

DEC. 2017

PHYSICS PAPER-A (Mechanics-I)

Time : 3 Hours

Max. Marks : 44

- Note: (i) Attempt five questions in all, selecting two questions each from Unit-I and Unit-II.
- (ii) Unit-III is compulsory.
- (iii) Use of non-programmable scientific calculator is allowed.
- (iv) Log tables may be asked for if needed.

Unit-I

1. (a) Define spherical polar co-ordinates. Derive an expression for volume element in this system and find volume of sphere. 6
- (b) The motion of a particle is expressed by the equations, $x = (5t - 9)$, $y = 2\cos(3t)$, $z = 2\sin(3t)$ calculate velocity and acceleration of particle. 3
2. (a) State homogeneity of flow of time. Prove that the law of conservation of energy is a consequence of homogeneity of time. 7
- (b) For what value of 'm' the given force $\vec{F} = (x^2 + y^2)\hat{i} + mxy\hat{j}$ is conservative. 2
3. (a) Prove that total kinetic energy of the system is the sum of the kinetic energy of the centre of mass of system and the kinetic energy of motion of the system about centre of mass. 6
- (b) If the centre of mass of three particles of masses 2kg, 3kg and 4 kg be at (2, 2, 2), then where should a fourth particle of mass 5 kg be placed so that combined centre of mass may be located at origin. 3

Unit-II

4. (a) Determine the turning points in the trajectory of a particle moving under a central force. Also discuss the relation of shape of trajectory with total energy. 6
- (b) Mention various forces in nature. Also arrange them in the increasing order of their strength. 2
- (c) Can a particle execute rotational motion in the absence of external torque. Explain. 1
5. (a) State Kepler's laws of planetary motion and use them to justify that force between sun and the planet obey inverse square law. 4
- (b) Prove that for a satellite in earth orbit, the ratio of its velocity at apogee to that at perigee is equal to the inverse ratio of its distance from apogee and perigee. 3
- (c) Show that for an elliptical orbit eccentricity 'E' is given by :
- $$E = \frac{r_{\max.} - r_{\min.}}{r_{\max.} + r_{\min.}}$$
- 2
6. (a) Find the relation between recoil angle in lab system and scattering angle in centre of mass system. 6
- (b) A particle of mass 'm', moving with velocity \vec{u} , collides elastically with a particle of mass '6m' at rest. After collision, the incident particle bounces back with same speed, while the target moves in forward direction. Calculate : (i) Velocity of both particles after collision in lab system (ii) Velocity of centre of mass. 3

Unit-III

7. Attempt any **eight** parts. Each part carries 1 mark.
- (a) Cartesian co-ordinates of a point are $(2\sqrt{2}, 2\sqrt{2}, 4\sqrt{3})$. Find corresponding spherical co-ordinates.
- (b) Find the direction of $\hat{\delta}$ for a particle moving in xy plane.
- (c) "Air friction increases the speed of satellite." Comment.
- (d) Give the significance of nuclear cross section.
- (e) Show that reduced mass of hydrogen atom is nearly equal to mass of electron.
- (f) Mention the conditions under which property of flatness of free space hold good.

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- (g) Define impact parameter giving its significance.
- (h) What do you mean by dimensionality of space ?
- (i) The potential energy of a particle is given by $U = (-2x^4 + 3x^2)$, where x is in meters. Find force acting on it when particle is located at $(2, 0, 0)$.
- (j) What is the advantage of studying a collision process in centre of mass system ?

$8 \times 1 = 8$

PHYSICS PAPER-B

(Vibrations, Waves and E.M. Theory-I)

Time : 3 Hours

- Note: (i) Attempt five questions in all, selecting two questions each from Unit I, II and Unit III is compulsory. Max. Marks : 44
- (ii) Use of non-programmable calculator is allowed.

