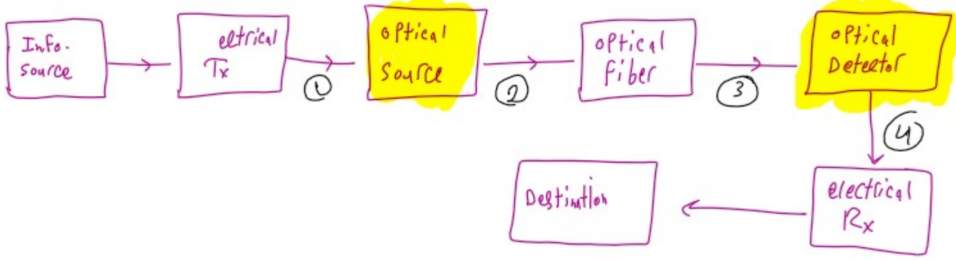
Optical Lec1

Sunday, April 10, 2022 8:39 PM



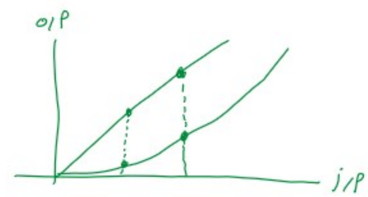
①. Information is converted into electrical signal.

②. then its changed to optical Pulses through:-
- Light emitting diode
- Laser

③. optical Pulses is transmitted through optical Fiber

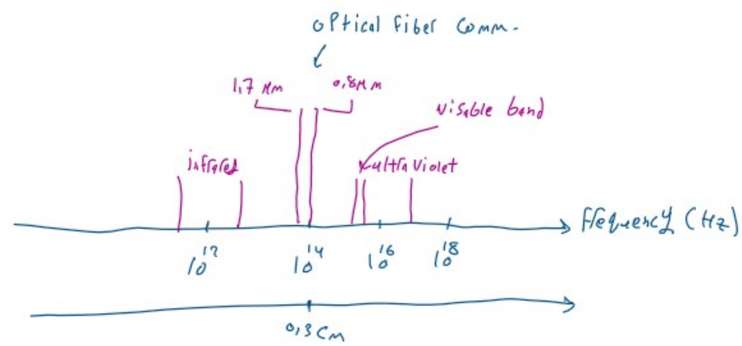
④ then optical detector changes optical Pulses into electrical Pulses through:
- Photodiode

→ the Modulation could be
- Analog: non-Linear ch.
- Digital: Linear ch.



→ Light emitting diode has non-Linear ch. → it cause distortion in Amplitude → that's why digital is Prefered

* Spectrum used in fiber optics system



* We want to implement a device that emits light with certain Freq.

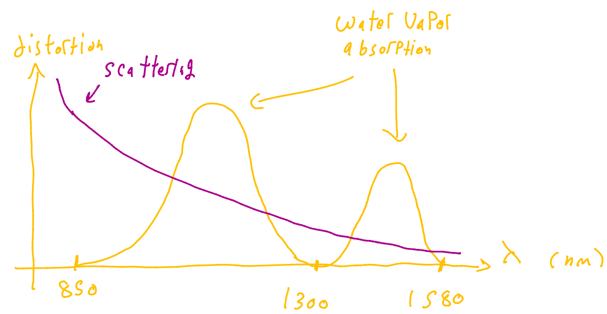
→ we control Freq from the matrial we use → combined matrial

→ when the electrons of this matrial is excited it Jumps to a higher level, after that it falls back to it's original level while emitting light.

→ why optical fiber communication works in between 0.8 μm → 1.7 μm wavelength?

→ why optical fiber communication works in between

↳ to minimize distortion made by scattering & water vapor absorption



→ fiber is a glass made from sillicon sand which contains:

Impurties
- causes light scattering
  ↳ depends on:
    ↳ distance between particles
    ↳ wave length

water vapor
- atoms want to complete their energy level to be stable ⟶ absorbs light energy
- Causes water vapor + absorption.

→ From graph:

→ need to avoid λ of peak of water vapor absorption

→ scattering increases at small λ & vise versa

→ we chose λ according to those conditions to make sure the signal can reach with lower losses.

Advantages & Disadvantages

→ B.W ↑↑

→ small size

→ electrical isolation "no radition"

→ Immunity to interference & crosstalk

→ Flexability - reliability - ease of maintance

→ low cost "as total section not individual components"

→ Fragity : to make sure it won't be broken we make protection & layers.

