ECE 3065
SAMPLE MIDTERM 1

1. The amplitude of an AM Radio Wave is described by the function:

\[ y(x,t) = 4.5 \cos(2 \times 10^7 \pi t - \frac{1}{3} \pi x + \frac{\pi}{6}) \times e^{-0.008x} \text{ (Volts)} \]  \hspace{1cm} (1)

(a) What is the amplitude A, the period T, the frequency f, the wavelength \( \lambda \), the reference phase \( \phi_0 \), and the attenuation factor \( \alpha \)? The velocity of light in the air is \( c = 3 \times 10^8 \text{m/sec} \). 5 %

(b) What is the value of the propagation constant \( \beta \) and the angular frequency \( \omega \)? DO NOT FORGET THE UNITS AT (a), (b) 5 %

(c) The above wave propagates at a 50–Ω lossless transmission line which is terminated in a parabola with impedance \( Z_L = (40-j50)\Omega \). What is the reflection Coefficient \( \Gamma \) and the Standing Wave Ratio \( S \) at the load? 10 %

(d) If the electrical length of the transmission line is \( l = 0.30\lambda \), what is the input impedance \( Z_{in} \)? Does the load behave as an inductor or as a capacitor? Use the Smith chart to verify your results. 15 %

2. The electric field of a uniform plane wave propagating in free space is given by: \( \vec{E} = (\hat{x} - j\hat{y})30e^{-j\pi z/3} \text{ (V/m)} \) for a remote sensing satellite.

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

(b) Calculate the magnetic field in phasor form. 10 %

(c) What would be the difference if the electric field was given by: \( \vec{E} = (\hat{x} + j\hat{y})30e^{-j\pi z/3} \text{ (V/m)} \)? 10 %

3. The electric field of a wireless communication wave propagating through a nonmagnetic lossless material is given by: \( \vec{E} = \hat{z}30\cos(10^9 t - 6\hat{y}) \text{ (mV/m)} \)

(a) Find the direction of wave propagation. 10 %

(b) Find the phase velocity and the wavelength in the material. 10 %

(c) Assuming that an electric signal with this amplitude propagates on a transmission line with \( Z_0 = 50\Omega \) and has to be transferred completely to a Radar antenna with \( Z_L = 200\Omega \), a quarter-wave transformer has to be used. What will be its electrical length and its characteristic impedance value? 15 %

GOOD LUCK !!!