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c.1

6.1:

a)

$$\Delta\beta = \frac{k_0^2}{2\beta}\frac{\int \Delta\epsilon\,|U|^2\,dA}{\int |U|^2\,dA} \tag{6.9}$$

$k_0 = 2\pi/\lambda_0$

$\beta = 2\pi\overline{n}/\lambda_0$

$\Delta\epsilon = 2n\Delta n$ where n is the index of the guiding region.

$$\Delta\beta = \left(\frac{2\pi}{\lambda_0}\right)\frac{n\Delta n}{\overline{n}}\frac{\int\int_0^{150\text{ nm}} |U|^2\,dA}{\int\int_{-\infty}^{\infty} |U|^2\,dA}$$

Assuming that the mode doesn't change significantly due to the index perturbation, the fraction containing the integrals is the confinement factor of the original mode ($\Gamma = 0.5$ given by problem) multiplied by the overlap of the part of the guide that changed ($\frac{150\text{ nm}}{300\text{ nm}}$).

$$\Delta\beta = \frac{2\pi}{\lambda_0}\frac{n}{\overline{n}}\Delta n\Gamma_{xy} = \frac{2\pi}{1.55\mu\text{m}}(0.02)\frac{1}{4} = 203\text{ cm}^{-1} \tag{6.12, 6.10}$$

(Note that this assumes that $n \approx \overline{n}$ in the waveguide region.)