B.Sc. PART–I, FIRST SEMESTER, (P.U.)

DEC. 2016

PHYSICS PAPER–A

(Mechanics–I)

Time : 3 Hours **Max. Marks : 22**

Note : (i) Attempt *five* questions in all, selecting *two* questions from each of Sections I and II and Section III is compulsory.

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

(iii) Logarithmic tables may be asked for if needed.

Section–I

1. (a) What are Cartesian and spherical polar coordinates ? How are the coordinates of a point in two systems related to each other ? 3

(b) The motion of a particle can be expressed in terms of the equation $x = 5t - 9, y = 2\cos 3t, z = 2\sin 3t$. Find the magnitude of velocity after 2 seconds. 1

2. (a) Prove that velocity of a particle in spherical polar. Coordinate is given by : 3

$$\vec{v} = \dot{r}\hat{r} + r\dot{\theta}\hat{\theta} + r\dot{\phi}\sin\theta\,\hat{\phi}$$

(b) Determine the area of a circle of radius a by using plane polar coordinates. 1

3. (a) What is Isotropy of space ? Which law of conservation is explained by it ? Prove this law. 3

(b) A bomb weighing 50 kg explodes into three parts in flight when its velocity is $20\hat{i} + 22\hat{j} + 10\hat{k}$ ms^{-1}. Two fragments of the bomb weighing 10 kg and 20 kg are found to have velocities $100\hat{i} + 50\hat{j} + 20\hat{k}$ and $30\hat{i} - 20\hat{j} + 10\hat{k}$ ms^{-1} respectively. Find the velocity of the third fragment. 1

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Section–II

4. (a) Prove that the shape of trajectory of a particle moving under inverse square law force depends on the relationship between the total energy and its angular momentum. 3

(b) Prove that the centre of mass of two particles divides the line joining the particles in the inverse ratio of their masses. 1

5. (a) Write down Kepler's laws of planetary motion. Prove Kepler's second law of planetary motion. 2½

(b) If the average distance of mass from the sun is 1·52 times that of the earth from the sun. Find the period of revolution of mass around the sun. 1½

6. What is Rutherford scattering ? Show that differential scattering cross-section for Rutherford scattering by an atomic nucleus is given by :

$$\sigma_{sc}(\theta) = \frac{1}{4}\left(\frac{ze^2}{E}\right)\frac{1}{\sin^4\left(\frac{\theta}{2}\right)}$$

where symbols have their usual meaning. 4

Section–III

Note : Attempt any *six* parts, each part carries 1 mark.

7. (i) The Cartesian coordinates of a point are (1, 0, 1). Find the spherical polar coordinates of this point.

(ii) Prove that :

$$\hat{r} \times \hat{\theta} = \hat{\phi}$$

(iii) Give *two* examples each of centred and non-central forces.

(iv) What are the dimensions of the quantity $\frac{L^2}{\mu r^2}$?

(v) In a carbon monoxide molecule (CO), if two atoms are separated by $5{\cdot}6 \times 10^{-10}$ m, locate centre of mass of the system w.r.t. carbon atom.

(vi) Mention the various forces in nature and which one of them is weakest force ?

(vii) How is collision between two balls different from a collision between α-particle and a nucleus ? $1 \times 6 = 6$

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PHYSICS PAPER–B

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

Time : 3 Hours **Max. Marks : 22**

Note : Attempt *five* questions in all, selecting *two* questions from each of the Unit-I and II. Unit-III is compulsory. Use of nonprogrammable scientific calculator is allowed. Logarithmic tables may be asked for, if needed.

