Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.TECH(OLD)/SEM-1/PH-101/2011-12

2011

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 for any *ten* of the following : $10 \times 1 = 10$

   i) In a perfectly inelastic collision between two equal masses (m), where one of the bodies with a velocity u collides with the other at rest, the change in K.E. of the system is

   a) $\frac{mu^2}{2}$ b) $-\frac{mu^2}{2}$

   c) $\frac{mu^2}{4}$ d) $-\frac{mu^2}{4}$.

ii) The number of degrees of freedom for a system of N particles with K holonomic constraint is

a) $2N - K^2$ b) $N - K$

c) $N - 3K$ d) $3N - K$.

iii) The Hamiltonian remains conserved for a system where

a) the lagrangian is independent of mass

b) the lagrangian is independent of velocity

c) the lagrangian is independent of energy

d) the lagrangian is independent of time.

iv) Two perpendicular SHMs with equal time periods but different amplitude are superposed. If the phase difference between these oscillation is 45°, then they form a

a) circle b) straight line

c) ellipse d) parabola.

v) The P.E. of a particle executing SHM of amplitude a is equal to its K.E. where displacement of the particle is

a) $\pm a$ b) $\pm \frac{a}{\sqrt{2}}$

c) $\pm \frac{a}{2}$ d) $\pm \frac{a}{4}$.

vi) When the centre of mass is in uniform motion

a) total external force acting on the system increases with time

b) total external force acting on the system is zero

c) total extent force acting on the system is constant

d) total external force acting on the system decreases with time.

vii) Displacement current through an ideal capacitor

a) is greater than conduction current

b) is less than conduction current

c) is equal to conduction current

d) none of these.

viii) The significance of div$B$ = 0 (B is the magnetic field of induction) is that

a) magnetic monopole can exist

b) magnetic monopole cannot exist

c) none of these

d) electric dipole can exist.

ix) The force of attraction between two long parallel current carrying wires in a magnetic field B separated by a distance r is

a) $B = \mu_0 I_1 I_2 / 2\pi r$ b) $B = \mu_0 I_1 I_2 / 2\pi r^2$

c) $B = \mu_0 I_1 I_2 / 2r^2$ d) none of these

where I_1 and I_2 are parallel current.

x) If a charge $+q$ is accelerated through the potential V, then kinetic energy of it, is

a) $qV^2/2$ b) qV^2

c) qV d) none of these.

xi) Electric field due to a uniformly charged sphere (having charge density ρ) at an external point is

a) $E = R^3\rho / 2\,\varepsilon_0 r^2$ b) $E = R^2\rho / 3\,\varepsilon_0 r^2$

c) $E = R^3\rho / 3\,\varepsilon_0 r^2$ d) none of these.

xii) The projection of the vector $A = i - 2j + k$ on the vector $B = 4i - 4j + 7k$ is

a) 18/5 b) 19/9

c) 9/19 d) none of these.

xiii) If $\varphi = 1/r$ the value of grad φ will be

a) r/r b) $-r/r^3$

c) r/r^3 d) none of these.

xiv) Relaxation time is the time in which the amplitude *A* of the damped oscillator falls to

a) $\frac{A}{e}$ b) Ae

c) iAe d) none of these.

xv) Which of the following is not a scalar field ?

a) Displacement of mosquito in space

b) Light intensity in a room

c) Temperature of a day

d) Humidity of Hooghly.

xvi) Which of the following is not valid ?

a) $\vec{a} \bullet (\vec{b} + \vec{c}) = \vec{a} \bullet \vec{b} + \vec{a} \bullet \vec{c}$

b) $\vec{a} \times (\vec{b} + \vec{c}) = \vec{a} \times \vec{b} + \vec{a} \times \vec{c}$

c) $\vec{a} \bullet (\vec{b} \times \vec{c}) = \vec{b} \bullet (\vec{a} \times \vec{c})$

d) none of these.

GROUP – B

(Short Answer Type Questions)

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

2. For a harmonic oscillator of mass m and natural frequency $F_0 \cos \omega t$ and damping proportional to p times the velocity of the oscillator, write its amplitude and displacement and show at velocity resonance velocity is in phase with the driving force ? (No need to calculate amplitude and displacement, only write the values).

