

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

2024

(December)

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) What is dot product and cross product
of two vectors? **1+1=2**

- (b) Show that the vector field

$$\vec{F} = \frac{\vec{r}}{|\vec{r}|^3}$$

is irrotational as well as solenoidal. **5**

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2. (a) State Green's theorem. 1
 (b) Write down the $\vec{\nabla}$ operator in Cartesian and curvilinear coordinates. 3
 (c) Solve the differential equation

$$(x^2 - y^2)dx + 2xydy = 0 \quad 3$$

3. Solve the following second-order differential equations : 3+4=7

(a) $\frac{d^2y}{dx^2} - 6\frac{dy}{dx} + 8y = 0$

(b) $(D^2 + 2D + 3)y = 0$

4. (a) State Newton's laws of motion. Show that Newton's first law of motion is simply a special case of second law. 2+2=4

- (b) What is a free body diagram? Draw a free body diagram of a bag being pushed down a ramp with friction and the ramp makes an angle of 15° with the horizontal. 1+2=3

5. (a) Show that the total linear momentum in the centre of mass system is zero. 4

- (b) Two particles, of masses 100 g and 300 g, have positions $2\hat{i} + 5\hat{j} + 13\hat{k}$ and $-6\hat{i} + 4\hat{j} - 2\hat{k}$, respectively. Find the instantaneous position of the centre of mass. 3

(3)

6. (a) State and prove the theorem of parallel axes of moment of inertia. $1+3=4$
- (b) Calculate the moment of inertia of a solid sphere about its diameter. 3
7. (a) What are the different types of fictitious forces acting on a body in a uniformly rotating frame of reference? 2
- (b) What is Coriolis force? Calculate the magnitude and direction of Coriolis acceleration of a rocket moving with a velocity of 2 km/s at 60° south latitude. $1+4=5$
8. (a) Define elastic limit and state Hooke's law in elasticity. $1+1=2$
- (b) Show that the value of Poisson's ratio lies between -1 and $\frac{1}{2}$. 3
- (c) A cylindrical bar of length 1 m and diameter 8 mm is fixed at one end and the other end is twisted through an angle of 5° by the application of a couple of 2.5 N m. Calculate the modulus of rigidity of the material of the bar. 2
9. (a) State and prove Bernoulli's theorem for a liquid along a streamline. $1+4=5$
- (b) Define streamline and turbulent flow of fluids. 2

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10. (a) Define surface tension of a liquid. Explain its origin. Also give the dimension of surface tension. $1+2+1=4$
- (b) Calculate the amount of energy that will be liberated if 1000 droplets of water each 10^{-8} m in diameter coalesce to form one large spherical drop. (Surface tension of water = 0.075 N m^{-1}). 3
11. (a) Write down the differential equation of a simple harmonic motion and obtain its solution. $1+2=3$
- (b) Show that the resultant of two simple harmonic motions at right angles to each other and having equal periods and amplitudes but a phase difference of 90° is a circle. 4
12. Write down the equation of motion of a damped simple harmonic motion. Obtain its solution and hence find the Q -factor when damping is very small. $1+3+3=7$.
