Academic year 2023-2024 (Even Sem)

(OFFLINE CIE-I FOR II SEM CS STREAM)

DEPARTMENT OF PHYSICS

Date	13.05.24	Semester- II	CIE-I
Course Code	PY221CI	Maximum Test Marks	50
Course Name	QPE	Duration	90 Min
Quantum Physics for Engineers (QPE)			

	Test Questions	**M**	**BTL**	**CO**
1a	Assuming Schrodinger wave equation, derive an expression for a microparticle confined in an infinite one-dimensional potential well of width 'a'. In the above situation the particle cannot have zero energy, why?	7	2	2
1b	What will be the kinetic energy of an electron, if its de-Broglie wavelength equals the wavelength of yellow photons of energy 2.11 eV? Mass of electron is 9.1×10^{-31} kg.	3	3	3
2a	Explain the construction and working of a semiconductor diode laser with suitable diagrams.	7	1	1
2b	Two levels of an atomic system at thermal equilibrium have energy difference of 1.8 eV. If the system is at 27° C, determine the ratio of population of these two energy levels. Boltzmann constant=1.38×10^{-23} J/K	3	3	3
3a	Arrive at an expression for energy density of photons interacting with matter under thermal equilibrium.	6	2	2
3b	Calculate the ratio of (i) Einstein's coefficient's (ii) Rates of Stimulated to Spontaneous Emissions, for a system in thermal equilibrium at 300 kelvin in which radiations of wavelength 1.39μm are emitted. Boltzmann constant=1.38×10^{-23} J/K	4	3	3
4a	An atom in an excited state shows more spectral broadening than an atom in metastable state. Justify the statement by deriving a relation for spectral width.	5	2	2
4b	Write the properties of a physically acceptable wave function. A microscope is employed to locate an electron in an atom to within a distance of 0.1 Å. What is the uncertainty in the velocity of the electron?	3+2	3	1,3
5a	Define group velocity. Arrive at the relation between group velocity and phase velocity.	6	2	1
5b	Find the probability of locating a particle in a box of width 'a' between 0.45a and 0.55a for the first excited state.	4	3	3

BT-Blooms Taxonomy, CO-Course Outcomes, M-Marks

Marks Distribution	Particulars	CO1	CO2	CO3	L1	L2	L3
	Max Marks	16	18	16	07	24	19

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RV College of Engineering®

Academic year 2023-2024 (Even Sem)

(OFFLINE CIE-II FOR II SEM CS STREAM)

DEPARTMENT OF PHYSICS

Date	18-06-2024	Semester- II	CIE-II
Course Code	PY221IC	Maximum Test Marks	50
Course Name	QPE	Duration	90 Min
Quantum Physics for Engineers (QPE)			

	Answer all Questions	**M**	**BTL**	**CO**
1a	Which type of optical fiber has more distortion of the signals. Derive the expression for acceptable angle of an optical fiber.	07	L2	1
1b	Calculate the numerical aperture and number of modes of propagation in an optical fiber for a signal of wavelength 820 nm and core diameter is 50μm. Core and cladding Refractive indices 1.51 and 1.40 respectively.	03	L3	3
2a	What is a phonon? Explain three assumptions and failures of classical free electron theory.	07	L1	1
2b	Find the probability of a level lying 0.1 eV below the Fermi level not being occupied by electrons at T = 300K	03	L3	3
3a	Obtain the expression for concentration of electrons in intrinsic semiconductors.	07	L1	2
3b	The Fermi level in silver is 5.5eV at zero kelvin. Calculate the number of free electrons per unit volume and the probability occupation for electrons with energy 5.6eV in silver at the same temperature.	03	L3	3
4a	What is Hall effect? Obtain the expression for hall co-efficient for n-type semiconductor.	07	L2	2
4b	A semiconducting material 9 mm long, 5 mm wide and 1 mm thick has a magnetic flux density of 0.6 Wb/m^2 applied perpendicular to the largest faces. A current of 30 mA flows through the length of the sample, and the corresponding voltage measured across its width is 47μV. Find the Hall coefficient of the semiconductor.	03	L3	3
5a	Find the Fermi energy of copper wire by using suitable formulae and the following experimental data. (Use least square method for calculating slope). Given the length of copper wire used 14 m and its diameter is 0.3 mm and density of copper is 8960 kg/m^3	05	L3	4
5b	Write the detailed procedure to determine the energy gap of a thermistor	05	L3	4

Temperature(°C)	85	80	75	70	65	60	55	50	45
Resistance (Ω)	16.1	16.0	15.8	15.7	15.4	15.2	15.1	14.9	14.7

