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JAIN COLLEGE OF ENGINEERING, BELAGAVI

Estd. 2010

Department of Physics
Academic year 2025-26

Continuous Internal Evaluation – 1
Course Name: Quantum Physics and Applications (CS)
Maximum Marks: 25 **Date: 05-11-2025**

Class: Sem.1 (A,B, C and D div.)
Course Code: 1BPHYS102
Duration: 60 Minutes

1. Boltzmann constant: $k = 1.33\times10^{-23} J/K$,
2. Speed of light: $c = 3\times10^{8} m/s$
3. Permittivity of free space: $\varepsilon_0 = 8.854\times10^{-12} F$,
4. Magnitude of charge: $e = 1.6\times10^{-19} C$

Note: Answer any ONE full question from PART- A and one full question from PART- B.

		PART A	M	CO's	PI's	BCL	PQP
Q. 1.	a	Apply Schrodinger's time-independent wave equation for a particle in an infinite height potential well. Arrive its Eigen energy and Eigen wave function for a particle.	8	1	1.2.1	2	NA
	b	Calculate the energy of first three states for an electron in a one dimensional potential well of width $0.2\ nm$.	5	1	1.2.1	2	E-25
		OR					
Q. 2.	a	Derive Schrodinger's time-independent differential wave equation for a particle. Mention the expression for 3 dimensional versions of the same.	8	1	1.2.1	2	E-23
	b	The inherent uncertainty in the measurement of time spent by the $Iridium-191$ nuclei in the excited state is found to be 1.4×10^{-10} sec. Estimate the uncertainty that results in its energy in the excited state.	5	1	1.2.1	2	E-17
		PART B					
Q. 3.	a	What is Fermi energy? Describe the variation of Fermi factor on temperature and energy.	6	2	1.2.1	2	E-23
	b	Calculate the probability of an electron occupying an energy level $0.04\ eV$ above the Fermi level at $400\ K$ and $600\ K$ in a material.	6	2	1.2.1	2	E-23
		OR					
Q. 4.	a	What is Hall effect? Obtain an expression for the Hall coefficient in terms of Hall voltage with neat diagram.	6	2	1.2.1	2	E-24
	b	A rectangular plane sheet of a semiconductor material has dimension $2\ cm$ along y direction and $1\ mm$ along z direction. Hall probes are attached on the two surfaces parallel to x-z plane and a magnetic field of flux density of $1\ W/m^2$ is applied along z-direction. A current of $3\ mA$ is flowing in it in the x-direction. Calculate the Hall voltage measured by the probes, if the Hall coefficient of a material is $3.68\times10^{-4} m^3/C$. Also Calculate the charge carrier concentration.	6	2	1.2.1	2	NA

*** M-Marks** ***CO-Course Outcome** *** PI-Performance Indicators** ***BCL-Bloom's Cognitive Levels**
***PQP-Previous year QP reference (O-Odd, E-Even, G-Gate)**

CO's: **1.** Explain core quantum concepts and their computational relevance.
2. Analyze electronic behavior in metals and semiconductors for key material properties.

PI's: **1.2.1.** Apply laws of natural science to an engineering problem

BCL: **1-** Remembering, **2-** Understanding, **3-** Applying, **4-** Analyzing, **5-** Evaluating, **6-** Creating

Prepared by: (CIE Moderation Committee Member)	Scrutinized by: (CIE Moderation Committee Member)	Approved by (Course Coordinator) Head of Department
Sign: 3.11.2025	Sign: 4/11/25	Sign: 03.Nov.25
Name: Dr. Hanamanta Badiger	Name: Dr. Ravi C. Bharamagoudar	Name: Dr. Shivkumar M. A.

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Estd. 2010

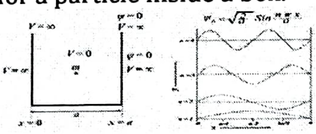
JAIN COLLEGE OF ENGINEERING, BELAGAVI

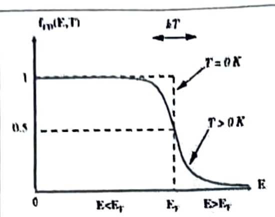
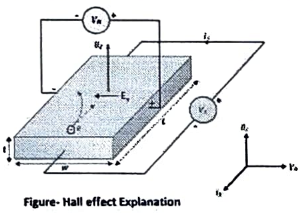
Department of Physics

Academic year 2025-26

Continuous Internal Evaluation – 1
Class: I Semester (A, B, C and D div.)
Course Name: Quantum Physics and Applications (CS)
Course Code: 1BPHYS102
Maximum Marks: 25
Date: 05-11-2025
Duration: 60 Minutes

