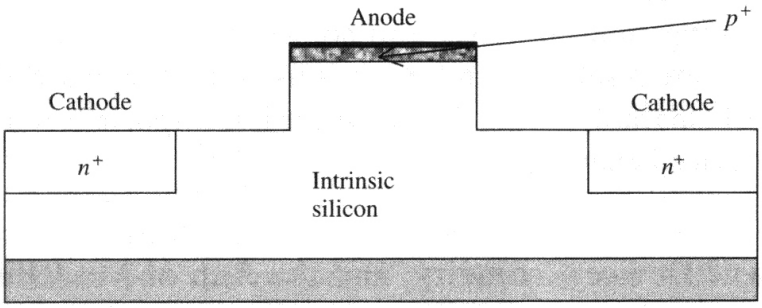
Silicon Photonics Homework #6

HW 6-1. Consider a silicon optical phase modulator/VOA shown in the following figure. Assume that when the current is injected through the anode and cathode, the carrier concentration $\triangle N$ ($=\triangle N_e = \triangle N_h$) is uniformly distributed in the intrinsic rib region. Assume the effective index of the waveguide mode is approximately the same as the refractive index in the rib region. Device length L = 2 mm. Operating wavelength λ_0 = 1.55 μm. Please calculate

(a) The required $\triangle N$ for π-phase shift. (i.e.,$|\triangle nL| = \lambda_0/2$)

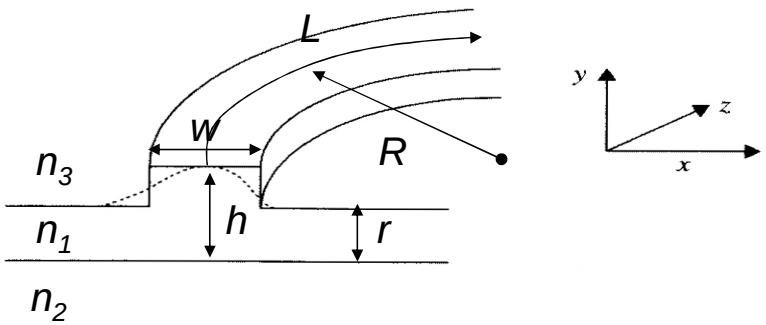
(b) The required $\triangle N$ for 30 dB attenuation. (i.e., $e^{-\triangle \alpha L} = 0.001$)



HW 6-2. Consider a rib waveguide shown in the following figure with n_1= 3.5, n_2=1.5, n_3=1.0, w = 2.5 μm, h = 3 μm, r = 1.7 μm, R = 1mm and λ_0 = 1.55 μm. Please calculate (by using the effective index method where $\beta = 2\pi N_{wg}/\lambda_0$, $k_{xg} = (n_{effg}^2 - N_{wg}^2)^{0.5} \cdot 2\pi/\lambda_0$, and $k_{xs} = (N_{wg}^2 - n_{effp}^2)^{0.5} \cdot 2\pi/\lambda_0$),

(a) the bending loss coefficient α_{bend}

(b) the total bending loss for a 90° bend (i.e., the total bending loss = $e^{-\alpha L}$ when the length of the arc $L = \pi R/2$)



HW 6-3. If two identical rib waveguides as described in HW-6.2 are placed closely parallel to each other with a separation s = 1 μm, please calculate (by using the effective index method as in HW 6-2, where $k_{xc} = k_{xg}$)

(a) the coupling coefficient κ

(b) the coupling length L_π