West Bengal State University

B.A./B.Sc./B.Com. (Honours, Major, General) Examinations, 2014

PART-II

PHYSICS– Honours

Paper– IV

Duration : 2 Hours Full Marks : 50

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

The figures in the margin indicate full marks.

Answer Q. No. 1 and any *four* from the rest, taking at least *one* from each group

1. Answer any five questions from the following : 5 × 2 = 10

a) State two differences between Ramsden's and Huygen's eye-piece.

b) Show that Fermat's principle can also be written in following form. $\delta\sum_i t_i = 0$.

c) What do you mean by cardinal points of an optical system ?

d) A glass block (r . i = 1·5) is immersed in water (r . i = 4/3). Find the Brewster's angle in this case.

e) A two-slit interference pattern is observed in air (refractive index = 1). Then the entire system is immersed in water (refractive index = 1·33). Mention the changes observed in the fringe system.

f) Define matrix representation of a light ray in a medium of refractive index n. Write down the matrix representing translation of light in such medium.

g) State Malus' law.

h) Describe the state of polarization of the wave represented by the equation

$E_x = E\sin(kz - wt)$

$E_y = E\cos(kz - wt)$.

Group-A

2. a) Find the condition of achromatism of separated doublet. Comment on the case when the lenses are made of same material and separation between the lenses vanishes. 2 + 2

b) Show that, Huygen's eye-piece satisfies condition for achromatism as well as minimum spherical aberration. Hence obtain cardinal points of Huygen's eye-piece. Show their positions on a diagram. 1 + 3 + 2

3. The relation between light ray on object space and image space for an optical system within paraxial approximation is given by the matrix equation $S\psi = \phi$, where S represents the system matrix given by $\begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix}$, and ψ and ϕ represent light ray on object and image space respectively.

Answer the following questions :

a) Determine the dimensions of the four elements of S.

b) If the optical system consists of a single convex refracting surface of refractive index n and radius of curvature R in air, then determine the refraction matrix.

c) If $|u|$ and $|v|$ be the object and the image distances respectively in (b) then determine all elements of S.

d) From (c) determine the relation between object and image distance.

2 + 3 + 3 + 2

a) What is meant by optical path ? What is the optical path length between the points separated by 30 cm in a medium having refractive index 1·33 ?

b) Show that when light goes from one point to another via a plane mirror, the path followed by light is the one for which the time of flight is the least.

c) Using Fermat's principle, derive the laws of refraction at a spherical surface. 1 + 2 + 3 + 4

Group - B

a) What is optical activity ? What factors do influence the specific rotation of an optically active substance ?

b) State Brewster's law.

c) A plane polarised light (λ = 6000 Å) is to be converted to a circularly polarised light by passing it through a quartz crystal ($n_e = 1{\cdot}551$, $n_0 = 1{\cdot}542$) cut parallel to the optic axis. Compute the minimum thickness of the crystal to produce such effect. 2 + 2 + 2 + 4

a) Write down the expression for resultant intensity of light produced by a plane diffraction grating explaining different terms. Obtain the condition for principal maxima. Show that intensity of principal maxima is proportional to N^2 where N is total no. of slits in the grating. 2 + 1 + 2

b) State three distinguishing features between grating and prism spectrum. 2

c) How many orders will be visible if the wavelength of incident radiation be 5000Å and the number of lines on the grating be 2620 per inch ? 3

7. a) Define coherent light sources. What are the different methods of producing coherent light sources. Give examples. 1 + 2

b) Derive an expression for energy distribution in the fringe pattern produced in a two-slit experiment. 3

c) Show that the fringes are hyperbolic in shape. Explain why do we observe straight fringes. 3 + 1