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1BPHEC102/202

First/Second Semester B.E./B.Tech. Degree Examination, June/July 2026 Quantum Physics and Electronics Sensors (ECE stream)

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 Hand Book is permitted.*

Module – 1			M	L	C
Q.1	a.	Setup Time independent Schrödinger wave equation in one dimension.	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 the de-Broglie wavelength of an electron having kinetic energy 100eV.	4	L3	CO1
OR					
Q.2	a.	Discuss Heisenberg's uncertainty principle and state the three relationships. Using energy-time uncertainty to explain the broadening of spectral lines.	8	L2	CO1
	b.	Derive a normalized wave function for a particle inside one-dimensional infinite potential well using Schrodinger wave equation.	8	L2	CO1
	c.	An electron is bound to 1-D potential well width 10^{-10} m & infinite height. Find the energy value in eV for the ground state and first excited state.	4	L3	CO1
Module – 2					
Q.3	a.	Define fermi factor. Discuss the variation of fermi factor with temperature and energy.	7	L2	CO2
	b.	Derive the expression for hall voltage with a neat diagram and mention its application.	8	L2	CO2
	c.	Find the temperature at which there is 1% probability that a state with an energy 0.5 eV above the fermi energy is occupied.	5	L3	CO2
OR					
Q.4	a.	Explain the failure of classical free electron theory of metals and list the assumptions of quantum free electron theory.	8	L2	CO2
	b.	Derive the expression for carrier concentration in an metals.	8	L2	CO2
	c.	The concentration of electrons at room temperature in an extrinsic semiconductor used in hall experiment is $1.7 \times 10^{29} \text{ m}^{-3}$. If a current of 100 A flows through the semiconductor strip of thickness 1 mm and the strength of the magnetic field perpendicular to the strip is 3.6 wb/m^2 . Estimate the hall co-efficient and hall voltage.	4	L3	CO2

Module – 3

Q.5	a.	Distinguish between Type I and Type II superconductors using M-H characteristics.	8	L2	CO3
	b.	Explain the term critical temperature, critical field mention the relation between I_c and H_c , and define critical current.	7	L2	CO3
	c.	For a superconducting sample with critical temperature 7.2 K and critical field at 0K is 6.5×10^{-4} A/m. find the critical field at 4 K.	5	L3	CO3

OR

Q.6	a.	Derive the relation for the critical current in a cylindrical wire using ampere's law (Silsbee effect).	8	L2	CO3
	b.	Explain the phenomenon of superconductivity. Discuss qualitatively BCS theory of superconductivity.	8	L2	CO3
	c.	A superconducting wire of radius 0.5mm carries a current in a magnetic field of 2×10^{-2} T. Calculate the critical current.	4	L3	CO3

Module – 4

Q.7	a.	Derive an expression for energy density in terms of Einstein's A and B coefficients.	8	L2	CO4
	b.	Describe the construction and working of single photon avalanche diode.	8	L2	CO4
	c.	The attenuation of light in an optical fiber is estimated at 2.2 dB/Km. What fractional initial intensity remains after 2 Km and 6Km?	4	L3	CO4

OR

Q.8	a.	Derive an expression for the numerical aperture and acceptance angle of an optical fiber, with the help of neat, labeled diagram.	8	L2	CO4
	b.	Describe the construction and working of a semiconductor laser based on energy level diagram.	8	L2	CO4
	c.	Calculate the V number and number of modes supported by an optical fiber of a core diameter 25 μ m, operating at wavelength 1.3 μ m with N.A.=0.2	4	L3	CO4

Module – 5

Q.9	a.	Explain the construction and working of Piezoelectric sensors and mention its application.	8	L2	CO5
	b.	What are LDR? Explain the characteristics of LDR and give its application.	8	L2	CO5
	c.	The resistance of a bulb filament is 100Ω at a temperature of 100°C . If its TCR is 0.005 per $^\circ\text{C}$, at what temperature its resistance will become 200Ω ?	4	L3	CO5

OR

Q.10	a.	Describe the working principle of a superconducting nanowire single-photon detector.	7	L2	CO5
	b.	Explain the construction and working of phototransistor and mention its applications.	8	L2	CO5
	c.	A hall sensor is made from hall coefficient R_H of $3.66 \times 10^{-4} \text{ m}^3/\text{C}$. the sensor has a thickness of 0.5mm and is operated with a constant bias current of 5.1 mA. Calculate the voltage sensitivity of the sensors and if the sensor is placed in a magnetic field with a flux density of 500 G what will be the hall voltage.	5	L3	CO5
