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$$EOP = \frac{b}{a} \times 100$$

Eye opening Panelty

5/11/19

Parameter Related to ~~Spectrum~~ Fibres :-

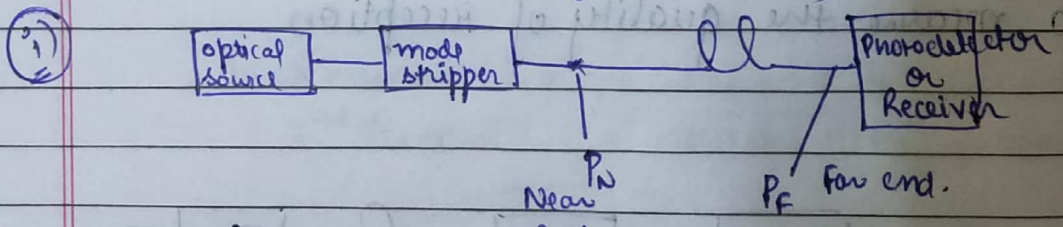
i) Attenuation
ii) Dispersion
iii) OTDR

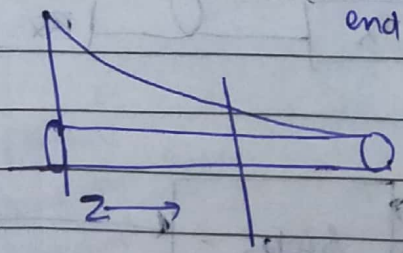
} linear effects

Loss is due to ~~absop~~ absorption, Rayleigh.

Attenuation
- Cut back method
- Insertion loss.
- OTDR.

~~optical source~~




$$P(z) = P(0)\, e^{-\alpha_p z}$$

$\alpha_p$ → attenuation constant (Nepers/km)

$$\alpha_p = \frac{1}{z} \ln\left[\frac{P(0)}{P(z)}\right]$$

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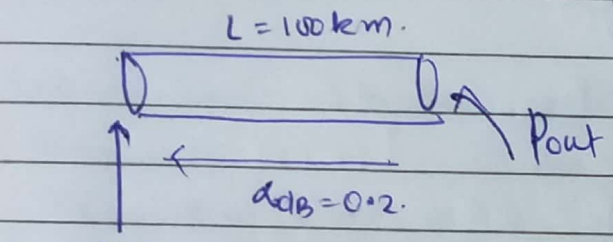
$$P(z) = P_0 10^{-\frac{\alpha_{dB} z}{10}}$$

$$\alpha_{dB} = \frac{1}{z} 10 \log_{10} \frac{P_{out}}{10}.$$

$$\alpha_{dB} = 4.343 \alpha_{nepers}.$$

$$P_{dBm} = 10 \log_{10} \frac{P(watt)}{10^{-3}}$$




$P_0 =$ 10dBm

$L = \alpha_{dB/km} \times 100$

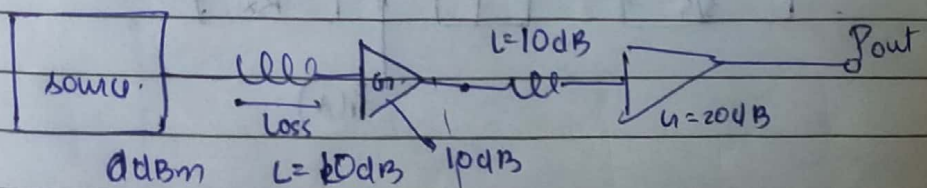
loss $= 0.2 \times 100$

$= 20$ dB.

$P_{out,dBm} = P_{0,dBm} - L_{dB}$.

$= 10 - 20$

$= -10$ dBm.




