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P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belagavi)

Seventh Semester, B.E. - Semester End Examination; Jan. / Feb. - 2021

Condensed Matter Physics

Time: 3 hrs *Max. Marks: 100*

***Note**: i) Answer **FIVE** full questions, selecting **ONE** full question from each unit.*
ii) Missing data, if any, may be suitably assume.

***Physical constants:** Electron mass, $m = 9.11\times10^{-31}$ kg, Electron charge, $e = 1.602\times10^{-19}$ C; Velocity of light, $c = 3\times10^{8}$ ms^{-1}; Planck's constant, $h = 6.626\times10^{-34}$ Js; Boltzmann constant, $K = 1.38\times10^{-23}$ JK^{-1}; Avogadro number, $N = 6.025\times10^{23}$/mole; Permittivity of free space, $\varepsilon_o = 8.85\times10^{-12}$ Fm^{-1}.*

UNIT - I

1 a. Derive an expression for the inter planar spacing of planes in terms of Miller indices in a cubic structure. 8

b. Explain briefly the Bravai's Lattice and Lattice parameter. 7

c. A Nacl crystal is used as a diffraction grating with *X*-rays for the $d_{(111)}$ spacing of the *cl* ions, the Bragg's angle is 13.75°. If the lattice constant of the crystal is 0.563 nm. Find the wavelength of *X*-rays. 5

2 a. Define coordination number and packing factor. Calculate the packing factor for BCC and FCC structures. 8

b. State Bragg's law and derive Bragg's equation for *X*-ray diffraction. 7

c. Copper has FCC structure and the atomic radius is 0.1278 nm. Calculate the inter planar spacing for (1, 1, 1) plane. 5

UNIT - II

3 a. Derive an expression for thermal conductivity of a conductor using classical free electron theory. 8

b. Explain the principle and working of refrigeration. 7

c. The temperature of air outside a room is 10°C and temperature of air in a room is three times that of outside temperature. Calculate the rate of loss of heat by conduction through a glass window of area 3 m^2 and thickness 2 mm. 5

(Given: Thermal conductivity of glass is1 w/m/degree).

4 a. Explain the determination of thermal conductivity by Lee-Charlton's method, with a neat diagram. 8

b. Derive an expression for Wiedemann-Franz's law using classical free electron theory. 7

c. A thermo cole cubical ice box of side 0.3 m has a thickness of 0.5 m. If 4 kg of ice is put in the box, estimate the amount of ice remaining after 4 hours. The outside temperature is 40°C and coefficient of thermal conductivity of thermo cole is 0.01 J/s/m/k. (Given heat of fusion of water is 335×10^3 J/kg). 5

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UNIT - III

5	a.	What is reversible and irreversible process and explain entropy-temperature diagram.	8
	b.	What is Carnot engine and derive an expression for efficiency of Carnot engine.	7
	c.	For a coal fired utility boiler, the temperature of high pressure steam is 540°C and the cooling tower water temperature is 20°C. Calculate the Carnot efficiency of the power plant.	5
6	a.	Write a note on adiabatic expansion, adiabatic compression, isothermal expansion and isothermal compression.	8
	b.	Define steam engine and internal combustion engine with an example. Derive an expression for thermal efficiency of heat engine.	7
	c.	In an engine working on Otto cycle, the temperatures at the beginning and at the end of adiabatic compression are 120° and 498° respectively. Find the air standard efficiency of an engine. (Given adiabatic index $\gamma = 1.4$).	5

UNIT - IV

7	a.	Define electrostatic potential of a dipole. Derive an expression for electrostatic potential due to dipole.	8
	b.	State and explain Biot-Savart's law of electromagnetic induction.	7
	c.	Explain the divergence of static magnetic field.	5
8	a.	Define curl of static magnetic field and derive an equation for curl of static magnetic field.	8
	b.	State and explain Faraday's law of electromagnetic induction.	7
	c.	State and explain Lenz's law.	5

UNIT - V

9	a.	Derive an expression for variation of mass with velocity and discuss the variation of it with reference to special theory of relativity.	8
	b.	Deduce an expression for Einstein mass-energy equivalence.	7
	c.	At what speed a clock be moved so that it may lose one minute in each hour.	5
10	a.	Deduce Lorentz transformations for space and time coordinates.	8
	b.	Derive the relation between energy and momentum using relativistic variation of mass.	7
	c.	A particle is moving with a speed of 0.5 C, calculate the ratio of the rest mass and the mass while in motion.	5

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