GR/LB
OUTSIDE	110		20		77.4
ROOM	75		50		64.9
DIFFERENCI	35	XX	30	0	12.5

Fresh Air Change per Hour (ACPH)	1
Fresh Air CFM/PERSON	7.5
Description of Area	Classs Room 1
AREA Sqft	1358.61

FLOOR		1st
Dimensions		
Length	ft	39.14
Breadth	ft	34.71
Height	ft	12

Glass							
N Sq.ft	NE Sq.ft	E Sq.ft	SE Sq.ft	S Sq.ft	SW Sq.ft	W Sq.ft	NW Sq.ft
0	0	0	0	59.06	0	31.50	0

Wall							
N Sq.ft	NE Sq.ft	E Sq.ft	SE Sq.ft	S Sq.ft	SW Sq.ft	W Sq.ft	NW Sq.ft
0	0	0	0	410.63	0	385.04	0

Other Parametres						
Roof Sq.ft	Partition Sq.ft	Ceiling Sq.ft	Floor Sq.ft	Occup. Nos.	Equip. Load in KW	Light in W/Sqft
0	469.69	0	0	80	11.4	1.24

Calculated Load	
Heat Load	Dehumidified CFM
TR	
13.63	5518

Figure17: summary of class 1

In E20 sheet we Calculate Heat load Calculation of particular filed where we have to install the HVAC system. We calculate to maintain temperature. we calculate with the parameters of room.

- E20 sheet (class2)

HEAT LOAD SHEET - E 20										
JOB NAME:	MAJOR PROJECT							DATE:	03-04-2022	
SPACE FOR:	Class Room 2							Estimated By	ARSHAD ALI	
SIZE:	1349.50	Sq ft	16194	Cu ft	ESTIMATE FOR : SUMMER					
SOLAR GAIN GLASS				HEAT GAIN	CONDITION	DB (°F)	WB (°F)	% RH	DP (°F)	GR/LB
ITEM	Area	Sun Gain	Factor	Btu/hour	OUTSIDE	110	0	20	0	77.4
	(Sq ft)	(Btu/h.sq ft)			ROOM	75	0	50	0	64.9
N - Glass	0.0	14	0.56	0	DIFFERENCE	35	XXXX	70	0	12.5
NE - Glass	0.0	12	0.56	0						
E - Glass	0.0	12	0.56	0	OUTSIDE AIR (VENTILATION)					
SE - Glass	0.0	14	0.56	0	88	People X	7.5	CFM/Person		660
S - Glass	59.1	12	0.56	397	16194	Cu ft X	1	Air change per hour		270
SW - Glass	0.0	100	0.56	0				CFM VENTILATION		660
W - Glass	0.0	164	0.56	0						
NW - Glass	0.0	123	0.56	0	EFF. SENSIBLE HEAT FACTOR (ESHF) =					
Sky light										
SOLAR & TRANS. GAIN WALLS & ROOF								Selected ADP =	54	°F
ITEM	Area	Eq. temp. diff	U					Dehum. temp rise =	18.48	°F
	(Sq ft)	(°F)	(Btu/h.sq ft)					DEHUMIDIFIED CFM =	4767	CFM
N - Wall	0.0	21.5	0.34	0	NOTES					
NE - Wall	0.0	27.5	0.34	0	Occupancy =	88	Nos			
E - Wall	0.0	35.5	0.34	0	Lighting =	1.24	W/Sq ft			
SE - Wall	0.0	35.5	0.34	0	Eq. Load =	12.44	KW			
S - Wall	407.5	33.5	0.34	4659	Height =	12.00	FT			
SW - Wall	0.0	31.5	0.34	0				*Load Summary*		
W - Wall	0.0	29.5	0.34	0						
NW - Wall	0.0	23.5	0.34	0				*Summer Load:*		
Roof Sun	0.0	49.5	0.34	0	*TR*		=	*12.48*	*TR*	
Roof Shaded					*DEHUMIDIFIED CFM*		=	*4767*	*CFM*	
TRANS. GAIN EXCEPT WALLS & ROOF										
ITEM	Area	Temp. diff.	U							
	(Sq ft)	(°F)	(Btu/h.sq ft)							
All Glass	129.76	35	1.13	5132						
Partition	466.54	30	0.30	4165						
Ceiling	0	25	0.4	0						
Floor	0	25	0.4	0						
INTERNAL HEAT GAIN										
People	80	Nos X	245	19600						
Light	1673.38	W X 1.25	3.41	7133						
Eq. Load	12440	W X	3.41	42420						
								CHECK FIGURES		
OUTSIDE AIR							*Btu/h/ Sq ft =*	*111.0*		
CFM	°F	BF	FACTOR				*CFM / Sq ft =*	*3.53*		
660	35	0.12	1.08	2994			*Sq ft / TR =*	*108*		
ROOM SENSIBLE HEAT (RSH)				86500			*CFM/ TR =*	*382*		
Supply duct heat gain +	Supply duct leak. loss +	Heat gain from fan HP(%)	0							
		Safety factor (%	10.0	8650						
EFFECTIVE ROOM SENSIBLE HEAT (ERSH)				95150						
LATENT HEAT										
People	88	Nos X	205	18040						
OUTSIDE AIR										
CFM	GR/LB	BF	FACTOR		Sensible Heat Per Person	245	btu/hr			
660	12.5	0.12	0.68	673	Latent Heat Per Person	205	btu/hr			
			RLH	18713						
Supply duct leakage l		Safety factor %	10.0	1871						
EFFECTIVE ROOM LATENT HEAT (ERLH)				20585						
EFFECTIVE ROOM TOTAL HEAT (ERTH)				115735						
OUTSIDE AIR HEAT (SENSIBLE)										
CFM	°F	1 - BF	FACTOR							
660	35	0.88	1.08	21954						
OUTSIDE AIR HEAT (LATENT)										
CFM	GR/LB	1 - BF	FACTOR							
660	12.5	0.88	0.68	4937						
			HEAT SUB TOTA	142626						
Return duct	HP Pump +	Dehum.&Pipe loss (%)	5.0	7131						
TR	12.48	GRAND TOTAL HEAT		149757						