Here we will have 0dBm

$P_{in}(dBm) - 10 + 20 = P_{out}$

$0 - 10 + 20 = 10$ dBm

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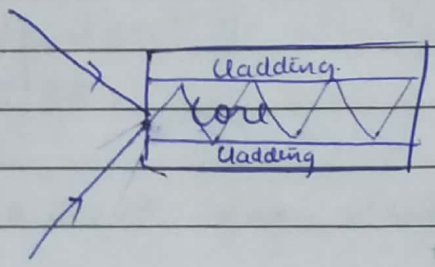
To find the $\alpha$ in the fig 1)

$$\alpha = \frac{1}{L} 10 \log_{10} \frac{P_N}{P_F}$$

Cut back

Measure $P_F$ and then cut at $P_N$ ~~and~~ ~~making~~ making sure that your fibre should not be in stretching condition



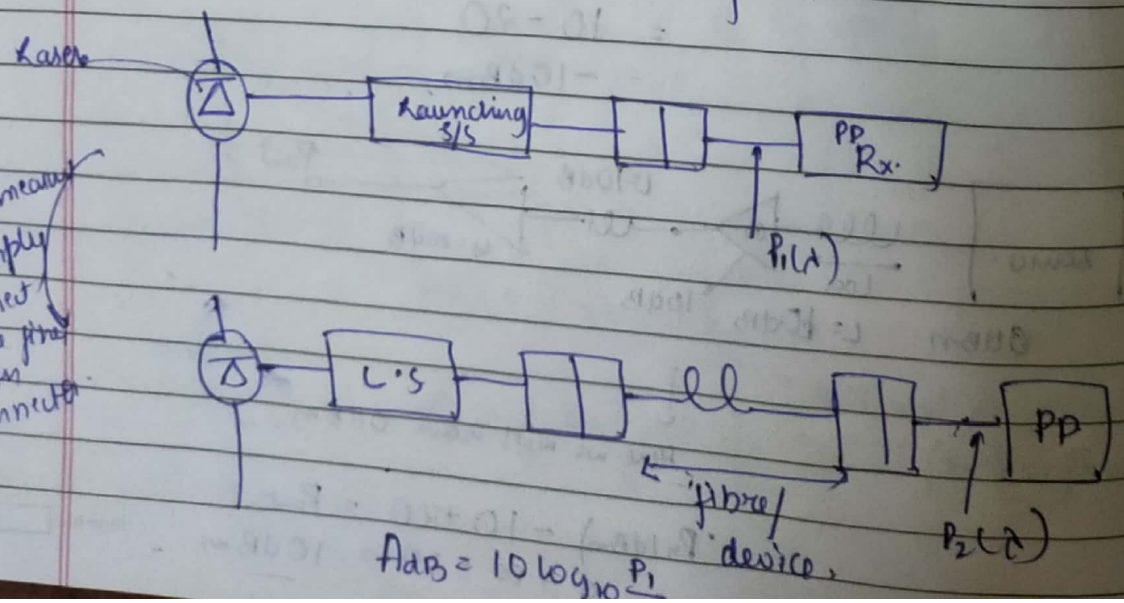

$\frac{1}{2}$ sin

Maximum acceptance angle → Numerical Aperture.

If angle is more than acceptance angle than the ray will enter the core goes to cladding and it is lost ∴ We have cladding loss.

Insertion loss

No need to cut the fibre.




$A_{dB} = 10 \log_{10} \frac{P_1}{}$

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Saathi

Attenuation is not constant for a fibre, it also depends on frequency and wavelength. : Called as spectral Attenuation.

850nm 4.5dB

1300nm 3.4dB.

1500nm 0.25dB → least attenuation.

↓ has least dispersion.

