GURU NANAK INSTITUTE OF TECHNOLOGY
An Autonomous Institute under MAKAUT
2021
PHYSICS-II
PH(ECE)401

TIME ALLOTTED: 3HR **FULL MARKS:70**

The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable

GROUP – A
(Multiple Choice Type Questions)

Answer any ***ten*** from the following, choosing the correct alternative of each question: **10×1=10**

			Marks	CO No.
1.	(i)	In Quantum mechanics a particle is free if it moves in a region where PE is a. Constant or zero b. varies with distance c. varies with time d. zero	1	CO1
	(ii)	Ampere's circuital law is valid for a. varying current b. static field c. alternating current d. harmonic field	1	CO1
	(iii)	Which of the following is well behaved wave function? a. $\psi(x) = Ae^{x}$ b. $\psi(x) = Ae^{-x}$ c. $\psi(x) = Ae^{x^2}$ d. $\psi(x) = Ae^{-ax^2}$	1	CO2
	(iv)	Quantum dot is a a. 1-D structure b. 2-D structure c. 0-D structure d. Bulk	1	CO1
	(v)	If E_1 be the energy of the ground state of a one dimensional potential box of length L and E_2 be the energy of the ground state when the length of the box is halved, then a. $E_2=2\ E_1$ b. $E_2= E_1$ c. $E_2=4\ E_1$ d. $E_2=3\ E_1$	1	CO3
	(vi)	A gas has two indistinguishable particles in 3 separate quantum states obeying BE statistics. The numbers of microstates are a. 6 b. 9 c. 3 d. 2	1	CO2

(vii)	The expectation value $\langle x \rangle$ for a one dimensional potential box of length L in the ground state is a) $\frac{L}{4}$ b) $\frac{L}{2}$ c) $\frac{L}{8}$ d) 0	1	CO2
(viii)	Does a charge at rest establish a magnetic field? a. Yes b. No c. cannot be concluded d. never	1	CO1
(ix)	The number of possible arrangements of two fermions in 3 cells is a. 9 b. 6 c. 3 d. 1	1	CO1
(x)	At the top of the band "E-K" graph is a. Parabolic b. Horizontal c. Elliptical d. None	1	CO3
(xi)	Commutator bracket of of [x, p] is a. +iħ b. - iħ c. -1 d. +1	1	CO2
(xii)	The flux through each turn of a 100 cm coil is $(t^3-2t)\times10^{-3}$ Wb, where t is in second. The induced emf at t = 2 second is a. 1 V b. -1 V c. 4 mV d. 0.4 V	1	CO2

GROUP – B
(Short Answer Type Questions)

Answer any ***three*** from the following: **3×5=15**

			Marks	**CO No.**
2.	(a)	Fermi level is an actual energy or any hypothetical level? Justify your answer with Fermi Dirac Distribution function at T=0 K	3	CO3
	(b)	Plot Fermi Dirac Distribution function at T > 0 K and interpret the action of an intrinsic semiconductor at T>0 K	2	CO3
3.	(a)	If the electric field at some point is given by $\vec{E} = \frac{1}{\epsilon_0}(\hat{i}x+\hat{j}y-2\hat{k}z)$, then calculate the charge density there. Can you identify the medium	3	CO2
	(b)	Express Faraday's laws of e.m.f induction in differential form.	2	CO1
4.	(a)	If any scalar function is denoted by, $\varphi = 3x^2y - y^3z^2$. Then find gradient of the scalar function at the point (1,-2,-1)	3	CO3

	(b)	What is "Quantum Dot"? Why are they called 'artificial atom'?	2	CO1,CO 2
5.	(a)	Find the expectation value of x for the wave function given by $\psi(x) = A \exp(-x^2 / a^2 + ikx)$.	2	CO3
	(b)	What is the potential felt by an electron in a solid due to the presence of positive ion? Show graphically the nature of the periodic potential inside the solid. Explain the region of maximum potential energy and minimum potential energy.	3	CO1,CO4
6.	(a)	Explain the term electric flux. What are the dimension and unit of it?	3	CO1
	(b)	For an electric potential $V = (x^2 + y^2 + z^2)$, calculate the electric field at (1,1,1).	2	CO2

GROUP – C
(Long Answer Type Questions)
Answer any ***three*** from the following: **3×15=45**

			Marks	CO No.
7.	(a)	Compare between conduction current and Displacement current.	2	CO1
	(b)	A capacitor is made with two infinitely long conducting cylinders of radii a and b (a>b) with vacuum in the intervening space. The inner cylinder is grounded and the outer cylinder has a charge density σ. Solve this boundary − value problem to find the electric potential in the space between the cylinders.	5	CO3
	(c)	Explain the working of Nicol as a polariser with the help of a neat diagram. Two polarizers are crossed to each other. One of them is then rotated through 30º. Calculate the percentage of incident unpolarized light that will pass through the optical system.	8	CO3
8.	(a)	One dimensional motion of a particle confined in a potential is given by $V(x) = 0 \; for \; 0 < x < a$ and $= \infty \; for \; x < 0$ and $x > a$ The ground state wave function of the above particle is given by $\Psi(x) = A \sin \frac{\pi x}{a}$. a) Find out the normalization constant 'A'. b) Find out the expectation value of x for the above state.	7	CO2
	(b)	Write down Gauss's law in electrostatics and derive its differential form.	5	CO1
	(c)	Write down the physical significance of Maxwell's equations in free space.	3	CO3
9.	(a)	Three particles each of which can be in one of ϵ, 2ϵ, 3ϵ , 4ϵ energy states have total energy 6ϵ. Find all possible number of distributions of the particles in the energy states if the particles obey (i) M-B statistics (ii) B-E statistics	6	CO3

(iii) F-D statistics

	(b)	Apply F-D statistics to find total number of free electrons in a metal at 0^0K temperature.	5	CO3
	(c)	What are bosons and fermions? Give examples	4	CO2
10.	(a)	What is "Free electron gas model"? What are the postulates made by Lorentz and Drude in developing free electron gas model? In case of electron conduction in metal, what are the forces acting on the electron? How does drift velocity is reached?	5	CO1, CO2,CO4
	(b)	Find out a relationship between resistivity and temperature for a metal	5	CO3
	(c)	Explain the changes in electrical properties of a metal if dimension is reduced and the metal becomes a nanomaterial .	5	CO4
11.	(a)	Show that $\nabla^2 (\frac{1}{r}) = 0$ when $r \neq 0$. Use spherical coordinate system.	3	CO2
	(b)	Show that the electric field $\vec{E} = \hat{i}$ yz +$\hat{j}$ zx+$\hat{k}$ xy is solenoidal as well as conservative. Do you practically encounter this type of field ? Justify.	9	CO1
	(c)	State &Explain Brewster's law. What happens to it for polished metallic reflector ?	3	CO3