

Homework 1
EE 381 Electric & Magnetic Fields (Fall 2024)
Wednesday, September 4, 2024

- 1) A planar transmission line of width 2 mm is made on Rogers Corporation RO4003C substrate which has a non-magnetic dielectric substrate with a relative permittivity of 3.55, loss tangent of 0.0021 ($\sigma = 10^{-3}$ S/m), thickness of 0.813 mm, and 0.5 oz copper cladding (17 μm thick). When operated at 2.4 GHz, find the per-unit-length parameters R , L , C , and G . Also, calculate the skin depth δ before finding R . [Hint: Consult Appendix B for copper material properties.]
- 2) For the planar transmission line, find the propagation constant γ , attenuation constant α (Np/m & dB/m), phase constant β , wavelength λ , phase velocity u , and characteristic impedance Z_0 .
- 3) 11.13 First, find the parameters R , L , C , and G per **meter**. **Give MKS answers!**
- 4) 11.18 First, find the phase velocity u and attenuation constant α (Np/m & dB/m).
- 5) **Assuming a frequency of 90 MHz**, is the transmission line of problem 11.18 low loss? Why or why not? Regardless, in a table, compare the exact values of α , β , u , and Z_0 from 11.18 to those calculated using the low loss approximations. Table format: Column 1 variable, column 2 exact value, column 3 low loss approximate value, column 4 percent difference.
- 6) 11.23

Due Monday, September 9, 2024.

Hint: Consult Appendix B for material properties.

Hint: Most hydrocarbons and organic compounds are non-magnetic, e.g., plastics.

Note: Express all phasor quantities, i.e., currents and voltages, in the polar/phasor format with angles in degrees (e.g., $10\angle 30^\circ$ V, $12\angle 140^\circ$ mA). Express impedances in rectangular format (e.g., $Z_L = 10 + j30\Omega$).