Assignment 3

Microwave theory 2015

The solutions should be handed in no later than May 27. If you run into major problems you may ask Anders for help.

1

Determine the ratio between radius a and length d for a circular cylinder such that the lowest resonance frequency for the TE and TM modes are the same. All walls are perfectly conducting and there is vacuum inside the cavity.

2

a) What is the lowest resonance frequency of a cube with side 1 dm?
b) The lowest resonance in the cube is degenerated which means that there are more than one mode that have the same resonance frequency. How many modes are there for this resonance?

3

Consider the TM_{010}-mode in a cylindric cavity with radius a and length L .

a) At what radius r_c is the magnetic field maximal.
b) Where is the surface current density maximal?
c) Where is the surface charge density maximal?

4

A resonance cavity is a cylinder with elliptic cross section. The ellipse has major half-axis $a = 3$ cm and minor half-axis $b = 2$ cm. The length of the cylinder is 3 cm. Determine the three lowest resonance frequencies of the cavity. All walls are perfectly conducting and there is vacuum inside the cavity.

Help: One can solve this problem in COMSOL using either a 2D or a 3D calculation.

5

A dielectric resonator has radius $a = 3$ cm and height $h = 3$ cm. The resonator consists of a dielectric material with relative permittivity $\varepsilon = 30$. There is air ($\varepsilon = 1$) outside the cylinder. Determine the three lowest resonance frequencies for axial-symmetric resonances.

Help: Use 2D-axial symmetry in COMSOL. You find a similar example in the book.

6

An optical fiber has a core with index of refraction $n = 1.504$ and a cladding with index of refraction $n = 1.5$. The radius of the core is $5\,\mu$m and the radius of the cladding can be considered to be infinite. Use COMSOL to determine the effective mode index and the phase velocity for the fundamental mode HE_{11} in the optical fiber. The wavelength of the light is 1.55 μm in vacuum. Hand in a plot of the power flow density in the cross section.