Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.Tech/SEM-1/PH-101/2009-10

2009

ENGINEERING PHYSICS

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 of the following : 10 × 1 = 10

   i) The centre of mass of a body is a point at which

      a) only translational motion occurs

      b) both translational and rotational motion occurs

      c) none of these.

   ii) If a system has f degrees of freedom the number of Hamilton's equations for the system is

      a) 2

      b) f

      c) $2f$.

iii) The value of $\nabla \cdot \bar{r}$ is equal to

a) 1

b) 0

c) -1.

iv) The electric flux through the surface vector $\oint \bar{S}$ equal to $6\hat{j}$ in a region of electric field $3\hat{i} + \hat{j}$ is

a) $10 \text{ N m}^2 \text{ C}^{-1}$

b) $6 \text{ N m}^2 \text{ C}^{-1}$

c) none of these.

v) In free space Poisson's equation reduces to

a) $\nabla^2 V = 0$

b) $\nabla^2 V = \rho/\varepsilon_0$

c) $\nabla^2 V = -\rho/\varepsilon_0$.

vi) The divergence of a magnetic flux density $(\bar{B})$ is

a) 0

b) 1

c) -1.

vii) The differential form of Faraday's laws of electromagnetic induction is

a) $\bar{\nabla} \times \bar{E} = \partial \bar{B} / \partial t$

b) $\bar{\nabla} \cdot \bar{E} = 2\bar{B}$

c) $\bar{\nabla} \times \bar{E} = -\partial \bar{B} / \partial t$.

viii) When a spring with spring constant K is cut into three equal parts, the force constant of each of the part would be

a) $K/3$

b) $3K$

c) K.

ix) If a is the force constant of an oscillating body of mass m, the Q-factor is

a) $Q = C\sqrt{am}$

b) $Q = C\sqrt{m/a}$

c) $Q = C\sqrt{a/m}$,

where C = relaxation time.

x) Superposition of two S.H.M.s of equal time period and equal amplitude with phase difference $\phi = \pi/2$ forms

a) circle

b) ellipse

c) parabola.

GROUP – B

(Short Answer Type Questions)

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

2. a) Show that, $y = a\ e^{i(\omega t - kx)}$. Do the solution of wave equation.

   b) The potential energy of a particle with mass 10 g is given by, $V(x) = 32x^2 + 0{\cdot}2$, where x is in metre and V is in joule. Write down the equation of motion and solve it. $2\frac{1}{2} + 2\frac{1}{2}$

3. a) Prove that $\bar{E} = \cos(y - t)\,\hat{k}$ and $\bar{B} = \cos(y - t)\,\hat{i}$ constitute possible electromagnetic wave.

   b) Define displacement current. $4 + 1$

4. a) Calculate the magnetic field intensity just outside and inside of a hollow cylinder of radius 4 cm carrying 50 A current.

   b) Differentiate between electrostatic field and magnetic field. $3 + 2$

5. Prove that $\bar{A} \propto \bar{B} \propto \bar{C} = \bar{B} \propto (\bar{A} \cdot \bar{C}) - \bar{C} \propto (\bar{A} \cdot \bar{B})$.

6. a) What is cyclic co-ordinate ? Explain with an example.

   b) Derive the Lagrangian for a particle falling freely under the influence of gravity. $(1 + 2) + 2$

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. 3 × 15 = 45

7. a) Define Hamiltonian function and explain its general significance. 2 + 3

b) If Lagrangian of a system is given as $L = \frac{1}{2}\dot{x}^2 + \dot{x} - \frac{x^2}{2}$, find the Hamiltonian and equation of motion. 2 + 3

c) At what angle must a body be incident on a perfectly hard plane, so that the angle between the directions before and after may be a right angle ?

[Coefficient of restitution, $e = \frac{1}{3}$] 5

8. a) Distinguish between scalar and vector fields with example. 3

b) If the potential of a field is given by

$V\ (\ x,\ y,\ z\ ) = (\ 4x^2 + 2y^2 + z^2\ )^{1/2}$, find the field intensity at the point (1, 1, 1). 3

c) Prove that curl grad $\phi = 0$. 3

d) Show that the potential function $x^2 - y^2 + z$ satisfies Laplace's equation. 3

e) Find the potential of a uniformly charged sphere of radius R having a constant charge density ρ at a distance r from the centre of the sphere where $r > R$. 3

9. a) State and prove Ampere's circuital law. 2 + 3

b) Define magnetic vector potential.

If the vector potential $\bar{A} = (10x^2 + y^2 - z^2) \hat{j}$ at any position, then find the magnetic field at the point (1, 1, 2). 2 + 3

c) Write down the condition of steady state current. Show that Ampere's law implies that the current is in the steady state. 1 + 2

d) Calculate the magnetic field intensity just outside a hollow cylinder of radius 4 cm. 2

10. a) Write down Maxwell's equations for free space. 4

b) Show that for free space the electromagnetic wave equation for $\bar{E}$ is $\nabla^2 \bar{E} = \mu_0 t_0 \frac{\partial^2 \bar{E}}{\partial t^2}$, where symbols have their usual significance. Prove that electromagnetic wave moves with the velocity of light in free space. 3 + 2

c) Prove that $\bar{E} = \sin (y - t) \hat{k}$ and $\bar{B} = \sin (y - t) \hat{i}$ constitute a possible electromagnetic wave. 3

d) Establish the integral form of Faraday's law of electromagnetic induction. 3

11. a) Establish the differentiation equation of damped harmonic motion. 3

b) Solve the equation for light damping and prove that the amplitude of vibration decreases exponentially with time. 4 + 2

c) A cubical block of side L cm and density d is floating in a water of density ρ ($\rho > d$). The block is slightly depressed and released. Show that it will execute simple harmonic motion and hence determine the frequency of oscillation. 4 + 2