RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College affiliated to University of Calcutta)

SECOND YEAR [2016-19]

B.A./B.Sc. THIRD SEMESTER (July – December) 2017

Mid-Semester Examination, September 2017

Date : 15/09/2017 **PHYSICS (General)**

Time : 12 noon – 1 pm Paper : III Full Marks : 25

(Answer any <u>five questions</u> taking at least <u>one from each group</u>) [5×5]

<u>Group – A</u>

1. a) How rings of fringes forms in Newton's ring arrangement. Find the condition for constructive and destructive interference. [2+3]

2. a) Define Fresnel's half period zones. [2]
   b) How zone plate can make. Find it's nth radius. [3]

3. a) What happens if in Newton's ring arrangement glass plate is replaced by a plane mirror. [2]
   b) In a Newton's ring experiment, the diameters of fifth and fifteenth dark rings are 0·336 cm and 0·590 cm respectively. If the radius of curvature of the curved surface of the plano-convex lens used be 100cm, find the wavelength of the light used. [3]

<u>Group – B</u>

4. a) What do you mean by inertial frame of reference? [1]
   b) What are the limitations of Newton's laws of motion? [2]
   c) Two observers, one is at OXYZ coordinate system and another is at $O'X'Y'Z'$ coordinate system observe that same force on a particle. Show that the two frames are connected by uniform velocity. [2]

5. a) Show that the acceleration $\vec{a}$ of a particle which travels along a space curve with velocity $\vec{V}$ is given by $\vec{a} = \frac{dV}{dt}\hat{T} + \frac{V^2}{R}\hat{N}$ where $\hat{T}$ is the unit tangent vector to the space curve, $\hat{N}$ is its unit principal normal and R is the radius of curvature. [3]
   b) Find the (i) tangential acceleration and (ii) normal acceleration of a particle which moves on the ellipse $\vec{r} = a\cos\omega t\,\hat{i} + b\sin\omega t\,\hat{j}$. [2]

6. An xyz coordinate system is rotating with respect to an XYZ coordinate system having the same origin and assumed to be fixed in space. The angular velocity of the xyz system relative to XYZ system is given by $\vec{\omega} = 2t\hat{i} - t^2\hat{j} + (2t+4)\hat{k}$ where t is the time. The position vector of a particle at time t as observed in the xyz system is given by $\vec{r} = (t^2+1)\hat{i} - 6t\,\hat{j} + 4t^3\hat{k}$. Find (a) the apparent velocity, (b) the true velocity, (c) apparent acceleration and (d) true acceleration at time t = 1. [1+1+1+2]

7. a) Prove that the centre of mass frame is zero momentum frame. [3]
   b) If the centre of mass of three particles of masses 1, 2 and 3 kg be at the point 3, 3, 3. where should a fourth mass of 4 kg be placed so that the centre of mass of the four particles be at the point 1, 1, 1? [2]

8. a) Prove that in the centre of mass frame of reference, the magnitudes of velocities of the particles remain unaltered in an elastic collision. [3]
   b) A sand bag of mass 10 kg is suspended with a 3 metre long weightless string. A bullet of mass 200 gm is fired with a speed 20 m/s into the bag and stays in the bag. Calculate the speed acquired by the bag. [2]

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