



'समानो मन्त्रः समितिः समानी'

## UNIVERSITY OF NORTH BENGAL

B.Sc. Honours 1st Semester Examination, 2022

### CC2-PHYSICS

#### MECHANICS

Time Allotted: 2 Hours

Full Marks: 40

*The figures in the margin indicate full marks.*

#### GROUP-A

1. Answer any **five** questions from the following: 1×5 = 5
- What is Coriolis force? When do they appear?
  - Three particles of masses 3g, 5g and 2g are located respectively at (1, 0, -1), (-2, 1, 3) and (3, -1, 1). Find out the location of their centre of mass.
  - What is damping? On what factors the damping depends?
  - Distinguish between streamline and turbulent flow.
  - Two bodies of different masses are moving with the same kinetic energy of translation. Which has greater momentum?
  - Show that Poisson's ratio lies between -1 and 0.5.
  - Show that the following force is conservative  $\vec{F} = (y^2 - x^2)\hat{i} + 2xy\hat{j}$ .
  - What is gravitational potential? Why is it always negative?

#### GROUP-B

Answer any **three** questions from the following

5×3 = 15

- Show that  $\vec{N} = \frac{d\vec{L}}{dt} = \vec{r} \times \vec{F}$ . 2
  - Show that the path of a projectile, as seen from another projectile, will always be a straight line. 3
- The potential energy function for the force between two atoms in a diatomic molecule can approximately be expressed as  $U_x = \frac{a}{x^{12}} - \frac{b}{x^8}$ , when  $a$  &  $b$  are positive constants and  $x$  is the distance between the atom. For what values of  $x$ ,  $U_{(x)}$  is equal to zero? 2
  - A particle of mass 100 gm is placed in a field of potential  $U = 5x^2 + 10$  ergs/gm. Find the frequency. 3
- State Kepler's laws of planetary motion and deduce them from Newton's Law of gravitation. 4
  - What is an artificial satellite? 1

5. (a) Explain the terms stress and strain. 2  
 (b) A cube of aluminium of side 10 cm is subjected to a shearing force of 10 N. The top surface of the cube is displaced by 0.01 cm with respect to the bottom. Calculate the shearing stress, shearing strain and modulus of rigidity. 3
6. (a) Distinguish between a Newtonian and a non-Newtonian fluid. 2  
 (b) Water flows through a horizontal tube of length 20 cm and internal radius 0.081 cm under a constant pressure head of the liquid 20 cm high. In 12 minutes 864 cc of liquid flows out from the tube. Calculate the viscosity co-efficient of water. The density of water is 1 gm per cc and  $g = 981$  cm per sec per sec. 3

**GROUP-C**

**Answer any two questions from the following**

10×2 = 20

7. (a) What are damped vibrations? Establish the differential equation of motion for a damped harmonic oscillator and obtain an expression for displacement. 1+2  
 (b) Discuss the case of heavy damping, critical damping and light damping. 3  
 (c) A simple pendulum has a period of 1 sec and an amplitude of  $10^\circ$ . After 10 complete oscillations, its amplitude is reduced to  $5^\circ$ . What is the relaxation time of the pendulum and quality factor? 4
8. (a) State and establish the theorems of parallel axes and perpendicular axes in connection with the moment of inertia of a rigid body.  $2\frac{1}{2} \times 2 = 5$   
 (b) Derive the expression for the moment of inertia of a  $2\frac{1}{2} \times 2 = 5$   
     (i) circular disc about an axis perpendicular to its plane and passing through the centre.  
     (ii) a solid sphere about a diameter.
9. (a) Determine the gravitational potential and field at a point 6  
     (i) outside (ii) inside and (iii) on the surface of a hollow and thin spherical shell.  
 (b) Derive the following differential operator  $\left(\frac{d}{dt}\right)_{\text{fix}} = \left(\frac{d}{dt}\right)_{\text{rot}} + \vec{\omega} \times \vec{A}$  4  
 where symbols have their usual meaning.
- 10.(a) State Einstein's postulates of special theory of relativity. 2  
 (b) On the basis of Lorentz transformations discuss the following Kinematic effects 4  
     (i) Length contraction  
     (ii) Time dilation.  
 (c) What speed must a body have for its mass to be 2  
     (i) three times,  
     (ii) five times its rest mass.  
 (d) Show that the rest mass of an electron ( $9.11 \times 10^{-22}$  g) is equivalent to 2  
 0.511 MeV.

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