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MADE EASY
ELECTRONICS ENGINEERING
Advance Commucation
By-Urvashi Maim

- Theory
- Explanation
- Derivation
- Example
- Shortcuts
- Previous Years Question With Solution

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Satellite Communication   (facultycomm @ gmail.com)

link design.   ✓ facultyadvancecomm @ gmail.com
optical Communication

* Syllabus :.

i) optical Communication. ⟶ John M Senior (3rd Edition)

ii) Cellular Communication ⟶ Rappaport

iii) Data Communication. ⟶ Forauzan

iv) Satellite Communication ⟶ Pratt.

	PRELIMS		MAINS (85 marks)

PRELIMS

1) OC   L (Jh)

2) CC.   L. (Jh)

3) DC   6→5(Jh)
                    1 (N)

4) SC   2→1(Jh)
                    1 (N)

MAINS. (85 marks)

40 marks ⟶ ⎡→10M ⎫ Basics
              ⎢→10M ⎬
              ⎣→20M ⎭ link design.

20 Marks → link design.

___

25 marks ⟶ ⎡→15m (link design)
              ⎣→10m (free space loss).

*OPTICAL FIBRE COMMUNICATION:-

→ Commⁿ is whatever sent by Tx is retrieved by Rx and can be understood at Rx end.

dealing with light!

visible UV | IR Region (IR Region) → not visible to normal eyes. Hence security is high. (Information is not leaked)

* Band width is also high.
* IR waves are not absorbed by the solid material. Hence attenuation is less. Need of ampl⁺, repeaters are less.
* Design of link is not costly
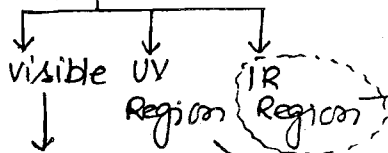
made up of VIBGYOR

*(Bandwidth is less hence data commⁿ not possible

* Since light is visible so security is less. The changes 0 to 1 are visible

not preffered because UV rays are absorbed by the solid. Hence attenuation occurs.
* need of ampl⁺

* FIBER:-
* behaves a [x mission waveguide.]

EMI → Electromagnetic Induction.
RFI → Radio frequency Interference.

made up of

SILICA (dielectric)   PLASTIC (dielectric)

* due to dielectric behaviour EMI, RFI is less. Hence CROSS TALK is low.

Note:- optical cables doesn't radiate the energy and also doesn't allow external signal from entering into the fiber

* Noise ↓ (Interference ↓) →

* Signal Fidelity ↑ (High)
* can be transmitted to long distance hence Range ↑.

Note:- (why light source can't be sent through free space?)
* In free space, dust particles, water particles will be present hence Fading occurs and hence the strength ↓. Hence light is not sent through unguided media.

↓BUFFER & JACKET
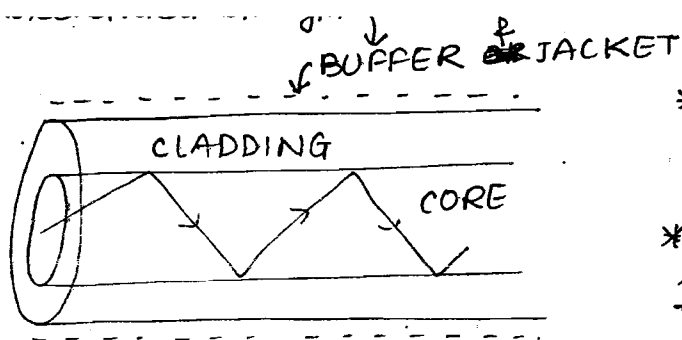
* Core & cladding are both made of silica.
* Light propagates by principle of TIR.

*cladding is made up of silica. since if air is present losses will be high and information is lost.

Note :- (Advantages of using optical Fiber Cable (OFC))

1) Bandwidth :-

Range is 10^{13} Hz to 10^{15} Hz

Bandwidth = $f_H - f_L$
$= 10^{15} - 10^{13}$

Information carrying capacity is → $\boxed{BW \cong 10^{15} \, Hz}$
High.

* channel capacity is

$$\boxed{\begin{array}{l} C = BW \log_2 (1 + S/N) \\ C \uparrow \; BW \uparrow \end{array}}$$

SHANNON THEOREM.

(PON)
* BW attainaible is of 40Gbps in passive optical network.

2) security :-

* IR rays are used.
* not visible to naked eyes. hence signal cannot be tracked.

3) less distortion & attenuation :-

* Attenuation in Fiber is of Range 0.5 dB/Km due to the dielectric used.
  ↳ doesn't allow anything to go out or come in.
  ↳ dielectric doesn't absorb anything and hence amplification requirement is ↓.

4) Amplification ↓ :-

* ampl & Repeater requirement is less.
* Amplr amplifies the Signal & Noise also.

* for

Amplifier → S↑ N↑ SNR const.

Repeater → 3R → SNR is boosted
(can advance or delay)
→ Retime
→ Reshape
→ Regenerate

Increase Tx Range.

(Signal is amplified whereas Noise is not amplified)

* for Satellite Comm^n and digital comm^n we mostly use Repeaters.

