# School of Basic and Applied Sciences

**Mathematics**

**ETE - Jun 2023**

**Time : 3 Hours** **Marks : 100**

**Sem II - C1UD201B / B010201T**

**Thermal Physics and Semiconductor Devices**

*Your answer should be specific to the question asked*

*Draw neat labeled diagrams wherever necessary*

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|---|---|---|---|
| **1.** | Write the expression for the Fermi-Dirac distribution function and draw Fermi-Dirac distribution function curve with energy (E) at T= 0K and T > 0 K. What is the significance of this function? | K1 CO1 | (5) |
| **2.** | A perfect gas at 300 K occupies a volume of 0.2 $m^3$ at a pressure of $5 * 10^6 N m^{-2}$. It is allowed to expand isothermally to a volume of 0.5 $m^{-3}$. Then the gas is expand isobarically to its original volume. Finally the pressure is increased isochorically and return to its original state. Plot the p-V diagram for the whole process and calculate the net work done during the cycle. | K1 CO1 | (5) |
| **3.** | An inductor of inductance 40 henry and a resister of resistance 10 ohm is connected to a d.c. source of 6 volts. Find the current after 4 sec. | K2 CO2 | (5) |
| **4)** | Derive an expression for the decay of charge of a capacitor in an LCR series circuit. | K3 CO3 | (10) |
| | **OR** | | |
| | Show that in an intrinsic semiconductor the conductivity of the material is given by the expression; $\sigma = en(\mu_e + \mu_p)$, where [ σ =conductivity, n carrier density $\mu_e$ = mobility of electron and $\mu_p$= mobility of hole and e= electronic charge]. The intrinsic carrier density of Ge at $27^{\circ}C$ is $2.4 * 10^{17} m^{-3}$. Calculate its resistivity, if the electron and hole mobility are 0.35 $m^2 V^{-1} s^{-1}$ and 0.18 $m^2 V^{-1} s^{-1}$ respectively. | K3 CO3 | (10) |
| **5.** | Sketch the circuit for a half – wave rectifier. Explain its operation and derive the expression for dc current. | K2 CO2 | (10) |
| **6.** | Analyze the law of equipartition of energy on the basis of the kinetic theory of gases? Derive the result in the case of mono, di and tri atomic gases with application of the law of equipartition of energy to specific heat of gases. | K4 CO4 | (10) |
| **7.** | Describe the fundamental postulates of the kinetic theory of an ideal gas. Find the expression for the pressure exerted by an ideal gas. | K3 CO3 | (10) |
| **8.** | Use the laws of thermodynamics to analyze the Carnot's reversible heat engine. Compute the work done and efficiency of Carnot Cycle. | K4 CO4 | (15) |
| **9.** | Define thermal radiation. Describe the main characteristics of radiation emitted by a perfectly black body. Show that the ratio of emissive power to absorptive power is constant and is equal to the emissive power of a perfectly black body. | K3 CO3 | (15) |
| **10)** | Analyze the volt-ampere characteristics of p-n junction diode. A diode with potential barrier 0.6 V across its junction, is connected in series with resistance of 24 Ω across source. If 0.2 A current passes through resistance, calculate the source voltage. Also draw the circuit diagram and mention the biasing of the diode. | K4 CO5 | (15) |
| | **OR** | | |
| | Analyze the breakdown mechanism of Zener diode. How does it differ from avalanche breakdown. Draw the IV curve for both mechanisms. Discuss the application of Zener diode. | K4 CO5 | (15) |