Menoufia University
Faculty of Electronic Engineering
Electronics and Electrical Commun. Eng. Dept.
Third Year – Spring 2018

ECE 323 - Microwave Engineering
Problem Set #2

Transmission Line Theory

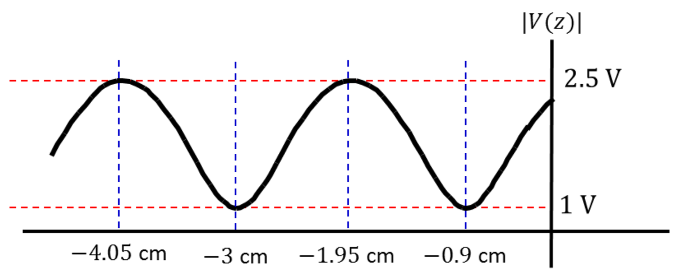
[P1] **2.11** - A 100 Ω T-line has an effective dielectric constant of 1.65. Find the shortest open-circuited length of this line that appears at its input as a capacitor of 5 pF at 2.5 GHz. Repeat for an inductance of 5 nH.

[P2] **2.17** - For a purely reactive load impedance of the form $Z_L = j\,X$, show that the reflection coefficient magnitude $|\Gamma|$ is always unity. Assume that the characteristic impedance Z_0 is real.

[P3] **2.12** - A lossless T-line is terminated with a 100 Ω load. If the SWR = 1.5, find the two possible values for the characteristic impedance of the line.

[P4] The results of a slotted-line experiment are plotted in the following figure. The length of the line is $\ell = 8.4$ cm; its characteristic impedance is $Z_0 = 50\ \Omega$. Find

(a) The reflection coefficient at the load.
(b) The load impedance.
(c) The input impedance.
(d) The reflection coefficient at the generator terminals.



[P5] **2.19** - A generator is connected to a transmission line shown in Fig. P5. Find the voltage as a function of z along the transmission line. Plot the magnitude of this voltage for $-l \leq z \leq 0$.

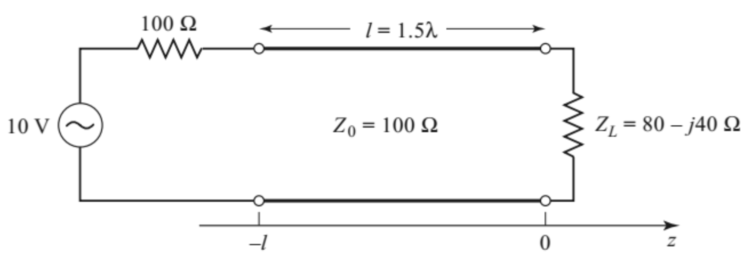


Fig. P5: Circuit for Problem P5.

[P6] **2.14** - A radio transmitter is connected to an antenna having an impedance 80 + j40 Ω with a 50 Ω coaxial cable. If the 50 Ω transmitter can deliver 30 W when connected to a 50 Ω load, how much power is delivered to the antenna?

[P7] **2.16** - The T-line has $V_g = 15$ V rms, $Z_g = 75\ \Omega$, $Z_0 = 75\ \Omega$, $Z_L = 60 - j40\ \Omega$, and $\ell = 0.7\lambda$. Compute the power delivered to the load using three different techniques.
Discuss the rationale for each of these methods. Which of these methods can be used if the line is not lossless?

[P8] **2.29** - A 50 Ω transmission line is matched to a 10 V source and feeds a load $Z_L = 100\ \Omega$. If the line is 2.3λ long and has an attenuation constant $\alpha = 0.5\ \text{dB}/\lambda$, find the powers that are delivered by the source, lost in the line, and delivered to the load.

[P9] **2.31** - Plot the bounce diagram for the transient circuit shown in Fig. P9. Include at least three reflections. What is the total voltage at the midpoint of the line ($z = l/2$), at time $t = 3l/v_p$?

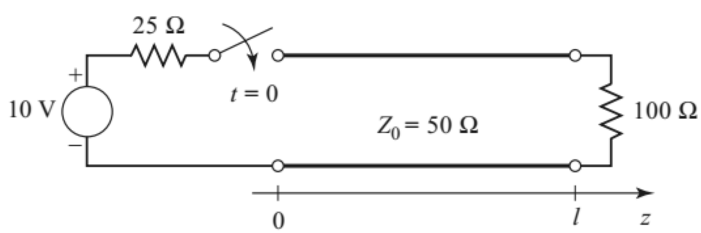


Fig. P9: Circuit for Problem P9.

[P10] A distortionless T-line with $Z_0 = 50\ \Omega$, $\alpha = 40 \times 10^{-3}$ Np/m, $v_p = 2.5 \times 10^8$ m/s, obtain the line parameters and wavelength at $f = 250$ MHz.

[P11] Find α and Z_0 of a distortionless T-line whose $R' = 2\ \Omega$/m and $G' = 2 \times 10^{-4}$ S/m.