B. Sc. 1st Year 1st Semester Examination, 2023

Elements of Basic Physics

Paper – GE 1

Time : Two hours   Full Marks : 40

Answer any *four*

1. (a) Write down the conditions for interference of light waves.

   (b) In a Young's double slit experiment for interference of light; show that the fringe width is proportional to the wavelength of light and are equally spaced.

   (c) In a Newton's rings experiment, the diameter of the 15th dark ring was found to be 0.590 cm and that of the 5th dark ring was 0.336 cm. If the radius of curvature of the plano-convex lens is 1 m, find out the wavelength of the light used.

   $(2 + 5 + 3)$

2. (a) Obtain the laws of reflection and refraction from the Fermat's principle.

   (b) Derive the intensity expression of Fraunhofer diffraction pattern for a single slit. Then find out the conditions for (i) central maximum (ii) secondary maxima and (iii) secondary minima.

   (c) For a plane transmission grating, does the diffraction pattern depend on grating element? Explain.

   $(3+4+3)$

3. (a) Show that the curl of gradient of any scalar function is zero.

   (b) Show that $\vec{A} = (2xy + z^3)\hat{\imath} + x^2\hat{\jmath} + 3xz^2\hat{k}$ is a conservative vector field.

   (c) State Stoke's theorem in vector calculus.

   (d) Calculate the directional derivative of $\varphi(x,y,z) = xy^2 + x^3y$ at point (1,2-1) in the direction of $2\hat{\imath} - \hat{\jmath} + 3\hat{k}$.

   $(3+2+2+3)$

4. (a) Prove: $\vec{\nabla} \times (\vec{A} + \vec{B}) = \vec{\nabla} \times \vec{A} + \vec{\nabla} \times \vec{B}$

   (b) Find a unit normal to the surface $x^2y + 2xz = 4$ at the point (1, 1, 1).

   (c) Evaluate $I = \int \vec{a}.\overrightarrow{dr}$ for $\vec{a} = (x + y)\hat{\imath} + (x - y)\hat{\jmath}$ along the following specified paths:

i) $y^2 = x$ from $(1,1)$ to $(4,2)$

ii) the line $y = 1$ from $(1,1)$ to $(4,1)$ followed by the line $x = 4$ from $(4,1)$ to $(4,2)$

iii) Interpret the result physically.

(3+2+(2+2+1))

5. (a) What do you mean by a conservative electrostatic field?

(b) State and explain the Gauss' law of electrostatics in the presence of dielectrics. What is its differential form?

c) Calculate the electric field inside and outside a charged solid sphere which carries a volume charge density $\rho = kr$, where k is a constant.

(2+(3+1)+4)

6. (a) State the Biot-Savart law and mention its validity, if any. Write the expression for the magnetic field due to a current carrying element at a point.

(b) By using the Ampere's law, calculate the magnetic field inside a long solenoid.

(c) What do you mean by magnetic vector potential?

((3+1)+4+2)

7. (a) State and explain Faradays' laws of electromagnetic induction.

(b) Calculate the relation between the coefficient of self- and mutual-inductance with the help of a toroid.

(c) Distinguish between para-, dia- and ferro-magnets.

(3+3+4)

8. (a) Write down the Maxwell's electromagnetic field equations and briefly explain the physical significance of each. Show that the equation of continuity is contained in the Maxwell's equations.

(b) Obtain the velocity of light in free space from Maxwell's equations.

(c) What is the significance of the Poynting vector?

((4+2)+2+2)