



# **SNS COLLEGE OF TECHNOLOGY**

**Coimbatore-35**  
**An Autonomous Institution**



Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A++' Grade  
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

## **DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING**

### **OPTICAL AND MICROWAVE ENGINEERING**

III YEAR/ VI SEMESTER

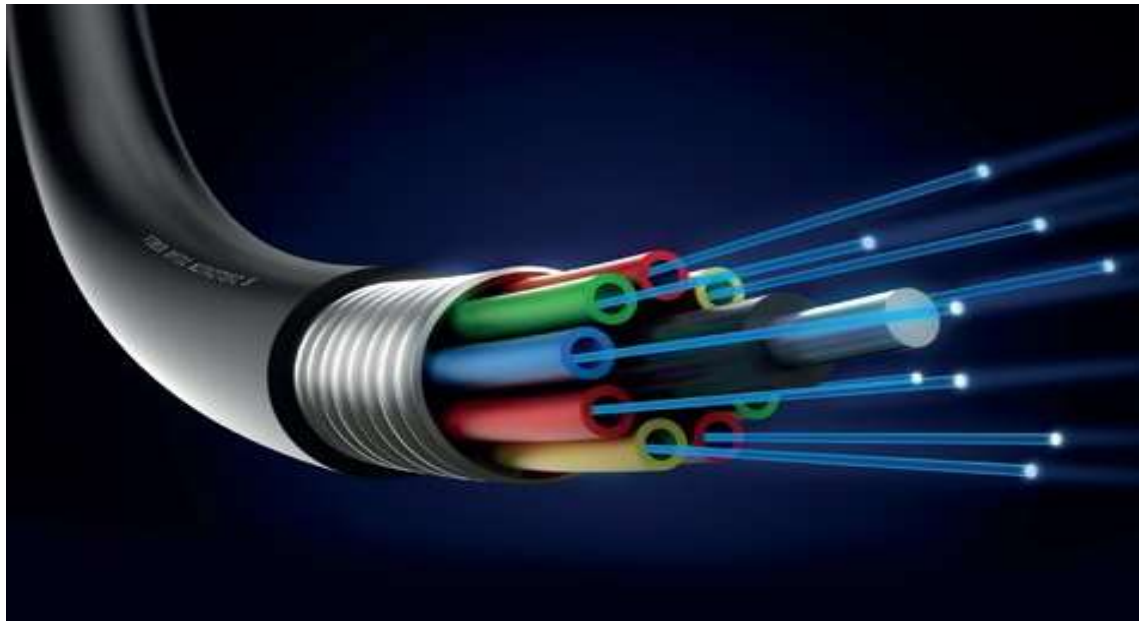
1

#### **UNIT 4 – OPTICAL COMMUNICATION**

**TOPIC – OPTICAL FIBERS AND DEVICES-PROPAGATION OF LIGHT,  
OPTICAL FIBER STRUCTURES**



# OPTICAL COMMUNICATION





## CONTENTS



- Introduction
- General communication system
- Optical fiber link
- Fiber structure
- Fiber types
- Optic fiber configuration
- Ray theory transmission



## INTRODUCTION

- Communication – transfer of information from one point to another.
- Communication system- transfer of information is achieved by modulating the information onto an electromagnetic wave which acts as a carrier for the information signal.
- Electromagnetic wave carrier is selected from
  - »Radio frequencies
  - »Microwave & millimeter wave frequencies
  - »Optical range of frequencies
- Limitation- information carrying capability.
- Information carrying capability is proportional to the bandwidth of the channel.



- **Radio Communication System**

- Information modulates a high frequency carrier.
- Information carrying capability – increased.
  - Bandwidth of the channel – increased.
  - Available spectrum space – decreased.

- **Microwave signal**

- » Used as high frequency carriers (1-300GHz).
- » Cost of equipment – high.

- **Communication by light**

- ✓ Light act as transmission medium.
- ✓ Electromagnetic wave carrier- optical range of frequencies (1.76 pHz to 3.75 pHz).
- ✓ Communication at optical wavelength (800nm to 1700nm) offer a increase in bandwidth by factor of  $10^4$ .



