Problem Set 7
Optical Waveguides and Fibers (OWF)

will be discussed in the tutorial on December 22, 2015

Exercise 1: Effective-index method applied to a rib waveguide.

Consider the rib waveguide shown in Fig. 1. The effective indices of the guided modes of this waveguide can be calculated by approximating the structure with related slab waveguide. In a first step, we need to calculate the effective indices of two horizontal slab waveguides of different thicknesses, corresponding to the slab heights in the regions 1 and 2, as indicated in the figure. We will then use these indices to define a new vertical slab waveguide. The solution of that waveguide will give the effective index of the rib waveguide mode.

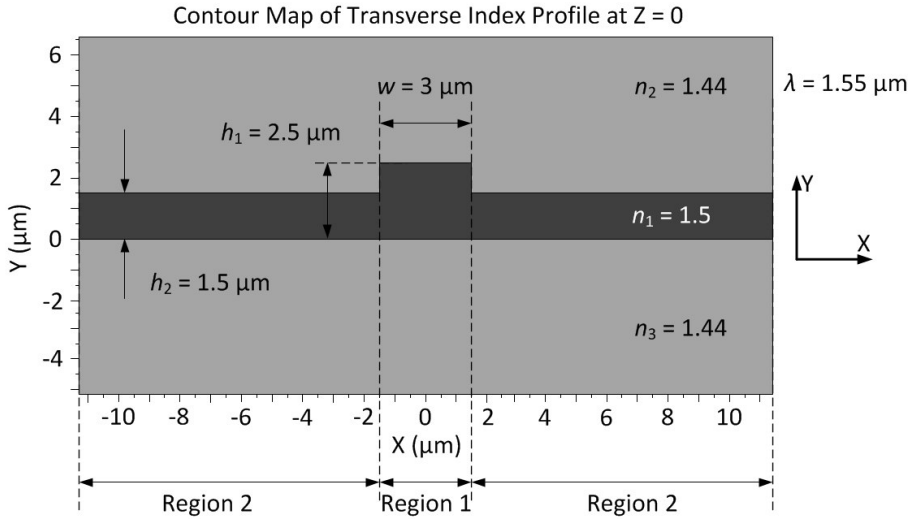

Figure 1: Rib waveguide with the definition of the dimensions and the refractive indices.

a) Assume a wavelength of $1.55\,\mu$m, and consider the $\mathcal{E}_y$-modes only. Choose the appropriate polarization and calculate the effective indices n_{es1} and n_{es2} in the two horizontal slab waveguides corresponding to the regions 1 and 2 in Fig. 1. You can either use the matlab code you already prepared in the Problem Set 4, or the online solver available on the following website:

http://www.computational-photonics.eu/oms.html.

b) Choose again the appropriate polarization, and calculate the effective index of the fundamental mode in the vertical slab waveguide defined by n_{es1} and n_{es2}. How many guided $\mathcal{E}_y$-modes are there?

c) Consider now a channel waveguide (rectangular cross section) made of silicon ($n_1 = 3.48$) and surrounded by silica ($n_2 = 1.44$). The width and the height of the waveguide are $w = 0.4\,\mu$m and $h = 0.2\,\mu$m, respectively. Calculate the fundamental $\mathcal{E}_y$-mode by using the same method as before.

d) Exchange the height with the width ($w = 0.2\,\mu$m and $h = 0.4\,\mu$m) i.e., rotate the waveguide by 90°, and calculate the fundamental $\mathcal{E}_x$-mode. Compare this result with the result that you got at c) and explain the differences.

Questions and Comments:

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