Coupling Into Waveguides (Single Mode Fiber)

End-Fire Coupling

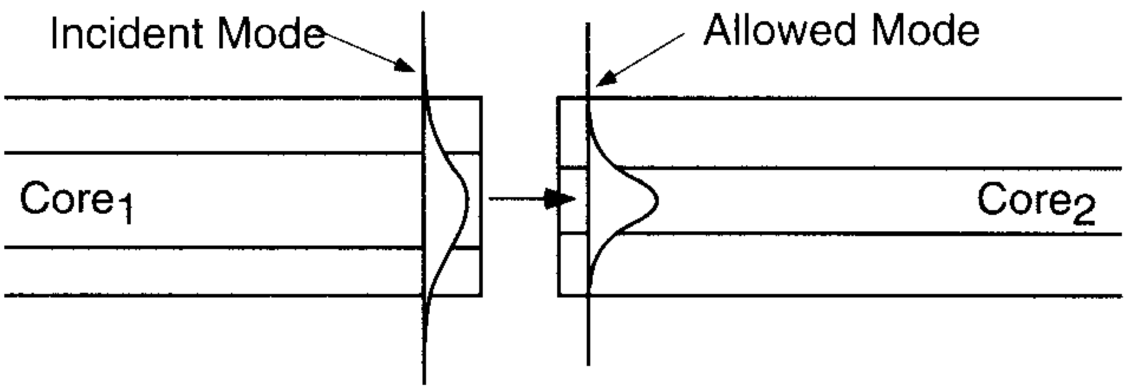

Figure 11.1 An incident mode usually has a different spatial profile than the field in the input waveguide. The overlap of the two modes determines the degree of coupling between the input and guided mode.

Figure 11.1 is from "Fundamentals of Optoelectronics" by Pollock

The continuity of tangential E and H can be used to find reflection and transmission coefficients for the incident mode (see Pollock for the "derivation").

Let n_{eff}^{1} be the effective index for the incident mode and n_{eff}^{2} be the effective index for the transmitted mode.

The reflection coefficients are:

$$r = \frac{n_{eff}^{1} - n_{eff}^{2}}{n_{eff}^{1} + n_{eff}^{2}} \text{ and } R = \left| \frac{n_{eff}^{1} - n_{eff}^{2}}{n_{eff}^{1} + n_{eff}^{2}} \right|^{2}$$

The transmittance is:

$$t = \frac{2\sqrt{n_{eff}^1 n_{eff}^2}}{n_{eff}^1 + n_{eff}^2} \frac{\sqrt{n_{eff}^1 n_{eff}^2}}{2} \sqrt{\frac{\varepsilon_0}{\mu_0}} \int_{-\infty}^{\infty} E_y^1 E_y^{2*} dx$$

for TE modes,

and we infer more generally

$$T = \frac{4 n_{eff}^1 n_{eff}^2}{\left(n_{eff}^1 + n_{eff}^2\right)^2} \frac{\left[\int E_t^1 E_t^{2*} dA\right]^2}{\left[\int \left|E_t^1\right|^2 dA\right]\left[\int \left|E_t^2\right|^2 dA\right]}$$

where E_t^1 and E_t^2 are the transverse electric fields for the incident and transmitted fields respectively.