Figure 18: E20 sheet of class 2

- Class2 (summary)

SUMMARY SHEET						
NAME MAJOR PROJECT	ESTIMATE FOR : SUMMER					
DATE 03-04-2022	CONDITION	DB (°F)	WB (°F)	% RH	DP (°F)	GR/LB
	OUTSIDE	110		20		77.4
	ROOM	75		50		64.9
	DIFFERENCI	35	XX	XX	0	12.5

Fresh Air Change per Hour (ACPH)	1
Fresh Air CFM/PERSON	7.5
Description of Area	Class Room 2
AREA Sqft	1349.50

FLOOR		1st
Dimensions		
Length	ft	38.88
Breadth	ft	34.71
Height	ft	12

Glass							
N Sq.ft	NE Sq.ft	E Sq.ft	SE Sq.ft	S Sq.ft	SW Sq.ft	W Sq.ft	NW Sq.ft
0	0	0	0	59.06	0	0	0

Wall							
N Sq.ft	NE Sq.ft	E Sq.ft	SE Sq.ft	S Sq.ft	SW Sq.ft	W Sq.ft	NW Sq.ft
0	0	0	0	407.48	0	0	0

Other Parametres						
Roof Sq.ft	Partition Sq.ft	Ceiling Sq.ft	Floor Sq.ft	Occup. Nos.	Equip. Load in KW	Light in W/Sqft
0	466.54	0	0	88	12.44	1.24

Calculated Load	
Heat Load	Dehumidified CFM
TR	
12.48	4767

Figure 19: summary class 2

- E20 (Faculty)

HEAT LOAD SHEET - E 20

JOB NAME:	MAJOR PROJECT							DATE:	03-04-2022	
SPACE FOR:	Faculty Room							Estimated By	ARSHAD ALI	
SIZE:	1084.76	Sq ft Vol.	13017	Cu ft	ESTIMATE FOR : SUMMER					
SOLAR GAIN GLASS				HEAT GAIN	CONDITION	DB (°F)	WB (°F)	% RH	DP (°F)	GR/LB
ITEM	Area	Sun Gain	Factor	Btu/hour	OUTSIDE	110	0	20	0	77.4
	(Sq ft)	(Btu/h.sq ft)			ROOM	75	0	50	0	64.9
N - Glass	0.0	14	0.56	0	DIFFERENCE	35	XXXX	70	0	12.5
NE - Glass	0.0	12	0.56	0						
E - Glass	31.5	12	0.56	212	OUTSIDE AIR (VENTILATION)					
SE - Glass	0.0	14	0.56	0	6	People X	7.5	CFM/Person		45
S - Glass	0.0	12	0.56	0	13017	Cu ft X	1	Air change per hour		217
SW - Glass	0.0	100	0.56	0				CFM VENTILATION		45
W - Glass	0.0	164	0.56	0						
NW - Glass	0.0	123	0.56	0	EFF. SENSIBLE HEAT FACTOR (ESHF) =					
Sky light										
SOLAR & TRANS. GAIN WALLS & ROOF								Selected ADP =	54	°F
ITEM	Area	Eq. temp. diff.	U					Dehum. temp rise =	18.48	°F
	(Sq ft)	(°F)	(Btu/h.sq ft)					DEHUMIDIFIED CFM =	1545	CFM
N - Wall	0.0	21.5	0.34	0	NOTES					
NE - Wall	0.0	27.5	0.34	0	Occupancy =	6	Nos			
E - Wall	234.3	35.5	0.34	2838	Lighting =	1.24	W/Sq ft			
SE - Wall	0.0	35.5	0.34	0	Eq. Load =	1.38	KW			
S - Wall	0.0	33.5	0.34	0	Height =	12.00	FT			
SW - Wall	0.0	31.5	0.34	0	***Load Summary***					
W - Wall	0.0	29.5	0.34	0						
NW - Wall	0.0	23.5	0.34	0	***Summer Load:***					
Roof Sun	0.0	49.5	0.34	0	*TR*		=	*2.98*	*TR*	
Roof Shaded					*DEHUMIDIFIED CFM*		=	*1545*	*CFM*	
TRANS. GAIN EXCEPT WALLS & ROOF										
ITEM	Area	Temp. diff.	U							
	(Sq ft)	(°F)	(Btu/h.sq ft)							
All Glass	0.00	35	1.13	0						
Partition	1441.34	30	0.30	12869						
Ceiling	0	25	0.4	0						
Floor	0	25	0.4	0						
INTERNAL HEAT GAIN										
People	6	Nos X	245	1470						
Light	1345.10	W X 1.25	3.41	5733						
Eq. Load	1380	W X	3.41	4706						
					CHECK FIGURES					
OUTSIDE AIR							*Btu/h/ Sq ft =*	*33.0*		
CFM	°F	BF	FACTOR				*CFM / Sq ft =*	*1.42*		
45	35	0.12	1.08	204			*Sq ft / TR =*	*364*		
ROOM SENSIBLE HEAT (RSH)				**28032**			*CFM/ TR =*	*518*		
Supply duct heat gain +	Supply duct leak. loss +	Heat gain from fan HP(%)	0							
		Safety factor (%)	10.0	2803						
EFFECTIVE ROOM SENSIBLE HEAT (ERSH)				**30836**						
LATENT HEAT										
People	6	Nos X	205	1230						
OUTSIDE AIR										
CFM	GR/LB	BF	FACTOR		Sensible Heat Per Person		245	btu/hr		
45	12.5	0.12	0.68	46	Latent Heat Per Person		205	btu/hr		
			RLH	1276						
	Supply duct leakage loss +	Safety factor %	10.0	128						
EFFECTIVE ROOM LATENT HEAT (ERLH)				**1403**						
EFFECTIVE ROOM TOTAL HEAT (ERTH)				**32239**						
OUTSIDE AIR HEAT (SENSIBLE)										
CFM	°F	1 - BF	FACTOR							
45	35	0.88	1.08	1497						
OUTSIDE AIR HEAT (LATENT)										
CFM	GR/LB	1 - BF	FACTOR							
45	12.5	0.88	0.68	337						
		HEAT SUB TOTAL		34073						
Return duct heat gain & leak. loss +	HP Pump +	Dehum. & Pipe loss (%)	5.0	1704						
TR	2.98	GRAND TOTAL HEAT		35776						

