

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 $\mu_e = 1.553$, $\mu_o = 1.544$ and $\lambda = 5000 \text{ \AA}$. 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

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

- (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 $\lambda = 5000 \text{ \AA}$, 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

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

- (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 $v = 0.8 c$.
- (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

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

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

Or

(b) (i) Prove that

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

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
