Homework Assignment 1 Deadline: November 10, 2016

Microwave Techniques

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PROBLEM 1. For a purely reactive load impedance of the form $Z_L = jX_L$, show that the reflection coefficient magnitude $|\Gamma|$ is always unity. Assume that the characteristic impedance Z_0 is real.

PROBLEM 2. RG-402U semi-rigid 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. Compute the R, L, G, and C parameters of this line at 1 GHz, and use these results to find the characteristic impedance and attenuation of the line at 1 GHz. Compare your results to the manufacturer's specifications of 50 Ω and 0.43 dB/m, and discuss reasons for the difference. Compute and plot the attenuation of this coaxial line in dB/m, over a frequency range of 1 MHz to 100 GHz. Use log-log graph scale.

PROBLEM 3. A $75-\Omega$ transmission line operating at 10 MHz is connected to a load composed of a resistor of 150 Ω in series with an inductor of 5 μH. Calculate the load impedance, reflection coefficient, standing wave ratio, return loss. On the other hand, determine the reflection coefficient and the input impedance at a distance of 0.4λ from the load.
Repeat the same problem by using Smith chart.

PROBLEM 4. A coaxial cable operating at 1 GHz has line parameters $R = 5$ Ω/m, $G = 600$ μS/m, $L = 400$ nH/m and $C = 45$ pF/m. Find
a) electrical parameters (characteristic impedance, complex wavenumber, propagation and attenuation constants, phase velocity) of the line.
b) When the line is terminated by a specific load, the voltage throughout the line is given as

$$V(z) = V_0^+ \mathrm{e}^{-\gamma z}.$$

If $V_0^+ = 8$ V, find the voltage and the current at $z = 2.5$ m.

PROBLEM 5. The voltage and the current at $z = -l$ of a line operating at 1 GHz are given as

$$V(-l) = 250\mathrm{e}^{(0.005+\mathrm{j}0.2)l} + 100\mathrm{e}^{-(0.005+\mathrm{j}0.2)l} \ \text{[V]}$$

$$I(-l) = 5\mathrm{e}^{(0.005+\mathrm{j}0.2)l} - 2\mathrm{e}^{-(0.005+\mathrm{j}0.2)l} \ \text{[A]}.$$

Find
a) characteristic impedance of the line,
b) reflection coefficient at the load and the load impedance,
c) propagation and attenuation constants,
d) reflection coefficient and the input impedance at a distance $l = 10$ cm from the load.