

RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College affiliated to University of Calcutta)

B.A./B.Sc. SECOND SEMESTER EXAMINATION, JUNE 2022

FIRST YEAR [BATCH 2021-24]

PHYSICS (HONOURS)

Paper : IV [CC4]

Date : 22/06/2022

Time : 11 am – 1 pm

Full Marks : 50

Answer **any five** questions:

[5×10]

1. a) Show that $\varphi(\vec{k}, \vec{r}, t)$ may represent a plane wave where $\vec{k}$ is normal to the wave front.
b) Given the travelling wave $\varphi(x, t) = 5.0e^{(-ax^2 - bt^2 - \sqrt{ab}xt)}$. Determine its direction of propagation. Calculate a few values of φ and make a sketch of the wave at $t = 0$, taking $a = 25.0 \text{ m}^{-2}$ and $b = 9.0 \text{ s}^{-2}$. What is the speed of light? [5+(1+2+2)]
2. a) What are beats?
b) Give an analytical description of the phenomenon of beats.
c) Show that the beat frequency is equal to the difference of frequencies of the component oscillations. [2+5+3]
3. a) What are phase and group velocities? Find a relation between them.
b) Show that particle velocity is equal to the group velocity.
c) The refractive index η of a medium for light waves of wave number k is given by $\eta^2 = \alpha + \beta k^2 - \gamma/k^3$, where α , β , and γ are constant. Show that the group velocity c_g can be expressed as $c_g = \frac{c_p}{\eta^2} \left(\alpha - \frac{2\gamma}{k^2} \right)$, where c_p is the phase velocity. [(2+3)+2+3]
4. A uniform stretched string of length l is fixed at both ends, is plucked at $x = l/4$ through a distance h and then released. Find the expression of vibration. Also find the absent harmonics from the expression. [7+3]
5. a) Explain *Huygen's* principle of wave propagation.
b) Use this principle to establish the laws of refractions of light at plane surface.
c) The wavelength of a light wave in vacuum is 632 nm. Obtain its frequency and velocity in a medium of refractive index 1.33. [2+5+3]
6. a) Give a comparative study of interference patterns obtained through *Fresnel's Biprism* and *Lloyd's Single Mirror*.
b) Explain how phase change take place due to reflection of light.
c) State the theory of colorification of soap bubbles or oil film on water surface.
d) In this context explain why we need broad source of light in these two cases. [2+2+4+2]
7. a) Describe the structure of *Fabry-Perot* interferometer in details.
b) Explain mathematically how intensity of light distribution takes place in the said interferometer.
c) In this context describe the terms *visibility* and *sharpness* of fringes. [4+3+(1+2)]
8. a) In *Newton's ring* experiment, the diameter of m^{th} dark ring is 10 mm and that for $(m+5)^{\text{th}}$ dark ring is 15 mm. If the radius of curvature of the lower surface of the lens is 10 m, then obtain the wavelength of the light used here.
b) What is *Zone plate*? What should be the resultant amplitude of light wave at the principal focus or 1st focus of the *Zone plate*?
c) State the theory of diffraction of light through a narrow single slit. Compare the intensities of first three maxima in this case. [3+(1+1)+(4+1)]

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