2024

PHYSICS

Paper : PHYM010104 / PHYS010104

(MATHEMATICAL PHYSICS AND MECHANICS)

·Full Marks : 45   Time : 2 Hours

The figures in the margin indicate full marks for the questions

*Answer **either** in English **or** in Assamese*

1. Answer the following questions :   1x5=5

   a) If $\vec{\nabla} \times \vec{F} = 0$, then F is called $-----$ Vector

   b) Write the valuws of scale factors h_1, h_2 and h_3 in spherical polar co-ordinate.

   c) What is coriolis force? Mention one application of it.

   d) State the work and kinetic energy theorem.

   e) Define Poisson's ratio. What is its unit.

2. Answer any five of the following questions :   2x5=10

   a) If $A = xz^3\hat{i} - 2x^2yz\hat{j} + 2yz^4\hat{k}$ find $\vec{\nabla} \times \vec{A}$ at the point $(1, -1, 1)$

   b) Find the expression for element of length in orthogonal curvilinear co-ordinates.

   c) Define Dirac Delta function? Write its shifting property.

   d) State Keplar's third law of planetary motion.

   e) What is the difference between inertial gravitational mass?

f) Rotational kinetic energy of a particle is 10 joule and moment of inertia $8 gm/cm^2$. Calculate the angular momentum of the particle.

g) The equation of simple harmonic motion of a particle is expressed as $Y = 10 \sin (10t + \frac{\pi}{6})$, where Y is measured in meters and 't' is in second. For the particle determine (i) amplitude, (ii) frequency

h) A wire of length 2m and diameter 1mm is clamped at one end. Find the couple needed to twist the other end by 90, $n = 2.8 \times 10^{11}$ dyne/cm^2

3. Answer any four of the following questions :   4x5=20

a) State Gauss divergence theorem. Evaluate $\iint_S \vec{r} \times \hat{n} \, ds$, wher 'S' is a closed surface.

b) Establish that centrifugal force produced as a result of earth's rotation is $\vec{F} = -m\vec{\omega} \times (\vec{\omega} \times \vec{r})$ where the symbols have their usual meanings.

c) Prove that conservative force in negative gradient of potential energy.

d) Write the transformation relation between the cartesion (x,y,z) and spherical polar coordinates (r, θ, ϕ) express $\vec{\nabla} \times \vec{A}$ in spherical polar coordinate.   1+4=5

e) Define inelastic collision. Discuss inelastic collision in the laboratory frame of reference and hence calculate the lost of kinetic energy during the colliasion.   1+4=5

f) Define torque and angular momentum as applied to

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rotational motion. Deduce the relation between them.
                                1+1+3=5

g) Consider a fluid having coefficient of viscosity η and density ρ flowing through a cylindrical tube of radius 'r' and length 'ℓ'. If P is the pressure difference in the liquid at the two ends, show that the volume of fluid flowing in time 't' is $V = \frac{\pi P r^4}{8 \eta \ell} \cdot t$
                                                        5

4. Answer any one of the following questions: 1x10=10

a) Prove the following vector identities   2+3+5=10
   i) $\text{div grad} \, \phi = \nabla^2 \phi$
   ii) $\text{div curl} \, \vec{F} = 0$
   iii) $\text{curl curl} \, \vec{F} = \text{grad div} \vec{F} - \nabla^2 \vec{F}$

b) State the three types of modulus of elasticity and deduce the relation   3+7=10
   Where Y = Young's modulus
      η = rigidity modulus
      K = Bulk modulus

c) i) Find the expression of moment of inertia of a solid cylinder about an axis passing through its centre and the relation   7
   ii) What is conservative force? Check if the force 1+2=3
      $\vec{F} = yz\hat{i} + zx\hat{j} + xy\hat{k}$ is conservative.

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