RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College affiliated to University of Calcutta)

B.A./B.Sc. SECOND SEMESTER EXAMINATION, MAY 2023

FIRST YEAR [BATCH 2022-25]

Date : 26/05/2023 **PHYSICS [Honours]**

Time : 11 am – 1 pm **Paper : CC 4** Full Marks : 50

Answer **any five** questions: [5x10]

1. a) The velocity of the gravity wave is given by $v=\sqrt{\frac{g\lambda}{2\pi}}$. Using this relation obtain an expression for the velocity of the waves under combined influence of gravity g and surface tension T.

   b) If two vibration in perpendicular directions are $x=a\sin\omega t$ and $y=b\sin(\omega t+\delta)$, then show that the resultant vibration would follow an elliptical path after super position.

   c) Comment on the pattern produced by two simultaneous vibration $y=a\sin\left(3\omega t+\pi/4\right)$ and $x=a\sin\omega t$. [4+4+2]

2. a) What are wave velocity, particle velocity, phase velocity and group velocity?
   b) Establish the relation between group velocity and phase velocity.
   c) Obtain an expression for the velocity of a plane longitudinal wave in a fluid medium. [2+4+4]

3. a) For a stretched string of length l fixed rigidly at two ends, the displacement at a point x at time t is $y(x,t)=\sum_{n=1}^{\infty}\sin\frac{n\pi x}{l}\left(a_n\sin\omega_n t+b_n\cos\omega_n t\right)$
   where the symbols have their usual significance. Obtain the fundamental frequency in terms of tension and mass per unit length of the string. Show that the total energy of the string is $E=\frac{M}{4}\sum_{n=1}^{\infty}\omega_n C_n^2$.

   b) i) If a string of length l is aligned along x axis and is placed at a position $x = a$, write down the boundary condition for solution of wave equation.
   ii) If the same string is struck by a hammer of width w with initial velocity u at the same position them find out the initial condition for that motion. [(2+4)+(2+2)]

4. a) Write down actual statement of Fermat in ray optics. Also mention its corrected form.
   b) The plane of separation of two medium of refractive indices n_1 and n_2 is considered.
   If a light ray comes from the medium n_1 and passes to the medium n_2 which make the angles with perpendicular to the plane θ_1 and θ_2 respectively on either sides then using Fermat's principle prove that $n_1\sin\theta_1=n_2\sin\theta_2$.

   c) Give a detailed construction of Ramsden's eye piece and find the object position. [(1+1)+4+4]

5. a) State and explain Huygens' principle. What is Fresnel modification of the said principle? Explain rectilinear motion of light using Fresnel-Huygens' principle.
   b) Consider refraction of a plane wavefront by a plane interface separating two media. Using Huygens' principle show that the speed of light in a rarer medium is greater than the speed of light in a denser medium.
   c) The wavelength of certain light in air is 600 nm. Find its wavelength in a medium of refractive index 1.5. Also comment on the change of frequency of the light if any. [(2+1+2)+3+2]

6. a) State the working principle for obtaining interference using Fresnel Biprism. Why is the base angle made very small? What is the expected change when the source thickness is increased gradually to a large value?
   b) How can you measure the thickness of a thin transparent film with this experiment?
   c) Newton's rings are formed with a source of light containing two wavelengths λ_1 = 600 nm and λ_2 = 450 nm. It is found that the m^{th} dark ring due to λ_1 coincides with the $(m+1)^{th}$ dark ring of λ_2. If the radius of curvature of the curved surface is 90 cm, find the diameter of the m^{th} dark ring of λ_1. [(3+1+1)+2+3]

7. a) A soap film of thickness 5.5×10^{-5} cm is viewed at an angle of 45^o. Its index of refraction is 1.33. Find the wavelength of light in the visible spectrum which will be absent from the reflected light.
   b) i) Derive the following expression for the intensity of transmitted light in Fabry-Perot interferometer $I_t = I_i \dfrac{(1-R)^2}{(1-R)^2 + 4R\sin^2 \delta/2}$ where symbols have their usual significances.
   ii) Comment on the maxima and minima depending upon possible values of δ.
   iii) What is coefficient of Finess?
   c) In Michelson interferometer 1000 fringes cross the field of view when the movable mirror is displaced through 0.293 mm. Calculate the wavelength of light. [4+(2+1+1)+2]

8. a) What is zone plate? Compare zone plate with convex lens.
   b) Derive an expression for intensity distribution for Fraunhofer type diffraction in a single slit using monochromatic light. What should be the diffraction pattern obtained by using white light?
   c) A parallel beam of light of wavelength 500 nm is incident normally on a narrow slit of width 0.2 mm. The Fraunhofer diffraction is observed on a screen which is placed at the focal plane of a convex lens of focal length 20 cm. Calculate the approximate distance between first two maxima. [(1+2)+(3+1)+3]

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