3. What do you mean by Lagrangian of the system ? Find the Lagrangian and Lagrange's equation of motion for electrical circuit containing inductance *L* and capacitance *C*. 1 + 4

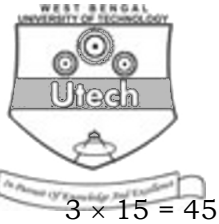
4. State and prove Gauss's law in electrostatics. Derive the expression of its differential form. 3 + 2

5. a) A square loop wire of edge a carries a current *I*. Show that the value of the magnetic induction *B* at the centre of the loop is given by $B = \left(2\sqrt{2}\mu_0 I\right)/\pi a$

   b) If the vector potential $A = \left(x^2 + y^2 - z^2\right)j$ at position (*x, y, z*) find the magnetic field at (1, 1, 1). 3 + 2

6. a) Find an equation for the plane perpendicular to the vector $A = 2i + 3j + 6k$, and passing through the terminal point of the vector $B = i + 5j + 3k$.

   b) In the above problem find the distance from the origin to the plane. 3 + 2



GROUP – C

(Long Answer Type Questions)

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

7. a) Establish the differential equation of damped harmonic motion, explaining each term. Solve the equation for underdamped motion and show that the amplitude of vibration decreases exponentially with time.

   b) State the algebraic relation how the displacement is related to time in case of a damped harmonic motion. Derive the relation between the damping constant and logarithmic decrement. (3 + 5 + 3) + 4

8. a) From the Hamiltonian, Lagrangian and Lagrange's equation for a system, derive the Hamilton's canonical equation of motion.

   b) What is cyclic coordinates ? Show that if a given coordinate is cyclic in the Lagrangian then it is also cyclic in the Hamiltonian.

   c) Write down the Lagrangian of a simple pendulum and explain each term. Hence obtain the equation of motion.

   5 + (1 + 4) + 5

9. a) For a two body system, show that the velocity of the centre of mass is conserved when the total force is zero.

   b) What is generalized coordinate and generalized force ?

   c) What is sharpness of resonance ? Derive the differential equation of progressive wave.

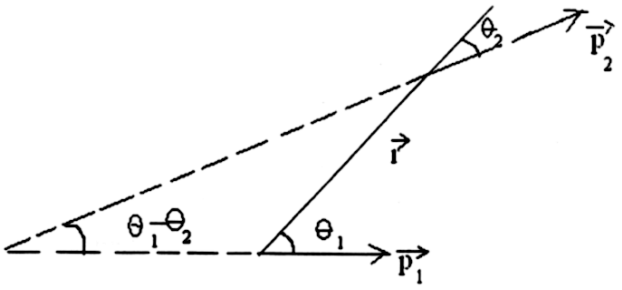
   d) Derive the expression for magnetic field for straight current carrying conductor at external point.

   5 + 2 + 3 + 5

10. a) Derive an expression for the electric field and potential for an electric dipole at an external point from the dipole.

    b) Derive the expression of the potential energy of one dipole placed in the field of another.

    c) A dipole of moment p_1 is fixed at the origin of coordinates. Another coplanar dipole of moment p_2 is placed at the position r and is free to rotate. Show that for equilibrium $\tan\theta_1 = -2\tan\theta_2$, where θ_1 and θ_2 are the angles that r makes with p_1 and p_2 respectively.



8 + 2 + 5

11. Define current density. Derive the equation of continuity. What is drift velocity ? State Ampere's Law. Derive the expression of its differential form. Derive an expression for the magnetic induction B for a solenoid.

    An electron of energy 1000eV describes a circle in field of magnetic induction 0·02 tesla. Calculate the radius of circle. Given e/m of electron = $1 \cdot 76 \times 10^{11}$ coulomb/kg.

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

12. a) Find the angle between the surfaces $x^2 + y^2 + z^2 = 9$ and $z = x^2 + y^2 - 3$ at the point (2, –1, 2).

b) Evaluate $\iint A.n\, dS$, where $A = 18zi - 12j + 3yk$ and S is that part of the plane $2x + 3y + 6z = 12$, which is located in the first octant.

c) When a vector is called solenoidal ? 5 + 8 + 2

Data given :

Electronic charge , $q_e = 1 \cdot 6 \times 10^{-9}$ coulomb

Electronic mass, $m_e = 9 \cdot 1 \times 10^{-31}$ kg.

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