

Bachelor of Science (B.Sc.) First Semester
1S-PHY 101 - Physics Paper-I (Mechanics and Oscillations)

P. Pages : 3

Time : Three Hours



GUG/W/18/1218

Max. Marks : 50

- Notes :
1. All questions are compulsory.
 2. Draw neat labelled diagram whenever necessary.

1. Either

- a) i) State Newton's laws of motion. Show that Newton's first law of motion is simply a special case of second law. **5**
Also discuss the limitations of Newton's laws of motion.
- ii) A particle is moving along a curve in a plane. Derive an expression for the radial and transverse components of velocity. **3**
- iii) A point moving in a plane has co-ordinates $x=3$, $y=4$ and has components of speed $\dot{x} = 5 \text{ m/sec.}$ and $\dot{y} = 8 \text{ m/sec.}$ at some instant of time. Find the components of speed in polar co-ordinates r , θ along directions \hat{r} and $\hat{\theta}$. **2**

OR

- b) i) Explain the terms **3**
a) Gravitational field.
b) Gravitational intensity
c) Gravitational potential
- ii) Derive an expression for gravitational potential and intensity due to thin spherical shell at a point, **5**
a) Outside the shell
b) On the surface of shell
c) Inside the shell.
- iii) What will be the gravitational potential and intensity of a thin spherical shell of mass 10 kg and radius 0.1m at a point 0.2m outside its surface **2**
Given : $G = 6.67 \times 10^{-11} \text{ Nm}^2 / \text{kg}^2$.

2. Either

- a) i) Define simple harmonic motion. Derive general differential equation of a simple harmonic oscillator and also obtain its solution. **6**
- ii) Obtain the resultant of two S.H.M.s of same period executing in the same direction but differing in phase and amplitude. **2**
- iii) Show that the number of beats produced is equal to the difference in the frequencies of the two sounding bodies. **2**

OR

- b) i) What are damped vibrations. Establish the differential equation of motion for a damped harmonic oscillator and obtain an expression for displacement. Discuss the case of underdamping ($k < \omega_0$). 6
- ii) Obtain an expression for quality factor of damped harmonic oscillator. 2
- iii) Calculate the band width of an acoustic system having $Q=1.75$ and resonant frequency 280 Hz. 2

3. Either

- a) Distinguish between inertial and non-inertial frame of reference. Give the example of each. Is earth inertial frame? Why? 2½
- b) What is linear momentum. State and explain the principle of conservation of linear momentum with examples. 2½
- c) Find the expression for resultant motion of a particle subjected simultaneously to two S.H.M.s of same period but of different amplitudes and phases in perpendicular directions. 2½
- d) What is sharpness of resonance? Explain the effect of damping on sharpness of resonance. 2½

OR

- e) State Kepler's laws of planetary motion. 2½
- f) Show that velocity of centre of mass of a system remains constant if no external force is applied on it. 2½
- g) Calculate the radius of gyration of a solid sphere rotating about its diameter if its radius is 5cm. 2½
- h) Show that in driven oscillator, the maximum power is absorbed at the frequency of velocity resonance and not at the frequency of amplitude resonance. 2½

4. Either

- a) Find the maximum speed of a body of mass 2kg revolving in a circular path of radius 2m, if the centripetal force of 400N applied towards the centre of circle. 2½
- b) Show that torque is the time rate of change of angular momentum. 2½
- c) Obtain an expression for the resultant of two S.H.M.s perpendicular to each other having different amplitudes and phases and having frequencies in the ratio 1:2. 2½
- d) What is forced harmonic oscillator. Derive differential equation of forced harmonic oscillator. 2½

OR

- e) What are central and non-central forces? Give three characteristics of each. 2½
- f) Two bodies of masses 2g and 10g have position vectors $3\hat{i} + 2\hat{j} + \hat{k}$ and $\hat{i} - \hat{j} + 3\hat{k}$ respectively. Find the position vectors and distance of centre of mass from the origin. 2½
- g) Give physical significance of moment of inertia. 2½
- h) Show that average power dissipation in damped harmonic oscillator is $2bE$. 2½

5. Attempt **any ten** from the following.

- a) Give two examples each of central and non-central force. 1
- b) What is conservative force. 1
- c) Define centripetal force. 1
- d) Define centre of mass. 1
- e) What is radius of gyration. 1
- f) State law of conservation of angular momentum. 1
- g) What are Lissajous figures. 1
- h) What are beats. 1
- i) State principle of perpendicular axes for M.I. 1
- j) Define quality factor of damped harmonic oscillator. 1
- k) Give two examples each of damped and forced harmonic oscillator. 1
- l) Define band width. 1
