

1m/PHY-100 (Th) Syllabus-2023

2 0 2 5

(Nov-Dec)

FYUP : 1st Semester Examination

MINOR

PHYSICS

**(Mathematical Physics, Properties of Matter
and Waves)**

PHY-100

Marks : 56

Time : 3 hours

*The figures in the margin indicate full marks
for the questions*

Answer *any eight* questions

1. (a) State Gauss' divergence theorem and Green's theorem, and explain their significance. 2+2=4

(b) Solve

$$\frac{d^2y}{dx^2} - y = x \sin x + (1 + x^2)e^x$$

3

(2)

2. (a) Prove that

$$\vec{V} = (2x^2 + 8xy^2z)\hat{i} + (3x^3y - 3xy)\hat{j} - (4y^2z^2 + 2x^3z)\hat{k}$$

is not a solenoidal vector. 2.

- (b) Prove that—

(i) $\text{div grad } \phi = \nabla^2 \phi$

(ii) $\text{curl grad } \phi = 0$ $2\frac{1}{2} + 2\frac{1}{2} = 5$

3. (a) The position coordinates (x, y, z) of a moving particle changes with time (t) as follows :

$$x = 2t^2, \quad y = t^2 - 4t, \quad z = 3t - 5$$

Here the numerical constants have proper dimensions. Find the component of its velocity and acceleration at time $t = 1$ in the direction of $\hat{i} - 3\hat{j} + 2\hat{k}$. 4

- (b) Solve the equation : 3

$$\frac{d^2y}{dx^2} - 4\frac{dy}{dx} + 4y = e^{3x}$$

4. (a) State and prove the theorem of parallel axes of moment of inertia. $1 + 2 = 3$

- (b) Calculate the moment of inertia of a disc about an axis through its centre and perpendicular to its plane. 4

(3)

5. What is bending moment? Obtain an expression for the depression due to a load attached to the free end of a rectangular cantilever. $2 + 5 = 7$

6. (a) Write the equation of continuity for fluids and explain its significance. $1 + 1\frac{1}{2} = 2\frac{1}{2}$

- (b) Derive the Poiseuille's equation for the streamline flow of liquid through a capillary tube. $4\frac{1}{2}$

7. (a) Explain surface tension and surface energy of a liquid. $1 + 1\frac{1}{2} = 2\frac{1}{2}$

- (b) State and explain one application of Bernoulli's theorem. 2

- (c) Water flows through a horizontal pipeline of varying cross-section. At a point where the pressure of water is 0.05 m of mercury, the velocity of flow is 0.25 m/s. Calculate the pressure at another point where velocity of flow is 0.4 m/s. Density of water = 10^3 kg/m^3 . $2\frac{1}{2}$

8. Derive a general differential equation of motion of a simple harmonic oscillator and obtain its various possible solutions. 7

9. What are damped oscillation? Obtain the differential equation of damped oscillation and its solution. Explain the case of large damping. $1\frac{1}{2}+3+2\frac{1}{2}=7$
10. Discuss the theory of forced vibration and obtain the condition for amplitude resonance. 7
11. What is sharpness of resonance? Explain the effect of damping on sharpness of resonance and resonance absorption bandwidth. Obtain quality factor Q of forced oscillator in terms of resonance absorption bandwidth. $2+3+2=7$
12. (a) What are group and phase velocities? $1\frac{1}{2}+1\frac{1}{2}=3$
- (b) What are spherical waves? Show that the amplitude of a spherical wave varies inversely with distance. $1\frac{1}{2}+2\frac{1}{2}=4$