Figure20:E20 Sheet of Faculty of room

- Faculty (Summary)

SUMMARY SHEET							
NAME	MAJOR PROJECT						
DATE	03-04-2022						

ESTIMATE FOR : SUMMER					
CONDITION	**DB (°F)**	**WB (°F)**	**% RH**	**DP (°F)**	**GR/LB**
OUTSIDE	110		20		77.4
ROOM	75		50		64.9
DIFFERENCI	35	XX	XX	0	12.5

Fresh Air Change per Hour (ACPH)	1
Fresh Air CFM/PERSON	7.5
Description of Area	Faculty Room
AREA Sqft	1084.76

FLOOR		1st
Dimensions		
Length	ft	48.98
Breadth	ft	22.15
Height	ft	12

Glass							
N Sq.ft	NE Sq.ft	E Sq.ft	SE Sq.ft	S Sq.ft	SW Sq.ft	W Sq.ft	NW Sq.ft
0	0	31	0	0.00	0	0	0

Wall							
N Sq.ft	NE Sq.ft	E Sq.ft	SE Sq.ft	S Sq.ft	SW Sq.ft	W Sq.ft	NW Sq.ft
0	0	234.25	0	0.00	0	0	0

Other Parametres						
Roof Sq.ft	Partition Sq.ft	Ceiling Sq.ft	Floor Sq.ft	Occup. Nos.	Equip. Load in KW	Light in W/Sqft
0	1441.34	0	0	6	1.38	1.24

Calculated Load	
Heat Load	Dehumidified CFM
TR	
2.98	1545

Figure21: summary of faculty

- E20 (Seminar Hall)

