

**2025/FYUG/ODD/SEM/
PHYDSM-101T/194**

FYUG Odd Semester Exam., 2025

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* of the following questions :

$2 \times 2 = 4$

- (a) Define scalar and vector triple product.
- (b) Define divergence of a vector field. Is it a vector or a scalar quantity?
- (c) State Gauss divergence theorem.

2. (a) Define gradient of a scalar function.

Explain its physical significance. $1 + 3 = 4$

(2)

(b) Derive the relation
 $\vec{a} \times (\vec{b} \times \vec{c}) = \vec{b}(\vec{a} \cdot \vec{c}) - \vec{c}(\vec{a} \cdot \vec{b})$

and hence show that

$$\vec{a} \times (\vec{b} \times \vec{c}) + \vec{b} \times (\vec{c} \times \vec{a}) + \vec{c} \times (\vec{a} \times \vec{b}) = 0$$

OR

3. (a) Explain first-order and second-order homogeneous differential equations with examples.

(b) Show that the vectors $\vec{A} = 2\hat{i} - 3\hat{j} - \hat{k}$ and $\vec{B} = -6\hat{i} + 9\hat{j} + 3\hat{k}$ are parallel. If $\vec{r}$ is the position vector given by $\vec{r} = \hat{i}x + \hat{j}y + \hat{k}z$, then show that $\text{div} \vec{r} = 3$ and $\text{curl} \vec{r} = 0$.

UNT-II

4. Answer any two of the following questions :

2×2

(a) State the principle of conservation of linear momentum.

(b) Define moment of inertia and radius of gyration of a body about an axis.

(c) Show that the net angular momentum of an isolated system always remains constant.

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(3)

5. (a) What is meant by torque of a rotating body? Find the relation between angular acceleration, moment of inertia and the torque of a rotating body. 1+4=5

(b) What are meant by work and energy? Explain the work-energy theorem. 2+3=5

OR

6. (a) State and prove the theorem of parallel axes of moment of inertia. 5

(b) Find the moment of inertia of a spherical shell about its diameter. 5

UNT-III

7. Answer any two of the following questions :

2×2=4

(a) State and explain Newton's law of gravitation.

(b) State Kepler's first and third law of planetary motion.

(c) Define orbital velocity. What do you mean by geostationary satellite?

8. What is central force? Prove the following for a particle moving under a central force :

1+3+3+3=10

(a) Angular momentum about the centre of force is a constant of motion.

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- (b) The motion of the particle is always confined to a plane.
(c) The areal velocity of the line joining the centre of force and the particle is a constant of motion.

OR

9. (a) Find an expression for orbital velocity of a satellite.
(b) What do you mean by weightlessness? State the necessary conditions for a satellite to be geostationary. Write a short note on global positioning system.

UNIT—IV

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

- (a) What is Poisson's ratio? State its limiting values.
(b) Explain the terms Young's modulus and bulk modulus of elasticity.
(c) Define cantilever. What do you mean by bending of beams?

11. (a) Explain stress-strain diagram. Obtain a relation between Young's modulus, bulk modulus and Poisson's ratio. 3+4

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(5)

- (b) Calculate the work done in deforming a body in longitudinal strain. 3

OR

12. (a) Define bending moment. Find an expression for bending moment of a rectangular beam. 1+4=5
(b) Obtain an expression for torsional couple per unit angular twist. 5

UNIT—V

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

- (a) Define coefficient of viscosity. How does viscosity of a liquid vary with temperature?
(b) Show that velocity is not invariant under Galilean transformation.
(c) State the fundamental postulates of special theory of relativity.

14. (a) Find an expression for excess pressure inside a spherical liquid drop. 4
(b) Derive Poiseuille's formula for the rate of flow of a liquid through a capillary of uniform bore. 6

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(6)

OR

15. (a) Deduce Lorentz transformation equations using the postulates of special theory of relativity.
- (b) What are meant by inertial and non-inertial frames of references? Explain in brief, what you mean by time dilation.
