B.Sc. 6th Semester (Honours) Examination, 2020-21

PHYSICS

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

Course Title: Electromagnetic Theory (T-13)

Time: 1 Hour 15 Minutes **Full Marks: 25**

The figures in the margin indicate full 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

(a) Distinguish between conductance current and displacement current.

(b) Write down the equation containing the fact of non-existence of magnetic monopole in integral form.

(c) Find current density associated with the auxiliary magnetic field given by $\vec{H} = (6r\hat{r} + 2r\hat{\phi} + 5\hat{z})$ A/m

(d) Mention a mechanism for magneto-optic effect.

(e) What is Kerr effect?

(f) What are the basic differences between a conducting media and plasma?

(g) Compare refractive indices for ordinary & extraordinary light rays.

(h) What is the main difference between single mode and multimode fibres?

Section-II

2. Answer any ***two*** *questions*: 5×2=10

a) Assuming that electric field is of the form $\vec{E} = E_0 e^{-\alpha z} \cos(\omega t - \beta z)\, \hat{\imath}$, symbols have their usual meaning. Find magnetic field vector and expression for intrinsic impedance of a medium. Show that intrinsic impedance of free space is ~377 ohm. [4+1]

P.T.O.

b) Explain the inconsistency of Ampere's circuital law and discuss necessary Maxwell's modification. [5]

c) Which modes of propagation are supported by a rectangular wave guide? 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. [1+4]

d) (i) 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.
(ii) Discuss the state of polarization when the x and y component of electric fields in a composite light are $E_x = E_0 \cos(\omega t - kz + \frac{\pi}{3})$ and $E_y = E_0 \cos(\omega t - kz - \frac{\pi}{6})$. [3+2]

Section-III

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

a) (i) From Maxwell's equation obtain the equation of electric field and magnetic field of an electromagnetic wave in a conducting medium.

(ii) What do you mean by skin depth related to EM wave propagation through conducting media? Calculate Skin depth and wave velocity at a frequency of 1.6MHz in Aluminium, where $\sigma = 38.2 MS/m$ and μ_r =1, ϵ_r =1 . [5+1+2+2]

b) (i) How can the Nicol prism be used both as a polariser and as an analyser?

(ii) Write an expression for a linearly polarised wave of angular frequency ω propagating in the positive x-direction with its plane of vibration at 30° to the zx-plane.

(iii) What is Pockels effect? What type of material exhibits Pockels effect? [4+4+1+1]