5) <u>Transmission Range ↑ (very high)</u>:

* due to Repeater being used Tx Range is very high.

<u>Note: (ICT Based - GS point of View)</u>:-

* <u>NOFN (National Optical Fiber network)</u>
  ↳ 2.5 lakh gram panchayat to be linked using Broadband connectivity. The speed is 100Mbps.

* 1st phase → 1 lakh grampanchayat connected and after name changed to BHARAT NET.

* for optical fibers → dielectric (RFI/EFI ↓) <u>hence instead</u> <u>of laying down, we are installing the cables on power</u> <u>towers along with the power cables.</u>

<u>Note:</u>-
* OFN are not preferred in hilly areas due to the terrain.
* Hilly areas, prone to landslides, weather conditions etc hence if OFN is installed then they are likely to get disturbed.
* Also laying down of OFN in hilly areas is difficult as digging and laying them down is difficult.
* Instead of OFN, microwave links (µwave comm^n) is preferred in Hilly areas.

*OPTICAL FIBER COMMUNICATION:.

* In this the signal is in the form of light pulses which is guided through dielectric waveguide made up of SILICA OR PLASTIC".

* The Transmission of Signal takes place through TOTAL INTERNAL REFLECTION (TIR)

* Why OFC is Preferred?

i) enormous Bandwidth. the frequency range of light signal is from 10^{13} Hz to 10^{15} Hz normally. Hence the Bandwidth is very high.

SHANNON CHANNEL CAPACITY	$C = BW \log_2 (1 + S/N)$	$C \propto BW$

* C = Channel capacity (Bits/sec)

Hence the Information carrying Rate is very high

ii) Electrical Isolation:.

* optical fibre is dielectric Transmission waveguide and doesnot conduct or radiate and it doesnot allow other electrical signals to Interfere. Hence there is less Interference like ELECTROMAGNETIC INDUCTION & RADIO FREQUENCY INTERFERENCE.

* So chances of CROSS TALK is less

ii) less Transmission loss:.

* The Fiber is fabricated with less loss ie around 0.2 dB/Km. Hence attenuation is less so less no. of REPEATERS are required. Hence overall cost is reduced.

IV) SECURITY:

* IR rays are preferred which are not visible and not also absorbed by the material. Hence chances of Radiation is less. Hence more security.

* Due to less losses the Transmission Range is very high.

* Due to these above advantages we are using OFC in
  i) PON (Passive optical Networks) (window 1 used)
  ii) Bharat net (Gram Panchayats Connectivity).

* NO signal amplification, no Repeaters are used. Hence called as Passive.

* Range is limited (20 Km – 40 Gbps).

iii) Submarine cables are used in an around chennai port, Kanya Kumari, ernakulam port to make Connectivity to the outside world. Repeaters are used at every 50 Km.

Note:-
* Transmission window Range is selected to find such that what wavelength of light can be sent so that the attenuation will be less and Requirement of Repeaters is less. (To find Range of wavelength so that attenuation is less)

Note:-
* In window 3 we have designed EDFA (Erbium Doped Fiber Ampr)
  ↳ EDFA can ~~provide~~ :-
     ↳ work as Repeaters also.

Note:-
* A TRANSMISSION WINDOW is the range of the wavelength at which attenuation is low.

* In OFC, WINDOW 3 ranging from 1500 nm to 1600 nm is most preferred because it has low attenuation, less dispersion & high Transmission Range & data rate. Supports wavelength

division multiplexing & EDFA (Erbium Doped Fiber Ampl^r)
can be used.

WINDOW 1 (800 nm - 900 nm):-

* LED is used as source so high dispersion, high loss and used for short distance communication.
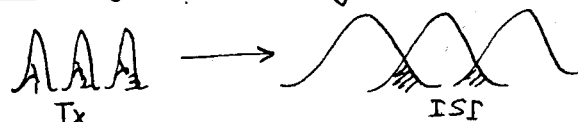
WINDOW 2 (1260 nm to 1360 nm):-

) Laser in single mode is used

) dispersion is negligible

) high Tx Range.

But it doesn't support multiplexing efficiently

Note :-

Tx   ISI

* LED (light emitting diode) is :-
   a) Non monochromatic (having multiple wavelength)
   b) Non Coherent.

Hence it is highly dispersive in nature. Due to these limitations LED is generally not preferred for long distance comm^n using optical fibres.

* Also, due to non-monochromatic & non coherent nature there is Intersymbol Interference and original information can't be Retrieved back at the Rx side.
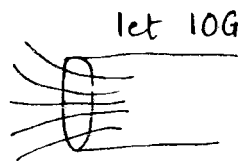
Note :-   let 10GHz (BW)   * one telephone caller needs 64 KHz BW for performing calling information. Hence if there is no wavelength division multiplexing the remaining BW is wasted.

