B.Sc. PART–I, FIRST SEMESTER, (P.U.)

DEC. 2015

PHYSICS PAPER–A

(Mechanics–I)

Time Allowed : Three Hours **Maximum Marks : 22**

Note : (1) Attempt **five** questions in all, selecting **two** questions each from of Unit I and Unit II.

(2) **Unit III is compulsory.**

(3) Use of non-programmable scientific calculator is allowed.

(4) Log tables may be asked for, if needed.

Unit-I

1. (a) Prove that polar unit vectors $\hat{e}_y, \hat{e}_\theta$ and $\hat{e}_\phi$ constitute a system of orthogonal vectors. 2½

(b) Path of a particle is defined by equations :

$$r = \left(3t - \frac{t^2}{30}\right) \text{ and } \theta^2 = (1600 - t^2)$$

Find velocity at time t = 1/2 min. 1½

2. (a) Discuss law of homogenity of space and show that it leads to law of conservation of linear momentum

(b) Two particles of mass 'm' and '3m' are located at (1, 0) and (–3, 0). If particle of mass '3m' is displaced by '1' unit in –ve X direction, find by what distance and in which direction particle of mass 'm' is to be displaced so that centre of mass of system remains at same point. 1½

3. (a) Define solid angle and its SI unit. Find the solid angle subtended by a sphere at the centre. 2½

(b) Why do we prefer spherical co-ordinate system ? ½

(c) Determine the surface area of a sphere of radius 'r' by using spherical polar coordinates. 1

UNIT-II

4. (a) Find the polar equation of orbit of a particle of mass 'm' moving under the action of an inverse square force field about the fixed centre. 2½

(b) Show that for an elliptical orbit eccentricity '$\in$' is given by

$$\in = \frac{r_{max} - r_{min}}{r_{max} + r_{min}}$$ 1½

5. (a) Prove that in Lab system the particles of same mass will move at right angle to each other after elastic collision if one of them were at rest before collision. 3

(b) The planet mars has aphelion distance 2.485×10^8 km and perihelion distance 2.06×10^8 km, w.r. to sun whose own radius is 7×10^6 km. Find its energy. Given :

mass of sun $= 2 \times 10^{30}$ kg, mass of mars $= 6.5 \times 10^{23}$ kg, $G = 6.67 \times 10^{-11}$ $N^2 kg^{-2}$. 1

6. (a) What is Rutherford Scattering ? Obtain a relation between angle of scattering and impact parameter. 3

(b) In Lab system two particles each of mass 2 kg, are moving with velocities $\left(3\hat{i} = 4\hat{j}\right)$ ms^{-1} and $\left(5\hat{i} + 6\hat{j}\right) ms^{-1}$ and.

Find total kinetic energy of system in centre of mass system. 1

UNIT-III

7. Attempt any six parts. Each part carries 1 mark.

(i) Is area scaler or vector ? What about volume ?

(ii) What do you mean by conservative force ? Give two examples.

(iii) The trajectory of a particle, moving in a plane, is a straight line passing through origin. What is transverse component of velocity of particle ?

(iv) Under what conditions property of flatness of (free) space holds good?

(v) "Air friction increases the speed of a satellite." Comment.

(vi) What is difference between scattering and reaction when two particles collide ?

(vii) Define scattering cross-section. Prove that it has dimensions of area.

PHYSICS PAPER–B

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

Time Allowed : Three Hours] **[Maximum Marks : 22**

Note : (1) Attempt **five** questions in all, selecting two questions each from of Unit I and Unit II.

(2) Unit III is compulsory.

(3) Use of non-programmable scientific calculator is allowed.

Unit-I

1. (a) Show that the total energy of a body executing S.H.M. is directly proportional to the square of the frequency.

(b) If $x = a \cos \omega t + b \sin \omega t$, show that it represents S.H.M. Also find the amplitude of S.H.M. 3, 1½

2. What are damped vibrations ? Derive expression for displacement in case of damped oscillatory motion. Discuss the case of critical damping. 4½

3. (a) What is meant by logarithmic decrement and quality factor of a damped Simple Harmonic oscillator ? Deduce their expressions.