- **Information put on a light beam** and transmitted through Free space
  - Impractical over long distance. Because, attenuation occurs due to atmospheric effects like rain, snow, fog etc.

Special cable- light carrying cable

- Optical fiber is a glass or plastic fiber that carries light along its length.



## ACTIVITY TIME



$2 \text{ pink candies} \times 2 \text{ pink candies} \times 1 \text{ orange candy} = 16$

$3 \text{ blue candies} \times 3 \text{ blue candies} = 27$

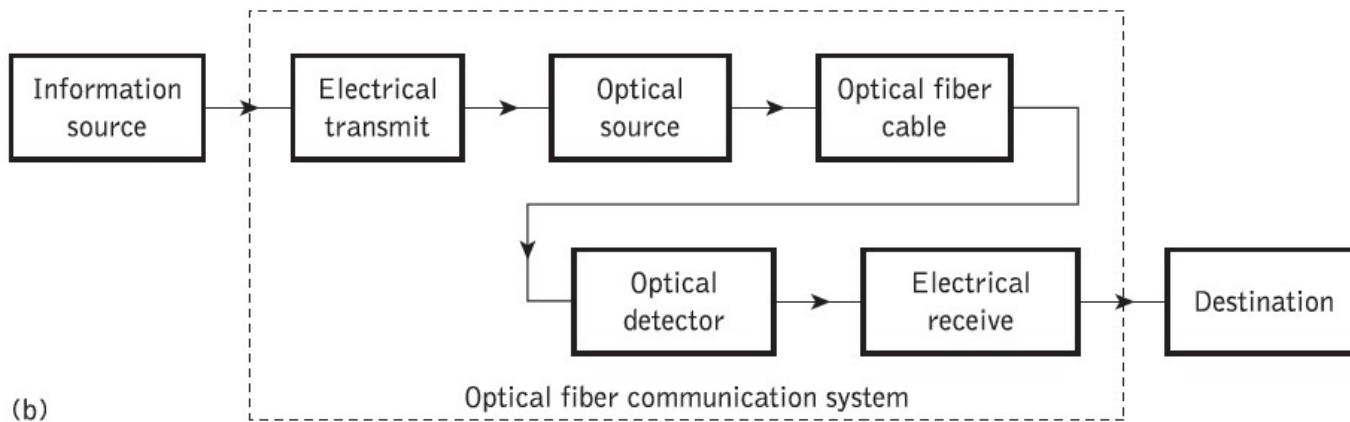
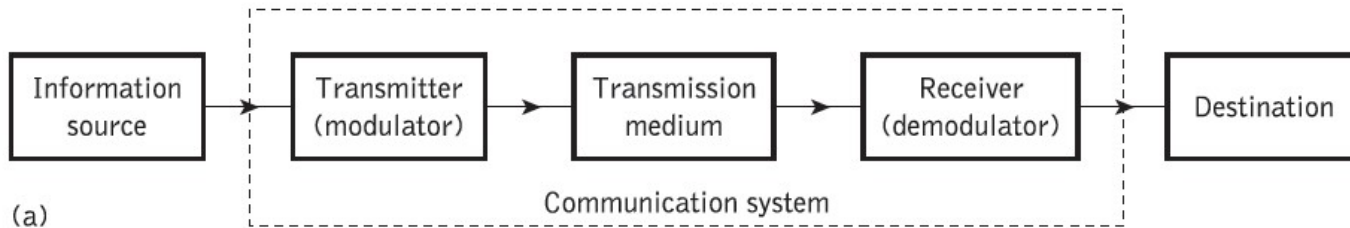
$2 \text{ blue candies} \times 2 \text{ orange candies} = 12$

