RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College affiliated to University of Calcutta)

B.A./B.Sc. FIRST SEMESTER EXAMINATION, DECEMBER 2017

FIRST YEAR [BATCH 2017-20]

Date : 20/12/2017 **PHYSICS [General]**

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

[Use a separate Answer Book for <u>each Group</u>]

<u>Group – A</u>

(***Answer <u>any seven</u> questions***) [7×5]

1. a) What do you mean by axial and polar vectors? Give suitable examples. 2

   b) Show that $\vec{A} = \left(2x^2 + 8xy^2z\right)\hat{i} + \left(3x^3y - 3xy\right)\hat{j} - \left(4y^2z^2 + 2x^3z\right)\hat{k}$ is not solenoidal but $\vec{B} = xyz^2\vec{A}$ is solenoidal. 3

2. a) State the divergence theorem. 1

   b) Evaluate $\iint_S \vec{F}\cdot\hat{n}\,dS$, where $\vec{F} = 2xy\hat{i} + yz^2\hat{j} + xz\hat{k}$ and S is the surface of the region bounded by $x = 0$, $y = 0$, $y = 3$, $z = 0$ and $x+2z = 6$. 4

3. A force $\vec{F} = \left(25\hat{i} + 6\hat{j}\right)N$ is acting on a particle of mass 2.5 kg for 5 sec. Initial position vector of the particle is $\vec{r}_0 = \left(6\hat{j} + 8\hat{k}\right)m$ and initial velocity is $\vec{u} = \left(2.5\hat{i} + 3\hat{k}\right)ms^{-1}$. Find out

   i) final velocity of the particle.

   ii) final position vector of the particle.

   iii) work done by the force $\vec{F}$. 1+2+2

4. a) Show that for a particle moving in a curved path, the expression of acceleration is given by

$$\vec{a} = \frac{dv}{dt}\hat{T} + \frac{v^2}{R}\hat{N}$$

   Where $\hat{T}$ and $\hat{N}$ are unit tangent and unit normal vectors respectively. v is the instantaneous speed and R is the radius of curvature of the path. 3

   b) Find the unit tangent $\hat{T}$ and principal normal $\hat{N}$ vectors for the space curve $x = t, y = \frac{1}{2}t^2, z = t$. 2

5. a) Find an expression for the velocity of a rocket moving against the presence of a constant gravitational field $\vec{g}$ by burning the fuel at constant rate. 4

   b) How the multistage rockets are useful in this case? 1

6. a) What is non-inertial frame of reference? 1

   b) Write down the expression of centrifugal force. Explain with suitable example. 2

   c) What is Coriolis force? Give one of its manifestation. 2

7. a) If Y, K and σ represent Young's modulus, Bulk modulus and Poisson's ratio respectively, then prove that $K = \frac{Y}{3(1-2\sigma)}$. 4

b) What are the practical limits for Poisson's ratio (σ). 1

8. a) Define neutral axis of a beam. 1
   b) Obtain an expression for the longitudinal stress in terms of bending moment *M*, in a beam at a distance *z* from the neutral axis. 4

9. a) What is meant by streamline motion of a liquid? 1
   b) Derive Poiseuille's equation for streamline flow of a liquid through capillary tube. 4

10. State Stoke's law related to the motion of a spherical body in a viscous fluid. Utilise this law to find out an expression for the terminal velocity of a spherical rain drop falling towards the earth. 5

11. a) A piece of camphor placed on water surface moves to and fro – explain the phenomenon. 2
    b) Water rises to a height of 10 cm when a certain capillary tube is dipped in water. If the same capillary tube is dipped in mercury, the level of mercury in tube is depressed by 3.42 cm. If the specific gravity of mercury be 13.6, the angle contact for water be 0^o and that for mercury be 135^o, compare the surface tensions of water and mercury. 3

Group – B

(***Answer <u>any three</u> questions***) [3×5]

12. Two thin lenses of focal length f_1 and f_2 are separated by a distance *d*. Find the equivalent focal length of the lens system. 5

13. a) What is 'Achromatic doublet'? 1
    b) Determine the condition of achromatism of two lenses separated by a distance *a*. 4

14. a) What is spherical aberration? 2
    b) Find the radii of curvature of a double convex lens of focal length 20 cm which shows minimum spherical aberration. (Index of refraction = 1.5) 3

15. a) Explain the working principle of an Astronomical Telescope with neat and clean ray diagram. 3
    b) What do you mean by entrance and exit pupil of optical instrument? 2

16. a) Prove that the focal length of a plano-concave glass lens is equal to twice the radius of curvature of its concave surface. [Refractive index of glass =1.5] 2
    b) Describe the working principle of Ramsden eyepiece with the help of a ray diagram. Indicate the position of crosswire within it. 2+1

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