NRT/KS/19/2078

Bachelor of Science (B.Sc.) Semester-III Examination

PHYSICS (PHYSICAL OPTICS & ELECTROMAGNETIC WAVES)

Optional Paper—II

Time : Three Hours] [Maximum Marks : 50

N.B. :— (1) **ALL** questions are compulsory.

(2) Draw neat diagrams wherever necessary.

EITHER

1. (A) Describe the experimental arrangement for the formation of Newton's rings. Derive an expression for the diameter of dark rings. 5

(B) (i) Derive the conditions for brightness and darkness in case of interference in thin films due to reflected light. 3

(ii) A parallel beam of light of wavelength 6000 Å is incident on a thin glass plate of refractive index 1.5, such that the angle of refraction in the plate is 60^{o}. Calculate the smallest thickness of the plate which will appear dark by reflected light. 2

OR

(C) State the principle of superposition. What is interference ? What are the conditions to obtain a steady interference pattern ? 2½

(D) Explain how the refractive index of a liquid can be determined by using Newton's ring experiment. 2½

(E) Draw a neat diagram of Michelson Interferometer. Explain the method of determination of wavelength of monochromatic light with it. 2½

(F) In the Michelson Interferometer experiment, light of wavelength 4800 Å is used. When a glass plate ($\mu = 1.5$) is placed in the path of one of the interfering beams, 500 bright fringes pass from the field of view. Calculate the thickness of the film. 2½

EITHER

2. (A) Explain the construction of Fresnel's half period zones on a plane wavefront with neat diagram. Obtain the radius and area of half period zone. 5

(B) (i) Explain Fraunhoffer diffraction at a circular aperture. 3

(ii) In Fraunhoffer diffraction pattern due to a circular aperture, the screen is at a distance of 100 cm from the lens. The aperture is illuminated by monochromatic light of wavelength 5893 Å. The diameter of the aperture is 0.1 mm. Calculate the radius of the first dark ring. 2

OR

(C) Explain Rayleigh's criterion for unresolved, just resolved and well resolved spectral lines. 2½

(D) What is zone plate ? Compare the zone plate with a convex lens. 2½

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(E) What is a plane diffraction grating ? Obtain an expression for resolving power of a grating. 2½

(F) A grating having 600 lines per cm is used to observe the sodium D_1 and D_2 lines of wavelength 5890 Å and 5896 Å. Will the grating resolve the lines :

(i) in first order

(ii) in second order ? 2½

EITHER

3. (A) Explain the construction and working of Nicol Prism. 5

(B) (i) Define quarter waveplate. Derive the expression for minimum thickness of quarter wave plate to convert plane polarised light into elliptically polarised light. 3

(ii) Calculate the minimum thickness of the quarter wave plate of quartz for light of wavelength 6000 Å. Given : $\mu_0 = 1.544$ and $\mu_e = 1.553$ 2

OR

(C) State and prove Brewster's law. 2½

(D) Compare the properties of ordinary ray and extraordinary ray in uniaxial crystals. 2½

(E) What is double refraction ? Give the Huygens theory of double refraction in uniaxial crystals. 2½

(F) A plane polarized light passes through a quartz plate cut with faces parallel to the optical axis. Find the least thickness of the plate for which the ordinary and extraordinary rays combine to form plane polarised light, for which $\lambda = 5 \times 10^{-5}$ cm and $\mu_0 = 1.542$ and $\mu_e = 1.553$. 2½

EITHER

4. (A) State and prove Poynting theorem. 5

(B) (i) State and prove Maxwell's second equation $\vec{\nabla} \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$. 3

(ii) Calculate the value of Poynting's vector at the surface of sun if the power radiated by sun is 3.8×10^{26} watts while its radius is 7×10^8 m. 2

OR

(C) State the characteristics of electromagnetic waves. 2½

(D) Derive the relation $\nabla^2 E = \mu_0 \in_0 \frac{\partial^2 E}{\partial t^2}$ for the electric field E in free space. 2½

(E) Show that electromagnetic waves are transverse in nature. 2½

(F) If the value of Poynting's vector due to sun's radiation at the earth's surface is 1.34×10^3 Watt/m^2. Calculate the magnitude of magnetic field at the surface of earth assuming that the radiation is a plane wave. (Given : $\in_0 = 9 \times 10^{-12}$ $C^2N^{-1}m^{-2}$) 2½

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5. Attempt any **TEN** questions :

(I) Write the relation between phase difference and path difference.

(II) When does the phase change on reflection ?

(III) In Michelson's Interferometer, the initial and final position of micrometer screws are 12.70 mm and 12.75 mm, when 100 fringes pass from the field of view. Calculate the wavelength of light used.

(IV) In a plane diffraction grating, there are 196 lines per cm. Calculate the grating element.

(V) Why convex lens is necessary to observe Fraunhoffer diffraction pattern ?

(VI) Calculate the resolving power of a telescope if the limit of resolution is 27.08×10^{-7} radians.

(VII) What is optic axis ?

(VIII) Why the color of sky is blue ?

(IX) The refractive index of diamond for sodium light is 2.417. Find the angle of incidence for which the light reflected from diamond is completely plane polarised ?

(X) The Coulomb's law can be obtained from which Maxwell's equation ?

(XI) Define characteristic impedance.

(XII) Calculate the speed of electromagnetic waves in free space.

(Given : $\mu_0 = 4\pi \times 10^{-7}$ SI unit and $\in_0 = 8.85 \times 10^{-12}$ SI unit) 1×10