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

Autonomous Institute Affiliated to VTU

December 2023 Supplementary Examinations

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

Instructions: 1. Answer **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 = 1.602×10^{-19} C
Boltzmann constant, $k_B = 1.38\times10^{-23}$ J/K
Permittivity of free space = 8.85×10^{-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, $m_p= 1.67 \times 10^{-27}$ kg

		MODULE - I	CO	PO	Marks
1.	a)	Describe the construction and working of semiconductor laser with neat energy band diagram.	CO 1	PO1	**8**
	b)	Discuss in detail the different types of optical fibers with neat diagrams.	CO 1	PO 1	**8**
	c)	The angle of acceptance of an optical fiber is 30° when kept in air. Find the angle of acceptance when it is in a medium of refractive index 1.33.	CO 1	PO 2	**4**
		OR			
2.	a)	Obtain an expression for energy density of radiation in terms of Einstein's coefficients at thermal equilibrium.	CO 1	PO 1	**8**
	b)	Define numerical aperture. Show that the numerical aperture (NA) of an optical fiber is $NA=\sqrt{n_1^2-n_2^2}$, where symbols have their usual meaning.	CO 1	PO 1	**8**
	c)	The ratio of population of two energy levels out of which upper one corresponds to a metastable state is 1.059×10^{-30}. Find the wavelength of light emitted at 330 K	CO 1	PO 2	**4**
		MODULE - II			
3.	a)	Setup a differential equation for a damped oscillator. Discuss critical damped oscillations of a damped oscillator. Sketch the result in a graph.	CO 1	PO 1	**8**

	b)	Define resonance. Obtain an expression for maximum amplitude.	*CO 1*	*PO 1*	**8**
	c)	Differential equation of forced oscillation (where all quantities are in SI units) is $(2\times10^{-4})\frac{d^2y}{dt^2}+(4\times10^{-2})\frac{dy}{dt}+5y=0.124\sin(100t)$. Calculate the amplitude of forced oscillation.	*CO 1*	*PO 2*	**4**
		MODULE - III			
4.	a)	Define Fermi factor. Discuss the probability of occupation of various energy states by free electrons at T = 0 K and T > 0 K and represent the results in the graph.	*CO 1*	*PO 1*	**8**
	b)	State and explain Weidemann-Franz law. Calculate Lorentz number using classical and quantum assumptions.	*CO 1*	*PO 1*	**8**
	c)	Aluminium is an FCC crystal with lattice constant 4.05 Å, and the metal has 3 free electrons per atom. Calculate the Fermi energy in eV for the metal.	*CO 1*	*PO 2*	**4**
		OR			
5.	a)	Define thermal conductivity. Derive an expression for thermal conductivity of metal using classical free electron theory.	*CO 1*	*PO 1*	**8**
	b)	Outline assumptions of quantum free electron theory and discuss any two merits of it.	*CO 1*	*PO 1*	**8**
	c)	Fermi level in silver is 5.5 eV. Find out the energy of the energy level for which the probability of occupancy at 300 K is 0.99.	*CO 1*	*PO 2*	**4**
		MODULE - IV			
6.	a)	Derive the relation between Young's modulus (Y), rigidity modulus (n), and bulk modulus (K).	*CO 1*	*PO 1*	**8**
	b)	State Hooke's law. Explain stress-strain diagram with a neat graph.	*CO 1*	*PO 1*	**8**
	c)	A steel wire of diameter 3.6×10^{-4} m and length 4 m elongated by 1.3×10^{-3} m under a load of 1 kg, and twist by 1.2 radians when subjected to total torsional couple of 4×10^{-5} Nm at one end. Find the values of Y and n.	*CO 1*	*PO 2*	**4**
		MODULE - V			
7.	a)	Define interplanar spacing. Obtain an expression for interplanar spacing in-terms of Miller indices for a cubic crystal.	*CO 1*	*PO 1*	**8**
	b)	Define packing factor. Derive Bragg's law for X-ray diffraction.	*CO 1*	*PO 1*	**8**
	c)	Determine the crystallite size in a cubic crystal. Given: wavelength of X-rays is 1.54 Å, full width at half maximum is 0.5°, peak position is 25° and Scherrer constant is 0.9.	*CO 1*	*PO 2*	**4**

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