

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

2 0 2 4

(December)

FYUP : 1st Semester Examination

MAJOR

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) The position vector of a particle is $\vec{r} = 4t^2\hat{i} + 2t\hat{j} + 3t^2\hat{k}$. Find the (i) displacement from $t = 1$ to $t = 2$, (ii) velocity and acceleration at $t = 2$. 2+2=4
- (b) Show that for a system of particles, the net external force acting on it is equal to the product of the mass of the system and the acceleration of the centre of mass. 3

(2)

2. (a) Show that $\nabla r^n = nr^{n-2}\vec{r}$, where $r = (x^2 + y^2 + z^2)^{\frac{1}{2}}$. 2
- (b) What is meant by curl of a vector? State Stokes' theorem. 1+1=2
- (c) Write down the unit vectors in cylindrical coordinates and show that they are perpendicular to each other. 3
3. (a) Same torque is applied to a disc and a flywheel having the same mass and same radius. Explain which will rotate with a larger angular velocity. 3
- (b) A horizontal beam of negligible weight is clamped at one end and loaded with a weight W at free end. Obtain the expression for the depression of the free end. 4
4. (a) What are inertial and non-inertial frames? Give one example of each. 2
- (b) What are fictitious forces? 1
- (c) Taking the earth to be a rotating frame, discuss the effect of centrifugal force on the value of g . Show that the effect is maximum at the equator and minimum at the pole. 4

(3)

5. Solve the following differential equations : 3+4=7
- (i) $\frac{dy}{dt} + y \cos t = 0$ with the initial condition $y(0) = \frac{1}{2}$
- (ii) $\frac{d^2y}{dx^2} - 2\frac{dy}{dx} - 3y = 0$ using the conditions $y(0) = 0, y'(0) = 1$
6. (a) Show that in stretching a wire
work done = $\frac{1}{2} \times \text{stress} \times \text{strain}$ 3
- (b) The Young's modulus of a material is 7×10^{11} dynes/cm² and rigidity modulus is 3×10^{11} dynes/cm². Calculate the bulk modulus and the Poisson's ratio. 2+2=4
7. (a) Explain the terms (i) surface tension and (ii) surface energy. Derive the relation between surface tension and surface energy. 1+1+2=4
- (b) Show how Bernoulli's theorem is applied to measure the rate of discharge of water. 3
8. (a) Distinguish between streamline and turbulent flows of a liquid and explain the significance of Reynolds number. 1+1+2=4

- (b) Obtain the expression for the terminal velocity of a sphere falling through the viscous medium of density σ . Given that ρ and a are respectively the density and radius of the sphere. 3
9. (a) What is SHM? Show that the sum of KE and PE of a particle executing SHM is constant. 1+3=4
- (b) A particle executes SHM according to the equation $x = 5 \sin(\pi t + \frac{\pi}{4})$. Find the (i) displacement, (ii) velocity and (iii) acceleration at $t = 0.5$ sec. 3
10. (a) Two vibrations at right angles to each other, are described by the equations $x = 3 \cos 4\pi t$ and $y = 3 \cos 8\pi t$. Write down their amplitudes and frequencies, and construct the Lissajous figure of the combined motion. 3
- (b) What is Q-value of a damped oscillation? Explain its significance. 2
- (c) Discuss the effect of damping on the frequency of oscillation. 2
11. Discuss the theory of forced vibration, and find the condition for resonance. 7

12. (a) What is progressive wave? Give example. 1+1=2
- (b) Deduce the classical differential wave equation of a plane progressive wave. 3
- (c) Explain the terms (i) phase velocity and (ii) group velocity. 2
