ECE 3065 MIDTERM 1 (60') - 15.September 2004

1. The amplitude of an 802.11a WLAN wave propagating in a lossy magnetic medium with $\epsilon_r=1$ is described by the function:

$$y(z,t) = 0.1\cos(10.8 \times 10^9 \pi t + 108\pi z) \ e^{0.008z} \ (mA/m) \tag{1}$$

(a) What is the amplitude A, the period T, the wavelength λ , the reference phase ϕ_o and the attenuation factor α ? The velocity of light in the air is $c = 3 \times 10^8 m/sec$. A material is considered to be good conductor for α larger than 0.1 Np/m and a low-loss dielectric for α smaller than this value.10 %

(b) What is the value of the phase velocity u_p , magnetic constant μ_r and conductivity σ ? DO NOT FORGET THE UNITS AT (a), (b) 10 %

(c)The above wave propagates at coaxial line with characteristic impedence equal to the intrinsic impedance of the medium. This line is terminated in a 100-users computer lab. Each user's modem is equivalent to a load $Z_{L'}=1000$ - and the users are connected in parallel. What is the reflection Coefficient Γ and the Standing Wave Ratio S at the load (i) if all users are connected and (ii) if only 10 users are connected? If a value of SWR smaller than 5 is considered to be satisfactory matching, how could you characterize this matching for the two cases? 10 %

(d) What percentage of the incident power gets reflected if all users are connected? 5 %

(e) Could you match this load with a quarter-wavelength transformer or do you need lumped-elements (justify your answer)? 5 %

(d) If the electrical length of the transmission line is $l = 1000.25\lambda$, what is the input impedance Z_{in} ? Does the load behave as an inductor, a capacitor or a resistor? 5 %

2. The magnetic field of a remote-sensing uniform plane wave propagating in cosmic powder is given by: $\tilde{H} = (\hat{x} + \hat{y}) \ 10 \ e^{-j \ 108\pi z} \ (\mu \text{A/m})$ for a remote sensing satellite.

(a) Specify the polarization of the wave. 10 %

(b) Assuming that the wave is propagating in a non-magnetic medium, calculate the electric field in phasor form. 15 %

(c) What would be the polarization if the magnetic field was given by: $\tilde{H} = (j\hat{x}+\hat{y})5e^{-j108\pi z} (\mu A/m)$? 10 %

(d) What would be the polarization if the magnetic field was given by: $\tilde{H} = (j\hat{y} + \hat{z})5e^{-j108\pi x} (\mu A/m)$? JUSTIFY YOUR ANSWER 5 %

3. Assuming that a DirecTV magnetic signal with frequency 6 GHz propagates on a transmission line with $Z_o = 50$ - and has to be transferred completely to a cable box with $Z_L = 800$ -, a quarter-wave transformer has to be used. Assuming that the medium has dielectric constant $\epsilon_r=4$ and has a similar magnetic and loss performance to free space, what will be its electrical length, physical length and its characteristic impedance value? If the maximum acceptable value of the reflection coefficient is 0.2, what will be the bandwidth of this transformer? How could you further improve the bandwidth?

GOOD LUCK !!!