2024/FYUG/EVEN/SEM/
PHYDSM-151T/027

FYUG Even Semester Exam., 2024

PHYSICS

(2nd Semester)

Course No. : PHYDSM-151T

(Mechanics, Reliability and Mathematical Physics)

Full Marks : 70
Pass Marks : 28

Time : 3 hours

The figures in the margin indicate full marks for the questions

SECTION—A

Answer any *ten* questions : 2×10=20

1. State Stokes' theorem of vectors.

2. Define scalar or dot product of two vectors.

3. Find the area of the parallelogram whose adjacent sides are $\hat{i}-2\hat{j}+3\hat{k}$ and $2\hat{i}+\hat{j}-4\hat{k}$.

4. State the law of conservation of linear momentum.

5. Define centre of mass and centre of gravity.

6. What are the dimensions of moment of inertia?

7. State Newton's law of gravitation.

8. What is a geostationary satellite?

9. What is a central force? Give an example of central force.

10. State Hooke's law.

11. What force is required to stretch a steel wire $\frac{1}{2}$ sq. cm in cross-section to double its length? $Y = 2\times10^{11}$ N m^{-2}.

12. What is the difference between angle of twist and angle of shear?

13. Define surface tension of a fluid.

14. Discuss the variation of viscosity of a liquid with temperature.

15. What is an inertial frame of reference?

SECTION—B

Answer any *five* questions : 10×5=50

16. *(a)* Define scalar triple product of vectors. Show that the scalar triple product $\vec{A}\cdot(\vec{B}\times\vec{C})$ represents the volume of the parallelopiped enclosed by the vectors $\vec{A}$, $\vec{B}$ and $\vec{C}$ as its edges. 1+4=5

(b) What do you mean by a solenoidal vector field? Give an example. Prove that $\vec{A}=3y^2z^2\hat{i}+3x^2z^2\hat{j}+3x^2y^2\hat{k}$ is a solenoidal vector. 1+1+3=5

17. *(a)* Explain with examples, what you mean by first-order and second-order homogeneous differential equations. 4

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

(i) $\frac{dy}{dx} = \frac{x(2\log x + 1)}{\sin y + y\cos y}$

(ii) $\frac{d^2y}{dx^2} - 6\frac{dy}{dx} + 9y = 0$

18. *(a)* Derive the law of conservation of linear momentum from Newton's laws of motion. 5

(b) State and explain the work-energy theorem. 5

19. *(a)* Define angular momentum $\vec{J}$ and torque $\vec{\tau}$. Show that torque is given by the time rate of change of angular momentum. 2+3=5

(b) Calculate the moment of inertia of a thin spherical shell (hollow sphere) about a diameter. 5

20. *(a)* State Kepler's three laws of planetary motion. Show that the areal velocity of a planet round the sun is constant. 3+3=6

(b) Derive an expression for the orbital velocity of a satellite in circular orbit. 4

21. *(a)* What do you mean by geosynchronous orbit? Give the basic concept of global positioning system (GPS). 2+2=4

(b) What are the necessary conditions for a satellite to be geostationary? Mention some applications of geostationary satellite. What do you mean by weightlessness? 2+2+2=6

22. *(a)* Define Young's modulus, bulk modulus, rigidity modulus and Poisson's ratio. 4

(b) If Y, K and σ represent Young's modulus, bulk modulus and Poisson's ratio respectively, then prove that

$$K = \frac{Y}{3(1-2\sigma)}$$ 6

23. *(a)* Deduce an expression for the couple required to twist a uniform solid cylinder by an angle. 5

(b) Derive an expression for the binding moment of a beam. What is flexural rigidity? 4+1=5

24. *(a)* Deduce an expression for the difference of pressure on the two sides of a spherical drop. 4

(b) Give with necessary theory Poiseuille's method of determining the coefficients of viscosity of a liquid. State clearly the assumptions made. 5+1=6

25. *(a)* State the postulates of special theory of relativity. On the basis of Lorentz transformation equations, derive an expression for length contraction. 2+5=7

(b) A rod 1 m long is moving along its length with a velocity 0·6c. Calculate its length as it appears to an observer on the earth. 3

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