GURU NANAK INSTITUTE OF TECHNOLOGY
An Autonomous Institute under MAKAUT
2022
PHYSICS-II
PH(ECE)401

TIME ALLOTTED: 3 HOURS **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)	Which one of the following functions is an eigen function of the operator $\frac{d^2}{dx^2}$? a) x b) x^2 c) e^{-x^2} d) cos x	1	CO 1
(ii)	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) $E_2=2E_1$ b) $E_2= E_1$ c) $E_2=4E_1$ d) $E_2=3E_1$	1	CO 1
(iii)	Spin of "photon" particle a) integer multiple of 'h' b) half integer multiple of 'h' c) spin is not defined. d) zero	1	CO 1
(iv)	Electrostatic field is a) Conservative b) Solenoidal c) Irrotational d) Both a) and c)	1	CO1
(v)	The equation of continuity essentially represents a) conservation of mass b) conservation of charge c) conservation of potential d) conservation of force	1	CO1

(vi)	The dimension of $(\mu_0 \varepsilon_0)$ is a) $L^{-2}T^{-2}$ b) $L^{-2}T^{2}$ c) LT^{-1} d) $L^{-1}T^{-1}$	1	CO2
(vii)	The displacement current through an ideal capacitor a) is greater than conduction current b) equal to conduction current c) less than conduction current d) none of these	1	CO1
(viii)	Electrons within a solid, moving under the influence of a) constant potential b) zero potential c) periodic potential d) linear potential	1	CO2
(ix)	The periodicity of Bloch function is a) same as that of potential b) half of that of potential c) double of that of potential d) no relation between them	1	CO1
(x)	The strongest material is a) graphite b) diamond c) graphene d) iron	1	CO1
(xi)	Example of zero dimensional nano material a) Quantum Dot b) Quantum well c) Quantum wire d) graphite	1	CO1
(xii)	According to Sommerfeld theory of electron conduction in metal, electrons obey a) M.B statistics b) F.D. statistics c) B.E. statistics d) does not obey any statistics	1	CO1

GROUP – B
(Short Answer Type Questions)
Answer any ***three*** from the following: **3×5=15**

		Marks	CO No
2.	If the wave function $\psi(x)$ of a quantum mechanical particle is given by $\psi(x) = a\sin\frac{n\Pi x}{L}$ for $0 \le x \le L$ $= 0$ *otherwise* then find the value of x where the probability of finding the particle is maximum. Show that the first excited state of a free particle in a cubicle box has three-fold degeneracy	5	CO2
3.	Evaluate $[L_x, L_y]$	5	CO4
4. a)	Express Ampere's circuital law in terms of magnetic vector potential **A**.	3	CO1
b)	Do you find similar expression in electrostatics ? Identify it.	2	CO1
5.	Show that the 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.	5	*CO1*
6.	What are the applications of nanomaterials in different fields.	5	CO1

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

		Marks	CO No
7.a)	Define macrostate and microstate.	3	CO1
b)	Derive the expression for average energy in a metal at T=0K temperature	7	CO3
c)	Three distinguishable particles each of which can be in one of the E, 2E, 3E, 4E energy states have total energy 6E. Find all possible number of distributions of all particles in the energy states. Find the number of microstates in each case.	5	CO4
8.a)	Write down Maxwell's field equation's in differential form and explain their physical significances.	6	CO1
b)	Use Faraday's laws of e.m. induction and the fact that magnetic induction **B** can be derived from a vector potential **A** , show that the electric field can be expressed as $\mathbf{E} = -\text{grad}\,\Phi - \partial\mathbf{A}/\partial t$, where Φ is the scalar potential	3	CO1
c)	Show that $E = E_0\,\text{Cos}(kx-wt)$ satisfy wave equation.	3	CO3
d)	Write down equation of continuity explaining all the terms. Hence find out the nature of current density under steady-current condition .	3	CO3
9.a)	If $\vec{A} = x\,2\,y\,\hat{i} - 2xz\,\hat{j} + 2yz\,\hat{k}$ is a vector, find its Curl.	2	CO1
b)	Solve Laplace's equation for 1-D coaxial cylindrical conductor system. Hence calculate the capacitance of the system when the outer conductor is earthed.	6	CO1

c)	What is Ampere's circuital law? Derive its differential form. What is the limitation of it? How was it modified?	7	CO1
10.a)	What was the correction made by Sommerfeld over the classical Lorentz-Drude theory?	6	CO1
b)	According to Sommerfeld's theory, show that electrons in a solid have discrete set of energies.	2	CO4
c)	Name a system in which free electron theory is applicable.	2	CO1
d)	According to free Electron Theory, show that the resistivity of a metal varies with square root of Temperature.	5	CO3
11.a)	State Bloch theorem.	2	CO1
b)	Starting from the equation found from the "Kronig-Penney model", show that the energy of particle becomes discrete if the barrier strength becomes infinite.	3	CO4
c)	Draw Energy (E) vs. Wave vector (k) graph for electrons moving within periodic potential. Explain the nature of the graph.	5	CO4
d)	Explain the optical property of a Quantum Dot (QD).	2	CO2
e)	Define Brewster's law related to the polarization of light	2	CO1
f)	Name a phenomenon that proves that light is transverse in nature.	1	CO1