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MANGALORE INSTITUTE OF TECHNOLOGY & ENGINEERING

(A Unit of Rajalaxmi Education Trust®, Mangalore)
Autonomous Institute affiliated to VTU, Belagavi, Approved by AICTE, New Delhi
Accredited by NAAC with A+ Grade & ISO 9001:2015 Certified Institution

Model Question Paper
First Semester B.E Degree Examination_____

Engineering Physics

Time: 3 Hours **Max. Marks: 100**

1. Answer any THREE full questions, choosing ONE full question from each set.
2. M: Marks, L: RBT (Revised Bloom's Taxonomy) level, C: Course Outcome
3. Constant Values: Boltzmann's Constant $= 1.38 \times 10^{-23}$J/K;
Planck's Constant $= 6.625 \times 10^{-34}$Js; Speed of light in vacuum $= 3 \times 10^{8}$ m/s;
Charge of electron = 1.6×10^{-19}C, Mass of electron = $9.1 \times 10^{-31}Kg$

		Module -1	M	L	C
Q1	a.	Describe the construction and working of the Heterojunction semiconductor laser diode with a neat, relevant diagram.	08	L2	CO1
	b.	Derive the expression for numerical aperture and acceptance angle of an optical fiber using the principle of total internal reflection. Also, define numerical aperture and acceptance angle.	08	L2	CO2
	c.	A light beam of wavelength 694.6 nm is emitted during an optical transition between two energy levels in a laser system at 348 K. Using the given data, calculate the ratio of the population of these two energy levels	04	L3	CO3
		OR			
Q2	a.	With a neat diagram, describe the construction and working of a Mach-Zehnder interferometer.	08	L2	CO1
	b.	Derive an expression for the energy density of radiation in terms of Einstein's coefficients by applying the concept of matter-radiation interaction.	08	L2	CO2
	c.	A multimode step-index fiber with a core diameter of 80 μm is operating at 0.85 μm. If the core and cladding refractive indices are 1.48 and 1.46, respectively, calculate the number of guided modes.	04	L3	CO3
		Module- 2			
Q3	a.	With the help of neat diagrams, describe the construction and working of a linear variable differential transformer (LVDT). What conclusions are drawn for the different positions of the soft iron core?	08	L2	CO1
	b.	Discuss the classification of sensors with an example for each type.	08	L2	CO1
	c.	A piezoelectric actuator has a cross-sectional area $\mathbf{3\times10^{-4}}$ m^2, Young's Modulus of $\mathbf{5\times10^{10}}$ N/m^2, and a length of 15 mm. The actuator has a free displacement of 18 µm. Calculate the stiffness $\boldsymbol{k_a}$ of the actuator and the blocking force $\boldsymbol{F_b}$.	04	L3	CO3
		OR			
Q4	a.	With relevant diagrams, discuss the construction, working, and characteristics of an Intensity-Based Displacement Fiber-Optic Sensor. Mention its applications	08	L2	CO1
	b.	With a suitable diagram, discuss the construction and working of a photodiode.	08	L2	CO1
	c.	A 40 mV output is produced by an LVDT when the core is displaced by 8 mm from its zero position. Calculate the core displacement when the output is 25 mV.	04	L3	CO3
		Module - 3			

Q5	a.	Explain the failure of engineering materials, highlighting ductile fracture, brittle fracture, stress concentration, and fatigue	08	L2	CO1
	b.	Derive the expression for Young's modulus of a rectangular beam using the uniform bending method.	08	L2	CO2
	c.	A 5 cm cube of a substance has its upper surface displaced by 0.65 cm by a tangential force of 0.25 N. Calculate the rigidity modulus of the substance.	04	L3	CO3
OR					
Q6	a.	Define Young's modulus, rigidity modulus, and bulk modulus, and write the expressions for the same. State and explain Hooke' law of elasticity.	08	L2	CO1
	b.	Derive the relation between Young's modulus, Poisson's ratio, and rigidity modulus.	08	L2	CO2
	c.	A rectangular beam of breadth 3 cm and thickness 0.5 cm is subjected to uniform bending. The distance between the knife edges is 80 cm, and the distance of each load from the nearest knife edge is 20 cm. Two loads of 1 kg each are suspended symmetrically at the ends, producing an elevation of 0.4 cm at the midpoint. Calculate the Young's modulus of the material of the beam.	04	L3	CO3
Module - 4					
Q7	a.	Explain the behaviour of the Fermi-Dirac distribution function [f(E)] for different energy levels and temperatures	08	L2	CO1
	b.	Define the Hall effect and derive an expression for Hall voltage in terms of the Hall coefficient.	08	L2	CO2
	c.	A dielectric material has a polarizability of $1 \times 10^{-40} Fm^2$ and the number density of atoms in the material is $7 \times 10^{28} atoms/m^3$. Assuming the internal field to be the Lorentz field, find the dielectric constant of the material.	04	L3	CO3
OR					
Q8	a.	Discuss polarization in dielectric materials by electronic, orientational, and ionic polarization mechanisms.	08	L2	CO1
	b.	Apply quantum-free electron theory to derive an expression for the electrical conductivity of metals.	08	L2	CO2
	c.	The electron and hole mobilities of silicon are $0.14\ m^2V^{-1}s^{-1}$ and $0.05\ m^2V^{-1}s^{-1}$respectively. If the electron concentration is $1.5 \times 10^{16}/m^3$. calculate the resistivity of silicon.	04	L3	CO3
Module – 5					
Q9	a.	Explain the broadening of spectral lines using Heisenberg's Uncertainty Principle.	08	L2	CO1
	b.	Apply the CNOT gate to the two-qubit states |00>, |01>, |10>, and |11>, and predict the resulting output states using matrix multiplication.	08	L2	CO2
	c.	An electron is confined in a one-dimensional box with walls 25 Å apart. Calculate the energy of the electron in the first and second excited states.	04	L3	CO3
OR					
Q10	a.	What is a qubit? Discuss the representation of a Qubit in a Bloch sphere.	08	L2	CO1
	b.	Set up the one-dimensional Schrödinger wave equation for a particle moving in a stationary potential field.	08	L2	CO2
	c.	The wave function of a particle in an infinite potential well is $\Psi = x\sqrt{3}$ for $0 < x < 1$ and zero elsewhere. Calculate the probability of finding the particle within the interval (0, ½).	04	L3	CO3

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