$1 \text{ orange candy} + 1 \text{ pink candy} \times 1 \text{ blue candy} = ?$

© www.ShakeTheBrain.com



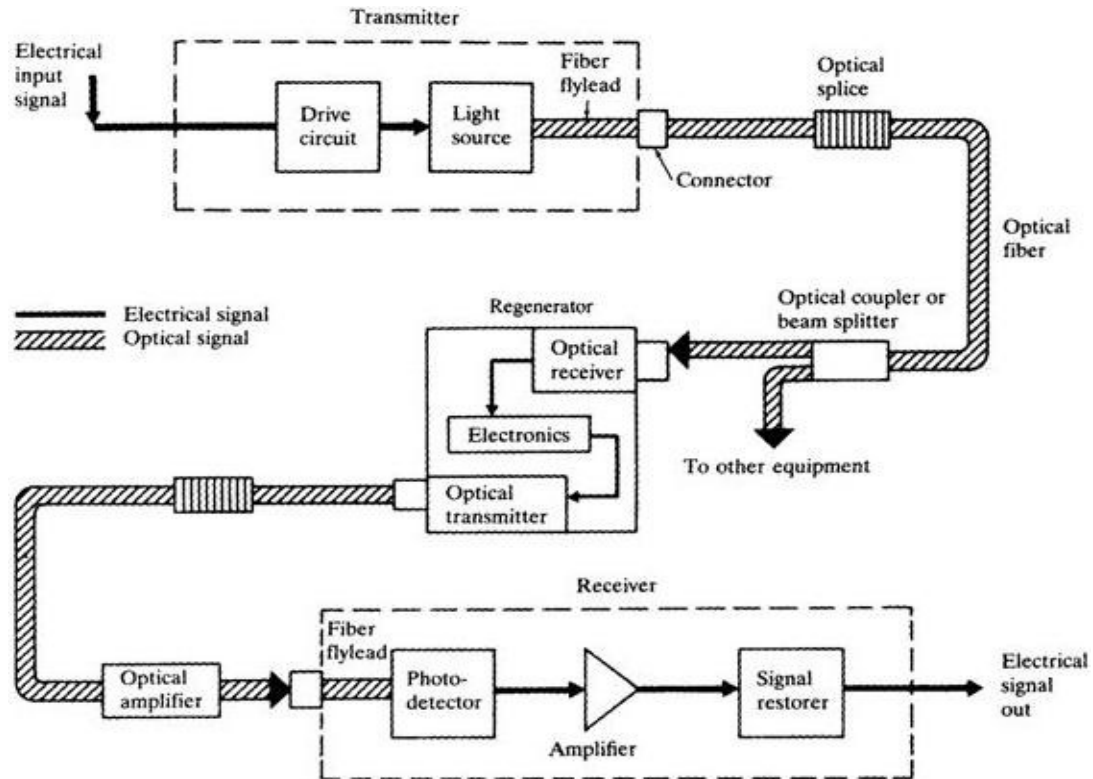
# General Communication System





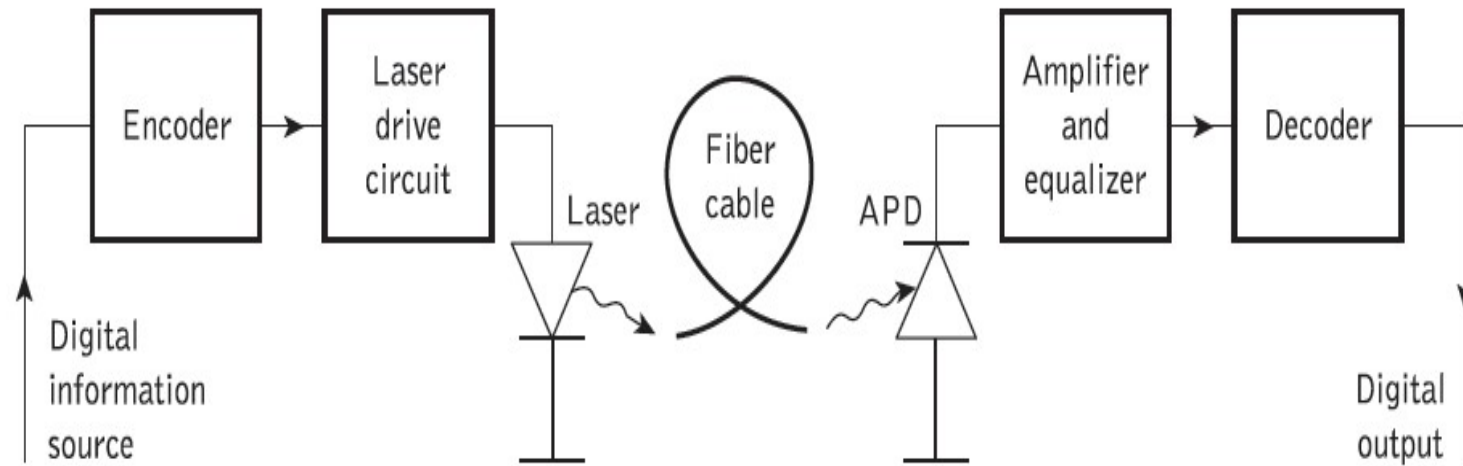


# Optical Fiber Comm. Link





## Digital Optical Fiber link





## Optical Fiber Modes



- Optical fiber
  - Dielectric waveguide
  - Operates at optical frequency
  - Cylindrical in form
- Modes of the waveguide – the propagation of light along a waveguide can be described in terms of set of electromagnetic waves.
- These guided modes are referred to as bound or trapped modes of the waveguide.



## Fiber Structure



■ It has

- ◆ Core
- ◆ Cladding.

■ **Core**

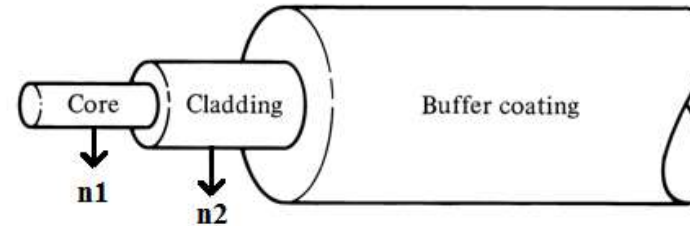
- ◆ Single solid dielectric cylinder
- ◆ Refractive index –  $n_1$

■ **Cladding**

- ◆ Core is surrounded by cladding.
- ◆ Refractive index –  $n_2$  &  $n_2 < n_1$ .

■ **Need for cladding**

- ◆ Reduces scattering loss
- ◆ Provides mechanical strength
- ◆ Protects core from absorbing surface contaminants.



■ **Buffer coating**

- ◆ Elastic, absorption resistant material
- ◆ Use- add further strength to the fiber



