U.G. 2nd Semester Examination - 2022

PHYSICS

[HONOURS]

Course Code : PHY-H-CC-T-04

(Thermal Physics)

Full Marks : 40 Time : $2\frac{1}{2}$ Hours

The figures in the right-hand margin indicate marks.

Candidates are required to give their answers in their own words as far as practicable.

GROUP–A

1. Answer any **five** questions: $2\times5=10$

a) Explain why the 'piano' is more melodious than the guitar?

b) State the Young-Helmholtz law of a vibrating string.

c) Show that the beats frequency is equal to the difference between the frequencies of the component oscillations.

d) Deep water waves are characterized by the dispersion relation $w=c\sqrt{k}$. Show that the group velocity is half of the phase velocity.

e) In Newton's ring experiment the diameters of the third and the twenty-third bright rings are 0.00181 m and 0.005014 m respectively. If the radius of curvature of the Plano-convex lens is 0.50 m, calculate the wavelength of the light used.

f) What do you mean by a coherent source of light? Justify their role in an interference phenomenon.

g) In Michelson interferometer 790 fringes cross the field of view when the movable mirror is displaced through a distance of 0.233mm. Calculate the wavelength of light used.

h) The velocity of sound waves in a fluid medium is $\sqrt{\frac{K}{\rho}}$, where K is the Bulk's modulus and ρ is the density of the medium. Derive the Laplace correction. Is this correction applicable for a solid medium?

GROUP–B

2. Answer any **two** questions: 5×2=10

a) The expression for displacement of a vibrating string of mass M and length L fixed rigidly at both ends is $y = \sum_{n=1}^{\infty} C_n \sin\frac{n\pi x}{L}\cos(w_n t - \phi_n)$; where C, w, and ϕ are amplitude at a distance x, angular frequency, and initial phase of the nth harmonics respectively. Show that the energy of the string is $E = \frac{M}{4}\sum_{n=1}^{\infty} C_n^2 w_n^2$. 5

b) What are Lissajous figures? Describe any one method for their experimental demonstration. 1+4

c) The intensity of the central maximum of a single slit Fraunhofer diffraction pattern is I_0. What is the approximate intensity of the first maximum beyond the central maximum? What do you mean by resolving the power of a grating? What is a normal spectrum? Where you will get normal spectrum? 2+1+1+1

d) Show that pressure antinodes coincide with the displacement nodes for a stationary wave. 5

GROUP–C

3. Answer any **two** questions: 10×2=20

a) Using the result, $(a+b)\sin\theta = n\lambda$, where a is the slit width of a plane transmission grating and b is the width of the opaque space, show that the resolving power of the grating having N number of lines is equal to nN.

In Newton's ring experiment, the light of two different wavelengths λ_1 and λ_2 are separately used. It is seen that the n^{th} dark ring corresponding to λ_1 coincides with the $(n+1)^{th}$ dark ring for λ_2. Show that, the radius r_n of the n^{th} dark ring for λ_1 is given by, $r_n = \left(\frac{\lambda_1\lambda_2 R}{\lambda_1 - \lambda_2}\right)^{\frac{1}{2}}$. Where R is the radius of curvature of the lens used. 5+5

b) State Huygen's principle of wave propagation in an isotropic medium. Apply the principle to deduce the formula: $\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{r}$ for refraction of light at the spherical surface of radius r separating two media of refractive indices n_1 and n_2, u and v have their usual meanings.

A plane wavefront of light of wavelength 5×10^{-5}cm fall on a zone plate. The radius of the first half period zone is 0.5 mm. Where should a screen be placed so that the light is focused at the brightest spot? 2+5+3

c) Obtain an expression for the distribution of intensity of the interference pattern formed on a screen and caused by two coherent point sources of light. Sketch the evaluated distribution as a function of the phase difference between the interfering light waves. A struck string of length L stretched between two fixed supports at its ends is struck at a distance 'a' from one end. Find the maximum amplitude of the fundamental mode for the resulting vibration of the string. 4+2+4

d) Derive an expression for the velocity of a transverse wave in a stretched string. Show that odd and even all modes of vibrations are present in the vibration of a stretched string. Hence find the expression for fundamental frequency of its vibration. 5+4+1

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