HEAT LOAD SHEET - E 20										
JOB NAME:	MAJOR PROJECT							DATE:	03-04-2022	
SPACE FOR	SEMINAR HALL							Estimated By	ARSHAD ALI	
SIZE:	2473.67	Sq ft Vol.	29684	Cu ft	ESTIMATE FOR : SUMMER					
SOLAR GAIN GLASS				HEAT GAIN	CONDITION	DB (°F)	WB (°F)	% RH	DP (°F)	GR/LB
ITEM	Area	Sun Gain	Factor	Btu/hour	OUTSIDE	110	0	20	0	77.4
	(Sq ft)	(Btu/h.sq ft)			ROOM	75	0	50	0	64.9
N - Glass	0.0	14	0.56	0	DIFFERENCE	35	XXXX	70	0	12.5
NE - Glass	0.0	12	0.56	0						
E - Glass	31.5	12	0.56	212	OUTSIDE AIR (VENTILATION)					
SE - Glass	0.0	14	0.56	0	120	People X	7.5	CFM/Person		900
S - Glass	59.1	12	0.56	397	29684	Cu ft X	1	Air change per hour		495
SW - Glass	0.0	100	0.56	0				CFM VENTILATION		900
W - Glass	0.0	164	0.56	0						
NW - Glass	0.0	123	0.56	0	EFF. SENSIBLE HEAT FACTOR (ESHF) =					
Sky light										
SOLAR & TRANS. GAIN WALLS & ROOF								Selected ADP =	54	°F
ITEM	Area	Eq. temp. diff.	U					Dehum. temp rise =	18.48	°F
	(Sq ft)	(°F)	(Btu/h.sq ft)					DEHUMIDIFIED CFM =	4193	CFM
N - Wall	0.0	21.5	0.34	0	NOTES					
NE - Wall	0.0	27.5	0.34	0	Occupancy =	120	Nos			
E - Wall	400.8	35.5	0.34	4856	Lighting =	1.24	W/Sq ft			
SE - Wall	0.0	35.5	0.34	0	Eq. Load =	2.33	KW			
S - Wall	765.0	33.5	0.34	8746	Height =	12.00	FT			
SW - Wall	0.0	31.5	0.34	0			*Load Summary*			
W - Wall	0.0	29.5	0.34	0						
NW - Wall	0.0	23.5	0.34	0			*Summer Load:*			
Roof Sun	0.0	49.5	0.34	0	*TR*		=	*12.99*	*TR*	
Roof Shaded					*DEHUMIDIFIED CFM*		=	*4193*	*CFM*	
TRANS. GAIN EXCEPT WALLS & ROOF										
ITEM	Area	Temp. diff.	U							
	(Sq ft)	(°F)	(Btu/h.sq ft)							
All Glass	0.00	35	1.13	0						
Partition	824.02	30	0.30	7357						
Ceiling	0	25	0.4	0						
Floor	0	25	0.4	0						
INTERNAL HEAT GAIN										
People	120	Nos X	245	29400						
Light	3067.35	W X 1.25	3.41	13075						
Eq. Load	2330	W X	3.41	7945						
							CHECK FIGURES			
OUTSIDE AIR							*Btu/h/ Sq ft =*	*63.0*		
CFM	°F	BF	FACTOR				*CFM / Sq ft =*	*1.69*		
900	35	0.12	1.08	4082			*Sq ft / TR =*	*190*		
ROOM SENSIBLE HEAT (RSH)				76070			*CFM/ TR =*	*323*		
Supply duct heat gain +	Supply duct leak. loss +	Heat gain from fan HP(%)	0							
		Safety factor (%)	10.0	7607						
EFFECTIVE ROOM SENSIBLE HEAT (ERSH)				83677						
LATENT HEAT										
People	120	Nos X	205	24600						
OUTSIDE AIR										
CFM	GR/LB	BF	FACTOR		Sensible Heat Per Person		245	btu/hr		
900	12.5	0.12	0.68	918	Latent Heat Per Person		205	btu/hr		
			RLH	25518						
	Supply duct leakage loss +	Safety factor %	10.0	2552						
EFFECTIVE ROOM LATENT HEAT (ERLH)				28070						
EFFECTIVE ROOM TOTAL HEAT (ERTH)				111747						
OUTSIDE AIR HEAT (SENSIBLE)										
CFM	°F	1 - BF	FACTOR							
900	35	0.88	1.08	29938						
OUTSIDE AIR HEAT (LATENT)										
CFM	GR/LB	1 - BF	FACTOR							
900	12.5	0.88	0.68	6732						
		HEAT SUB TOTAL		148417						
Return duct heat gain & leak. loss +	HP Pump +	Dehum. & Pipe loss (%)	5.0	7421						
TR	12.99	GRAND TOTAL HEAT		155837						

Figure22: E20 sheet of Seminar Hall

- Summary (Seminar Hall)

SUMMARY SHEET

NAME	MAJOR PROJECT
DATE	03-04-2022

ESTIMATE FOR : SUMMER					
CONDITION	DB (°F)	WB (°F)	% RH	DP (°F)	GR/LB
OUTSIDE	110		20		77.4
ROOM	75		50		64.9
DIFFERENCI	35	XX	XX	0	12.5

Fresh Air Change per Hour (ACPH)	1
Fresh Air CFM/PERSON	7.5
Description of Area	SEMINAR HALL
AREA Sqft	2473.67

FLOOR		1st
Dimensions		
Length	ft	68.67
Breadth	ft	36.02
Height	ft	12

Glass							
N Sq.ft	NE Sq.ft	E Sq.ft	SE Sq.ft	S Sq.ft	SW Sq.ft	W Sq.ft	NW Sq.ft
0	0	31	0	59.06	0	0	0

Wall							
N Sq.ft	NE Sq.ft	E Sq.ft	SE Sq.ft	S Sq.ft	SW Sq.ft	W Sq.ft	NW Sq.ft
0	0	400.79	0	764.96	0	0	0

Other Parametres						
Roof Sq.ft	Partition Sq.ft	Ceiling Sq.ft	Floor Sq.ft	Occup. Nos.	Equip. Load in KW	Light in W/Sqft
0	824.02	0	0	120	2.33	1.24

Calculated Load	
Heat Load TR	Dehumidified CFM
12.99	4193

Figure 23: Summary of Seminar Hall

- E20 (Computer Lab)

