UNIT-2

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1 Attenuation

$$\alpha_{dB} L = 10 \log_{10} \frac{P_i}{P_o} \quad L: \text{ length of fiber} \tag{1}$$

2 Linear Scattering Loss

2.1 Rayleigh scattering

$$\gamma_R = \frac{8\pi^3}{3\lambda^4} n^8 p^2 \beta_c K T_F \tag{2}$$

where γ_R is Rayleigh scattering coefficient, λ is optical wavelength, n is refractive index of medium, p is average photoelastic coefficient, β_c is isothermal compressibility at a fictive temperature T_F and K is Boltzmann constant

3 Nonlinear Scattering Loss

3.1 Stimulated Brillouin Scattering

$$P_B = 4.4 \times 10^{-3} d^2 \lambda^2 \alpha_{dB} v \text{ watts} \tag{3}$$

where d and λ are fiber core diameter and operating wavelength, measured in micrometers. v is source bandwidth.

3.2 Stimulated Raman Scattering

$$P_R = 5.9 \times 10^{-2} d^2 \lambda^2 \alpha_{dB} \tag{4}$$

4 Fiber bend Loss

$$R_c \simeq \frac{3 n_1^2 \lambda}{4\pi (n_1^2 - n_2^2)^{1/2}} \tag{5}$$

critical radius of curvature for single mode fiber

$$R_{cs} \simeq \frac{20\lambda}{(n_1 - n_2)^1/2} \left(2.748 - 0.996 \frac{\lambda}{\lambda_c}\right)^{-3} \tag{6}$$

5 Dispersion

$$\beta = kn_1[1 - 2\Delta(1-b)]^{1/2} \tag{7}$$

$$B_T \leq \frac{1}{2\tau} \quad \tau = \text{pulse duration due to dispersion} \tag{8}$$

5.1 Chromatic dispersion : Material Dispersion

$$\begin{aligned}
\text{rms pulse broadening : } \sigma_m &= \frac{\sigma_\lambda L}{c}\left|\lambda \frac{d^2 n_1}{d\lambda^2}\right| \\
\text{material dispersion parameter : } M &= \frac{\lambda}{c}\left|\frac{d^2 n_1}{d\lambda^2}\right| \\
\sigma_m &= \sigma_\lambda L M
\end{aligned} \tag{9}$$

5.2 Intermodal Dispersion

$$\begin{aligned}
\text{delay difference : } \delta T_s &= \frac{L n_1 \Delta}{c} = \frac{L(NA)^2}{2n_1 c} \\
\sigma_s &= \frac{L n_1 \Delta}{2\sqrt{3}c} = \frac{L(NA)^2}{4\sqrt{3}n_1 c}
\end{aligned} \tag{10}$$

5.3 Overall fiber dispersion

$$D_T(\lambda) = \frac{\lambda S_0}{4}\left[1 - \left(\frac{\lambda_0}{\lambda}\right)^2\right] \tag{11}$$