2023/FYUG/ODD/SEM/
PHYDSM-101T/029

FYUG Odd Semester Exam., 2023
(Held in 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

SECTION—A

Answer *ten* questions, selecting any *two* from each Unit : 2×10=20

UNIT—I

1. State Gauss divergence theorem.

2. Show that the vectors, $\vec{A} = 2\hat{i} + 3\hat{j} - 4\hat{k}$ and $\vec{B} = 5\hat{i} + 2\hat{j} + 4\hat{k}$ are perpendicular to each other.

3. Write down the general expression for first- and second-order homogeneous ordinary differential equations.

UNIT—II

4. Explain what is radius of gyration.

5. What is the physical significance of moment of inertia?

6. What are meant by centre of mass and centre of gravity?

UNIT—III

7. State the characteristics of a central force.

8. State and explain Newton's law of gravitation.

9. Write a short note on GPS.

UNIT—IV

10. What is elasticity? Define elastic limit.

11. Explain stress-strain diagram.

12. What is Poisson's ratio? State the limiting values of Poisson's ratio.

UNIT—V

13. What is viscosity? Define coefficient of viscosity of a liquid.

14. Discuss the variation of surface tension with temperature.

15. State the postulates of special theory of relativity.

SECTION—B

Answer *five* questions, selecting *one* from each Unit : 10×5=50

UNIT—I

16. *(a)* What is meant by gradient of a scalar function? Explain its physical significance. 1+3=4

(b) Define scalar and vector triple products. Prove that

$$\vec{A}\times(\vec{B}\times\vec{C}) = \vec{B}(\vec{A}\cdot\vec{C}) - \vec{C}(\vec{A}\cdot\vec{B})$$ 2+4=6

17. *(a)* Explain first-order and second-order homogeneous differential equations with examples. 4

(b) Solve the following : 3+3=6

(i) $\frac{dy}{dx} + xy = 2x$

(ii) $y'' - 5y' + 6y = 0$

UNIT—II

18. (a) What are meant by work and energy? Explain the work-energy theorem. 1+1+3=5

(b) What is angular momentum? State and prove the law of conservation of angular momentum for a system of particles. 1+4=5

19. (a) Define moment of inertia. State and prove the perpendicular axes theorem of moment of inertia. 1+4=5

(b) Calculate the moment of inertia of a solid sphere about a diameter and hence obtain the MI of the sphere about a tangent. 4+1=5

UNIT—III

20. (a) What is an artificial satellite? Derive an expression for orbital speed of the satellite. 1+4=5

(Continued)

(b) What is a central force? Show that the areal velocity of the radius vector of a particle under central force remains constant. 1+4=5

21. (a) What is geostationary satellite? State the necessary conditions for a satellite to be geostationary. Mention some of its uses. 1+2+2=5

(b) State Keplar's laws of planetary motion. How can the law of gravitation be obtained from Keplar's third law? 3+2=5

UNIT—IV

22. (a) Find the relation among elastic constants connecting Y, K and σ, where the symbols have their usual meanings. 5

(b) Find the expressions for work done in stretching and twisting a wire. 3+2=5

23. (a) Deduce an expression for the couple required to twist a uniform rod. What is torsional rigidity? 4+1=5

(b) Find the expression for bending moment for a beam. What is flexural rigidity? 4+1=5

(Turn Over)

UNIT—V

24. *(a)* Find the expression for excess pressure on a curved membrane. 4

(b) Deduce Poiseuille's equation to determine the coefficient of viscosity of a liquid flowing through a tube. 6

25. *(a)* What are meant by inertial and non-inertial frames of references? What are Galilean transformation equations? 1+1+2=4

(b) Derive Lorentz transformation equations. 6

★ ★ ★