NOTRE DAME UNIVERSITY
Faculty of Engineering
ECCE Department

EEN 331: Electromagnetics II | Midterm | 2 December 2009

Duration: 1.5 hours | Closed Book | 2 pages

Numerical answers required, where applicable
SI System unless otherwise noted
6 points per part

Problem # 1

The magnetic flux density is given by the expression $\mathbf{B} = 15.0\ t\ \mathbf{a}_z$ (T) where t is time in seconds.
At t=0, a square conducting loop is centered at the origin in the x-y plane with corners at A(0.1, 0.1, 0), B(-0.1, 0.1, 0), C(-0.1, -0.1, 0), D(0.1,-0.1,0) and has 10.0 Ω distributed resistance.

1.a Make a 3-D sketch showing the coordinate axes, the loop ABCD and the flux density **B**

1.b Determine the magnetic flux enclosed by the loop at any time 't' and at t=0.

1.c Determine the voltage induced at any time 't' and at time t=0, stating whether it is it is a transformer emf or a motional emf

1d Determine the magnitude of the current induced. State its direction between the two corners A and B, and justify

1-e The loop is rotated at a constant speed by an angle of 107.5° around the x-axis according to right hand rule: A to A', B to B', C to C' and D to D'. After the loop has reached its final position, determine the current and its direction between A' and B'

Continue 1/2

1.f The loop reaches its final position in 1/3 (second). Determine the net voltage induced at any time t, for $0 \leq t \leq 1/3$, in seconds. Comment.

Problem # 2

The electric and magnetic field intensities of a uniform plane wave are given by:

$\mathbf{E}=300\pi \cos(15\pi 10^6 t - 0.08\pi y)\, \mathbf{a}_z$ (V/m)

and $\mathbf{H}=4 \cos(15\pi 10^6 t - 0.08\pi y)\, \mathbf{a}_x$ (A/m)

2.a Determine the angular frequency, linear frequency and period of the wave

2.b Determine the velocity of propagation of the wave and direction of propagation

2.c Give the phasor form of **E** and **H**

2.d Determine the propagation constant, attenuation constant, phase constant and the wavelength of the wave

2.e Determine the intrinsic impedance of the medium and the nature of medium: conductor or lossy dielectric or perfect conductor

2.f Determine the conductivity, permittivity and permeability of the medium

2.g Determine the instantaneous Pointing vector and the time average power density

2.h Specify the polarization type of the wave and its direction at $t=0.25*10^{-6}$ (s) and y=0

Problem # 3

A plane wave specified by $\mathbf{H}^i = 0.9 \cos(2\pi 10^7 t - \beta_i z + \pi/4)\, \mathbf{a}_y$ (A/m) is incident from a nonmagnetic, lossless, $\varepsilon_r = 9$ medium (at $z < 0$) to a medium ($z > 0$) with $\sigma = 0.02$ (S/m), $\mu_r = 2.0$ and $\varepsilon_r = 16.0$

3.a Determine $\mathbf{E}^t$ in the lossy magnetic medium

3.b Determine $\mathbf{H}^t$ in the lossy magnetic medium

3.c Determine what percentage of the average incident power is reflected