Unit-I

1. (a) What is a compound pendulum ? Derive an expression for its time period. What is the condition for time period to be minimum ?
- (b) At what displacement will the kinetic energy and potential energy be equal in a simple harmonic oscillator ? 7,2
2. What are damped vibrations ? Derive expression for displacement in case of damped oscillatory motion. Discuss the case of critical damping. 9
3. (a) Write and solve the differential equation for damped electrical LCR circuit and discuss the case of oscillatory discharge of capacitor.
- (b) The mass of 1 kg is suspended from a spring of stiffness constant 25Nm^{-1} . If the frequency of natural oscillations be $2/\sqrt{3}$ times the frequency of damped oscillations, find the damping constant. 6,3

Unit-II

4. (a) Discuss the driving force frequency behaviour with velocity and displacement.
- (b) Show that in the resonant LCR circuit, the maximum potential drop

across an inductor occurs at a frequency : $\omega = \frac{\omega_0}{\left[1 - \frac{1}{2Q^2}\right]^{1/2}}$ 6,3

- 4 (b) A damped oscillator consisting of mass 0.2 kg, damping constant 80 Nm^{-1} is driven by force $F = 6 \cos 30t$ Newton. Calculate the average power dissipated.
6. (a) Two LC circuits are coupled by mutual inductance. Discuss the behaviour of the coupled system and find the frequency of oscillation of the system. What is the effect if the coupling is loose or tight?
- (b) Show that the total energy dissipated over one cycle in a forced oscillator is proportional to the square of the amplitude.

Unit-III

7. Attempt any eight parts :
- (a) What is damping? On what factors the damping depends?
- (b) The amplitude of simple harmonic oscillator is doubled. How does this affect the total energy of the oscillator?
- (c) An inductor, capacitor and resistor of values 0.2 H, $1 \mu\text{F}$ and 800Ω are connected in series. Calculate the frequency of oscillations.
- (d) Are all periodic motion SHM? Explain.
- (e) What is importance of normal modes of vibration?
- (f) Is the transformer loose or tight coupled if it has mutual inductance of two coils as 0.3 H, self-inductance of primary and secondary as 0.28 H and 0.36 H respectively.
- (g) What are free oscillations and resonant oscillations?
- (h) Is energy stored in the forced oscillator? Explain.
- (i) What is meant by inertia controlled and stiffness controlled oscillator?
- (j) What determines the natural frequency of an oscillator?

PHYSICS PAPER-C

(Electricity and Magnetism-I)

Time : 3 Hours

Max. Marks: 40

Note: Attempt five questions in all, selecting two questions from each Unit (I & II). Unit III is compulsory. Use of non-programmable scientific calculator is allowed.

Unit-I

1. (a) Find the electric field due to uniformly charged wire of length l at a point on its axis.
- (b) Prove that divergence of curl of any vector field is always zero.

$$\vec{\nabla} \cdot \vec{\nabla} \times \vec{A} = 0$$

2. (a) What is a local minimum?
- (b) Two electric charges are placed at a distance r apart. Calculate the work done in moving a charge q from a distance r to a distance $2r$.
3. (a) State and explain Gauss's theorem for electrostatics.
- (b) Obtain an expression for the electric field due to a uniformly charged infinite plane sheet.
4. (a) State and explain the Biot-Savart law.

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B.Sc. PART-I (SEM I & II, (P.U.)) (D17-M18)

2. (a) What is an electric dipole? Find the electric field due to electric dipole at a point on its axial line. 5
(b) Two point charges q and $-3q$ are located at a distance d apart. If the electric field at a location of charge q is E , find the electric field at the location of charge $-3q$.
3. (a) State and prove Stobe's theorem. 6,3
(b) Obtain Gauss's law of electrostatics in its differential form. 6,3
4. (a) Show that potential at a point due to electric dipole is

$$\frac{\vec{P}}{4\pi\epsilon_0} \text{grad}\left(\frac{1}{r}\right) \text{ where } \vec{P} \text{ is the electric dipole moment.}$$

Unit-II

- (b) How is the potential difference between two points related to concept of work? 6,3
5. (a) Derive an expression for electric potential at any point due to an arbitrary charge distribution.
(b) Show that electric potential function $x^2 - y^2 + z$ satisfies Laplace's equation. 6,3
6. (a) What is electrical image? Find the potential energy of point charge placed near conducting sheet at zero potential.
(b) Prove that the line integral of electric field due to point charge between two points is path independent. 6,3

Unit-III

7. Attempt any eight parts :
(i) What is an irrotational field?
(ii) What is gradient V ?
(iii) What are limitations of Coulomb's law?
(iv) State law of conservation of charge.
(v) Define electric line of force.
(vi) Define electric flux.
(vii) Can potential at a point be zero if electric field there is not zero? Explain.
(viii) What is conservative field?
(ix) What is atomic polarizability?
(x) Define electrical susceptibility.