FYUG Odd Semester Exam., 2024

PHYSICS

(1st Semester)

Course No. : PHYDSM-101T

(Mathematical Physics, 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 : 2×2=4

(a) State Stokes' theorem.

(b) Write down the order and degree of the following differential equation :

$$\frac{d^2y}{dx^2}+2x=0$$

(c) If $\phi = 3x^2y - y^3z^2$, find $\nabla\phi$ at the point $(1, -2, -1)$.

2. *(a)* Find the value of m so that the vectors $2\hat{i}-4\hat{j}+5\hat{k}$, $\hat{i}-m\hat{j}+\hat{k}$ and $3\hat{i}+2\hat{j}-5\hat{k}$ are coplanar. 4

(b) What is the physical significance of curl of a vector? If $\vec{a}=\hat{i}+\hat{j}-\hat{k}$, $\vec{b}=\hat{i}-\hat{j}+\hat{k}$ and $\vec{c}=\hat{i}-\hat{j}-\hat{k}$, show that

$$\vec{a}\times(\vec{b}\times\vec{c})=2\hat{i}-2\hat{j}$$ 2+4=6

OR

3. *(a)* Find the angle θ, between the vectors $\vec{A}$ and $\vec{B}$, where $\vec{A}=2\hat{i}-\hat{j}+2\hat{k}$ and $\vec{B}=\hat{i}+\hat{j}+\hat{k}$. 4

(b) Define divergence of a vector. Find ∇r, where $\vec{r}$ is position vector. 2+4=6

UNIT—II

4. Answer any *two* from the following : 2×2=4

(a) State the law of conservation of momentum. Mention one of the applications of the law of conservation of momentum.

(b) "When force and displacement are in the same direction, kinetic energy increases." Justify.

(c) Define angular velocity and angular momentum.

5. *(a)* Distinguish between centre of mass and centre of gravity. Find the expression of position vector of centre of mass of a two-body problem. 2+4=6

(b) State and prove work-energy theorem. 4

OR

6. *(a)* Define torque. Find the relation between angular momentum and torque. 1+3=4

(b) What is the physical significance of moment of inertia? Find the expression of moment of inertia of a rectangular bar about an axis passing through its centre. 2+4=6

UNIT—III

7. Answer any *two* from the following : 2×2=4

(a) What is the difference between gravity and gravitation?

(b) Write two properties of central force.

(c) What is weightlessness?

8. *(a)* What are the characteristics of motion of a particle moving under the influence of a central force? 3

(b) Write two examples of central force. Prove that both angular momentum and areal velocity of a particle moving under the action of central force is constant. 1+6=7

OR

9. *(a)* What is geostationary satellite? Mention some of its applications. 1+2=3

(b) Find the expression of time period of a satellite moving in circular orbits. Write a short note on GPS mentioning its applications. 4+3=7

UNIT—IV

10. Answer any *two* from the following : 2×2=4

(a) State Hooke's law.

(b) What is meant by modulus of rigidity? Write down its dimension.

(c) How many types of stress are there? Name all of them.

11. *(a)* Explain stress-strain diagram. 3

(b) Deduce the following relations :

$$Y = 2\eta(1+\sigma) \text{ and } Y = 3K(1-2\sigma)$$

where symbols have their usual meanings. 3½+3½=7

OR

12. *(a)* Show that for an elastic body undergoing longitudinal strain, elastic potential energy per unit volume

$$= \frac{1}{2} \times \text{stress} \times \text{strain}$$ 4

(b) What is cantilever? Find the expression of depression at a point of a cantilever beam loaded at the free end without considering weight of the beam. 1+5=6

UNIT—V

13. Answer any *two* from the following : 2×2=4

(a) What is surface tension?

(b) What are flow lines and streamlines in the context of fluid motion?

(c) Define inertial and non-inertial frame of reference.

14. *(a)* Find the dimension of surface tension. Explain the variation of surface tension with temperature. What is critical temperature? 2+2+1=5

(b) Show that the excess pressure acting on the curved surface of a curved membrane is given by

$$P = 2S\left(\frac{1}{r_1} + \frac{1}{r_2}\right)$$

where r_1, r_2 are the radii of curvature and S is the surface tension. 5

OR

15. *(a)* Show that velocity is not invariant but acceleration is invariant under Galilean transformation. 4

(b) Explain relativistic time dilation in detail. 6

★ ★ ★