

3 (Sem-4) PHY M 2

2016

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)

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

(a) The phase difference between two waves reaching a point is $\pi/2$. What is the resultant amplitude if the individual amplitudes are 3 mm and 4 mm?

(b) What is the grating constant of a plane transmission grating?

(c) A single-slit diffraction pattern is completely immersed in water without changing any other parameter. How is the width of central maximum affected?

(d) Write one dissimilarity of a zone plate and a convex lens.

2. (a) Why does an excessively thin film appear black in reflected light? 2

(b) Calculate the possible order of spectra with a plane transmission grating having 18000 lines per inch when light of wavelength 4500 Å is used. 2

(c) Calculate the thickness of double refracting plate capable of producing a path difference $\lambda/4$ between extraordinary and ordinary waves.

(Given : $\lambda = 5890 \text{ \AA}$, $\mu_o = 1.53$,

$\mu_e = 1.54$) 2

3. Answer any *two* questions of the following :

5×2=10

(a) Draw a neat diagram of Michelson's interferometer. Explain the use of a compensating glass plate. State the conditions for—

(i) circular fringes;

(ii) straight line fringes;

(iii) white light fringes.

1+1+3=5

(b) Show that the intensity distribution pattern in Fraunhofer diffraction due to double slit is

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

where the symbols have their usual meanings.

5

(c) Distinguish between plane, circular and elliptical polarizations. How would you produce and detect circularly polarized light?

2+3=5

4. Answer any *two* questions of the following :

10×2=20

- (a) (i) Discuss the condition necessary for observing interferences of light. How are these satisfied in a biprism? Explain the interference pattern produced by a biprism with white light.

1+2+2=5

- (ii) Write a short note on half-shade polarimeter.

5

- (b) (i) In Newton's rings set-up, the plano-convex lens of radius of curvature R is separated from the glass plate by a distance x . Show that the wavelength λ of the monochromatic light used is independent of x and is given by

$$\lambda = \frac{(D_{m+p}^2 - D_m^2)\mu}{4pR}$$

where D_m and D_{m+p} are the diameters of the m th and $(m+p)$ th bright rings and μ the refractive index of the material of the film enclosed between the lens and the plate.

5

(ii) Discuss the phase change due to reflection of light from the surface of a denser medium. 5

(c) (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. Compare the grating spectra with prism spectra. 3+2=5

GROUP—B

(Special Theory of Relativity)

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

(a) What do you mean by an inertial frame?

(b) Write the relativistic mass variation formula.

(c) What is twin paradox of special theory of relativity?

6. (a) A constant force F is acted upon a particle of mass m and moving with velocity v . Show that the acceleration of the particle is

$$a = \frac{F}{m} \left(1 - \frac{v^2}{c^2} \right)^{3/2} \quad 2$$

- (b) Write the inverse Lorentz transformation equation for space and time. Derive the formula for time dilation using the inverse Lorentz transformation.

2+3=5

7. Answer any *two* questions of the following :

- (a) Derive the relativistic formula for composition of velocity. 5

- (b) (i) From the relativistic concept of mass and energy, show that the kinetic energy of the moving mass m with velocity v is $m_0 v^2 / 2$, when $v \ll c$ (c being the velocity of light). 3

- (ii) Show that $E^2 = c^2 P^2 + m_0^2 c^4$ is Lorentz invariant. 2

(7)

- (c) What is relativistic Doppler effect? If the angle between the direction of motion of a light source of frequency γ_0 and the direction from it to an observer is θ , show that the frequency γ , the observer finds is given by

$$\gamma = \gamma_0 \frac{\sqrt{1 - v^2 / c^2}}{1 - \frac{v}{c} \cos \theta}$$

where v is the relative speed of source.

2+3=5