## FEATURES



- » **Ultra high bandwidth**
- » **Small size and weight**
- » **Electrical isolation**
- » **Immunity to interference and crosstalk**
- » **Signal security**
- » **Low transmission loss**
- » **Ruggedness and flexibility**
- » **System reliability and ease of maintenance**
- » **Potential low cost**
- » **Point to point communication**



## APPLICATIONS



- Long distance communication backbones
- Inter-exchange junctions
- Video transmission
- Broadband services
- Computer data communication (lan, wan etc..)
- Military application
- Non-communication applications (sensors etc...)



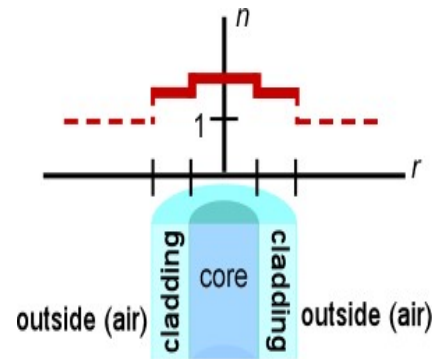
## FIBER TYPES



✓ Variation in material composition of the core gives 2 types of fiber.

- **Step index fiber**

- » Refractive index of core is uniform throughout and undergoes an abrupt change at the core cladding boundary.



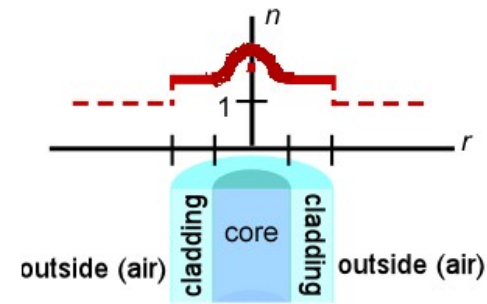


## FIBER TYPES



- **Graded index fiber**

- » Refractive index of core is made to vary as a function of radial distance from the centre of the fiber.



- ✓ Based on modes 2 types of fibers are available.

- ✓ Single Mode Fiber.

