Microwave Physics and Techniques

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Exam 1
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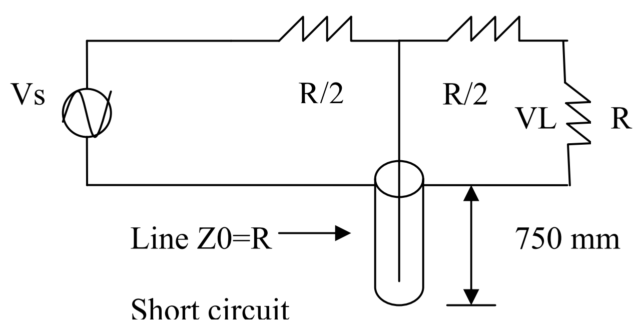
Problem1. (a) Calculate the radiation resistance of a short dipole of length 10 cm, carrying an oscillating current of 100 mA peak at 150 MHz, the current being assumed to be uniform along its length (b) Calculate the total power radiated by the dipole. (c) If the dipole is located at the origin and is directed along the z-axis, calculate the strength of the electric field radiated at a distance of 1km along the z-axis and along the x-axis. (d) Calculate the skin depth in copper (conductivity 5.8x10^7 S/m) at 150MHz, and hence derive the series loss resistance of the above dipole assuming it has the form of a copper rod 2mm in diameter. Compare this value with the radiation resistance.

Problem2.How does the losses of a coaxial line vary with Z_0, if the outer diameter is kept fixed? Is there an optimum Z_0, and if so, what is its approximate value, if the dielectric constant is 2.25?

Problem3. A uniform plane transverse electromagnetic wave at a frequency of 3750 MHz is normally incident from left upon a lossless dielectric slab, of thickness 10 mm and relative dielectric constant 4 which is backed by a perfectly conducting plate in the plane z=0. If the wave is polarized with its electric field parallel to the x-axis, find (a) The transmission line arrangement analogous to the slab and plate assembly. (b) The resultant reflection coefficient at the air-dielectric interface. (c) Expressions for the resultant electric and magnetic field distributions in the free space region to the left of the air-dielectric interface. (d) Expression for the resultant electric and magnetic field distributions in the dielectric. Using the above results determine the percentage of the incident power which is reflected by the structure.

Problem4. A transmission line has the following distributed parameters per unit length: L=0.5 μH/m, R=2.0Ω/m, C=50 pF/m, and G=0 S/m. Calculate the characteristic impedance and the attenuation and phase constants at 31.8 MHz, 318MHz, 3.18 GHz, and 318 GHz.

Problem5. In the circuit shown, the transmission line has air dielectric and the resistors are lumped elements.



(a) Sketch the frequency response of the circuit over the frequency range from 0 to 500 MHz. (b) Sketch the frequency response when the short circuit on the transmission line is replaced by an open circuit.

Problem6. Using the results of a reflection measurement technique, the intrinsic impedance of a material at 200 MHz is found to be approximately given by

$$\eta = 22.5e^{j37^\circ}\,\Omega$$

Assuming that the material is nonmagnetic, determine its conductivity and the relative dielectric constant ε'.