Unit-2

Lecture -3

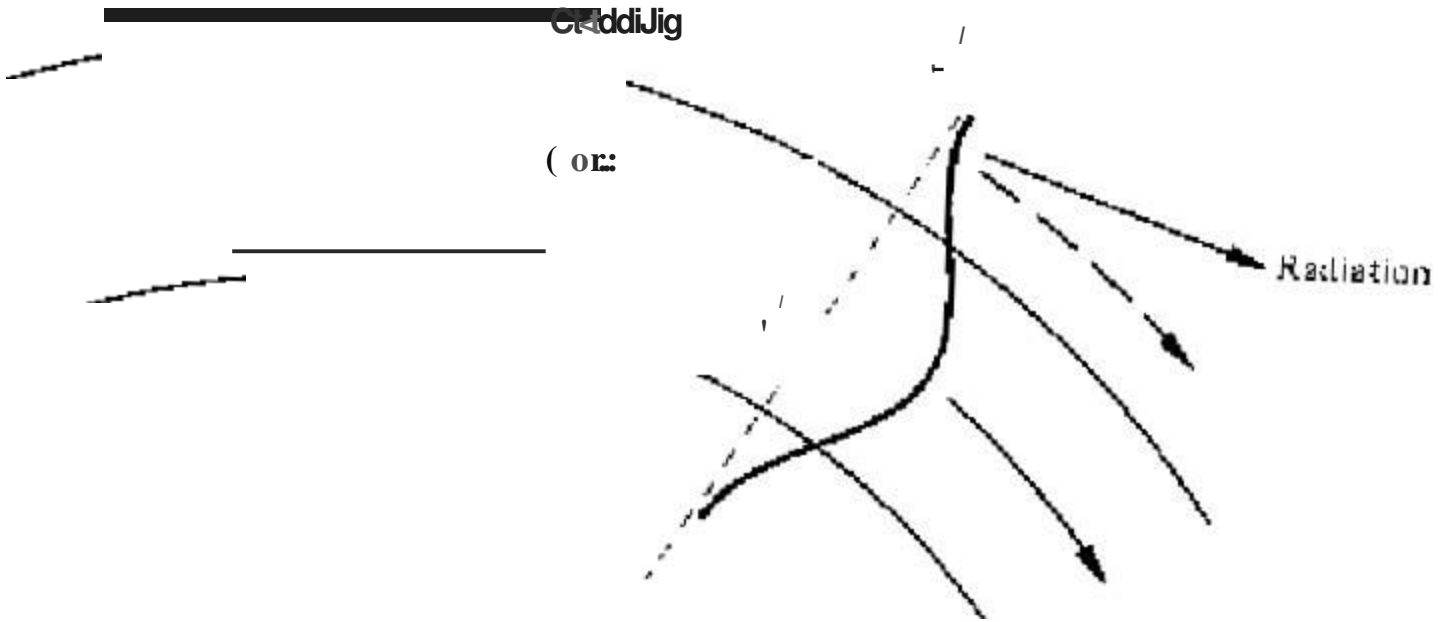
Bending Losses, Micro bending & Macro bending

Bending Loss

Optical fibers suffer radiation losses at bends or curves on their paths.

The bending losses are due to the energy in the existing field at bend exceeds the velocity of light in the cladding.

The part of mode in the cladding needs to move faster than the velocity of light in that medium in order to keep the mode field in the fiber core


Radiation

But this is not possible, so the energy associated with this part will be radiated out of the cladding.

The bending loss can be represented by radiation attenuation coefficient.

$$\alpha_r = c_1 e^{-(c_2 R)}$$

Where R is the radius of curvature of the fiber bend & c1 &c2 are the constant.

