RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College affiliated to University of Calcutta)

B.A./B.Sc. FIRST SEMESTER EXAMINATION, MARCH 2021

FIRST YEAR [BATCH 2020-23]

Date : 30/03/2021 **PHYSICS (GENERAL)**

Time : 11 am - 1 pm **Paper: I** Full Marks : 50

Group : A

Answer **any three** questions : [3×10]

1. a) Prove that $\left[\left(\vec{B}\times\vec{C}\right)\cdot\left\{\left(\vec{C}\times\vec{A}\right)\times\left(\vec{A}\times\vec{B}\right)\right\}\right]=[\vec{A}\cdot(\vec{B}\times\vec{C})]^2$. [2]

   b) The temperature at any point in space is given by $T=xy+yz+zx$. Determine the directional derivative of T in the direction of the vector $3\hat{\imath}-4\hat{k}$ at the point (1,1,1). [2]

   c) If $\vec{A}=3xyz^2\hat{\imath}+2xy^3\hat{\jmath}-x^2yz\hat{k}$ and $\varphi=3x^2-yz$, find $\vec{A}\cdot\vec{\nabla}\varphi$ and $\vec{\nabla}\cdot(\varphi\vec{A})$. [2+2]

   d) Verify whether the force $\vec{F}=(3x-4y-3z^2)\hat{\imath}+(4x+2y+2z)\hat{\jmath}+(xz-4y^2+2x^3)\hat{k}$ is conservative. [2]

2. a) Determine the moment of inertia of a solid cylinder about an axis perpendicular to the axis of the cylinder and passing through the diameter of its flat surface. [3]

   b) A particle of mass m moves along the space curve defined by $\vec{r}=a\cos\omega t\,\hat{\imath}+b\sin\omega t\,\hat{\jmath}$. Find (i) the torque and (ii) the angular momentum about the origin. [3]

   c) A student sits on a freely rotating stool holding two weights, each of which has a mass 3 kg. When his arms are extended horizontally, the weights are 1 m from the axis of rotation and he rotates with an angular speed of 0.75 rad/s. The moment of inertia of the student plus stool is 3 kgm^2 and is assumed to be constant. The student pulls the weights inward horizontally to a position 0.3 m from the rotational axis. Find (i) the new angular speed of the student and (ii) the kinetic energy of the system before and after he pulls the weights inwards. [2+2]

3. a) A steel stud (Shear Modulus, S = 8.27 x 10^{10} Pa) of 1 cm in diameter projects 4 cm from the wall. A 36,000 N shearing force is applied to the end. What is the deflection of the stud ? (Give answer in mm). [5]

   b) Show that a small and uniform strain v is equivalent to three linear strains v/3, in any three perpendicular directions. [5]

4. a) A square metal bar of 2.51 cm breadth, 37.95 cm long, and weighing 826 gm is suspended by a wire 37.85 cm long and 0.0501 cm radius. It is observed to make 50 complete swings in 335.7 s. What is the rigidity coefficient of the wire? [4]

   b) A brass bar 1 cm. square in cross-section is supported on two knife edges 100 cm apart. A load of 1 Kg at the centre of the bar depresses that point by 2.51 mm. What is Young's modulus for brass? [3]

   c) Find the work done in Joules in stretching a wire of cross-section 1 sq. mm. and length 2 metres through 01 mm., if Young's modulus for the material of the wire is.2x 10^{18} dynes/cm^2 . [3]

5. a) A flat plate of area 10 cm^2 is separated from a large plate by a layer of glycerine 1 mm thick. If the viscous coefficient of glycerine is 20 $gm.cm^{-1}.s^{-1}$, what force is required to keep the plate moving with a velocity of 1 cm/s. [3]

b) Water is escaping from a cistern by way of a horizontal capillary tube, 10 cm long and 0.4 mm. in diameter, at a distance of 50 cms, below the free surface of water in the cistern. Calculate the rate at which the water is escaping. [3]

c) A cylindrical vessel of radius 7 cm is filled with water to a height of 50 cm. It has a capillary tube 10 cm long, 0·2 mm radius, protruding horizontally at its bottom. If the viscosity of water is 0·01 C.G.S units. Find the time in which the level will fall to a height of 25 cm? [4]

Group : B

Answer **any two** questions : [2×10]

6. a) What do you mean by Coherent sources? [2]

b) In young's double slit experiment the separation of the slit is 1.9 nm and the fringe spacing is 0.31 mm at a distance of 1 meter from the slits. Calculate the wave length of light. [5]

c) How energy conservation law is obeyed in young's double slit experiment? [3]

7. a) In Newton's ring experiment how rings are formed? [3]

b) In Newton's ring experiment, the diameter of the 5^{th} ring was 0.336 cm and the diameter of the 15^{th} ring = 0.590 cm. Find the radius of curvature of the plano convex lens. if the wave length of used light is 5890 Å. [5]

c) Write difference between diffraction and interference? [2]

8. a) What is fermat's principle? [2]

b) Prove the law of refraction from Fermat's principle. [2]

c) How chromatic aberration can remove by achromatic doublet? [2]

d) An achromatic cemented doublet of focal length 25 cm is to be made from a combination of an equiconvex flint glass lens $(n_b = 1.505, n_r = 1.49)$ and a crown glass lens $(n_b = 1.66, n_r = 1.64)$. Calculate the radii of curvature of the different surfaces and the focal lengths of each of the two lenses. [4]

9. a) What are the differences between Frusnel diffraction and Fraunhofer type diffraction? [2]

b) Find out condition for principal maxima and minima for single shit diffraction pattern. [8]

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