(b) What is the effect of damping on the natural frequency of an oscillator? 3, 1½

Unit-II

4. (a) Drive expression for the velocity of a forced oscillator. Discuss the variation of velocity amplitude with driving force frequency and show its behaviour graphically.

(b) Show that the maximum displacement amplitude of a forced oscillator having damping constant r and driven by the force $F = F_0 \cos \omega t$ is given by :

$$A_{max} = \frac{F_0}{\omega' r} \text{ where } \omega' = \sqrt{\frac{s}{m} - \frac{r^2}{4m^2}} . \quad 3, 1\frac{1}{2}$$

5. (a) Find expression for the quality factor of a forced oscillator in terms of resonance absorption band width.

(b) Find the frequency of a circuit containing inductance of 5×10^{-2} H and a capacitance of 5×10^{-10}F. Find the wavelength of the radiowaves to which it will respond. 3, 1½

6. (a) Explain the transfer of energy between two electrical circuits which are inductively coupled. When the coupling is loose or tight ?

(b) Define normal mode, normal co-ordinates and degrees of freedom of an oscillatory system. 3, 1½

UNIT-III

7. Attempt any **six** parts :

(a) The amrching troops are asked to break their steps while crossing the bridge. Why ?

(b) What are forced oscillations ?

(c) What is stiffness controlled forced oscillator ?

(d) What are units of damping constant ?

(e) A mass of 1 kg is attached to a spring of stiffness constant 16 Nm^{-2}. Find its natural frequency.

(f) What is mechanical impedance of a forced oscillator ?

(g) What do you mean by inductive coupling ? 4

PHYSICS PAPER–C

(Electricity and Magnetism-I)

Time Allowed : Three Hours **[Maximum Marks : 22**

Note : (1) Attempt **five** questions in all, selecting **two** questions each from of Unit I and Unit II.

(2) **Unit III (Q. No. 7) is compulsory.**

(3) Use of non-programmable scientific calculator is allowed.

(4) Log tables may be asked for, if needed.

Unit-I

1. (a) State and prove Gauss's Divergence theorem.

   (b) Prove that curl (ϕ grad ϕ) = 0. 3, 1

2. (a) Derive an expression for electric field due to uniformly charged infinite wire at a point on a line perpendicular to the wire.

   (b) An electric dipole of dipole moment 5×10^{-7} cm is located at the origin and is aligned along x-axis. What is electric field due to dipole at the point (0, 0.3, 0.4)m ? 3, 1

3. (a) Show that potential at a point due to electric dipole is $\frac{\vec{P}}{4\pi\varepsilon_0}\text{grad}\left(\frac{1}{r}\right)$

   where $\vec{P}$ is the electric dipole moment.

   (b) Show that Coulomb's force between stationary charges satisfies Newton's Third Law of Motion. 3, 1

Unit-II

4. (a) What is Electrical Image ? Find the potential energy of a point charge placed near conducting sheet at zero potential.

   (b) What is Laplace's equation ? Show that function $V = x^2 - y^2 - z$ satisfies Laplace's equation. 3, 1

5. (a) What is Atomic Polarizability ? Derive an expression for it in terms of dielectric constant.

   (b) Show that the energy stored in a parallel plate capacitor per unit volume of capacitor is $\frac{1}{2}\frac{q^2}{c}$ where q be the charge on capacitor and c be the capacitance. 3, 1

6. (a) Discuss the effect of introducing a dielectric between plates of capacitor. Hence establish the relation $\kappa = 1 + \chi e$.

   (b) Two molecules are 3 mm apart. One molecule has one excess electron and the other has deficiency of one electron. Find the force between these molecules if they are in water. Given dielectric constant of water is 80. 3, 1

Unit-III

7. Attempt any six parts :

   (i) What is charge on electron moving with velocity 0.8 c?