→ difficult to install : need to make sure inser cables are alligned

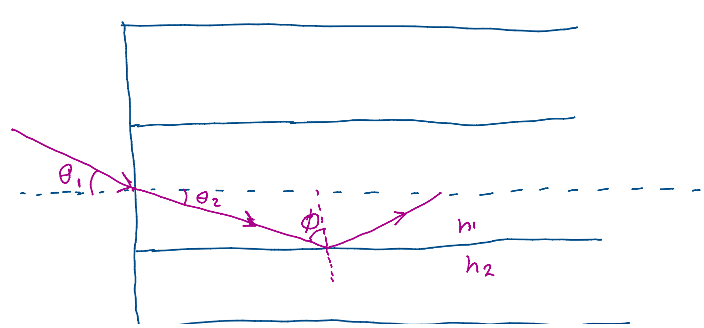
Prove of acceptance angle

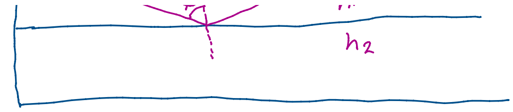
at input

$n_0 \sin\theta_1 = n_1 \sin\theta_2$, $\theta_2 = \frac{\pi}{2} - \phi$

$\therefore n_0 \sin\theta_1 = n_1 \sin[\frac{\pi}{2} - \phi]$

$\therefore n_0 \sin\theta_1 = n_1 \cos\phi$





$\therefore n_0 \sin\theta_1 = n_1 \cos\phi$

$\therefore n_0 \sin\theta_a = n_1 \sqrt{1-\sin^2\phi_c}$ ----- (1)

at the core

$n_1 \sin\phi_c = n_2 \cancel{\sin(\frac{\pi}{2})}^{1}$

$\therefore \sin\phi_c = \frac{n_2}{n_1}$ ---- (2)

(1),(2)

$\therefore n_0 \sin\theta_a = n_1\sqrt{1-\frac{n_2^2}{n_1^2}} = \cancel{n_1}\sqrt{\frac{n_1^2-n_2^2}{\cancel{n_1^2}}}$

$\therefore \boxed{n_0 \sin\theta_a = \sqrt{n_1^2-n_2^2}} = NA$

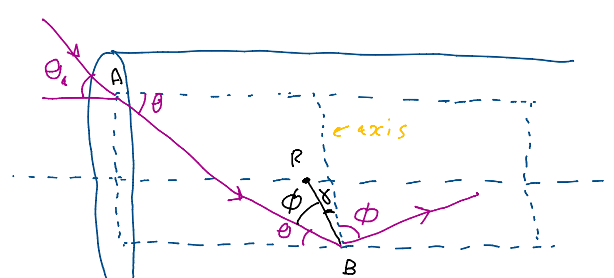
* relative refraction index difference

$\Delta = \frac{n_1^2-n_2^2}{2n_1^2} \simeq \frac{n_1-n_2}{n_1}$ ↓↓↓ $\rightarrow n_1^2 - n_2^2 = 2n_1^2\Delta$

$\therefore NA = n_1 \sin\theta_a = \sqrt{n_1^2-n_2^2}$

$\therefore NA = \sqrt{2n_1^2\Delta} \rightarrow \therefore \boxed{NA = n_1\sqrt{2\Delta}}$

* Skew rays



$\cancel{AB}\sin\theta\cos\gamma = \cancel{AB}\cos\phi$

$\therefore \sin\theta\cos\gamma = \cos\phi$ ----- (1)

→ critical angle ϕ_c

$n_1 \sin\phi_c = n_2 \sin\frac{\pi}{2} \rightarrow \therefore \sin\phi_c = \frac{n_2}{n_1}$

$\therefore \sqrt{1-\cos^2\phi_c} = \frac{n_2}{n_1} \rightarrow \therefore \cos\phi_c = \sqrt{1-\frac{n_2^2}{n_1^2}} = \sqrt{\frac{n_1^2-n_2^2}{n_1^2}}$ --- (2)

(1)(2)

$\sin\theta\cos\gamma = \cos\phi_c = \sqrt{\frac{n_1^2-n_2^2}{n_1^2}}$ ----- (3)

Point A

$n_0 \sin\theta_{as} = n_1 \sin\theta$

$\therefore \sin\theta_{as} = \frac{n_1}{n_0} \sin\theta$

$= \frac{\cancel{n_1}}{n_0} \cdot \sqrt{\frac{n_1^2 - n_2^2}{\cancel{n_1^2}}} \cdot \frac{1}{\cos\gamma}$

$\therefore \boxed{\sin\theta_{as} = \frac{\sqrt{n_1^2 - n_2^2}}{n_0 \cos\gamma}}$

$\therefore NA = \sqrt{n_1^2 - n_2^2}$

$\therefore NA = n_0 \sin\theta_{as} \cos\gamma$