Homework 1
EE 381 Electric & Magnetic Fields (Fall 2025)
Wednesday, September 3, 2025

1) 11.4 For part a), first calculate the skin depth for the copper strips.
2) For a 16 AWG center conductor, design 75 Ω coaxial transmission lines with (a) paraffin, (b) hard rubber, and (c) paper dielectric insulators. That is, determine the center conductor radius a and shield radius b. Assume $\sigma_{ins} \approx 0$ and perfect electrical conductors, $\sigma_c \to \infty$.
3) A twin-lead transmission line is made of brass wires with diameters of 1.2 mm, separated by 8 mm center-to-center, embedded in a dielectric insulator characterized by $\varepsilon = 1.6\varepsilon_0$, $\mu = \mu_0$, and $\sigma = 5 \times 10^{-6}$ S/m. Determine the skin depth δ and per-unit-length parameters R, L, C, and G at a frequency of 530 MHz.
4) For the twin-lead transmission line, find a) the propagation constant γ, attenuation constant α (Np/m & dB/m), phase constant β, wavelength λ, phase velocity u, and characteristic impedance Z_0. b) Is the twin-lead transmission line low loss? Why or why not? Regardless, in a table, compare the exact values of α, β, u, and Z_0 from already found to those calculated using the low loss approximations. Table format: Col. 1 variable, col. 2 exact value, col. 3 low loss approximate value, and col. 4 percent difference.
5) A lossless twin-lead transmission line ($Z_0 = 250\,\Omega$, $u = 2.75 \times 10^8$ m/s) of length $\ell = 1.65\lambda$ is connected to a signal generator operating at 950 MHz. Determine (a) the inductance per-unit-length L and capacitance-per-unit-length C, (b) phase constant β, wavelength λ, and length ℓ (m) of the transmission line.
6) 11.22 Also, calculate the conductance G per-unit-length and attenuation constant α (Np/m & dB/m).

Due Monday, September 8, 2025.

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 polar/phasor format with angles in degrees (e.g., $10\angle 30°\,\text{V}$, $12\angle 140°\,\text{mA}$). Express impedances & propagation constants in rectangular format (e.g., $Z_L = 10 + j30\,\Omega$).