

Department of Electronic Engineering
EE 3109 Applied Electromagnetics

Assignment 2
Deadline: 17th Apr 2015

Question 1

A plane wave

$$\vec{E}_i = \hat{x}3.3e^{-j275z} \quad \text{V/m}$$

is normally incident from air ($z < 0$) into a lossless dielectric half-space ($z > 0$) with a dielectric constant of $\epsilon_r = 9$.

- (a) Find the incident H -field phasor in air.
- (b) Find the reflection coefficient Γ .
- (c) Find the reflected E -field and H -field phasors.
- (d) Find the transmission coefficient T .
- (e) Find the transmitted E -field and H -field phasors.
- (f) Calculate the average power densities of the incident wave and the reflected wave.
- (g) By using the result of (f), calculate the average power density of the transmitted wave.

(25)

Question 2

A 1.2m-long lossless transmission line with a characteristic impedance $Z_0 = 50 \Omega$ operating at 480 MHz is terminated with a load $Z_L = 77 + j48 \Omega$. The line is connected to a sinusoidal voltage generator with a voltage amplitude $V_g = 50\text{V}$ and an internal impedance $Z_g = 50 \Omega$. The phase velocity of the traveling wave in the line is 30% of the velocity of light in vacuum.

Without using a ~~Smith Chart~~, calculate

- (a) the reflection coefficient at the output port of the transmission line;
- (b) the standing wave ratio;
- (c) the phase coefficient β of the signal traveling in the transmission line;
- (d) the input impedance Z_{in} at the input port of the transmission line;
- (e) the voltage V_i and current I_i at the input port of the transmission line;
- (f) the average power delivered to the transmission line from the voltage generator;
- (g) the average power delivered to the load.

(25)

Question 3

A lossless transmission line has a characteristic impedance of $600\ \Omega$. The operating frequency is 200MHz. The line has an unknown impedance Z_L and is to be matched by using a short circuited stub connecting in parallel to the main line. The length l_s and position d of the stub from the load Z_L are found to be 0.237m and 0.534m respectively. By using Smith chart, calculate,

- (a) the impedance of the short-circuited stub, Z_s ,
 - (b) the SWR of the main line, S , if the stub is disconnected,
 - (c) the load impedance Z_L ,
 - (d) the voltage reflection coefficient at the load,
 - (e) the location of the first voltage minimum from the load l_{min} if the stub is disconnected.
- (25)

Question 4

- (a) State the major advantage and disadvantage of a hollow metallic waveguide over an electrical cable.
- (b) An air-filled $a \times b$ rectangular wave guide is operating at 5 GHz. Given that $a = 7.2\text{ cm}$ and $b = 3.4\text{ cm}$, do the followings:
 - (i) List all the modes that can propagate at this frequency.
 - (ii) Among those modes of part (i), identify the mode that have the highest phase velocity. Find that value of the highest phase velocity.
- (c) An air-filled $a \times b$ ($a > b$) rectangular wave guide has a wave impedance of $800\ \Omega$.
 - (i) Is it operating in a TE or a TM mode? Why?
 - (ii) What is the group velocity of the propagating wave?
 - (iii) If the waveguide is operating in the dominant mode, sketch the surface currents on the guide walls.

(25)