

2024/FYUG/ODD/SEM/
PHYDSM-101T/054

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 : $2 \times 2 = 4$

(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).

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(2)

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

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

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 $\nabla \cdot \vec{r}$, 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.

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(Continued)

(3)

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?

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(4)

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.

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(5)

11. (a) Explain stress-strain diagram. 3
- (b) Deduce the following relations :
 $Y = 2\eta(1 + \sigma)$ 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.

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(6)

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