CIE-I Scheme of Evaluation

			Marks
		PART- A	
Q. 1.	**a**	**Apply Schrodinger time independent wave equation for a particle in an infinite height potential well. Arrive its Eigen energy and Eigen wave function for a particle.** Student will apply the knowledge about the fundamentals of Schrodinger time independent wave equation to derive Eigen energy and Eigen wave function for a particle inside a box.  $\frac{d^2\varphi}{dx^2}+\frac{8\pi^2 m}{h^2}\varphi(E-V), \varphi = Asinkx + Bcoskx$, A= $\sqrt{\frac{2}{a}}$, B=0, $E_n = \frac{n^2h^2}{8ma^2}$, $\varphi_n = \sqrt{\frac{2}{a}}\sin\left(\frac{n\pi}{a}\right)x$	02(Diagram) 03 (En)+03 (φ_n)
	b	**Calculate the energy of first three states for an electron in a one dimensional potential well of width 0.2 nm.** Student will apply the knowledge about the fundamentals of one dimensional potential well to solve problem. width a = 2 Å = $2x10^{-10}$m E = $\frac{n^2h^2}{8ma^2}$, $E_1 = \mathbf{1.50}$ X 10^{-18} J, $E_2 = \mathbf{6.02}$ X 10^{-18} J, $E_3 = \mathbf{1.35}$ X 10^{-17} J	01 (Formula) 02 (E_1 ans. with unit) 02 (E_2 and E_3 ans. with unit)
		OR	
Q. 2.	**a**	**Derive Schrodinger time independent differential wave equation for a particle. Mention the expression for 3 dimensional versions of the same.** Student will apply the knowledge about the fundamentals of Schrodinger time independent wave equation. $\varphi = e^{-i(kx-\omega t)}$, $\frac{d^2\varphi}{dx^2}$, $\frac{d^2\varphi}{dt^2}$, $\frac{dy^2}{dx^2} = \frac{1}{v^2}\frac{dy^2}{dt^2}$, E=KE+PE, $\frac{d^2\varphi}{dx^2}+\frac{8\pi^2 m}{h^2}\varphi(E-V)$,, $\frac{d^2\varphi}{dx^2}+\frac{d^2\varphi}{dy^2}+\frac{d^2\varphi}{dz^2}+\frac{8\pi^2 m}{h^2}\varphi(E-V)$.	02+02+02+01+01
	b	**The inherent uncertainty in the measurement of time spent by the Iridium-191 nuclei in the excited state is found to be $1.4x10^{-10}$ sec. Estimate the uncertainty that results in its energy in the excited state.** $\Delta E.\Delta t \geq \frac{h}{4\pi}$, $\Delta E = \mathbf{3.77}x10^{-25}J$, $\Delta E = \mathbf{2.35}x10^{-6}eV$	02(Formula) 03 (Answer with unit)
		PART B	
Q. 3.	**a**	**What is Fermi energy? Describe the variation of Fermi factor on temperature and energy.** Student will apply the knowledge about fundamentals of Fermi energy and derive the variation of Fermi factor on temperature and energy.	02(Def.) 01(Formula) 03(3 condition with diagram)

		 $f(E)=\frac{1}{e^{\frac{E-E_F}{kT}}+1}$ $E > E_f$, = 0, $E < E_f$ = 1, $E = E_f$ = 0.5	
	b	**Calculate the probability of an electron occupying an energy level 0.04 eV above the Fermi level at 400K and 600K in a material.** Student will apply the knowledge about the fundamentals of Fermi level to solve this problem. $f(E)=\frac{1}{e^{\frac{E-E_F}{kT}}+1}$, E-$E_F$ = 0.04eV = 0.64 $x10^{-19}$ J, 1) **0.22** at 400 K 2) **0.30** at 600 K	**01**(Formula) **01** (E-E_F *value in J*) **02** (400k Ans.) **02** (600k Ans.)
		OR	
Q. 4.	a	**What is Hall effect? Obtain an expression for the Hall coefficient in terms of Hall voltage with neat diagram.** Student will apply the knowledge about the fundamentals of Hall voltage and Hall coefficient to derive the derivation.  Figure- Hall effect Explanation $R_H = \frac{1}{n_e e}, V_H = \frac{B\,x\,I}{R_H x\,w}$	**01**(Diagram) **03**(R_H equation) **02**(V_H equation)
	b	**A rectangular plane sheet of a semiconductor material has dimension 2cm along y direction and 1mm along z direction. Hall probes are attached on the two surfaces parallel to x-z plane and a magnetic field of flux density of 1 W/m2 is applied along z-direction. A current of 3 mA is flowing in it in the x-direction. Calculate the Hall voltage measured by the probes, if the Hall coefficient of a material is 3.68 X 10-4 m³/C. Also Calculate the charge carrier concentration.** Student will apply the knowledge about the fundamentals of Hall voltage and Hall coefficient to solve the problem $R_H=\frac{1}{n_e e}$ = n_e = $\mathbf{1.7x10^{22}}$ m^{-3}, $V_H = \frac{BxI}{R_H xw}$ = $\mathbf{1.1x10^{-3}}$ *V or 1.1mV*	**02** (Formula) **02** (n_e Ans. with Unit) **02** (V_H Ans. with Unit)

Prepared by: **(CIE Moderation Committee Member)**	**Scrutinized by:** **(CIE Moderation Committee Member)**	**Approved by** **(Course Coordinator)** **Head of Department**
Sign: 4.11.25	**Sign:** 4/11/25	**Sign:** 4.11.2025
Name: Dr. Hanamanta Badiger	**Name: Dr. Ravi C Bharamagoudar**	**Name: Dr. Shivkumar M. A.**

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