U.S.N.										

B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

February / March 2025 Semester End Main Examinations

Programme: B.E. **Semester: II**
Branch: Mechanical Engineering stream **Duration: 3 hrs.**
Course Code: 22PH2BSPME **Max Marks: 100**
Course: Applied Physics for Mechanical Stream

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

Physical constants:

Mass of electron, $m_e = 9.1\times10^{-31}$ kg
Electronic charge, $e = 1.602\times10^{-19}$ C
Boltzmann constant, $k_B = 1.38\times10^{-23}$ J/K
Permittivity of free space$=8.85\times10^{-12}$ F/m
Speed of light, $c = 3\times10^{8}$ m/s
Planck constant, $h = 6.626\times10^{-34}$ Js
Mass of neutron, $m_n = 1.67\times10^{-27}$ kg
Mass of proton, $m_p = 1.67\times10^{-27}$ kg

Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

			Module - I	*CO*	*PO*	Marks
1	a)		Derive an expression for the energy density of radiation under thermal equilibrium conditions in terms of Einstein's coefficients.	*CO 1*	*PO 1*	**8**
	b)		Discuss the different types of optical fibers with suitable diagram.	*CO 1*	*PO 1*	**8**
	c)		Find the ratio of population of two energy levels, if the wavelength of the light emitted at 330 K is 632.8 nm	*CO 1*	*PO 2*	**4**
			OR			
2	a)		What is numerical aperture? Derive an expression for numerical aperture and discuss the conditions for light propagation.	*CO 1*	*PO 1*	**8**
	b)		Articulate the construction and working of semiconductor diode LASER along with suitable energy level diagram.	*CO 1*	*PO 1*	**8**
	c)		Compute the numerical aperture and acceptance angle of an optical fiber having core and cladding refractive indices of 1.50 and 1.45, respectively.	*CO 1*	*PO 2*	**4**
			Module -II			
3	a)		What is damped oscillation? Derive an equation for decaying amplitude in the case of under damping.	*CO 1*	*PO 1*	**8**
	b)		Derive an expression for the total energy of a simple harmonic oscillator and represent graphically the variation of potential, kinetic, and total energy with time.	*CO 1*	*PO 1*	**8**
	c)		The Q-factor of a spring loaded with 0.3 kg is 60. It vibrates with a frequency of 2 Hz. Calculate the relaxation time and damping constant.	*CO 1*	*PO 2*	**4**

			OR			
	4	a)	Define simple harmonic motion. Derive its differential equation.	*CO 1*	*PO 1*	**8**
		b)	What is forced vibration? Derive an expressions for amplitude of a forced vibrations.	*CO 1*	*PO 1*	**8**
		c)	Calculate the time period for a particle executing SHM if its acceleration at 3 cm from its mean position is 15 cm/s^2.	*CO 1*	*PO 2*	**4**
			Module - III			
	5	a)	Define Fermi energy and Fermi factor. Discuss the variation of Fermi factor with energy and temperature suitable graph.	*CO 1*	*PO 1*	**8**
		b)	Discuss the experimental determination of the thermal conductivity of a given sample by Lee–Charlton's method with suitable diagrams.	*CO 1*	*PO 1*	**8**
		c)	Find the temperature at which there is 1% probability that a state with an energy 0.5 eV above Fermi level is occupied.	*CO 1*	*PO 2*	**4**
			OR			
	6	a)	Define thermal conductivity. Derive the classical expression for thermal conductivity of a conductor.	*CO 1*	*PO 1*	**8**
		b)	What are the postulates of the quantum free electron theory? Discuss any two failures of classical free electron theory which were overcome from quantum free electron theory.	*CO 1*	*PO 1*	**8**
		c)	The thermal conductivity of a material is 4.00 W/m/K and the electrical conductivity of the material is given by 6.32×10^7 $\Omega^{-1}m^{-1}$ at a temperature of 200 K. Find the Lorentz number for the given material.	*CO 1*	*PO 2*	**4**
			Module - IV			
	7	a)	Define bending moment and derive an expression for the bending moment with neat diagram.	*CO 1*	*PO 1*	**8**
		b)	Define Hooke's law. Describe stress-strain diagram.	*CO 1*	*PO 1*	**8**
		c)	Find the work done in stretching a wire of cross sectional area 10^{-2} cm^2 and 2 m long through 0.1 mm, if Young's modulus for the material of wire is 2×10^{11} Nm^{-2}.	*CO 1*	*PO 2*	**4**
			OR			
	8	a)	Define Poisson's ratio. Obtain the relation between Young's modules, rigidity modulus and Poisson's ratio.	*CO 1*	*PO 1*	**8**
		b)	What is couple force? Derive an expression for couple per unit twist of a solid cylinder.	*CO 1*	*PO 1*	**8**
		c)	In a stretching experiment, the extension produced in a wire for a load of 1.5 kg is 0.2×10^{-2} m. The length of the wire is 2 m and its radius is 0.013×10^{-2} m. Find the Young's modulus of the material of the wire.	*CO 1*	*PO 2*	**4**

			Module - V			
	9	a)	Discuss the procedure to obtain the Miller indices of crystal planes. Obtain the expression for inter-planar spacing in terms of Miller indices.	*CO 1*	*PO 1*	**8**
		b)	Elucidate the principle, construction and working of X-ray photo-electron spectrometer (XPS).	*CO 1*	*PO 1*	**8**
		c)	A beam of X-rays of wavelength 0.071 nm is diffracted by (1 1 0) plane of cubic lattice with lattice constant 0.28 nm. Find the glancing angle for the second order diffraction.	*CO 1*	*PO 2*	**4**
			OR			
	10	a)	What is atomic packing factor? Obtaining the atomic radius, and hence determine the atomic packing factor for a simple and face centered cubic system.	*CO 1*	*PO 1*	**8**
		b)	State Bragg's law. Discuss the construction and working of X-ray diffractometer.	*CO 1*	*PO 1*	**8**
		c)	The interplanar spacing of the (1 0 1) plane is 2 Å for a simple cubic crystal. Calculate the atomic radius.	*CO 1*	*PO 2*	**4**

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