ECE3065
HW1
Due by Thursday, 24. January 2013

1. The amplitude of an FM Radio Wave is described by the function
$Y(x,t) = 1.5\cos(2x10^8\pi t - 2/3\ \pi x + \pi/3)\ e^{-0.0005x}$ (Volts)

(a) What is the amplitude A, the period T, the frequency f, the wavelength λ, the reference phase ϕ_o and the attenuation factor α? The velocity of light in the air is $c=3x10^8$ m/sec.
(b) What are the values of the propagation constant β and of the radial frequency ω? Do not forget the units!
(c) What is the propagation direction and why?
(d) What will be the amplitude of the FM wave for $t=10^{-5}$ sec and x=3km? Supposing that a Radio receiver can pick up FM waves with amplitude larger than 0.1V without deterioration of the quality of reception, could a radio placed at the above distance receive efficiently this FM wave at $t=10^{-5}$ sec?

2. A transmission line of length L connects a wireless communication antenna to a voltage source with frequency f. Assuming that the velocity of wave propagation is $c=3x10^8$ m/sec, for which of the following situations it is reasonable to ignore the presence of the transmission line in the analysis of the circuit:
(a) L=0.1m, f=1 GHz
(b) L=1m, f=1.8GHz
(c) L=0.01m, f=0.9 GHz
(d) L=5cm, f=60 GHz

3. A 50 Ω lossless coaxial transmission line is terminated in an antenna with impedance $Z_L=(30-j60)\Omega$. The wavelength is 5 cm. Calculate:
(a) The reflection coefficient Γ at the load
(b) The Standing Wave ratio S on the line
(c) If the electrical length of the coaxial line is $L=0.35\lambda$, what is the input impedance?
(d) If under matched conditions, the transmitter can deliver 10 Watts to the load, how much power does it deliver to this antenna?

4. A 50W lossless line used in a Radar filter:
(a) has electrical length $L=\lambda/4$ and is terminated with a 60Ω resistive load. What is the reflection coefficient and the input impedance?
(b) has electrical length $L=\lambda/8$ and is terminated with an Open Circuit. What is the reflection coefficient and the input impedance? Does the Open Circuit behave as an inductor or as a capacitor and why?
(c) Has electrical length $L=\lambda/6$ and is terminated with a Short Circuit? What is the reflection coefficient and the input impedance? Does the Short Circuit behave as and inductor or as a capacitor and why?

5. A lossless 50 Ω microstrip transmission line, that is used in a nanosensor is terminated in a short circuit. Find:
(a) The reflection coefficient Γ

(b) The input impedance at a distance 2.3λ from the load
(c) The input admittance at a distance 2.3λ from the load

6. A lossless 50Ω coaxial transmission line is to be matched to a satellite parabolic antenna with Z_L= (75-j20)Ω using an L,C matching network around the center frequency of 6GHz.
(a) Calculate the TWO solutions and their respective bandwidth for Γ_M=0.05.
(b) How would the matching circuit get modified if we used a different antenna with Z_L=(25-j20)Ω. Calculate the new TWO solutions and their respective bandwidth for Γ_M=0.05.

7. A 100 MHz FM broadcast station uses a 300Ω transmission line between the transmitter and a tower-mounted half-wave dipole antenna with impedance equal to 73 Ω. You are asked to match the antenna to the line.
(a) Using a quarter-wave section, determine the electrical length and the characteristic impedance of the quarter-wave section.
(b) Determine the physical length of the quarter-wave section if it is made of polysterene with ε_r=2.56.
(c) What is the bandwidth of the transformer for Γ_M=5%?
(d) Using a 3-stage binomial transformer, determine the characteristic impedance and the electrical length of each section
(e) What is the bandwidth of the binomial transformer for Γ_M=5%?