Problem Set 5
Optical Waveguides and Fibers (OWF)

will be discussed in the tutorial on December 8, 2015

Exercise 1: Qualitative plots of the electromagnetic field components of the $m = 0$ TM mode of a symmetric slab waveguide.

As in Problem Set 4, consider the slab waveguide depicted in Fig. 1, and assume that the slab is made of silicon and the substrate and the cladding are made of silica, i.e., $n_2 = n_3 = 1.44$ and $n_1 = 3.48$.

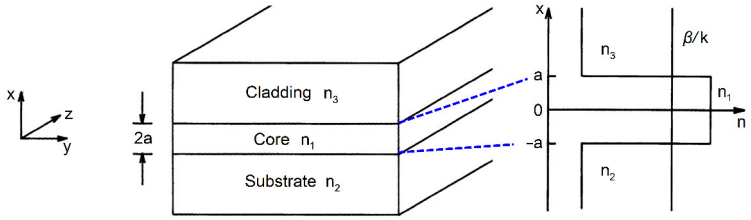

Figure 1: Slab waveguide and coordinate system.

For the TM modes, the mode field $\underline{\mathcal{H}}_y(x)$ is given by

$$\underline{\mathcal{H}}_y(x) = \begin{cases} A\cos(k_{1x}a)\exp\left(-k_{3x}^{(i)}(x-a)\right) & \text{for } a < x \\ A\cos(k_{1x}x) & \text{for } -a \le x \le a \\ A\cos(k_{1x}a)\exp\left(k_{2x}^{(i)}(x+a)\right) & \text{for } x < -a \end{cases} \tag{1}$$

a) Sketch in a *qualitative* way the non-vanishing field components of the fundamental ($m = 0$) TM mode as a function of x.

b) Explain the behavior of the $\underline{\mathcal{E}}_x(x)$ component at the boundaries by using the continuity of the normal component of the displacement vector $\underline{\mathbf{D}} = \epsilon_0\epsilon_r\underline{\mathbf{E}}$.

c) How does the $\underline{\mathcal{E}}_x(x)$ profile of the fundamental TM mode change if you open a narrow silica slot in the center of the slab (see Fig. 2)? Note that narrow slot means $|b| \ll |a|$. A qualitative sketch is sufficient; no quantitative analysis is needed.

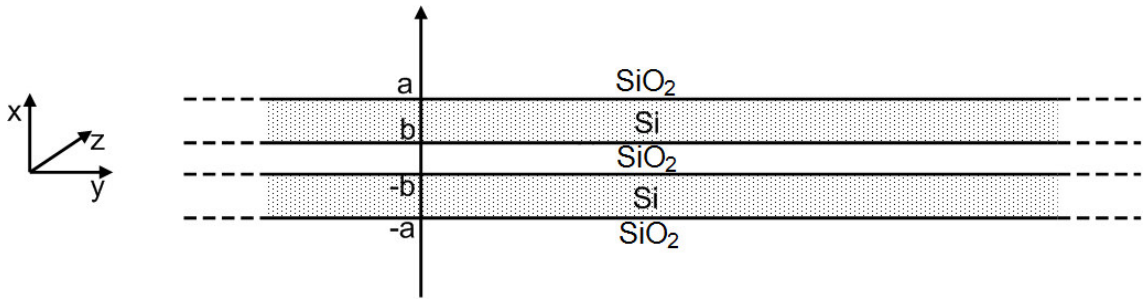

Figure 2: Slot waveguide made of silicon and silica.

Questions and Comments:

Aleksandar Nesic
Building: 30.10, Room: 2.32-2
Phone: 0721/608-42480
aleksandar.nesic@kit.edu

Philipp Trocha
Building: 30.10, Room: 2.32-2
Phone: 0721/608-42480
philipp.trocha@kit.edu