## Dispersion Measurement

Inter model dispersion → (Take place when Multi Mode Fibre is they)

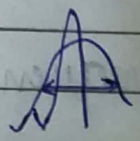
Material / Chromatic " Single Mode Fibre

Polarisation mode "

→ $\eta(\lambda)$

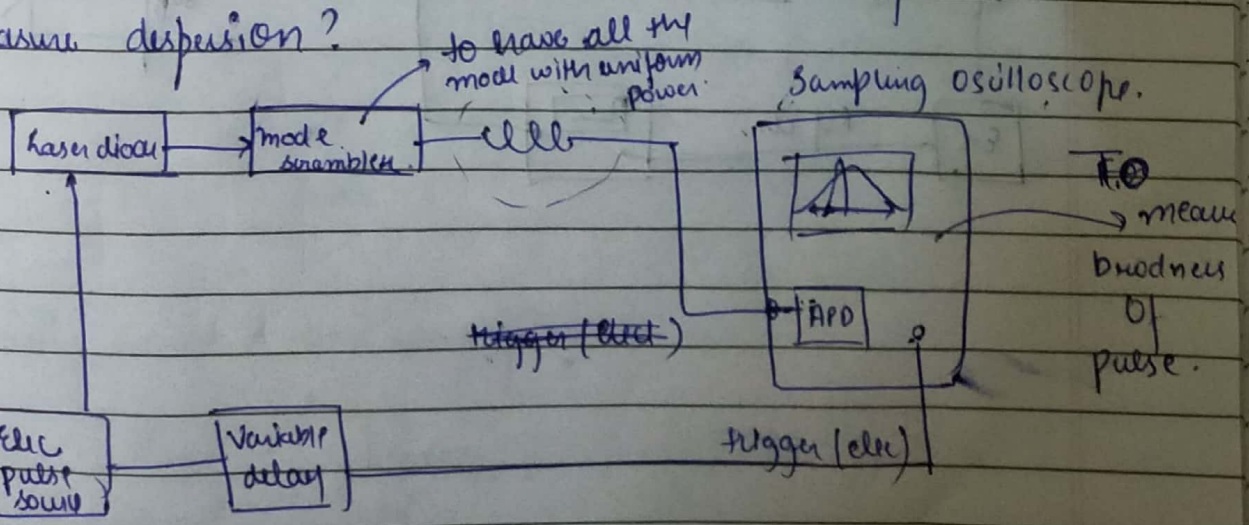
Refractive index.

Chromatic dispersion creates broadening of pulse.



→ leads to inter symbol interference.

How To measure dispersion?

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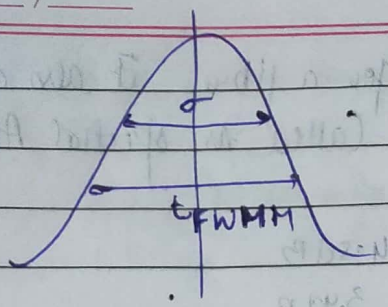



$$g(t) = \frac{1}{\sqrt{2\pi}\cdot\sigma} e^{-t^2/2\sigma^2}$$

$$g(t_{1/2}) = 0.5\, g(0)$$

$$t_{FWHM} = 2t_{1/2} = 2\sigma(2\ln 2)^{1/2}$$

Full width half Maximum

$$G(\omega) = \frac{1}{\sqrt{2\pi}} e^{-\omega^2\sigma^2/2}.$$

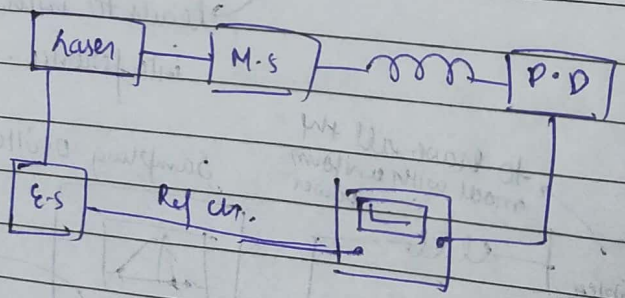
$$f_{3dB} = B_{3dB} = \frac{0.44}{t_{FWHM}}$$

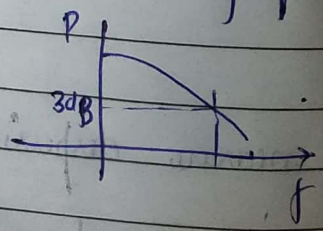
Power budget — $P_s$ - loss = $P_H$ → Reflected Power.