Unit–I

1. (a) What is simple harmonic oscillator ? Obtain its differential equation from the expression of its total energy and discuss general solution of the equation. 2½

   (b) A particle of mass 0.1 kg is executing SHM. Its P. E. as a function of the displacement at any instant is given by $V = V_0 + 2y + 3y^2$ where V_0 is a constant and y is in meters. Find the position of stable equilibrium, the stiffness of the spring and the frequency of oscillations. 1½

2. (a) Explain analytically how two simple harmonic vibrations at right angles to each other and having same time periods acting simultaneously on a particle can be compounded ? 2½

   (b) Show that centre of suspension and centre of oscillation are interchangeable in a compound pendulum. 1½

3. (a) Define logarithmic decrement. Derive a relation for it in case of an electrical oscillator. 2½

   (b) The smaller the damping, larger will be the relaxation time and greater the quality factor. Is it so ? Explain. 1½

Unit–II

4. (a) Find Q-factor of an oscillator in terms of reasonance absorption band width. 2½

   (b) Show that the band width of resonance absorption curve defines the phase angle range $\tan \phi = \pm 1$. 1½

5. (a) Show that an steady state, the amplitude and phase of driven oscillator adjust themselves such that the average power supplied by the driving force is just equal to that being dissipated against frictional force. 2

   (b) Deduce natural undamped frequency and value of quality factor of LCR circuit with $L = 2$ mh, $C = 5\ \mu F$ and $R = 0.2\ \Omega$. 2

6. (a) What is a forced electrical oscillator ? Discuss variation of current amplitude with driving emf frequency in it.

   (b) Show that in a resonant LCR circuit, the maximum potential drop across the inductor is equal to Q times the applied emf.

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Unit–III

7. Attempt any *six* parts :

(a) What determines the number of modes of a system of coupled oscillators ?

(b) Differentiate between free and forced vibrations.

(c) Show that for a pure LC circuit, quality factor is infinite.

(d) State the condition under which a damped oscillator is overdamped.

(e) What is theoretical limit of time in which amplitude of lightly damped oscillator decays to zero ?

(f) When coupling of oscillators is said to be loose or tight ?

(g) When does driving agency delivers maximum power to the driven oscillator ? $1 \times 6 = 6$

PHYSICS PAPER–C

(Electricity and Magnetism-I)

Time : 3 Hours **Max. Marks : 44**

Note : (1) Do *five* questions, selecting *two* questions from each Unit. Unit III is compulsory.

(2) The paper will be evaluated out of 44 marks and the score obtained will be halved.

(3) Put correct serial no. of each question attempted.

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

Unit–I

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

(b) Define gradient of a scalar field. Give its physical interpretation. 6,3

2. (a) Derive an expression for electric field due to an electric dipole at a point on its axial line.

(b) A partical of charge 3 mC and mass 20 g is projected with velocity $5\hat{i} - 12\hat{j}$ m/s in uniform electric field of so $80\hat{j}$ N/C. Find speed of the charge after 2 sec. 6,3

3. (a) State and prove Stokes's theorem. What is its importance ?

(b) A cube of side 5 cm is given charge of 6 μC. Assuming that the charge is distributed uniformly on all the faces of the cube, find the surface charge density. 6,3

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Unit–II

4. Derive an expression for electric potential at a far off point due to an arbitray charge distribution. Show that it is the sum of potentials due to a monopole, a dipole, quardupole etc. 8½

5. (a) Show that in an electrostatic field $\vec{E}$, the potential difference between two point A and B is given by $N_B - N_A = \int_A^B \vec{E} : \vec{dr}$

Using this relation, define electric potential at a point.

(b) Electric potential V at any point in space is given by $V = 4x^2$. Find the electric field. Will the electric field be uniform ? 4½, 4

6. (a) Derive Gauss's law in differential form for dielectrics.

(b) Define atomic polarizability. On which factors does it depend. Give its S.D. Units. 4½, 4

Unit–III

7. Attempt any six parts :

(i) What is a conservative field ? Give example.

(ii) What is a solenoidal field ? Give example.

(iii) What is an equipotential surface ? What will be its shape for a point charge ?

(iv) Define electric susceptibility.

(v) Is the potential difference more basic than potential ?

(vi) What is the source of electric field in a dielectric ?

(vii) Distinguish between a free charge and a bound charge. $6 \times 1\frac{1}{2} = 9$

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