2018

PHYSICS

(Major)

Paper : 4.2

Full Marks : 60

Time : 3 hours

The figures in the margin indicate full marks for the questions

GROUP—A

(Wave Optics)

(*Marks* : 40)

1. Answer the following questions : 1×4=4

(a) In case of Young's double-slit experiment, if one slit is covered with green transparent paper and the other with blue transparent paper, what will be the effect on interference pattern?

(b) On what factors does the width of central maxima of a grating depend?

(c) What are phase retardation plates?

(d) In a plane transmission grating, 15000 lines/inch are taken. Why?

2. (a) If in an interference pattern, the ratio between the maximum and minimum intensities is 36 : 1, calculate the ratio between the amplitudes and intensities of the two interfering waves. 2

(b) Two plane diffraction gratings *A* and *B* have same width of ruled surface but *A* has greater number of lines than *B*. Which has greater intensity of fringes? Greater width of principal is maximum. 2

(c) Calculate the thickness of quarter-wave plate. Given that $\mu_e = 1{\cdot}553$, $\mu_0 = 1{\cdot}544$ and $\lambda = 5000$ Å. 2

3. Answer any *two* questions of the following : 5×2=10

(a) In a Newton's ring arrangement, light consisting of wavelengths λ_1 and λ_2, falls normally on a plano-convex lens of radius of curvature *R* resting on a glass plate. If the *n*th dark ring due to λ_1 coincides with the $(n+1)$th dark ring due to λ_2, then show that the radius of the *n*th dark ring of λ_1 is given by

$$\sqrt{\frac{\lambda_1 \lambda_2 R}{\lambda_1 - \lambda_2}}$$ 5

(b) The values of refractive indices for *E* and *O* rays for quartz are 1·5508 and 1·5418 respectively. Calculate the phase retardation for $\lambda = 5000$ Å, when plate thickness is 0·032 mm. 5

(c) Show that the resultant intensity in Fraunhofer diffraction at double slit is

$$I = 4 I_0 \left(\frac{\sin^2 \alpha}{\alpha^2} \right) \cdot \cos^2 \beta$$

where the symbols have their usual meanings. 5

4. *(a)* *(i)* Give Stokes' treatment to explain the change of phase when reflection takes place at a denser medium. 5

(ii) The inclined faces of a biprism of refractive index 1·50 make angle of 2° with the base. A slit illuminated by a monochromatic light is placed at a distance of 10 cm from the biprism. If the distance between the two dark fringes observed at a distance of one metre from the biprism is 0·18 mm, find the wavelength of light used. 5

Or

(b) *(i)* Show that the intensities of successive maxima in single-slit Fraunhofer diffraction are nearly in the ratio

$$1 : \frac{4}{9\pi^2} : \frac{4}{25\pi^2} : \frac{4}{49\pi^2}$$ 5

(ii) Explain briefly the theory of plane transmission diffraction grating. 5

5. *(a)* Give the theory of the formation of the spectra of various orders on the Rowland circle by a concave reflection grating. What are the merits of a concave grating over a transmission grating? 8+2=10

Or

(b) *(i)* What do you mean by Fresnel half-period zone? Show that the radii of half-period zones are proportional to the square roots of natural number. 2+3=5

(ii) Explain how the wavelength of light can be determined with a plane transmission grating. 5

GROUP—B

(Special Theory of Relativity)

(Marks : 20)

6. Answer the following questions : 1×3=3

(a) What is time dilation?

(b) Find the moving mass of an electron in terms of rest mass m_0, if $v = 0{\cdot}8\ c$.

(c) Can it be justified that a body can never attain or exceed the speed of light? Justify your answer.

7. (a) What was the main objective of the Michelson-Morley experiment? Write the conclusions. 2

(b) Establish the relation

$$E^2 - p^2c^2 = m_0^2\, c^4$$

where p is linear momentum, m_0 is the rest mass and E is the total energy of the particle. 5

8. (a) (i) Derive the relativistic formula for composition of velocities. 5

(ii) Explain the concept of twin paradox with the help of space-time diagram. 5

(*Continued*)

Or

(b) (i) Prove that

$$x^2 + y^2 + z^2 = c^2t^2$$

is invariant under Lorentz transformation. 5

(ii) A rocket ship is 100 m long on the ground. When it is in flight, its length is 99 m to an observer on the ground. Find its speed. 5

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