



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 : $10 \times 1 = 10$
 - 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 $\vec{\nabla} \cdot \vec{r}$ is equal to

- a) 1
- b) 0
- c) -1.

iv) The electric flux through the surface vector \vec{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) $\nabla^2 V = \rho/\epsilon_0$
- c) $\nabla^2 V = -\rho/\epsilon_0$.

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

- a) 0
- b) 1
- c) -1.



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

- a) $\vec{\Phi} \propto \vec{E} = \partial \vec{B} / \partial t$
- b) $\vec{\Phi} \cdot \vec{E} = 2\vec{B}$
- c) $\vec{\Phi} \propto \vec{E} = -\partial \vec{B} / \partial t$

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 × 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, $V(x) = 32x^2 + 0.2$, 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 $\vec{E} = \cos(y - t) \hat{k}$ and $\vec{B} = \cos(y - t) \hat{i}$ 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 $\vec{A} \times \vec{B} \times \vec{C} = \vec{B} \times (\vec{A} \cdot \vec{C}) - \vec{C} \times (\vec{A} \cdot \vec{B})$.
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

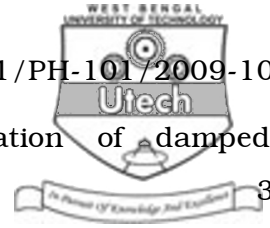
7. a) Define Hamiltonian function and explain its general significance. 2 + 3
- b) If Lagrangian of a system is given as $L = \frac{1}{2} \dot{x}^2 + \dot{x} - \frac{x^2}{2}$, find the Hamiltonian and equation of motion. 2 + 3
- c) At what angle must a body be incident on a perfectly hard plane, so that 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 $\text{curl grad } \phi = 0$. 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 $\vec{A} = (10x^2 + y^2 - z^2)\hat{j}$ 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 \vec{E} is $\nabla^2 \vec{E} = \mu_0 \epsilon_0 \frac{\partial^2 \vec{E}}{\partial t^2}$, where symbols have their usual significance. Prove that electromagnetic wave moves with the velocity of light in free space. 3 + 2
- c) Prove that $\vec{E} = \sin(y - t)\hat{k}$ and $\vec{B} = \sin(y - t)\hat{i}$ 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

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