Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.TECH/EE(NEW)/EEE(NEW)/EIE(NEW)/ICE(NEW)/SEM-4/PH(EE)-401/2013

2013

PHYSICS – II

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)

1. Choose the correct alternatives for any *ten* of the following : $10 \times 1 = 10$

i) A constraint is holonomic when

a) they are integrable and equational form

b) they are non-integrable and inequational form

c) they are integrable and inequational form

d) they are non-linear equational form.

ii) The number of lattice points in the cubic cell of an *fcc* latice is

a) 4 b) 14

c) 6 d) 2.

iii) The atomic radius of a face centred cubic crystal of lattice constant a is

a) $a/2$ b) $\sqrt{3a}/4$

c) $\sqrt{2a}/4$ d) none of these.

iv) A crystal is equivalent to

a) n-D grating b) 3-D grating

c) 1-D grating d) 2-D grating.

v) Hamiltonian is defined as

a) $H = T - V$ b) $H = T + V$

c) $H = 2T + L$ d) $H = V - T$.

vi) Torque ($\vec{\tau}$) on an electric dipole having dipole moment ($\vec{p}$) in electric field $\vec{E}$ can be exposed as

a) $\vec{\tau} = -\vec{p} \times \vec{E}$ b) $\vec{\tau} = -\vec{p} \cdot \vec{E}$

c) $\vec{\tau} = \vec{p} \times \vec{E}$ d) $\vec{\tau} = \vec{p} \cdot \vec{E}$.

vii) The electrical conductivity of an insulator is zero due to the absence of

a) bound electrons b) free electrons

c) protons d) neutrons.

viii) The ionic polarizability is

a) dependent on temperature

b) independent on temperature

c) dependent on current density

d) dependent on the concentration of ions.

ix) The degree of freedom of a phase space is

a) 6 b) 3

c) 2 d) 1.

x) Which one of the following is not an acceptable wave function of a quantum particle ?

a) $\psi = e^{x}$ b) $\psi = e^{-x}$

c) $\psi = x^{n}$ d) $\psi = \sin x$.

xi) The probability of a particle in space at time t is

a) 0 b) 1

c) $\frac{1}{2}$ d) ∞.

xii) The wave functions of an one-dimensional box represent

a) progressive waves

b) standing waves

c) progressive and standing waves

d) none of these.

xiii) The eigenvalues of Hermitian operator are

a) imaginary

b) real

c) dependent upon the eigenvectors

d) none of these.

xiv) Maxwell-Boltzmann statistics is applicable for

a) ideal gas b) photons

c) electrons d) none of these.

xv) Pauli's exclusion principle is applied to

a) M.B. Statistics b) F. D. Statistics

c) B. E. Statistics d) none of these.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following $3 \times 5 = 15$

2. a) A bead of mass m slides without friction on a frictionless wire in the shape of cycloid with equations, $x = a(\theta - \sin\theta)$ and $y = a(1 + \cos\theta)$ where $0 \le \theta \le 2\pi$. Find the Lagrangian function and the Lagrangian equation of motion.

b) Derive the expression for energy operator. 3 + 2

3. a) "All primitive cells are unit cells but all unit cells are not primitive cells." Justify.

   b) If V is the volume of a primitive unit cell of a direct lattice, then show that the volume of a primitive unit cell of the reciprocal lattice is $8\pi^3 / V$. 2 + 3

4. a) Why is diamagnetism almost independent of temperature ?

   b) What is Bohr magnetron ? Show that Bohr magnetron represents the magnetic moment of an elementary dipole. 2 + 3

5. What do you mean by quantum mechanical operator ? Find the eigenvalues of momentum and energy operators for a wave function $\psi(x,t) = Ae^{i(kx-\omega t)}$. 1 + 2 + 2

6. a) What are meant by degenerate and non-degenerate states ?

   b) Four distinguishable particles are distributed over two non-degenerate energy levels of energies e, $2e$ and $3e$. Calculate the total number of microstates and the total energy of the distribution when the thermodynamic probability is maximum. 2 + 3

GROUP – C
(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

7. a) The lattice constant for unit cell of aluminium is 1·04Å. What is the distance between planes with Miller indices (200) ?

b) Distinguish between metals, insulators and semiconductors.

c) Define and discuss Wiedemann-Franz law.

4 + (2 + 2 + 2) + 5

8. a) Define displacement vector $\vec{D}$ and show that for an isotropic dielectric $\vec{D} = \epsilon_0 \vec{E} + \vec{P}$ where $\vec{P}$ is the polarization vector.

b) For ferromagnetic substance how $\vec{B}$, $\vec{M}$ and μ_r vary with magnetizing field $\vec{H}$?

c) Assuming that the electric polarizibility of an Argon atom is $1 \cdot 43 \times 10^{-40}$ F.m^2, find the dielectric constant of solid Argon. Given density of Argon is 1·8 g. cm^{-3} and atomic mass of Argon is 39·95 g.mol^{-1}.

d) Show that the electronic polarizability is proportional to the atomic volume. 3 + 3 + 5 + 4

9. a) Explain what you understand by hysteresis, remanence and coercivity. What is hysteresis loop ? How will you determine the value of remanence and coercivity from a loop ?

b) What are ferrites ? How do ferrites differ from ferromagnetic substances ? Why do we use ferrite material in radios and other communication equipment ? Discuss their other applications.

1 + 1 + 1 + 2 + 2 + 1 + 2 + 2 + 3

10. a) Discuss the basic postulate of quantum mechanics.

b) Define expectation value of any observable.

c) If the wave function of a quantum mechanical particle is given by

$$\psi(x) = a \sin\frac{\pi x}{L} \text{ for } 0 \le x \le L$$

$= 0,$ otherwise,

then determine the value of a.

Also determine the value of x where the probability of finding the particle is maximum. 5 + 3 + (5 + 2)

11. a) What are fermions and bosons ? Give two examples of each of them.

b) Write the expressions for the distribution laws of MB, BE and FD Statistics. Sketch these distribution functions as functions of energy for their visual comparisons.

c) Derive Planck's black body radiation law using BE statistics.

d) How many photons are present in 1 cm^3 of radiation in thermal equilibrium at 100 K ? What is their average energy ? 2 + 5 + 4 + 4

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