BT-Blooms Taxonmy, CO-Course Outcomes, M-Marks

Marks Distribution	Particulars	CO1	CO2	CO3	CO4	L1	L2	L3
	Max Marks	14	15	11	10	15	14	21

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Academic year 2023-2024 (Even Sem)

(OFFLINE IMPROVEMENT TEST FOR II SEM CS STREAM)

DEPARTMENT OF PHYSICS

Date	01-07-2024	Semester- II	Improvement test
Course Code	PY221CI	Maximum Marks	10+50
Course Name	QPE	Duration	120 Min
Quantum Physics for Engineers (QPE)			

	Quiz Questions	M	BTL	CO
1	State Matthiessen's rule of resistivity in metals.	1	L1	1
2	What is Meissner effect in superconductors?	1	L1	1
3	Prove that superconductors are perfectly diamagnetic materials.	2	L2	3
4	Explain, why type-1 superconductivity is a low temperature phenomenon?	2	L2	2
5	How a qubit is different from a regular bit?	1	L1	1
6	Mention the principle that allows quantum computers to run many computations simultaneously.	1	L1	1
7	A magnetic material having a magnetic susceptibility of 5×10^{-6} is placed in an external magnetic field of intensity 10^6 A m^{-1}. Calculate magnetic induction in the material.	2	L2	3

BT-Blooms Taxonomy, CO-Course Outcomes, M-Marks

Marks Distribution	Particulars	CO1	CO2	CO3	L1	L2	L3
	Max Marks	4	2	4	4	4	2

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RV College of Engineering

Academic year 2023-2024 (Even Sem)

(OFFLINE IMPROVEMENT TEST FOR II SEM CS STREAM)

Answer all the questions

	Test Questions	M	BTL	CO
1a	Classify superconductors into different types and provide a detailed explanation of each type with suitable graphs.	7	L2	2
1b	The critical field of Niobium is 1×10^5 A/m at 8 K and 2×10^5A/m at 0 K. Calculate the transition temperature of the element.	3	L3	3
2a	Explain DC Josephson effect and AC Josephson effect in superconductors. Calculate the frequency of the radiation emitted by the junction when $6\mu V$ is applied across the junction.	7	L2	3
2b	Calculate the critical current for a wire of a lead having a diameter of 1 mm at 4.2 K. The critical temperature for lead is 7.18 K and $H_0 = 6.5 \times 10^4$ A m^{-1}.	3	L3	3
3a	Describe BCS theory of superconductivity.	5	L2	2
3b	Describe the construction and working of DC SQUID.	5	L2	2
4a	What is quantum superposition? Explain single-particle quantum interference experiment to demonstrate quantum superposition.	7	L1	1
4b	Mention the three differences between classical information and quantum information.	3	L1	1
5a	With the labelled circuit diagram, graphs, formulae, tabular column, describe the procedure to determine the capacity of a parallel plate capacitor and the dielectric constant of the dielectric medium in it.	6	L2	4
5b	With the following given data, identify the passive component and estimate its value showing the substitution and calculations.	4	L3	4

SL No	Frequency (Hz)	Voltage (V)	Current (mA)
1	300	2.2	76.7
2	400	2.5	73.7
3	500	2.8	63.4

BT-Blooms Taxonomy, CO-Course Outcomes, M-Marks

Marks Distribution	Particulars	CO1	CO2	CO3	CO4	L1	L2	L3
	Max Marks	10	17	13	10	10	30	10

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PY221IC

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RV COLLEGE OF ENGINEERING®

(An Autonomous Institution affiliated to VTU)

I / II Semester B. E. Regular / Supplementary Examinations Aug-2024

QUANTUM PHYSICS FOR ENGINEERS

Time: 03 Hours *Maximum Marks: 100*

Instructions to candidates:

1. Answer all questions from Part A. Part A questions should be answered in first three pages of the answer book only.
2. Answer FIVE full questions from Part B. In Part B question number 2 & 11 are compulsory. Answer any one full question from 3 and 4, 5 and 6, 7 and 8, 9 and 10, and 11 lab components (compulsory).
3. Handbook of Physics is allowed.