HEAT LOAD SHEET - E 20

JOB NAME:	MAJOR PROJECT			
SPACE FOR:	COMPUETR LAB			
SIZE:	1459.20	Sq ft Vol	17510	Cu ft
SOLAR GAIN GLASS				HEAT GAIN
ITEM	Area	Sun Gain	Factor	Btu/hour
	(Sq ft)	(Btu/h.sq ft)		
N - Glass	29.5	14	0.56	231
NE - Glass	0.0	12	0.56	0
E - Glass	31.5	12	0.56	212
SE - Glass	0.0	14	0.56	0
S - Glass	0.0	12	0.56	0
SW - Glass	0.0	100	0.56	0
W - Glass	0.0	164	0.56	0
NW - Glass	0.0	123	0.56	0
Sky light				
SOLAR & TRANS. GAIN WALLS & ROOF				
ITEM	Area	Eq. temp. diff.	U	
	(Sq ft)	(°F)	(Btu/h.sq ft)	
N - Wall	558.3	21.5	0.34	4097
NE - Wall	0.0	27.5	0.34	0
E - Wall	326.0	35.5	0.34	3950
SE - Wall	558.3	35.5	0.34	6764
S - Wall	0.0	33.5	0.34	0
SW - Wall	0.0	31.5	0.34	0
W - Wall	0.0	29.5	0.34	0
NW - Wall	0.0	23.5	0.34	0
Roof Sun	0.0	49.5	0.34	0
Roof Shaded				
TRANS. GAIN EXCEPT WALLS & ROOF				
ITEM	Area	Temp. diff.	U	
	(Sq ft)	(°F)	(Btu/h.sq ft)	
All Glass	0.00	35	1.13	0
Partition	945.28	30	0.30	8440
Ceiling	0	25	0.4	0
Floor	0	25	0.4	0
INTERNAL HEAT GAIN				
People	40	Nos X	245	9800
Light	1809.41	W X 1.25	3.41	7713
Eq. Load	28600	W X	3.41	97526
OUTSIDE AIR				
CFM	°F	BF	FACTOR	
300	35	0.12	1.08	1361
ROOM SENSIBLE HEAT (RSH)				140093
Supply duct heat gain +	Supply duct leak. loss +	Heat gain from fan HP(%)	0	
		Safety factor (%)	10.0	14009
EFFECTIVE ROOM SENSIBLE HEAT (ERSH)				154102
LATENT HEAT				
People	40	Nos X	205	8200
OUTSIDE AIR				
CFM	GR/LB	BF	FACTOR	
300	12.5	0.12	0.68	306
			RLH	8506
Supply duct leakage los		Safety factor %	10.0	851
EFFECTIVE ROOM LATENT HEAT (ERLH)				9357
EFFECTIVE ROOM TOTAL HEAT (ERTH)				163459
OUTSIDE AIR HEAT (SENSIBLE)				
CFM	°F	1 - BF	FACTOR	
300	35	0.88	1.08	9979
OUTSIDE AIR HEAT (LATENT)				
CFM	GR/LB	1 - BF	FACTOR	
300	12.5	0.88	0.68	2244
			HEAT SUB TOTAL	175682
Return duct heat gain &	HP Pump +	Dehum. & Pipe loss (%)	5.0	8784
TR	15.37	GRAND TOTAL HEAT		184466

			DATE:	03-04-2022	
			Estimated By:	ARSHAD ALI	
ESTIMATE FOR : SUMMER					
CONDITION	DB (°F)	WB (°F)	% RH	DP (°F)	GR/LB
OUTSIDE	110	0	20	0	77.4
ROOM	75	0	50	0	64.9
DIFFERENCE	35	XXXX	70	0	12.5
OUTSIDE AIR (VENTILATION)					
40	People X	7.5	CFM/Person		300
17510	Cu ft X	1	Air change per hour		292
			CFM VENTILATION		300
EFF. SENSIBLE HEAT FACTOR (ESHF) =					
			Selected ADP =	54	°F
			Dehum. temp rise =	18.48	°F
			DEHUMIDIFIED CFM =	7721	CFM
NOTES					
Occupancy =	40	Nos			
Lighting =	1.24	W/Sq ft			
Eq. Load =	28.60	KW			
Height =	12.00	FT			
Load Summary					
Summer Load:					
TR		=	15.37	TR	
DEHUMIDIFIED CFM		=	7721	CFM	
CHECK FIGURES					
		Btu/h/ Sq ft =	126.4		
		CFM / Sq ft =	5.29		
		Sq ft / TR =	95		
		CFM/ TR =	502		
Sensible Heat Per Person		245	btu/hr		
Latent Heat Per Person		205	btu/hr		

Figure24: E20 sheet of Computer Lab

- Summary (Computer Lab)

SUMMARY SHEET						
NAME	MAJOR PROJECT					
DATE	03-04-2022					

ESTIMATE FOR : SUMMER					
CONDITION	DB (°F)	WB (°F)	% RH	DP (°F)	GR/LB
OUTSIDE	110		20		77.4
ROOM	75		50		64.9
DIFFERENCI	35	XX	XX	0	12.5

Fresh Air Change per Hour (ACPH)	1
Fresh Air CFM/PERSON	7.5
Description of Area	COMPUETR LAB
AREA Sqft	1459.20

FLOOR		1st
Dimensions		
Length	ft	48.98
Breadth	ft	29.79
Height	ft	12

Glass							
N Sq.ft	NE Sq.ft	E Sq.ft	SE Sq.ft	S Sq.ft	SW Sq.ft	W Sq.ft	NW Sq.ft
29.53	0	31	0	0.00	0	0	0

Wall							
N Sq.ft	NE Sq.ft	E Sq.ft	SE Sq.ft	S Sq.ft	SW Sq.ft	W Sq.ft	NW Sq.ft
558.27	0	325.98	0	0.00	0	0	0

Other Parametres						
Roof Sq.ft	Partition Sq.ft	Ceiling Sq.ft	Floor Sq.ft	Occup. Nos.	Equip. Load in KW	Light in W/Sqft
0	945.28	0	0	40	28.60	1.24

Calculated Load	
Heat Load TR	Dehumidified CFM
15.37	7721

Figure 25: summary of Computer Lab

- Heat Load and Equipment Summary

It an excel format containing Heat load data in single sheet.

