Total No. of printed pages = 5

3 (Sem 4) PHY M2

2015

PHYSICS

(Major)

Theory Paper : M-4.2

Full Marks – 60

Time – 2½ 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) What becomes of energy of light waves whose destructive influence leads to dark fringes in interference pattern ?

   (b) From Stoke's law, establish the relation $r = -r'$

   (c) Define specific rotation for an optically active solution.

   (d) What do you mean by grating element and corresponding points ?

[Turn over

2. (a) Why do we see colours when white light falls on a thin film of transparent medium ? Explain. 2

(b) A slit is situated at a distance of 9 cm from the Fresnel's biprism. Each angle of the prism is 2^0 and the refractive index of materials of prism is 1.5. Calculate the fringe-width when the eyepiece is placed at a distance of 91 cm from the biprism and the wavelength of light is 6280 Å. 2

(c) Explain double refraction and optic axis. 1+1=2

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

(a) Monochromatic light coming from two co-herent sources interfere at any point P(y,x) in XY plane. Show that interference fringes are hyperbolic in general.

(b) Derive the mathematical expression of resultant intensity of the beam suffering Fraunhoffer diffraction in single slit. 5

(c) What is quarter wave plate ? Plane polarised light is normally incident on a quarter wave plate. State the condition under which circularly and elliptically polarised light can be obtained. 1+2+2=5

4. Answer any *two* questions of the following : 10×2=20

(a) (i) Sustained interference is not possible without co-herent sources. Explain two interference beams have intensities 9:4. Calculate the ratio of maximum and minimum intensities produced. 2+3=5

(ii) Find an expression for resolving power of a plane transmission grating in terms of grating constant and wave length of light. 5

(b) (i) Give the theory of the formation of the spectra of the various order on the Rowland circle by a concave grating. 8

(ii) Show from Brewster's law that when light is incident on a transparent substance at the polarizing angle, the reflected and refracted rays are at right angle to each other. 2

(c) (i) Describe in detail how the wavelength of monochromatic light can be determined with the help of Fresnel's bi-prism. 5

(ii) Write a short note on zone plate and its lensing property. 5

GROUP – B

(Special Theory of Relativity)

Answer any *two* questions.

5. (a) Write the Lorentz transformation equations for space and time. On the basis of these equations how could you justify that space and time are inter connected with each other ? 3+2=5

(b) A light source with frequency γ_o is approaching an observer at rest. If the velocity of the source is v, show that the effective frequency, measured by the observer is

$$\gamma=\gamma_o\sqrt{\frac{\left(1+\frac{v}{c}\right)}{\left(1-\frac{v}{c}\right)}}$$ 5

6. (a) (i) Establish the Relativistic Energy and momentum relation 3

$$E=\sqrt{m^2c^4+p^2c^2}$$

(ii) Show that a particle with zero rest mass must travel at the speed of light in vacuum. 2

(b) Describe Twin Paradox of special theory of Relativity. 5

7. (a) (i) Show that four-dimensional volume element dx dy dz dt is invariant under Lorentz transformation. 2

(ii) In the laboratory the life-time of a particle moving with speed 2.8×10^{10} cm/sec is found to be 2.5×10^{-7} sec. Calculate the proper life-time of the particle. 3

(b) Establish length contraction as a consequence of Lorentz transformations. 5