

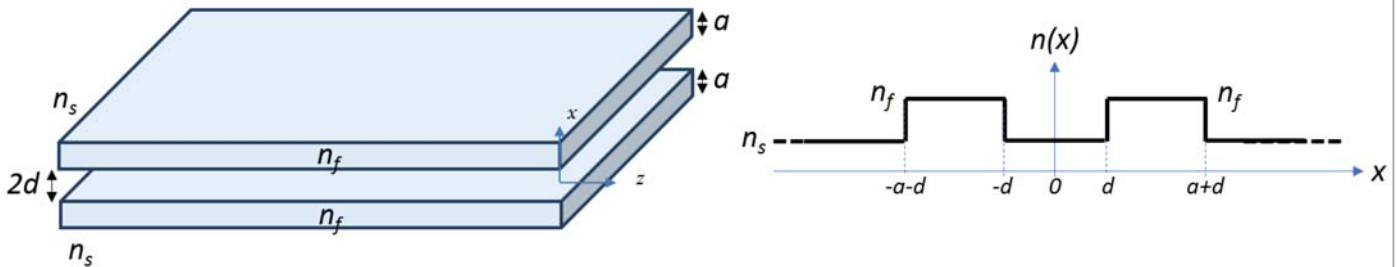
Task EO1 / Home Assignment

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Consider a composite planar waveguide consisting in two parallel slabs of a lossless dielectric material of refractive index n_f . The two slabs have the same thickness (a) and are separated by a distance $2d$ along x . They are surrounded by a medium of refractive index $n_s < n_f$, as illustrated by the picture here below.



- Starting from Maxwell's equations, outline the procedure providing the modal effective index and the electric field distribution of the TM_0 mode of the structure at a given wavelength λ . *Hint* - To solve the eigenvalue equation, assume a modal eigenfunction of the following form:

$$\psi(x) = \cosh(\gamma x) \quad \text{for } |x| \leq d$$

$$\psi(x) = \cosh(\gamma d) \cos[\kappa(|x| - d)] + \frac{n_f^2 \gamma}{n_s^2 \kappa} \sinh(\gamma d) \sin[\kappa(|x| - d)] \quad \text{for } d < |x| < d + a$$

$$\psi(x) = \left\{ \cosh(\gamma d) \cos(\kappa a) + \frac{n_f^2 \gamma}{n_s^2 \kappa} \sinh(\gamma d) \sin(\kappa a) \right\} e^{-\gamma(|x| - a - d)} \quad \text{for } |x| \geq d + a$$
- Express the parameters κ and γ as a function of a , d , n_s , n_f and the modal effective index N_{eff} , check that the equations above satisfy the appropriate boundary conditions and provide the characteristic (eigenvalue) equation yielding N_{eff} as a function of the field wavelength λ and of the waveguide parameters.
- Calculate the effective index and sketch (or plot) the spatial profiles of the vectorial components of the electromagnetic field for the guided TM_0 mode, assuming $a = 450$ nm, $d = 50$ nm, $n_f = 2.24$, $n_s = 1.33$ and $\lambda = 980$ nm. Comment on the results and in particular on the field evolution in the section comprised between the two slabs.
- Which ansatz would you use to analyze the TE_0 mode in the same structure? What would you expect to be the main difference with respect to the results you obtained for the TM_0 mode?

Points 1

Submitting a file upload

Due	For	Available from	Until
11 Feb	Everyone	25 Jan at 0:00	18 Mar at 23:59

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