EE3140 Hour Exam 2, Fall 2012

There are 5 problems. Note that the problems have different point values. All units are mks. Show your work for full credit. Useful constants:

\[ \varepsilon_0 = 8.854 \times 10^{-12} \text{ F/m} \]

\[ \mu_0 = 4\pi \times 10^{-7} \text{ H/m} \]

1. A wave propagates between two parallel plates of infinite extent which are a = 10 cm apart and perpendicular to the x-axis. The magnetic field of the wave is:

\[ H_x = H_1 \cos(2\pi x) e^{-jk_z z} \]

\[ H_z = H_2 \sin(2\pi x) e^{-jk_z z} \]

What mode is propagating? (5 points)

1) Wave propagating in +z-direction, with \( H_x \) (transverse) and \( H_z \) (longitudinal) components \( \Rightarrow \) TE mode

2) From \( 20\pi = \frac{m\pi}{a} \Rightarrow m = 2 \Rightarrow \) \( \underline{TE_2} \) mode

mode = \( \underline{TE_2} \)

2. A load is measured to be \( Z_L = 50 + j75 \Omega \) using 50\( \Omega \) cable. What is the reflection coefficient, \( \Gamma \)? (4 points)

\[ \Gamma = \frac{Z_L - Z_0}{Z_L + Z_0} = \frac{50 + j75 - 50}{50 + j75 + 50} = \frac{j75}{100 + j75} = \frac{j3}{4 + j3} \]

\[ \Gamma = 0.6/53.1^\circ \]
3. A pulse generator having an internal resistance of 25Ω produces a pulse of amplitude 15V and duration 1μs with no transmission line connected. A 50Ω line, 400m long and open-circuited at the far end, is connected to the generator. In the spaces below, sketch the voltage reflection diagram and the voltage at z=400m, assuming that z = 0 is at the load and the phase velocity is 200m/μs (3 points each).
4. A 10Ω load is connected to a 50Ω line. Assuming single-stub tuning in order to create a match, what is the minimum distance from the load that the stub should be placed? Give your answer in wavelengths. (5 points)

\[ Z_L = 10, \quad Z_\text{norm} = 0.2 \implies y_L = 5 \]

See Smith Chart

\[ \downarrow \]

distance from load to stub = 0.066 λ

5. Assume the power received by an antenna is 1 Watt. If the distance from that antenna to the transmitter is then doubled, what is the new power received by the antenna? (4 points)

\[ E \sim \frac{1}{r}; \quad \text{Power} \sim |E|^2 \sim \frac{1}{r^2} \]

\[ \therefore \text{New power is } \text{1 Watt} \left( \frac{1}{2} \right)^2 = \frac{1}{4} \text{ Watt} \]