Rise Time budget : Rise time of the entire S/S -

$$t_{sys} = \sqrt{t_{Rx}^2 + t_{tx}^2 + t_{modl}^2}$$

For frequency domain use spectrum analyze given Power Vs freq.




OTD

gt. can als
tell when th
fibre has b

# OTDR

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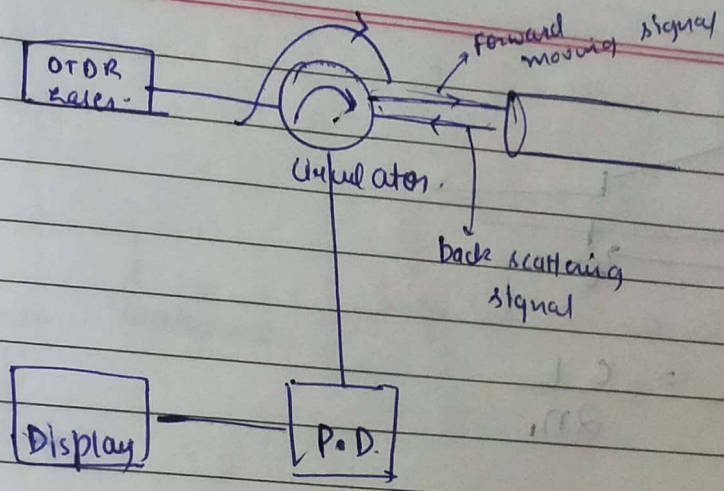
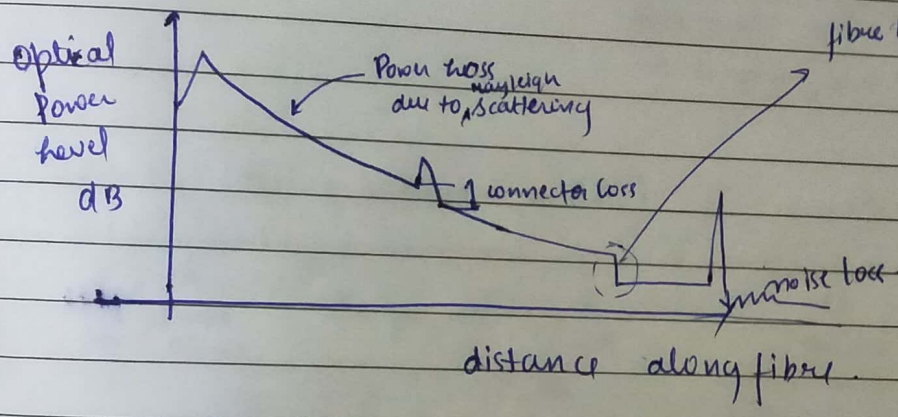



It can also tell where the fibre has ~~break~~.




## Fresnel loss


because of mismatch of refractive index we have certain loss.

$$P_R = P_0 \left( \frac{n_{fibre} - n_{air}}{n_{fibre} + n_{air}} \right)^2$$

$P_R$ → reflected Power

$P_0$ → incident Power.

Dynamic range = one way fibre loss.

$$R_{max} = \frac{D_{OTDR}}{\alpha}$$

$R_{max}$ → max measurement Range

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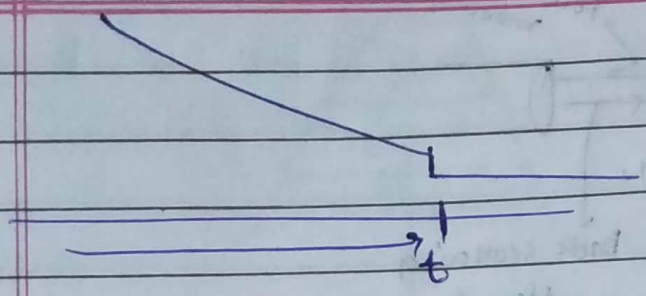


$$L = \frac{ct}{2n_1}$$

1 usec