Rc is the critical curvature radius at which large bending loss occurs.

$$Rc \simeq \frac{3n_1^2 \lambda}{4\pi (n_1^2 - n_2^2)^{3/2}}$$

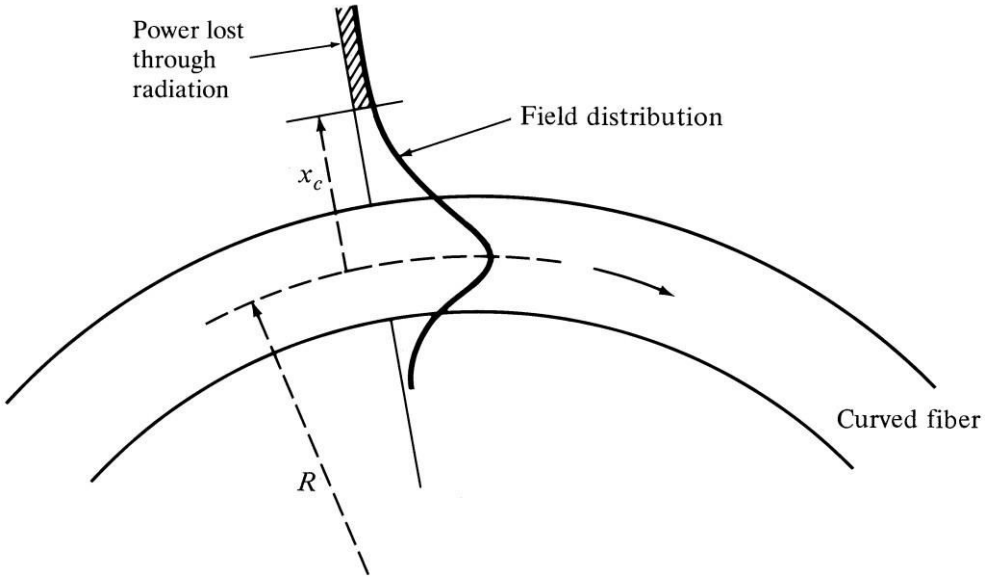
From the expression we can observe that the bending loss may be reduced by:

I.Designing fiber with large relative refractive index differences.

II. Operating at shortest possible wavelength.

Bending Loss (Macrobending & Microbending)

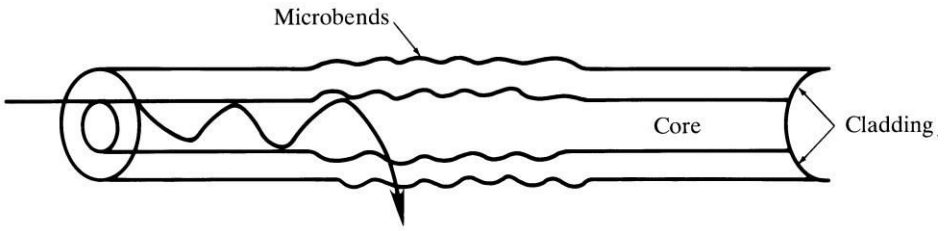
- **Macrobending Loss**: The curvature of the bend is much larger than fiber diameter. Lightwave suffers sever loss due to radiation of the evanescent field in the cladding region. As the radius of the curvature decreases, the loss increases exponentially until it reaches at a certain critical radius. For any radius a bit smaller than this point, the losses suddenly becomes extremely large. Higher order modes radiate away faster than lower order modes.



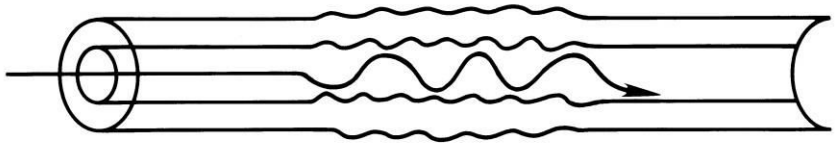
Optical Fiber communications, 3rd ed.,G.Keiser,McGrawHill, 2000

Microbending Loss

- **Microbending Loss:** microscopic bends of the fiber axis that can arise when the fibers are incorporated into cables. The power is dissipated through the microbended fiber, because of the repetitive coupling of energy between guided modes & the leaky or radiation modes in the fiber.



Power loss from higher-order modes



Power coupling to higher-order modes

Optical Fiber communications, 3rd ed.,G.Keiser,McGrawHill, 2000