* Now suppose if we are doing wavelength division multiplexing then multiple users can use the same 10GHz BW simultaneously and no. of users can be given as :-

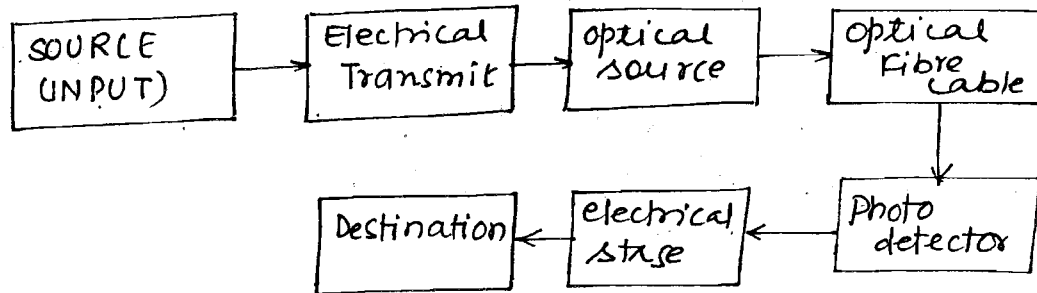$$64 \times 10^3 \times n = 10 \times 10^9$$

$$n = 10^6 \times 0.15625$$

$$= 156.25 \times 10^3 \text{ users.}$$

{ wavelength division multiplexing uses light of different colours to be multiplexed }

Note :-

*OPTICAL FIBRE SYSTEM :-

```
┌──────────┐    ┌──────────┐    ┌──────────┐    ┌──────────┐
│ SOURCE   │───▶│ Electrical│──▶│ optical  │──▶│ optical  │
│ (INPUT)  │    │ Transmit │    │ source   │    │ Fibre    │
│          │    │          │    │          │    │ Cable    │
└──────────┘    └──────────┘    └──────────┘    └──────────┘
                                                       │
                                                       ▼
┌──────────┐    ┌──────────┐    ┌──────────┐
│Destination│◀──│ electrical│◀──│ Photo    │
│          │    │ stage    │    │ detector │
└──────────┘    └──────────┘    └──────────┘
```

* Optical Source :-

* It does Electrical to optical conversion and provides max^m coupling of the signal in the form of light pulses with the fiber and the coupling is done with the help of mechanical Interfaces like LENS OR PRISM.

* These are of two types LED & LASER.

* optical Cable Transmit the light pulse through "Total Internal Reflection".

Reciever :-

* The Photodetectors like Avalanche Photodiode, PIN DIODE & phototransistors do optical to electrical conversion so that information can be retrieved.
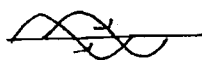
*** Note :-

* OPTICAL SOURCE operates in FORWARD BIAS mode whereas PHOTO DETECTORS operate in REVERSE BIAS mode.

*RAY THEORY & BASIC CONCEPTS OF OFC:.

wave nature aken when

Light → wave $\sim\!\!\sim$ Tx channel → Optical fibre (TIR)

Light → Particle (flowing in the form of packets of Photons).

Generation & Recieving of the light we take particle nature.

(LED, LASERS ← for Generation
APD, PIN diode, Photodiode)
for Detection

* LIGHT has DUAL NATURE which defines its generation in the form of PHOTONS ie PARTICLE NATURE and the other is how does the light travel in any medium ie WAVE NATURE.

* The working of the OPTICAL SOURCE & PHOTODETECTORS is defined by PARTICLE NATURE in which the energy of the PHOTON is given by
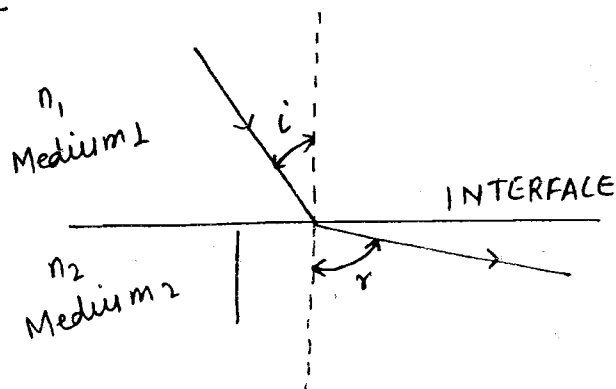
$$E = h\nu = \frac{hc}{\lambda}$$

$$E(ev) = \frac{1.2406}{\lambda(\mu m)}$$

$$E_c$$

$$E_v$$

$h\nu$
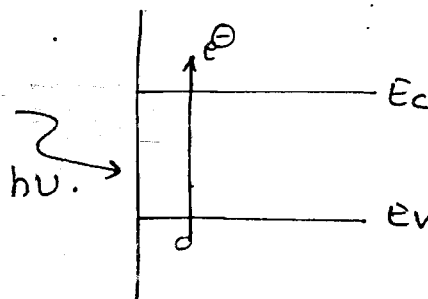
* The total ontinual Reflection is based on WAVE NATURE & is defined with the help of SNELL'S LAW.

ok:.

n_1 Medium 1

i

INTERFACE

n_2 Medium 2

r

$$RI = \frac{c}{V}$$ ← Velocity of light in free space
← Velocity of light in any medium

$$n_1 \sin i = n_2 \sin r$$

SNELL'S LAW.