

U.G. 4th Semester Examination-2026**PHYSICS****[MAJOR-IV]****Course Code : PHY-M-T-4****(Wave Optics and Electro-magnetic Theory)****[NEP-2020]**

Full Marks : 40

Time : $2\frac{1}{2}$ Hours*The figures in the right-hand margin indicate marks.**Candidates are required to give their answers in their own words as far as practicable.***GROUP-A**

1. Answer any five of the following questions: $2 \times 5 = 10$
 - a) Write one similarity and one dissimilarity between the vibrations of a plucked string and of a struck string.
 - b) How can the resolving power of a diffraction grating be enhanced?
 - c) A sodium atom radiates for 4×10^{-12} sec. What is the coherence length of light from a sodium lamp?
 - d) How is Ampere's law modified by the introduction of displacement current?

[Turn over]

- e) A black dot marked on a paper is viewed through a calcite crystal from the top. How many images are seen and why?
- f) What are Lorentz and Coulomb gauges?
- g) What are localised and non-localised fringes?
- h) Calculate the depth of penetration of a 1 MHz wave into copper which has a conductivity $\sigma = 5.8 \times 10^7 \Omega^{-1} \text{m}^{-1}$ and $\mu = 4\pi \times 10^{-7} \text{Am}^{-2}$.

GROUP-B

2. Answer any two of the following questions: $5 \times 2 = 10$

- a) What is Poynting vector? Write the S.I. unit of it. Prove the Poynting theorem. $1+1+3$
- b) Write two differences between interference and diffraction of light. Show that the area of half-period zone on a plane wavefront is independent of the order of the zone. $2+3$
- c) What is the difference between E-ray and O-ray? What is optic axis? Two polaroids are adjusted so as to obtain maximum intensity. Through what angle should one polaroid be rotated to reduce the intensity to half and one-fourth. $1+1+3$

- d) For a plucked string show that the amplitude of the s-th harmonic is proportional to $\frac{1}{s^3}$.

GROUP-C

3. Answer any two of the following questions: $10 \times 2 = 20$

- a) What do you mean by circularly and elliptically polarised light? Explain the Fresnel's theory of optical rotation. What are quarter and half wave plates? A plane polarised light is incident perpendicularly on a quartz plate cut with faces parallel to optic axis. Find the thickness of quartz plate, which introduces phase difference of 60° between E-ray and O-ray ($\mu_e = 1.553$ and $\mu_o = 1.544$). $2+2+2+4$
- b) What are coherent sources? What are Fizeau fringes? Explain the formation of interference fringes by Fresnel biprism with a monochromatic light. Describe the construction, principle and production of interference fringes with Fabry-Perot interferometer. $1+1+2+6$

- c) State the boundary conditions to be satisfied by electro-magnetic field vectors $\vec{E}, \vec{D}, \vec{B}$ and $\vec{H}$ at the plane interface of two media. An electromagnetic wave is incident on the plane interface between two different media. Show that i) the frequency of the wave remains unchanged on reflection and refraction, ii) the wave vectors of the incident, reflected and refracted waves all lie on the same plane. An electro-magnetic wave is incident normally on the surface of water of refractive index 1.33. What is the percentage of incident intensity transmitted into water? 2+3+3+2

- d) Find an expression for the intensity of Fraunhofer diffraction pattern due to a single slit. Explain the conditions for maxima and minima. What is the difference between single-slit diffraction pattern and double-slit interference pattern? In a plane transmission grating, the angle of diffraction for the second order maximum for wavelength $5 \times 10^{-7} \text{m}$ is 30° . Calculate the number of lines per cm of the grating. 4+2+2+2