EE 481/581 Microwave Engineering (Fall 2024)

Homework 6

Wednesday, October 2, 2024

1) 3.5 Hint: See Appendix I
2) A 3.5" × 1.5" aluminum ($\sigma = 3.8 \times 10^7$ S/m) rectangular waveguide is filled with beeswax ($\varepsilon_r = 2.4$, $\tan\delta = 0.004$). In order, find the cutoff frequency of the: a) lowest four TE modes and b) lowest two TM modes. [Hint: neglect loss tangent.]
3) For a 3.5" × 1.5" aluminum ($\sigma = 3.8 \times 10^7$ S/m) rectangular waveguide filled with beeswax ($\varepsilon_r = 2.4$, $\tan\delta = 0.004$) operating at 1.8 GHz in the TE_{10} mode, find: a) k, b) k_c, c) β, d) λ_g, e) v_p, and f) Z_{TE}. [Hint: neglect loss tangent.]
4) 3.19 Assume the land is 1 oz. copper. Draw a fully-labeled sketch of the design.
5) A microstrip TL is made using a gold ($\sigma = 4 \times 10^7$ S/m) land that is 3 mm wide and 20 μm thick on a 1.6 mm thick dielectric substrate ($\varepsilon_r = 2.4$, $\tan\delta = 0.004$) with a 2 oz. copper ground plane for operation at 5 GHz. For this microstrip, find the: a) effective relative permittivity, b) phase velocity, c) phase constant, d) characteristic impedance, and e) overall attenuation constant (Np/m & dB/m).
6) Design a 40 Ω microstrip TL using a 1 oz. copper clad ($\sigma = 5.8 \times 10^7$ S/m) PTFE/woven fiberglass substrate ($\varepsilon_r = 2.33$, $\tan\delta = 0.0011$) that is 3.25 mm thick for use at 8 GHz. Draw a full-labeled sketch of your design. Compute: a) the effective relative permittivity, b) phase velocity, c) phase constant, d) dielectric attenuation constant (Np/m & dB/m), e) conductor attenuation constant (Np/m & dB/m), and f) overall attenuation constant (Np/m & dB/m).
7) **EE 581 only:** For a 3.5" × 1.5" aluminum ($\sigma = 3.8 \times 10^7$ S/m) rectangular waveguide filled with beeswax ($\varepsilon_r = 2.4$, $\tan\delta = 0.004$), find the dielectric, conductor, and overall attenuation constants (Np/m and dB/m) for the TE_{10} mode at 1.8 GHz.
8) **EE 581 only:** For a microstrip TL made using a gold ($\sigma = 4 \times 10^7$ S/m) land that is 3 mm wide and 20 μm thick on a 1.6 mm thick dielectric substrate ($\varepsilon_r = 2.4$, $\tan\delta = 0.004$) with a 2 oz. copper ground plane, calculate the threshold frequencies. Is an operating frequency of 5 GHz lower than these threshold frequencies?

Due Friday, October 11, 2024.