Dept. of Electrical Eng.
Faculty of Engineering
Assiut University
1st Semester - Final Exam
January 04, 2015

Communication & Electronics Eng. Program
Course: Electromagnetic Fields
Theory (2)A , 2nd year – bylaw:2004
Time: 3 Hours, Marks: 50 points

Important remarks
- This exam measures ILOs no.: a2.1 & b6.3 & c4.1 & c4.2
- No. of pages: 5 - No. of questions: 4

$\varepsilon_o = 10^{-9}/36\pi$ and $\mu_o = 4\pi \times 10^{-7}$

Answer all the following questions:

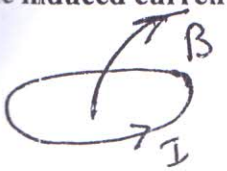
Question # 1 [15 points, 9 points for (a)]:

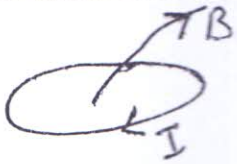
(a)circle the correct answer for each of the following:

(i)The magnetic field H in a region is: $10\cos(10t+20z)\ a_y$ A/m. In phasor form this field is:

$10e^{j20z}\ a_y$ A/m $20e^{j20z}\ a_y$ A/m $10e^{-j20z}\ a_y$ A/m $200e^{j20z}\ a_y$ A/m

(ii)In the following figure the magnetic flux density B is increasing in the direction shown. The induced current *i* flows in which direction?





Non of these

(iii)An infinitely long wire carries a current of $5\cos(1000t)$ A in the positive z direction. The magnetic field at 0.1 m away from the wire is closest to:

$3\ a_\varphi$ A/m $5\cos(1000t)\ a_\varphi$ A/m $8\cos(1000t)\ a_\varphi$ A/m $5\sin(1000t)\ a_\varphi$ A/m

$5\ a_z$ mA/m

(iv)The magnetic field H at some point is $10\cos(10t)\ a_x$ A/m. The electric field at this point is $20\cos(10t)\ a_y$ V/m. The time average power flows in the:

a_x direction $-a_x$ direction a_z direction $-a_z$ direction non of these

(v)An electron is travelling with a velocity of $2a_x$ m/s in a magnetic field with $B=5\times10^{-4}\ a_x + 2\times10^{-4}\ a_y$ teslas. The force on the electron is:

$5\times10^{-20}\ a_y$ N $6.4\times10^{-23}\ a_x$ N $6.4\times10^{-23}\ a_z$ N $-6.4\times10^{-23}\ a_z$ N

(vi)An electric field in phasor form is $E=(2\ a_x + 3j\ a_y)e^{-j10z}$. The polarization is:

linear left hand circular right hand circular

left hand elliptical right hand elliptical

Please turn over ⟹

(b) A current I flow in the inner conductor of an infinitely long coaxial line and returns via the outer conductor. The radius of the inner conductor a, and the inner and outer radii of the outer conductor are b and c, respectively. Find the magnetic flux density B for all regions and plot B versus r. [6 points]

Question # 2 (15 points):

(a)Under what conditions will the reflection and transmission coefficients for perpendicular polarization be the same as those for parallel polarization? [3 points]

(b)A uniform plane wave of an angular frequency 3.121×10^9 rad/sec is incident from a very large, perfectly dielectric nonmagnetic medium occupies $x > 0$ space of $\varepsilon_r = 2.45$ at an angle $\theta_i = 35^\circ$ to free space with perpendicular polarization. The amplitude of the incident electric field is 50 mv/m. Find [2 points each]:

- **the reflection coefficient Γ.**
- **the transmition coefficient T.**
- **the Brewster angle θ_b.**
- **the critical angle θ_c.**
- **expression for the instantaneous reflected magnetic field, H_r.**
- **expression for the instantaneous transmitted electric field, E_t.**

Question # 3 (10 points, 4 points for (a) and 6 points for (b)):

(a) The xy-plane serves as the interface between two different media. Medium 1 ($z < 0$) is filled with a material whose $\mu_{r1} = 6$, and medium 2 ($z > 0$) is filled with a material whose $\mu_{r2} = 4$. If the interface carries current of $(1/\mu_o)\, a_y$ mA/m, and $B_2 = 5a_x + 3a_y + 8a_z$ mWb/m^2. Find H_1 and H_2.

(b)A uniform plane wave with $E=E_x\, a_x$ propagates in a linear isotropic medium ($\mu_r=1.25$, $\varepsilon_r=4$, $\sigma=1.8$) in the +z-direction. Assume that the field is sinusoidal with a frequency 100 MHz and has a maximum value of $+10^{-4}$ v/m at t=0 and z=1/8 m.

(i)What are the propagation constant, phase constant, and the attenuation constant?

(ii) What is the wavelength in the medium.

(iii)Write the instantaneous expression for H at any t and z.

(iv)Determine the locations where the field E is a positive maximum at $t=10^{-8}$ s.

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Question # 4 (10 points):

a) For a harmonic uniform plane wave propagating in a simple medium, both E and H vary according with the factor exp(-jk.r). Show that the four Maxwell's equations for uniform plane wave in a source-free region reduces to the following: [5 points]

$\nabla \times E = \omega\mu H$, $\nabla \times H = -\omega\varepsilon E$, $\nabla \cdot E = 0$, $\nabla \cdot H = 0$

b) The current in a long wire is $I = I_o t$. A small circular loop of 5 cm radius is placed 0.5 m away from the wire in free space. The loop is oriented so that the magnetic flux passing through it is maximized. The voltage induced on this loop is measured at $5.0 \times 10^{-4}\ \mu_o$ Volts. Find I_o. State any assumptions that you make.

==End of the questions========Prof. Elsayed Esam M. Khaled======Best Wishes=====