ECE 3065

MIDTERM 2/2006

Problems

1. A rectangular waveguide used for WiMax applications has a cross-section $1.1in \times 0.5in$ and is filled with a silicon-based nonmagnetic lossless material with μ_r=1 and ϵ_r=12.

(a) Calculate the cutoff wavelength λ_{oc} and the cutoff frequency f_{co} for the dominant, the first two higher-order TE modes and the first two higher-order TM modes. (10%)

(b) Determine the transverse-wave impedance for the dominant, the first higher-order TE and the first higher-order TM modes at $f = 3.5GHz$. How close are they to the TEM value? What will be the value of the transverse-wave impedance of the dominant mode at a dual-band short-range broadband module operating at $f = 50GHz$ (DO NOT CALCULATE IT!!) and why? (10%)

(c) There have been three proposed frequencies for WiMax operations: 1.7 GHz, 2.5 GHz and 3.5 GHz. Which one(s) would operate with the best power efficiency for this waveguide and why? (10%)

(d) After removing the side walls (short side), recalculate the cutoff frequency for the dominant and the first two-higher modes, after identifying them. (10%)

2. A perpendicularly polarized monochromatic laser wave in air is obliquely incident upon a planar LTCC-Air interface at an incidence angle of 60°, as it is used for defect detection of 3D (multilayer) integrated ceramic 3G-telecom modules. The wave frequency is 5 THz (1 THz = 10^{12} Hz), and the dielectric constant of LTCC is 5.6 (assume that LTCC is a nonmagnetic lossless ceramic material). If the electric field amplitude of the incident wave is 20 mV/m, determine:

(a) the reflection and transmission coefficients, (15%) and

(b) how many db's it's lower than the incident field (5%)

(c) the MAGNETIC field amplitude of the transmitted wave (15%).

(d) the angle of minimum power reflection. Would this angle have a different value if the incident wave were parallel-polarized? (10%)

3. (a) Find the ABCD and Z matrices of an RFID whose electronics consist of a shunt open-circuit stub of length 8.85 cm built on a nonmagnetic lossless flexible organic (LCP) material with $\epsilon_r = 3.0$ and $Z_o = 125$- and a series inductor L=62.5nH, used as a resonant structure at 0.9 GHz. (10%)

(b) Is this a reciprocal and/or lossless structure and why? (10%)

(c) Give the τ- and the π- equivalent circuit. (10%)

(d) What is the exact resonant frequency of this geometry? Does it need to be modified for an effective RFID operation? (5%)

GOOD LUCK!!!