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First Semester B.E./B.Tech. Degree Examination, Dec.2025/Jan.2026

Quantum Physics and Electronics Sensors

Time: 3 hrs.

Max. Marks: 100

- Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.*
 2. M : Marks , L: Bloom's level , C: Course outcomes.
 3. VTU formula handbook is permitted.

Module – 1			M	L	C
Q.1	a.	Discuss Heisenberg's uncertainty principle and state the three relationships. Use the energy-time uncertainty to explain the broadening of spectral lines.	8	L2	CO1
	b.	Set up Schrodinger's time independent wave equation in one dimension.	8	L2	CO1
	c.	A particle of mass $0.5 \text{ MeV}/C^2$ has kinetic energy 100 eV. Find its de-Broglie wavelength where C is the velocity of light.	4	L3	CO1
OR					
Q.2	a.	Use the time-independent Schrödinger wave equation for the particle in an infinite well to arrive at an expression for the eigenvalues and eigen functions.	8	L2	CO1
	b.	Explain the wave function; mention its properties and physical significance of a wave function. Discuss the principle of complementarity.	8	L2	CO1
	c.	Calculate first three energy Eigen values in a one-dimensional infinite well of width 1 nm.	4	L3	CO1
Module – 2					
Q.3	a.	Explain the any two failures of Classical free electron theory of metals and the Assumptions of Quantum free electron theory.	8	L2	CO2
	b.	Derive an expression for carrier concentration in a conductor.	8	L2	CO2
	c.	Calculate the probability of an electron occupying an energy level 0.024eV below the Fermi level at 400K.	4	L3	CO2
OR					
Q.4	a.	With a neat labeled diagram, derive an expression for the Hall voltage and its applications.	8	L2	CO2
	b.	Derive an expression for Fermi level in an intrinsic semiconductor.	8	L2	CO2

	c.	A semiconductor sample 0.5 mm thick carries a current of 5 mA in a magnetic field of 0.2 T. If the Hall voltage is 1 mV, determine the Hall coefficient.	4	L3	CO2
Module – 3					
Q.5	a.	Explain Josephson effect with a diagram. What is flux quantization? Explain DC & AC Josephson effect.	8	L2	CO3
	b.	Explain the term Critical Temperature, Critical field and Critical field, Critical current?	7	L2	CO3
	c.	For a superconducting sample with critical temperature 7.2 K and critical field at 0K is $6.5 \times 10^4 \text{ Am}^{-1}$, find the critical field at 4 K.	5	L3	CO3
OR					
Q.6	a.	Distinguish between Type I and Type II superconductors using M-H characteristics.	8	L2	CO3
	b.	Explain the phenomenon of super conductivity. Discuss qualitatively BCS Theory of super conductivity.	7	L2	CO3
	c.	Calculate the ratio of critical fields for a superconductor at 7K and 5K gives the critical temperature 8K.	5	L3	CO3
Module – 4					
Q.7	a.	Derive an expression for the numerical aperture and acceptance angle of an optical fiber, with the help of a neat labeled diagram.	8	L2	CO4
	b.	Explain the construction working of Mach-Zehnder interferometer with a neat diagram.	7	L2	CO4
	c.	Calculate the V-number and number of modes supported by an optical fiber of core radius 25 μm , operating at wavelength 1.3 μm with NA = 0.2.	5	L3	CO4
OR					
Q.8	a.	Explain the principle and working of a Single Photon Avalanche Diode.	8	L2	CO4
	b.	Derive an expression for the energy density using Einstein's A and B coefficients.	8	L2	CO4
	c.	The ratio of population inversion of two energy levels is 1.059×10^{-30} . Find the wavelength of Light emitted by spontaneous emissions at 330K.	4	L3	CO4

Module – 5

Q.9	a.	What is LDR? Explain the Characteristics of LDR and give its applications.	8	L2	CO5
	b.	Explain the construction and working of Phototransistor and mention its applications.	8	L2	CO5
	c.	The resistance of a bulb filament is 112Ω at a temperature of 110°C . And its resistance is 180Ω at 375°C . Calculate its temperature coefficient.	4	L3	CO5
OR					
Q.10	a.	What is semiconductor gas sensors? Explain Metal Oxide Semiconductor (MOS) sensors.	8	L2	CO5
	b.	What is Hall effect sensors? Explain the construction and working of Hall effect sensors.	7	L2	CO5
	c.	A Hall sensor is made from a semiconductor with Hall coefficient R_H of $3.66 \times 10^{-4} \text{ m}^3/\text{C}$. The sensor has a thickness d of 0.5mm and is operated with a constant bias current of 5.1mA . Calculate the voltage sensitivity (S_v) of the sensor and if the sensor is placed in a magnetic field with a flux density (B) of 500G what will be the hall voltage.	5	L3	CO5
