RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College affiliated to University of Calcutta)

FIRST YEAR [BATCH 2015-18]

B.A./B.Sc. SECOND SEMESTER (January – June) 2016

Mid-Semester Examination, March 2016

Date : 17/03/2016 **PHYSICS (Honours)**

Time : 11 am – 1 pm Paper : II Full Marks : 50

[Use a separate Answer Book for each group]

Group – A

(Answer any three questions taking atleast 1 from each unit) [3×10]

Unit - I

1. a) Sketch and expand in Fourier series of the following function

$$f(x)=\begin{cases} x+\frac{1}{2} & -\frac{1}{2}<x<0 \\ -x+\frac{1}{2} & 0<x<\frac{1}{2} \end{cases}$$ [1+4]

   b) Deduce the expression in exponential form for Fourier integral. [5]

2. a) A string is stretched and fastened to two points distance 'ℓ' apart. Motion is started by displacing the string into the form $y=K(\ell x-x^2)$ from which it is released at time t = 0. Find the displacement of any point on the string at a distance of 'x' from one end at time 't' by the method of separation of variables. [5]

   b) Use the method of separation of variables to calculate the potential due to uniformly changed infinitely long hollow conducting cylinder at a distance 'r'. Given that the charge per unit length on the cylinder is 'λ' and the radius of the cylinder is 'a', such that r > a. Assume the necessary boundary conditions. [5]

Unit - II

3. a) Define a central force and express it in a vector form. [2]

   b) Prove the following theorems for a central-force motion:

      i) Total energy is a constant of motion.

      ii) The motion is confined to a fixed plane. [1+1]

   c) For an inverse-square law of force show that the Laplace-Lenz-Runge vector is also a constant of motion. [3]

   d) Use the LLR-vector to show that the general orbit of a particle moving under an inverse-square attractive force is a conic. [3]

4. a) Using suitable approximation, find the equation of motion of a particle relative to an observer on the Earth's surface by considering Earth is rotating about its own axis with angular velocity $\omega=7\cdot27\times10^{-5}$ rad/s. [4]

   b) Explain physically why the plane of oscillation of a Foucault pendulum should rotate clockwise when viewed from above the Earth's surface on the northern hemisphere but counter clockwise in the southern hemisphere. [2]

   c) A solid cylinder, a thin walled cylindrical shell, a solid sphere, a thin walled spherical shell are all rolled down an inclined plane sloped at angle θ. Each object has the same radius R. Find the acceleration of each. [4]

5. a) What is a cantilever? Find the depression of a cantilever when load at the free end is W and its own weight is W_0. [6]

b) If the breadth and thickness of a cantilever are 2 cm and 1 cm respectively what will be the depression at the free end compared to the depression when breadth is 1 cm and thickness is 2 cm. [2]

c) Find out the ratio of depression of two cantilevers of same length under same load given that the cross section area of the two are same and one is square while the other is circular. [2]

Group – B
(Answer any two questions)

6. a) Find wave equation for string stretched perpendicular to its length. [2]

b) Is $y = Ae^{-b(x-vt)^2}$ a wave? Give reason, where b is a constant and others are conventional. [1]

c) How standing waves are formed? Define node and antinode. [3]

d) Write the relation of group and phase velocity. From this relation determine when group velocity is equal, less and greater than phase velocity. [1+1·5]

e) Show velocity of the group of matter waves is just equal to the velocity of the particle. [1·5]

7. a) Derive an expression for velocity of longitudinal wave in gaseous medium. [5]

b) The distance from a Fresnel biprism to a narrow slit is 25 cm and a screen is placed at 100 cm from the biprism. Base angle of the prism is $20'$ and refractive index of the biprism glass is 1·5. Find the wavelength of light fringe width is 0·55 mm. [3]

c) In Newton's rings experiment, the diameter of n^{th} and $(n+20)^{th}$ dark rings are 0·324 cm and 0·736 cm respectively. Radius of curvature of the lens is 1m. Find the wavelength of light used. [2]

8. a) In a double slit experiment the distance between slits is 5 mm and distance to the screen is 1m. There are two interference pattern on the screen : one due to light with $\lambda_1 = 480\text{m}$ and another $\lambda_2 = 600\text{m}$. What is the separation between the two third order bright fringes. Explain why these fringes are called non-localized. [3+2]

b) Suppose the double slit experiment is totally immersed in water. How does the fringe pattern change? [2]

c) What do you mean by interference by division of wave front and division of amplitude? Give one example each. [3]

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