বিদ্যাসাগর বিশ্ববিদ্যালয়
VIDYASAGAR UNIVERSITY

Question Paper

B.Sc. Honours Examinations 2021
(Under CBCS Pattern)
Semester - II
Subject : PHYSICS
Paper : C 4-T & P
Waves and Optics

Full Marks : 60 (Theory - 40 + Practical - 20)
Time : 3 Hours

Candidates are required to give their answers in their own
words as far as practicable.
The figures in the margin indicate full marks.

(Theory)

Group-A

Answer any *two* of the following questions : $2 \times 15 = 30$

1. (a) A particle is subjected simultaneously to N simple harmonic motions of the same frequency. If the amplitude of each oscillation is A_0 and Φ is the phase difference between successive oscillations, show that amplitude of the resultant oscillation is given by $A = A_0 \dfrac{\sin\left(N\Phi/2\right)}{\sin\left(\Phi/2\right)}$.

    (b) What are Lissajous figures? Explain how these figures are used to determine the difference between two nearly equal frequencies.

(c) The vibration along the same line are described by the equations

$x_1 = 0.05 \cos (8\pi t)$

$x_2 = 0.03 \cos (10\pi t)$

where x_1 is expressed in meters and t in seconds. Obtain the equation describing the resultant motion and hence find the beat period. Draw a careful sketch of the resultant displacement over one beat period.

4 + (2 + 3) + 6

2. (a) What do you understand by the terms, phase velocity and group velocity? Deduce a relation between phase velocity and group velocity.

(b) Define dispersion and cite an example of a dispersive medium. Distinguish between normal and anomalous dispersion.

(c) What is the difference between ripple and gravity waves? Show that the phase velocity of a linear gravity wave is $\sqrt{g/k}$, where g is the acceleration due to gravity and k is the wavenumber. Also show that the group velocity is half the phase velocity. (2 + 2) + (2 + 2) + (2 + 3 + 2)

3. (a) In Young's Double Slit Experiment, if instead of monochromatic light white light is used, what would be the observation?

(b) Suppose you use to perform Young's double-slit experiment in air and then repeat the experiment in water. Do the angular positions of the fringes change? Comment on it with explanation.

(c) Two narrow slits are illuminated by a laser with a wavelength of 552 *nm*. The interference pattern on a screen located $x = 5.10$ m away shows that the second-order bright fringe is located $y = 5.40$ cm away from the central bright fringe.

(i) Calculate the distance between the two slits.

(ii) The screen is now moved 1.8 *m* further away. What is the new distance between the central and the second-order bright fringe?

(d) Why is central fringe black in Lloyd mirror?

(e) What will be the effect on diameter of rings in the Newton's ring experiment if air is replaced by water ?

(f) In a Newton's ring experiment, the diameter of the 20th dark ring was found to be 5.82 *mm* and the 10th ring is 3.36 *mm*. If the radius of the plano-convex lens is 1*m*, calculate the wavelength of light used.

$$2 + 2 + (2 + 2) + 2 + 2+3$$

4. (a) Explain the phenomenon of diffraction and the conditions under which is to observed.

(b) What is the difference between Fresnel diffraction and Fraunhofer diffraction?

(c) Calculate the intensity of light for a single slit Fraunhofer diffraction.

(d) A monochromatic light with wavelength of 500 *nm* strikes a grating and produces the forth-order bright line at an angle of 30º. Determine the number of slits per centimeter.

(e) Why is a diffraction grating better than a prism? $3 + 2 + 5 + 3 + 2$

Group-B

Answer any *one* of the following questions : $1 \times 10 = 10$

5. (a) What is Laplace correction in Newton's formula to find speed of sound?

(b) How can we create plane waves and spherical waves?

(c) Obtain the frequencies of the normal modes of a pipe open at both ends of length L. Sketch graphically the shapes of the first three normal modes.

(d) A string of length 100 *cm* is stretched with a force of 2*N*. It vibrates in the fundamental mode with a maximum amplitude of 1 *cm*. Calculate the energy of the vibrating string. $1 + 2 + 4 + 3$

6. (a) What is a hologram ? What are the main requirements for making a hologram ? How does a hologram differ from a photograph ?

(b) How does a Fresnel zone plate work ? How do you find the focal length of a zone plate ?   (2 + 2 + 2) + (2 + 2)

(Practical)

Answer any *one* question :   1 × 20 = 20

1. Determine the refractive index of the material of a prism using a monochromatic source and a spectrometer.

    (a) Apparatus used.

    (b) Theory with working formula

    (c) Schuster's focusing

    (d) Procedure for determination of the angle of prism (with diagram)

    (e) Procedure for measurement of the angle of minimum deviation.

                                     2 + (3 + 1) + 4 + (4 + 1) + 5

2. Determine the wavelength of a monochromatic source of light with the help of Fresnel's biprism.

    (a) Apparatus used

    (b) Schematic diagram

    (c) Theory with working formula

    (d) Procedure for measurement of fringe-width

    (e) Procedure for measurement of the distance between two virtual slits

    (f) State what types of precautions should be taken.   2 + 3 + (3 +1) + 6 + 3 +2

3. Determine the wavelengths of light emitted by a mercury vapour lamp by using a plane diffraction grating.

    (a) Apparatus used

(b)   Theory with working formula

(c)   Schuster's focusing

(d)   Setting up the diffraction grating for normal incidence

(e)   Procedure for determination of the angles of diffraction

(f)   State what types of prceautions should be taken.

$$2 + (3 + 1) + 4 + 4 + 4 + 2$$

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