

**2025/FYUG/ODD/SEM/
PHYDSC-102T/193**

FYUG Odd Semester Exam., 2025

PHYSICS

(1st Semester)

Course No. : PHYDSC-102T

(Mechanics and Relativity)

Full Marks : 70

Pass Marks : 28

Time : 3 hours

*The figures in the margin indicate full marks
for the questions*

UNIT—I

1. Answer any two of the following questions :

2×2=4

- (a) Define impulse. What is its SI unit?
- (b) What do you mean by conservative force? Give one example.
- (c) State the law of conservation of mechanical energy. Give one example.

(2)

2. (a) Define centre of mass of a system. Prove that the centre of mass is unique point. 1+2

(b) Explain the principle of motion of a rocket and deduce an expression for the instantaneous velocity of the rocket.

OR

3. (a) What is meant by elastic potential energy of a spring? Obtain an expression for it. 1+3

(b) Distinguish between elastic and inelastic collisions. Show that in an elastic one-dimensional collision, the relative velocity with which the two particles approach each other before collision is equal to the relative velocity with which they recede from each other after collision. 2+4

UNT-II

4. Answer any two of the following questions : 2x2=

(a) Define angular momentum of a particle. How is it related to the torque acting on it? 2x2=

(3)

(b) Explain the physical significance of moment of inertia.

(c) Define Poisson's ratio. What are the limiting values of Poisson's ratio?

5. (a) Show that $\vec{L} = \vec{L}_{CM} + \vec{R}_{CM} \times M\vec{V}_{CM}$, where the symbols have their usual meanings. 5

(b) Calculate the moment of inertia of a solid sphere about a diameter as axis. Hence find its moment of inertia about a tangent. 3+2=5

OR

6. (a) A solid cylinder of length l and radius a is clamped at one end and twisted at the other end by a torque about its axis. Show that the restoring torque that comes to play during the twisting of the cylinder is given by $\rho = \frac{\eta \pi a^4}{2l} \phi$, where η is the modulus of rigidity of the material of the cylinder and ϕ is the angle of twist. 7

(b) Show that a hollow rod is a better shaft than a solid tube of the same material, mass and length. 3

UNIT—III

Answer any two of the following questions :

2×2=

7. Answer any two of the following questions. Write

(a) State Newton's law of gravitation. Write the value of gravitational constant.

(b) Mention two characteristics of central force.

(c) Describe in brief global positioning system (GPS).

8. (a) Define gravitational potential. Find the gravitational potential due to a solid sphere at (i) an external point and (ii) an internal point.

$$1 + (2+4) =$$

(b) Show that gravitational potential at the centre of a solid sphere is $\frac{3}{2}$ times that on the surface.

OR

9. (a) Find expressions for orbital velocity and time period of a satellite in circular orbit.

(b) Find an expression of escape velocity. Determine the escape velocity from moon. Given, mass of moon =

$$7.35 \times 10^{22} \text{ kg and radius of moon } =$$

$$1.5 \times 10^6 \text{ m. } 3+2=5$$

UNIT—IV

10. Answer any two of the following questions :

$$2 \times 2 = 4$$

(a) What do you mean by simple harmonic motion? Give one example.

(b) The acceleration of a particle is given by $a = -\pi^2 x$. Find time period of the particle.

(c) Explain fictitious force.

11. (a) Define forced oscillation. Obtain the differential equation of forced oscillation. $2+4=6$

(b) Explain resonance and sharpness of resonance. 4

OR

12. (a) Distinguish between inertial and non-inertial frames. Find the expressions for velocity and acceleration of a particle relative to a uniformly rotating frame. 2+3=5
- (b) Deduce Coriolis theorem. 5

UNNT—V

13. Answer any two of the following questions : 2×2=4

- (a) Show that the length is invariant under Galilean transformation.
- (b) Prove that Lorentz transformations reduce to Galilean transformations when $v \ll c$.
- (c) Obtain the value of velocity of massless particle.

4. (a) Describe Michelson-Morley experiment and discuss its outcome. 7
- (b) Find the relative velocity of two β -particles travelling in opposite directions with velocity $0.9c$. 3

OR

15. (a) What do you understand by time dilation? Show that $\Delta t = \frac{\Delta t'}{\sqrt{1-v^2/c^2}}$, where the symbols have their usual meanings. Briefly discuss one experiment in support of time dilation. 1+3+3=7
- (b) If total energy of a particle is 3 times its rest energy, what will be its velocity? 3
