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| | 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)

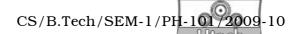
- 1. Choose the correct alternatives of the following: $10 \times 1 = 10$
 - i) The centre of mass of a body is a point at which
 - a) only translational motion occurs
 - b) both translational and rotational motion occurs
 - c) none of these.
 - ii) If a system has f degrees of freedom the number of Hamilton's equations for the system is
 - a) 2
 - b) *f*
 - c) 2*f*.

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- iii) The value of $\overline{\Box} \propto \overline{r}$ is equal to
 - a) 1
 - b) 0
 - c) -1.
- iv) The electric flux through the surface vector $\overset{\frown}{S}$ 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) $\prod^2 V = 0$
 - b) $\Box^2 V = \rho/\epsilon_0$
 - c) $\Box^2 V = -\rho/\epsilon_0$.
- 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)
$$\overline{\Box} \propto \overline{E} = \partial \overline{B} / \partial t$$

b)
$$\overline{\Box} \cdot \overline{E} = 2\overline{B}$$

c)
$$\bar{\Box} \propto \bar{E} = -\partial \bar{B} / \partial t$$
.

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)
$$K/3$$

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.

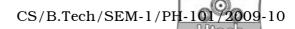
 $3 \times 5 = 15$

- 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, $V(x) = 32x^2 + 0.2$, 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 $\overline{E} = \cos(y t) \hat{k}$ and $\overline{B} = \cos(y t) \hat{i}$ 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

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GROUP - C

(Long Answer Type Questions) Answer any *three* of the following. $3 \times 15 = 45$

- 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.
 - 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 $(1, 1, 1)$.

- c) Prove that curl grad $\phi = 0$.
- d) Show that the potential function $x^2 y^2 + z$ satisfies Laplace's equation.
- 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.

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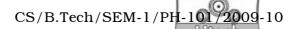
(1, 1, 2).



2 + 3

- 9. a) State and prove Ampere's circuital law.
 - 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
 - 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.
- 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 $\Box^2 \bar{E} = \mu_0 t_0 \frac{\partial^2 \bar{E}}{\partial t^2}$, where symbols have their usual significance. Prove that electromagnetic wave moves with the velocity of light in free space. 3+2
 - c) Prove that $\overline{E} = \sin(y t) \hat{k}$ and $\overline{B} = \sin(y t) \hat{i}$ constitute a possible electromagnetic wave.
 - d) Establish the integral form of Faraday's law of electromagnetic induction.3

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