Heat Load and Equipment Summary

Customer	MAJOR PROJECT
Date	03-04-2022
Fresh Air Change per Hour (ACPH)	1
Fresh Air CFM/PERSON	7.5

ESTIMATE FOR : SUMMER					
CONDITION	DB (˚F)	WB (˚F)	% RH	DP (˚F)	GR/LB
OUTSIDE	110		20		77.4
ROOM	75		50		64.9
DIFFERENCE	35	XXXX	70	0	12.5

				Dimensions			Glass							
S.No.	Description of Area	FLOOR	AREA	Length	Breadth	Height	N	NE	E	SE	S	SW	W	NW
			Sqft	ft	ft	ft	Sq.ft	Sq.ft	Sq.ft	Sq.ft	Sq.ft	Sq.ft	Sq.ft	Sq.ft
1	Classs Room 1	1st	1358.6	39.1	34.7	12					59.06		31.50	
2	Class Room 2	1st	1349.5	38.9	34.7	12			0		59.06			
3	Faculty Room	1st	1084.8	49.0	22.1	12			31.50					
4	COMPUETR LAB	1st	1459.2	49.0	29.8	12	29.53		31.50					
5	SEMINAR HALL	1st	2473.7	68.7	36.0	12			31.50		59.06			
HL18														

	Wall								Other Parametres							Calculated Load	
S.No.	N	NE	E	SE	S	SW	W	NW	Roof	Partition	Ceiling	Floor	Occup.	Equip.	Light in	Heat Load	Dehumidified CFM
	Sq.ft	Sq.ft	Sq.ft	Sq.ft	Sq.ft	Sq.ft	Sq.ft	Sq.ft	Sq.ft	Sq.ft	Sq.ft	Sq.ft	Nos.	Load in KW	W/Sqft	TR	
1			0		410.63		385.04			469.69	0	0	80	11.40	1.24	13.63	5518
2			0		407.48					466.54			88	12.44	1.24	12.48	4767
3			234.25							1441.34			6	1.38	1.24	2.98	1545
4	558.268		325.98							945.28			40	28.60	1.24	15.37	7721
5			400.79		764.96					824.02			120	2.33	1.24	12.99	4193
																57.45	23744

