COLLEGE OF ENGINEERING & TECHNOLOGY

Department: Electronics and Communications Engineering
Lecturer: Associate Prof. Dr. Hussein Hamed Ghouz
Course: Electromagnetic Wave Propagation
Course Code: EC442 **Time : 60 Min.**
Date : Sat., Nov., 8, 2014 **Total Marks:30**

7th Exam Version (A) **Answer All Questions**

Question No. A1 :(10-Mark)

(a) Drive the wave equation for vertically polarized Time-Harmonic uniform plane wave propagating in a general medium along the x-direction using Maxwell's equations. Find the wave parameters **(5-Mark)**

(b) A Time-Harmonic magnetic flux density propagating in lossless material (ε_r=4.4 and $\mu=\mu_o\mu_r$) is given as: $\bar{B} = 0.24\pi \cos[628.318\times10^{08}\,t-(5\pi/3)z]a_y$. Assume there is no source in the material. Using Maxwell's equations find the electric flux density in the material, then: compute the wave parameters inside the material **(5-Mark)**

Question No. A2 :(10-Mark)

(a) The electric field intensity of a uniform plane wave propagating in a low loss dielectric material is given by:

$$\mathbf{E}(z) = E_o\left[\left(e^{(-j\,131.8\,z)} + e^{(-j\,131.8\,z - j\pi/2)}\right)\mathbf{a}_x + \sqrt{2}\; e^{(-j\,131.8\,z + j3\pi/4)}\,\mathbf{a}_y\right] e^{(-0.6z)}$$

What is the polarization type of this wave and its propagation factor? **(2-Mark)**

(b) In part (a), if $\varepsilon_r' = 2.2$ and f_o =3.0 GHz find the following:

1. The imaginary part ε_r'' and the wave impedance η **(4-Mark)**
2. The instantaneous form of the magnetic field **H (z, t)** **(2-Mark)**
3. The propagation factor at f_o =10.0 GHz. Comment on the result **(2-Mark)**

Question No. A3 :(10-Mark)

(a) A linearly polarized uniform plane wave (y-polarized) propagating in the free space region along the forward **x-direction** is normally incident on a lossless dielectric region. Assume, maximum incident electric field E^{+}_{y01}=5.0 v/m, wave frequency f_0=2.0 GHz, ε_{r2}=6.8 and $\mu_2=\mu_o$.

1. Derive the analytical equations for both reflection and transmission coefficients **(2-Mark)**
2. Derive the maxima and minima of standing wave, then, plot it **(2-Mark)**
3. Compute the wave parameters in each region **(2-Mark)**

(b) If a single lossless dielectric layer having a thickness "**d**" and ε_r=2.2 is inserted between the given two regions in part (a), derive the wave impedance of this layer and find the value of "**d**" to achieve zero reflection in the first region **(4-Mark)**

GoodLuck

$$\alpha = \omega\sqrt{\frac{\mu\varepsilon'}{2}\left(\sqrt{1+(\delta)^2}-1\right)}^{1/2} \qquad \beta = \omega\sqrt{\frac{\mu\varepsilon'}{2}\left(\sqrt{1+(\delta)^2}+1\right)}^{1/2}$$

$\varepsilon_o = 8.854\text{x}10^{-12}$ F/m $\qquad$ $\mu_o = 4\pi\text{x}10^{-07}$ H/m