- ✓ Multi Mode Fiber.





# Comparison



## Single mode fiber

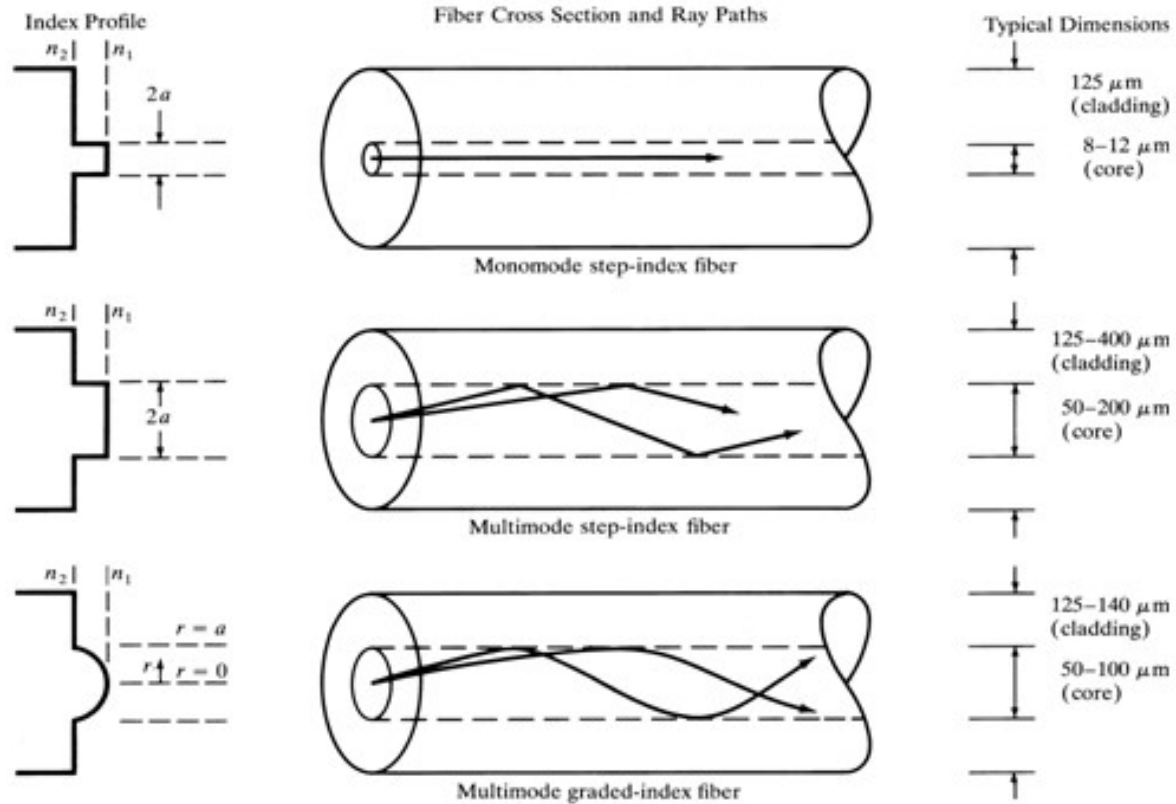
- ▶ Core radius is small.
- ▶ Supports one mode of propagation.
- ▶ Optical source- LASER.
- ▶ The launching of optical power into fiber is difficult as the core radius is small.
- ▶ Supports larger bandwidth.
- ▶ Intermodal dispersion is absent.
- ▶ Used for long distance communication.

## Multi mode fiber

- ▶ Core radius is large.
- ▶ Supports hundreds of modes.
- ▶ Optical source- LED.
- ▶ The launching of optical power into fiber is easier as the core radius is large.
- ▶ Supports lesser bandwidth.
- ▶ These fiber suffer from Intermodal dispersion.
- ▶ Used for short distance communication.



# Optic-fiber Configuration






## ASSESSMENT TIME



### Think, Pair, Share

| What's the issue/<br>question/ topic? | What do I think<br>about it? | What does my<br>partner think? | What will<br>we share?   |
|---------------------------------------|------------------------------|--------------------------------|--|
|                                       |                              |                                |  |



**THANK YOU**