Figure 26: Heat load and equipment summary

Supply Air Duct(SAD) & Diffuser

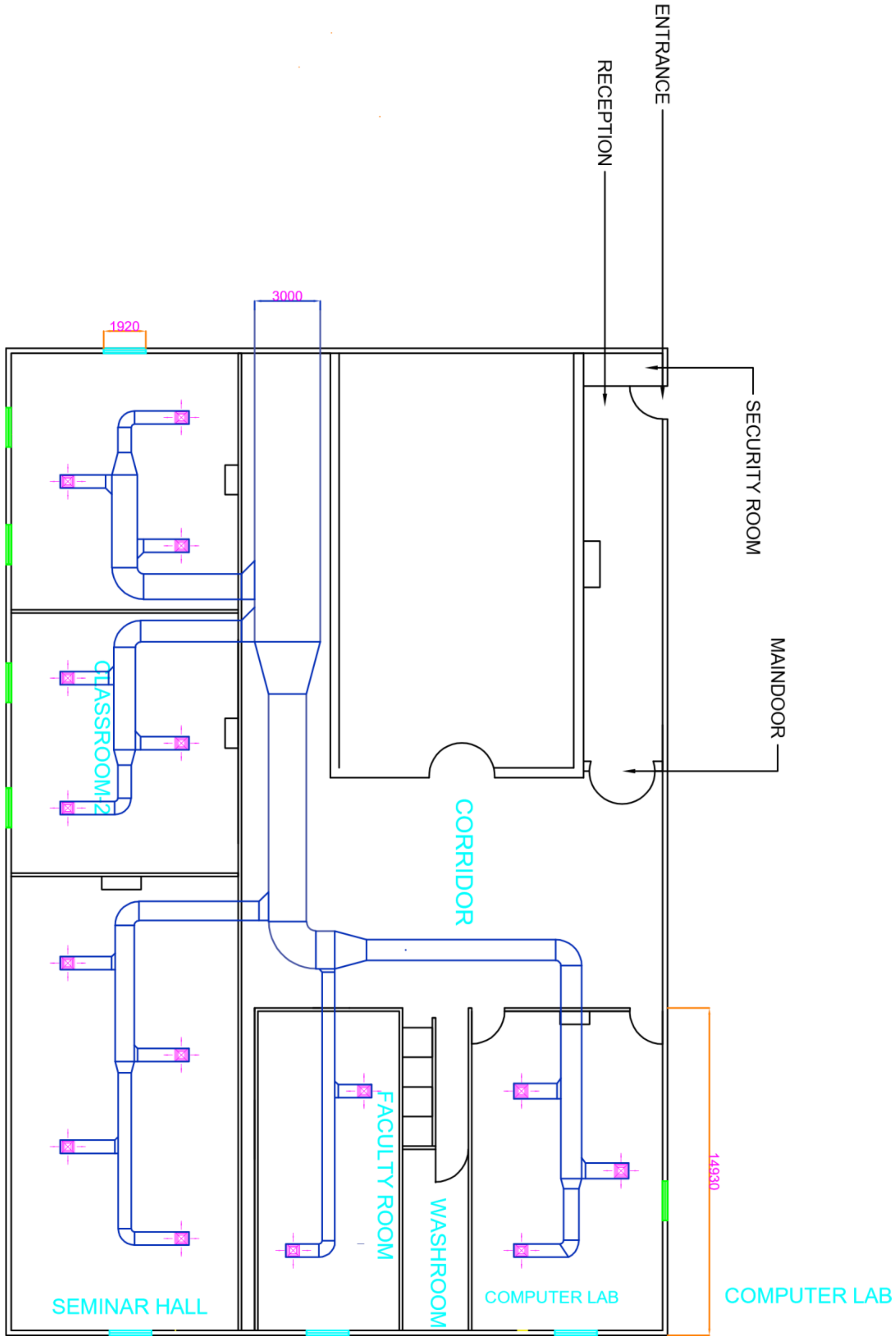

Figure 27: Supply Air Duct(SAD) & Diffuser

Return Air Duct(RAD) & Diffuser

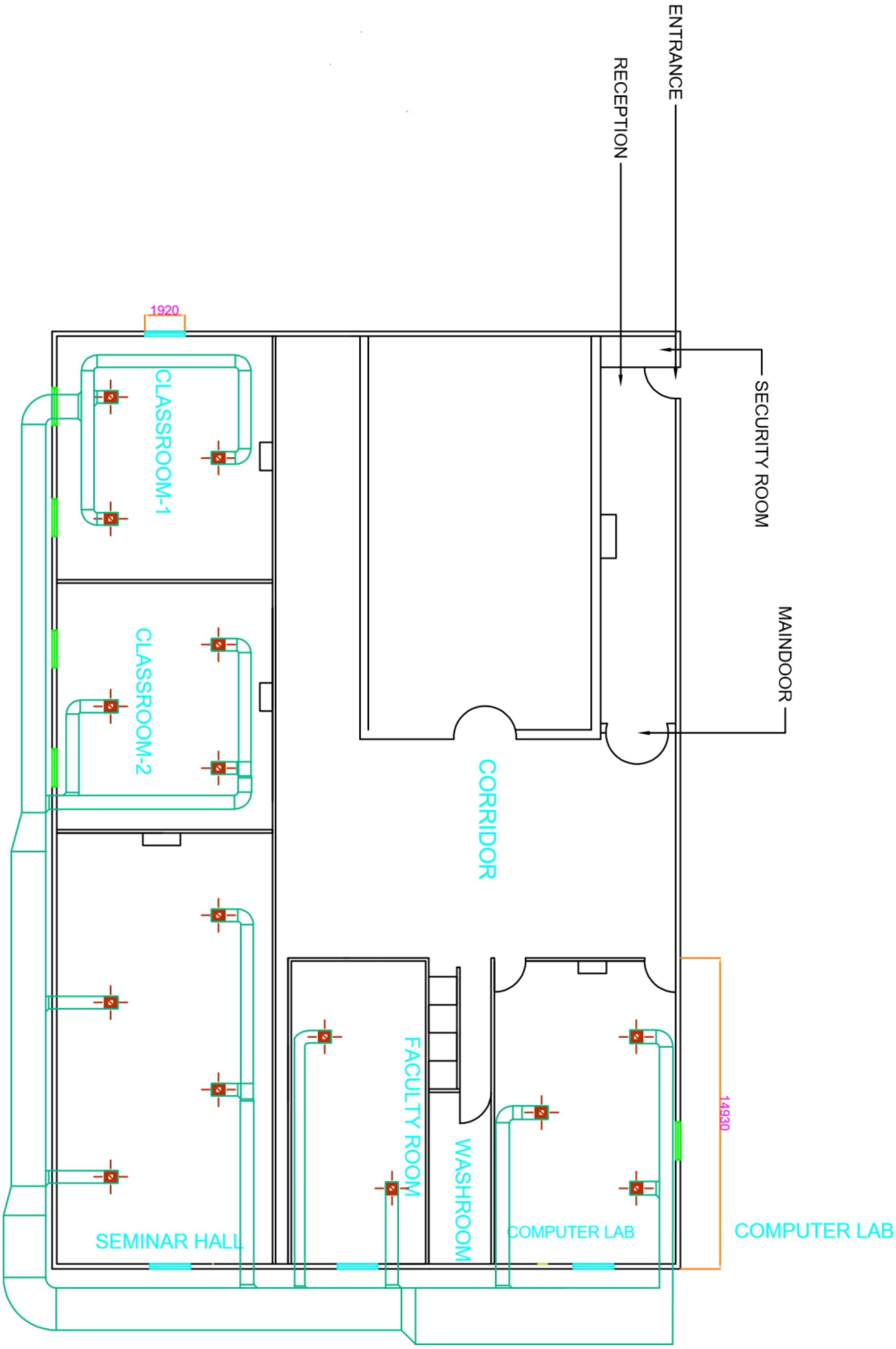

Figure 28: Return Air Duct(RAD) & Diffuser

- Final Design of plan

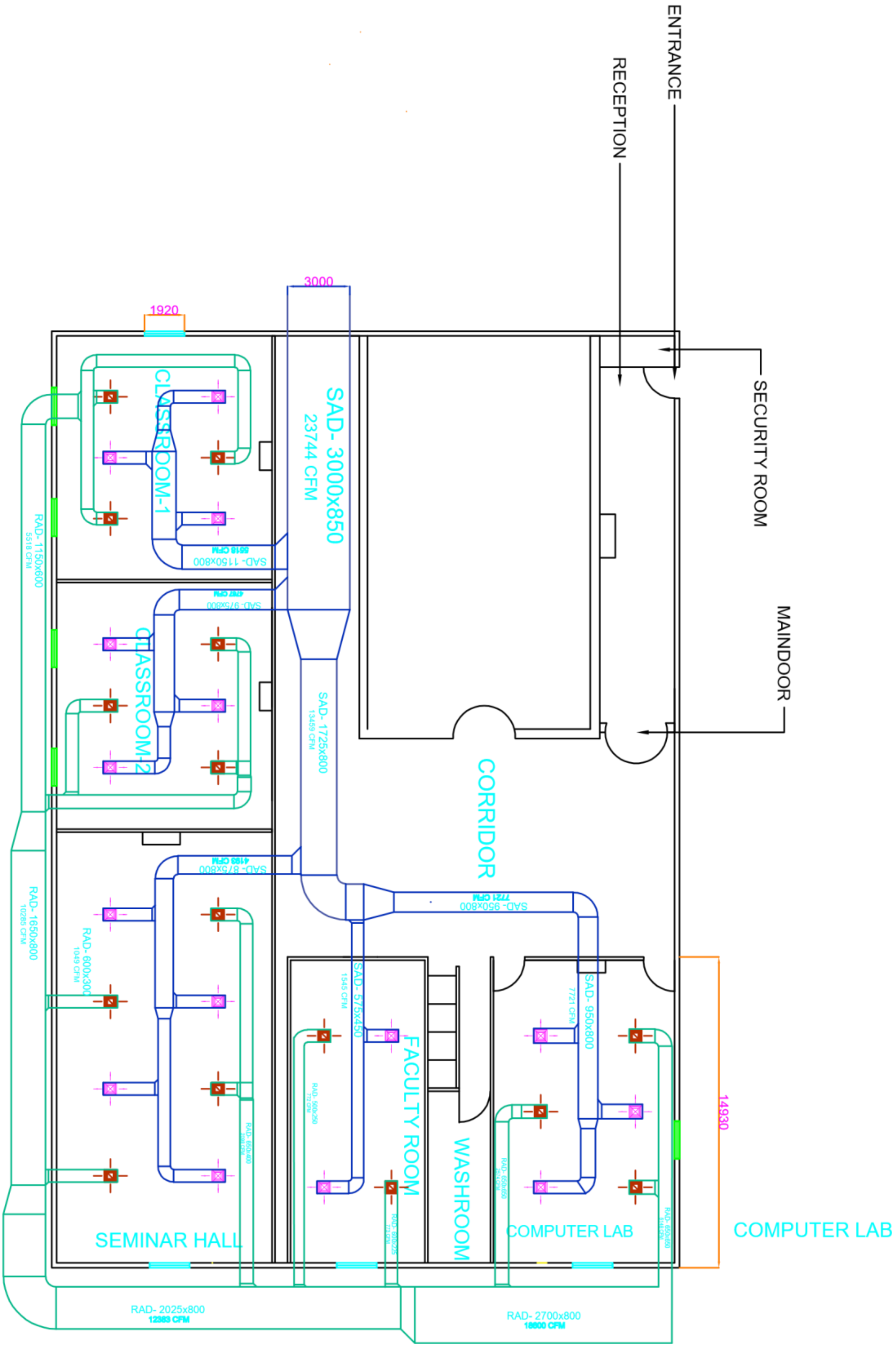

Figure 29: Final Design

Plan containing proper HVAC system which contain duct which maintain temperature of room.

CHAPTER-5

CONCLUSION

An institute can be made energy-efficient by using an Appropriate system for heating and cooling when paired up with a traditional HVAC system. This system utilizes water/air temperatures for heating and cooling surfaces available from natural sources like atmospheric air along with chiller systems. It works at temperature close to the surrounding temperature and results in reduction in energy consumption. For a sustainable HVAC system, the main aim is to gain thermal comfort by the utilization of minimum amount of energy and proper conditioning of the indoor air along with the quality ventilation. The air is mostly cooled more than the required temperature by after mixing with the indoor air it comes at the target temperature. Puncture in ducts or conditioned air supply can lead to drop in the heating or cooling capacity by 38%. The whole HVAC system should work CONTINUOUSLY to achieve the peak performance.

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