BACHELOR OF SCIENCE EXAMINATION, 2019

(1st Year, 2nd Semester, Old Syllabus)

PHYSICS (HONOURS)

Optics - I and Electricity Magnetism - I

Paper : HO-4

Time : Two hours | Full Marks : 50 (25 for each group)

GROUP - A

Answer any ***five*** questions.

1. Derive the system matrix for a thick lens placed in air. Hence find the focal length of the thick lens. 4+1

2. An optical system consists of two thin convex lenses of focal lengths 30 cm and 40 cm separated from each other by 20 cm in air. Using matrix method find the positions of the image when an object is placed at a distance 48 cm from the first lens. 5

3. (a) What do you mean by coherent sources ? Give two practical examples.

   (b) Considering the intensity distribution pattern for interference between two coherent sources show that there is no destruction of light energy in interference. 2.5+2.5

4. (a) Following Stoke's treatment discuss phase change on reflection of a light wave.

   (b) Suppose Newton's rings are formed in an experiment with a plano-covex lens placed on a plane glass plate in air. What would be the nature of Newton's rings when observed with transmitted white light? 3+2

5. (a) Following Fresnel give an explanation of the phenomenon of diffraction of light.

   (b) What is a zone plate? Explain how it can be used as a convex lens. 2+3

6. (a) Write down an expression for the intensity of Fraunhofer diffraction pattern due to a double slit. Explain the symbols involved.

   (b) In a double slit, slit width is 0.16 mm and separation between the slits is 0.8 mm. Find the missing orders in its Fraunhofer diffraction pattern. 3+2

7. (a) What is a Polaroid? What is the advantage of a Polaroid over a Nicol prism?

   (b) A thin Polaroid, placed between a pair of crossed Polaroids, is made to rotate at a rate ω about their common central axis. If an unpolarised light of intensity I_0 is incident on the first Polaroid what would be the intensity of the transmitted light? 2+3

13. (a) Electric field inside a conductor is zero. What happens when a potential difference is deliberately maintained between the ends of a conductor?

   (b) Derive the equation of continuity and explain its significance.

   (c) Modify the above equation for steady current. [1+3+1]

14. (a) State and explain Kirchhoff's laws for the distribution of currents and voltages in a network.

   (b) Apply the above laws to formulate equations for current flowing through different branches in case of an unbalanced Wheatstone bridge network (solution is not required). [2+3]

15. (a) Write down Biot-Savart law in terms of current density $\vec{j}$.

   (b) Starting from the above expression show that $\vec{\nabla}.\vec{B} = 0$. What is it's physical significance? [1(3+1)]

16. (a) State and explain Faraday's laws of electromagnetic induction. Express it in differential form.

   (b) A copper rod of length L rotates at angular velocity ω in a uniform magnetic field $\vec{B}$ which is perpendicular to the length of the rod. Find the emf developed between the two ends of the rod. [(1+2)+2]

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(c) Use Gauss theorem to find an expression for the charge density of the above electrostatic field. [1+2+2]

11. (a) Write down Gauss law in integral form.

(b) Use the above law to calculate electric field at distances (i) r > a and (ii) r < a, due to a spherical charge distribution given by

$$\rho = \rho_0\left(1-\frac{r}{a}\right),\ for\ r \le a$$

$$\rho = 0,\quad for\ r > a$$

where ρ_0 and a are constants. [1(2+2)]

12. (a) What is an electrical image ?

(b) A point charge +q is placed in front of a grounded conducting infinite plane. Using the method of image find

(i) the surface density of induced charge on the plane, and

(ii) the force between the plane and the point charge. [1(2+2)]

8. (a) Describe the state of polarization of the wave represented by

$$\vec{E} = \hat{i}E_0\cos(\omega t - kz + \pi/2) + \hat{j}E_0\cos(\omega t - kz)$$

where the symbols have their usual significance.

(b) A plane polarized light of wavelength 600 nm changes to a circularly polarized light on passing through a quartz crystal cut parallel to optic axis. Calculate the minimum thickness to produce such effect. Given $n_e \sim n_0 = 0.005$. 2+3

GROUP - B

Answer any ***five*** questions.

9. What do you mean by electric field and potential ? Find expressions for electric field and potential at an axial point due to a uniformly charged thin circular ring of radius a, total charge Q and line charge density λ. [1+(2+2)]

10. (a) Define flux and circulation of a vector field.

(b) Show that the following function may be a possible electrostatic field :

$$\vec{E} = A\left[2x\hat{i} - yz^2\hat{j} - \left(1+y^2z\right)\hat{k}\right]$$

where A is constant with appropriate dimensions.