

2024/FYUG/ODD/SEM/
PHYDSC-102T/053

FYUG Odd Semester Exam., 2024

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* from the following : $2 \times 2 = 4$
- (a) Define linear momentum of a moving particle. How is it related to force?
- (b) Three particles of masses 2 gm, 3 gm and 5 gm are located in space. Their position vectors are $\vec{r}_1 = 2\hat{i} + 2\hat{j} + 2\hat{k}$, $\vec{r}_2 = \hat{i} + \hat{j} + \hat{k}$ and $\vec{r}_3 = \hat{i} - \hat{k}$ respectively. Find the position vector of the centre of mass.
- (c) Distinguish between elastic collision and inelastic collision.

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2. (a) What do you mean by projectile? Show that the trajectory of a projectile fired at an angle with the horizontal direction is parabolic in nature. 1+5=6
- (b) Find expressions for the (i) time of flight and (ii) horizontal range. 2+2=4

OR

3. (a) Define conservative force. Show that the central force is conservative in nature. Obtain the law of conservation of mechanical energy. 1+3+2=6
- (b) State and prove work-energy theorem. 1+3=4

UNIT—II

4. Answer any two from the following : 2×2=4
- (a) Define moment of inertia and radius of gyration of a body about an axis.
- (b) The trajectory of a particle of unit mass is given by the radius vector $\vec{r} = \hat{i}a \cos \omega t + \hat{j}b \sin \omega t$, where a and b are constants. Calculate the angular momentum of the particle about the origin.
- (c) State Hooke's law. What do you mean by modulus of elasticity?

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5. (a) State the two theorems of moment of inertia. 3
- (b) Calculate the moment of inertia of a solid cylinder about (i) its own axis and (ii) an axis passing through its centre of mass and perpendicular to its own axis. 2+5=7

OR

6. (a) Define Young's modulus (Y), bulk modulus (K), modulus of rigidity (η) and Poisson's ratio (σ). 4
- (b) Show that—
- (i) $Y = 3K(1-2\sigma)$;
- (ii) $Y = 2\eta(1+\sigma)$. 3+3=6

UNIT—III

7. Answer any two from the following : 2×2=4
- (a) Define central force. Give one example.
- (b) State Kepler's laws of planetary motion.
- (c) Explain weightlessness.
8. (a) State Newton's law of gravitation. Find the gravitational potential inside and outside of a spherical shell. 1+6=7
- (b) The potentials within two homogeneous shells of same surface density are in the ratio 1:2. Calculate the ratio of their radii. 3

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(4)

OR

9. (a) Define angular momentum of a particle. Show that when a particle moves under central force, angular momentum is a constant of motion. 1+2=3
- (b) Write short notes on the following : $3\frac{1}{2}+3\frac{1}{2}=7$
- (i) Escape velocity
 - (ii) Global Positioning System (GPS)

UNIT—IV

10. Answer any two from the following : $2 \times 2 = 4$
- (a) What are the characteristics of simple harmonic motion?
 - (b) Obtain the differential equation of simple harmonic motion.
 - (c) Distinguish between inertial and non-inertial frames.
11. (a) The displacement of a particle executing SHM is represented by
- $$y = 10 \sin \left(100\pi t + \frac{\pi}{6} \right) \text{ m}$$
- Find its (i) amplitude, (ii) angular frequency, (iii) frequency and (iv) time period. 4

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(5)

- (b) Obtain the expressions for average kinetic energy and average potential energy of a particle executing simple harmonic motion. 3+3=6

OR

12. (a) Obtain the expressions of fictitious forces appearing in a uniformly rotating frame of reference. 7
- (b) Explain the effect of coriolis force on a freely falling body. 3

UNIT—V

13. Answer any two from the following : $2 \times 2 = 4$
- (a) Write down Galilean transformation equations.
 - (b) State the postulates of special theory of relativity.
 - (c) What do you mean by length contraction?
14. (a) Derive Lorentz transformation equations. 7
- (b) Show that
- $$L = L_0 \sqrt{1 - \frac{v^2}{c^2}}$$
- where the symbols have their usual meanings. 3

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(6)

OR

15. (a) Obtain the expression of relativistic addition of velocities. 4
- (b) Obtain Einstein's mass-energy relation. Show that the rest mass of photon is zero. 4+2=6

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