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

ECE 323 - Microwave Engineering
Problem Set #1

Transmission Line Theory

[P1] **2.1** - A 75 Ω coaxial line has a current $i(t,z) = 1.8\cos(3.77\times10^9 - 18.13z)$ mA. Determine (a) the frequency, (b) the phase velocity, (c) the wavelength, (d) the relative permittivity of the line, (e) the phasor form of the current, and (f) the time domain voltage on the line.

[P2] **2.2** - A T-line has the following per-unit-length parameters: $L' = 0.5$ μH/m, $C' = 200$ pF/m, $R' = 4.0$ Ω/m, and $G' = 0.02$ S/m.
Calculate the propagation constant and characteristic impedance of this line at 800 MHz. If the line is 30 cm long, what is the attenuation in dB? Recalculate these quantities in the absence of loss (i.e., $R' = G' = 0$).

[P3] **2.7** - Show that the transmission line model (T model) shown in Fig. P3 yields the same telegrapher's equations given by given by Eqs. (2.2a) and (2.2b).

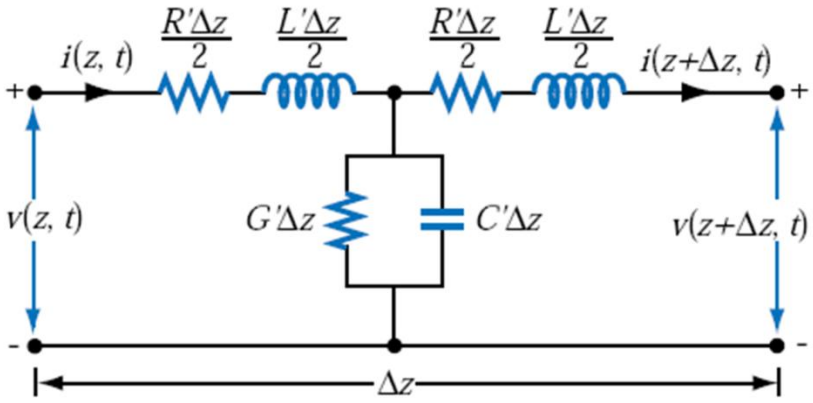


Fig. P3: Transmission line model.

[P4] A lossless transmission line of electrical length $l = 0.35\lambda$ is terminated in a load impedance as shown in Fig. P4. Find Γ_L, SWR, Γ_{in} and Z_{in}.

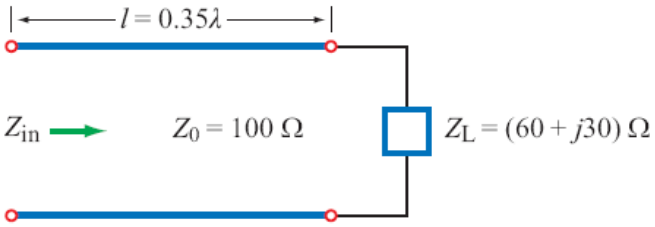


Fig. P4: Circuit for Problem P4.

[P5] Two half-wave dipole antennas, each with an impedance of 75 Ω, are connected in parallel through a pair of transmission lines, and the combination is connected to a feed transmission line, as shown in Fig. P5.

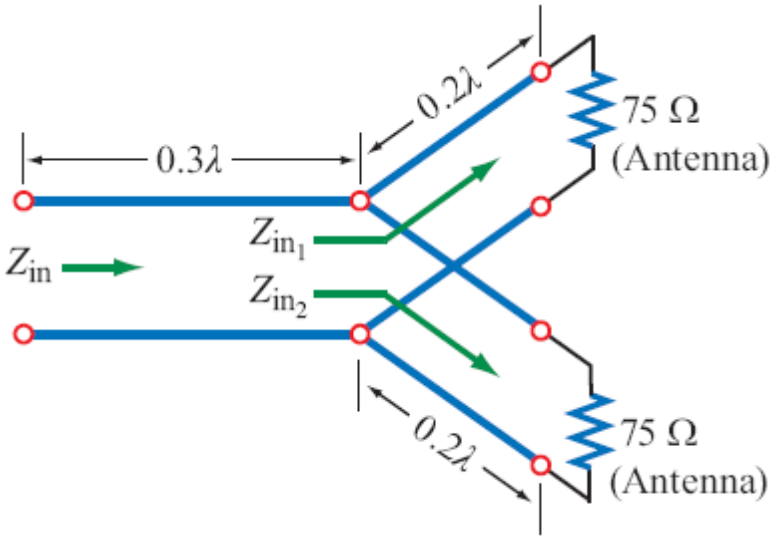


Fig. P5: Circuit for Problem P5.

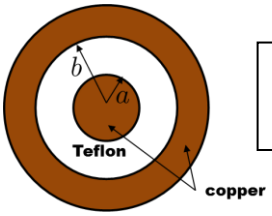
All lines are 50 Ω and lossless.

(a) Calculate Z_{in1}, the input impedance of the antenna-terminated line, at the parallel juncture.

(b) Combine Z_{in1} and Z_{in2} in parallel to obtain Z_L', the effective load impedance of the feedline.

(c) Calculate Z_{in} of the feedline.

[P6] **2.3** - RG-402U semirigid coaxial cable has an inner conductor diameter of 0.91 mm and a dielectric diameter (equal to the inner diameter of the outer conductor) of 3.02 mm. Both conductors are copper, and the dielectric material is Teflon.



Teflon: $\epsilon_0, \epsilon_r = 2.08, \sigma = 0$
Copper: $\epsilon_0, \epsilon_r, \sigma_c = 5.7 \times 10^7$ S/m

Fig. P6: Coaxial cable T-Line.

(a) Compute the $R, L, G,$ and C parameters of this line at 1 GHz, and use these results to find Z_o and attenuation of the line at 1 GHz.

(b) Does it matter how thick the outer conductor is?

[P7] **2.5** - For the parallel plate line shown in Fig. P7, derive the R, L, G, and C parameters. Assume W ≫ d.

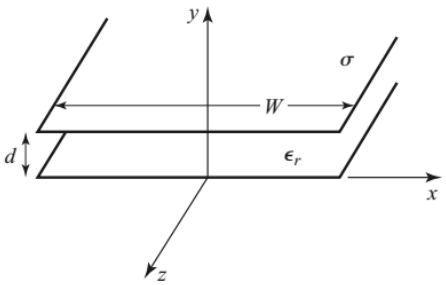


Fig. P7: Parallel plate T-Line.