PART A

			M	BT	CO
1	1.1	Two particles of masses m_1 and m_2 move with a same momentum. Find the ratio of their deBroglie wavelengths.	01	2	2
	1.2	Write the expression for superposition state of a qubit.	01	1	1
	1.3	At low temperature, what is the value of resistivity due to phonons?	01	2	2
	1.4	Name the ion which enters into fiber constitution at the time of fiber fabrication and causes absorption loss.	01	1	1
	1.5	Prove that superconductors are ideal diamagnetic.	02	2	2
	1.6	In a laser system when the energy difference between two energy levels is $2 \times 10^{-19} J$, the average power output of laser beam is found to be $4mW$. Calculate the number of photons emitted per second.	02	3	3
	1.7	An electron is moving in a box of length 'a'. If ψ_1 is the wave function at $x = \frac{a}{4}$ with $n = 1$ and ψ_2 at $x = a$ with $n = 2$. Find $\frac{\psi_2}{\psi_1}$.	02	3	3

PART B

2	a	Solve the Schrodinger wave equation for a particle in an infinite potential well for Eigen values and prove that the energy is quantized.	07	2	2
	b	What is expectation value of a physical quantity and write the expression for the position $\langle x \rangle$. Calculate the probability of finding a particle in the interval $0.2a$ and $0.6a$ when the particle is in a potential well of width 'a' and infinite height. The particle is in its ground state.	07	2	2
3	a	Enumerate the difference between classical and quantum computing.	06	1	1
	b	What is quantum superposition? With a neat labeled diagram, explain single photon interference experiment to demonstrate quantum superposition.	08	2	2

OR

4	a	The Pauli matrices are given as $A = \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}, B = \begin{pmatrix} 0 & -i \\ i & 0 \end{pmatrix}$, $C = \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$. Show that Pauli matrices are unitary matrices.	06	3	3
	b	Explain S and T-phase gate and write its Dirac and matrix representation. Write any four differences between classical information and quantum information.	08	1	1
5	a	With an energy band diagram of biased and unbiased condition of a pn junction, explain how population inversion is achieved and coherent light is produced in a diode laser.	06	2	2
	b	Write the two necessary conditions for light amplification in terms of Einstein's coefficients. Find the wavelength at which the rates of spontaneous and stimulated emission become equal at a temperature of $500K$.	08	1,3	1,3
		OR			
6	a	Explain the interaction of electromagnetic radiation with matter; show that under equilibrium condition, probability of stimulated absorption is equal to probability of stimulated emission.	06	2	2
	b	Compare a single mode and multimode step index fiber with a neat sketch of ray propagation and refractive index profile diagram. The acceptance angle of an optical fiber with the core of refractive index 1.45 is 5^0. Calculate the refractive index of the clad.	08	1,3	1,3
7	a	Derive an expression for the carrier concentration in metals at zero Kelvin and also arrive at an expression for Fermi energy.	06	2	2
	b	Prove that Fermi level of an intrinsic semiconductor lies in the middle of the band gap. And discuss what is the effect of temperature on Fermi level in an intrinsic semiconductor? Calculate the temperature at which silicon ($E_g = 1.14eV$) will have the same concentration of electrons in the conduction band as germanium ($E_g = 0.72eV$) has at $300K$.	08	2,3	2,3
		OR			
8	a	With a neat labeled diagram, explain Hall effect in a p-type semiconductor and derive an expression for the Hall coefficient in terms of Hall voltage.	06	2	2
	b	With an energy band diagram, discuss the variation of Fermi level with temperature in an $n-$type semiconductor. Evaluate the Fermi energy of an intrinsic semiconductor at $400K$. Given that the band gap is $1.12eV$. The effective mass of an electron and effective mass of holes are $0.14m_0$ and $0.28m_0$ respectively, given that top of valence band is $5eV$.	08	1,3	1,3
9	a	With relevant graphs, discuss the difference between hard and soft superconductors.	06	1	1
	b	What is quantum tunneling? Discuss how weak magnetic fields can be measured by passing direct current through a Josephson's junction. A Josephson's junction with a voltage difference of $650\mu V$ radiates electromagnetic radiation. Calculate its frequency.	08	2,3	2,3

OR

10	a	What is superconductivity? Explain in detail why superconductivity is a low temperature phenomenon with the help of *BCS* theory.	06	1,2	1,2
	b	With the help of graph, explain the variation of resistivity versus temperature in a normal conductor and a super conductor. The critical temperature of a superconductor when no magnetic field is applied is T_c. Find the temperature at which the critical field becomes half its value at $0K$.	08	2	2
11	a	Outline the procedure to determine the Fermi energy of copper. Compute the Fermi energy of copper by using graphical method. Given: density of copper is $8960kg/m^3$, diameter of the copper is $0.15mm$ and length of the wire is $12m$.			

Temperature (^0C)	85	80	75	70	65	60	55
Resistance(Ω)	15.5	15.2	14.8	14.6	14.4	14.1	13.9

	b	Outline the principle and procedure to determine the capacitance of a parallel plate capacitor and the dielectric constant of the dielectric medium including necessary circuit diagram. Formulate model graphs and tabular columns.	10	2,3	2,3
			10	1	1