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**MCA-003-1152002** Seat No. _____

# M. Sc. (Electronics) (Sem. II) (CBCS) Examination

**April / May - 2018**

## Paper - 6 : Advance Electromagnetics

**Faculty Code : 003**

**Subject Code : 1152002**

Time : $2\frac{1}{2}$ Hours] [Total Marks : **70**

**1** Answer Any **Seven** from the following : **14**

(1) Write the wave equations in free space and for a conducting medium.

(2) Define and draw uniform plane wave.

(3) Prove that E and H fields are perpendicular to each other.

(4) Write the expressions for propagation constant, phase shift constant, velocity of propagation, and attenuation constant for EM wave in free space.

(5) Find out the frequency, phase constant and wavelength of an electric field of an EM wave which is given as $E = 5.0\sin\left(10^8 t - 4.0x\right)a_z$.

(6) Prove that $\delta = \frac{1}{\alpha}$

(7) Draw and define the direction cosine.

(8) Draw the diagram of fields of EM wave for the cases of parallel and perpendicular polarization.

(9) The magnetic field, H of a plane wave has a magnitude of 5 mA/m in a medium defined by $\in_r = 4, \mu_r = 1$. Determine the average power flow.

(10) Write very briefly on Poynting vector.

**2** Answer any **two** from the following :

(A) You are given the following wave equations and field components : **7**

$$\frac{\partial^2 E}{\partial x^2} + \gamma_p^2 E = -\omega^2 \mu_0 \in_0 E \text{ and } \frac{\partial^2 H}{\partial x^2} + \gamma_p^2 H = -\omega^2 \mu_0 \in_0 H$$

$$H_x = \frac{-\gamma_p}{h_p^2}\frac{\partial H_z}{\partial x}, \quad H_y = \frac{-j\omega\varepsilon_0}{h_p^2}\frac{\partial E_z}{\partial x}, \quad E_x = \frac{-\gamma_p}{h_p^2}\frac{\partial E_z}{\partial x},$$

$$E_y = \frac{j\omega\varepsilon_0}{h_p^2}\frac{\partial H_z}{\partial x} \text{ where, } h_p^2 = \gamma_p^2 + \omega^2 \mu_0 \in_0 .$$

Find the field components for TE mode and draw the field patterns of these components

(B) Discuss attenuation in parallel plate guides : **7**

If a wave of 6 GHz is propagating between two parallel conducting plates separated by 30mm, find the cut-off wavelength, guide wavelength for $TE_1$ mode.

(C) The wave equations for $E_z$ *and* $H_z$ are given for a rectangular wave guide as : **7**

$$\frac{\partial^2 E_z}{\partial x^2} + \frac{\partial^2 E_z}{\partial y^2} + \gamma_g^2 E_z = -\omega^2 \mu \in E_z \text{ and}$$

$$\frac{\partial^2 H_z}{\partial x^2} + \frac{\partial^2 H_z}{\partial y^2} + \gamma_g^2 H_z = -\omega^2 \mu \in H_z.$$

The filed components are given as :

$$H_y = \frac{-\gamma_g}{h_g^2}\frac{\partial H_z}{\partial y} - \frac{j\omega\varepsilon}{h_g^2}\frac{\partial E_z}{\partial x}, \; E_x = \frac{-\gamma_g}{h_g^2}\frac{\partial E_z}{\partial x} - \frac{j\omega\mu}{h_g^2}\frac{\partial H_z}{\partial y},$$

$$E_y = \frac{-\gamma_g}{h_g^2}\frac{\partial E_z}{\partial y} - \frac{j\omega\mu}{h_g^2}\frac{\partial H_z}{\partial x}$$

Derive the expressions for the field components for TM mode in rectangular wave guide.

**3** Answer the following :

(A) Discuss wave impedance in wave guide. **7**

A hollow rectangular waveguide operates at $f = 1\,GHz$ and it has the dimension of $5 \times 2\,cm$. Check whether $TE_{12}$ mode propagates or not.

(B) Derive expression for characteristic impedance and reflection coefficient for a parallel wire transmission line with the derivation of the transmission line equations. 7

**OR**

**3** Answer the following :

(A) Derive the expression for the input impedance of a transmission line Obtain the formulae for $\alpha$ *and* $\beta$ for the same. 7

(B) Discuss losses in transmission line. 7

A lossless transmission line used in a TV receiver has a capacitance of $50 pF/m$ and an inductance of $200\ nH/m$. Find the characteristic impedance for sections of a line 10–meter–long and 500 meter long.

**4** Answer the following :

(A) Write on the Smith chart by deriving the expressions for the $r-$circles and $x-$circles. 7

(B) Design a stub to match a transmission line which is connected to a load impedance of $Z_L = (450 - j600)\Omega$. The characteristic impedance of the line is $300\Omega$. The operating frequency is 20 *MHz*. 7

**5** Answer any **two** from the following :

(A) Write on the antenna parameters. 7

(B) Derive the expressions for radiation fields of an alternating current element. 7

(C) Discuss the radiated power and radiation resistance of a current element through mathematical derivation. 7

(D) Find the directivity of a current element *Idl*. 7