

B.Sc. Semester-VI Examination, 2022-23**PHYSICS [Honours]**

Course ID : 62411 Course Code : SH/PHS/601/C-13/T-13

Course Title : Electromagnetic Theory

Time : 1 Hour 15 Minutes

Full Marks : 25

*The figures in the right-hand margin indicate marks.**Candidates are required to give their answers in their own words as far as practicable.***SECTION-I**

1. Answer any **five** questions: 1×5=5
- Write do you mean by displacement current?
 - What is the unit of specifying attenuation constant in EM wave propagation?
 - Mention a mechanism for magneto-optic effect.
 - What is the main advantage of Babinet's compensator over a half wave or quarter wave plate?
 - Compare refractive indices for ordinary and extraordinary light rays.

- Find current density associated with the auxiliary magnetic field given by $\vec{H} = 6r\hat{r} + 2r\hat{\phi} + 5z\hat{z} \text{ A/m}$.
- What is optical activity?
- What is angle of acceptance related to an optical fiber?

SECTION-II

2. Answer any **two** questions: 5×2=10
- Explain the inconsistency of Ampere's circuital law and discuss necessary modification implemented by Maxwell. 5
 - A plane electromagnetic wave is incident obliquely on a boundary between media of different electric and magnetic properties. Derive Fresnel's formula for perpendicular polarization case.
 - Discuss the state of polarization when the x and y component of electric fields in a composite light are

$$E_x = E_0 \left(\cos \omega t - kz + \frac{\pi}{3} \right) \quad \text{and}$$

$$E_y = E_0 \left(\cos \omega t - kz - \frac{\pi}{6} \right). \quad 4+1$$

c) What do you mean by skin depth related to EM wave propagation through conducting media? Calculate (i) Skin depth, (ii) wave velocity at a frequency of 1.6MHz in Aluminium, where $\sigma=38.2MS/m$ and $\mu_r = 1$.

1+2+2

d) i) Define numerical operture.
 ii) What is graded index fibre?
 iii) Derive an expression for numerical aperture of an optical fibre.
 iv) An optical fibre has a cove refractive index 1.50. Calculate the refractive index of cladding for an acceptance angle 26° .

1+1+2+1

SECTION-III

3. Answer any **one** question: 10×1=10

a) i) Show that in time varying EM field, the time varying electric field can be expressed as: $\vec{E} = -\vec{\nabla}V - \partial\vec{A}/\partial t$.

ii) What is the significance of Lorentz-gauge? Show that under Lorentz-gauge condition $\vec{\nabla}\cdot\vec{A} = -\mu\epsilon(\partial V/\partial t)$, vector potential will satisfy $\nabla^2\vec{A} = -\mu\epsilon(\partial^2\vec{A}/\partial t^2) = -\mu\vec{j}$, where symbols have their usual meanings.

(3) [Turn Over]

iii) Show that EM waves are transverse in nature.

iv) Find magnitude of Poynting vector at a distance 1m from a 200W blub.

2+4+2+2

b) i) A hollow rectangular waveguide is to be used to transmit signals at a carrier frequency of 6 GHz. Choose its dimensions so that the cut-off frequency of the dominant TE mode is lower than the carrier by 25% and that of the next mode is at least 25% higher than the carrier.

ii) Show that refractive index of a dielectric can be expressed as $n = \sqrt{\epsilon_r}$ considering $\mu_r = 1$. Hence show that refractive index of a medium-1 w.r.t. another medium-2 $= n_1/n_2$.

iii) Discuss different sources of losses in optical fibre communication system.

iv) What is Pockel's effect. What type of material exhibits Pockel's effect.

5+2+1+2

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