



# **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**

### **MICROWAVE ENGINEERING**

IV YEAR/ VII SEMESTER  
1

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

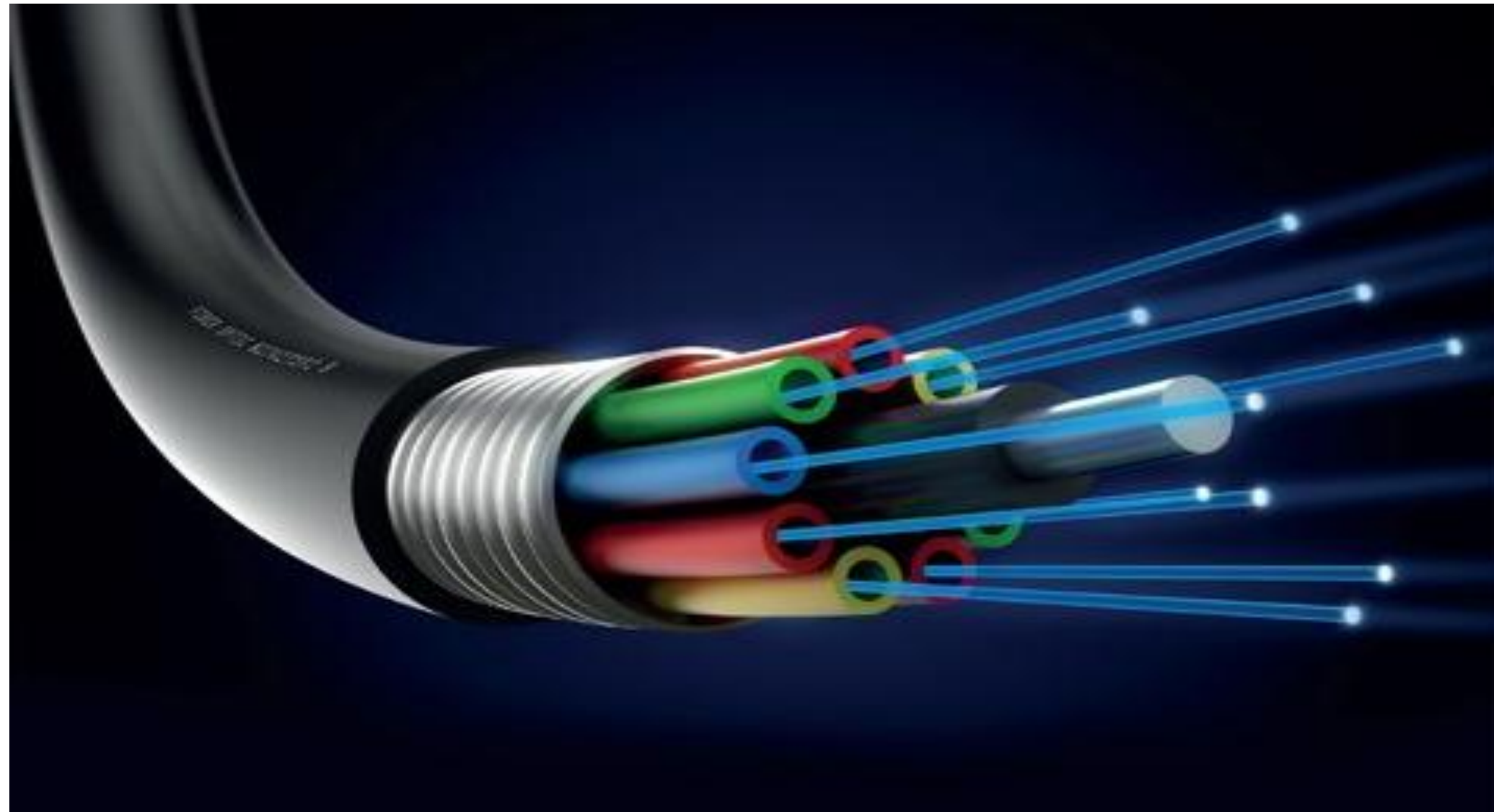
**TOPIC – OPTICAL FIBERS AND DEVICES-PROPAGATION OF LIGHT,**

**OPTICAL FIBER STRUCTURES**

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# 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.

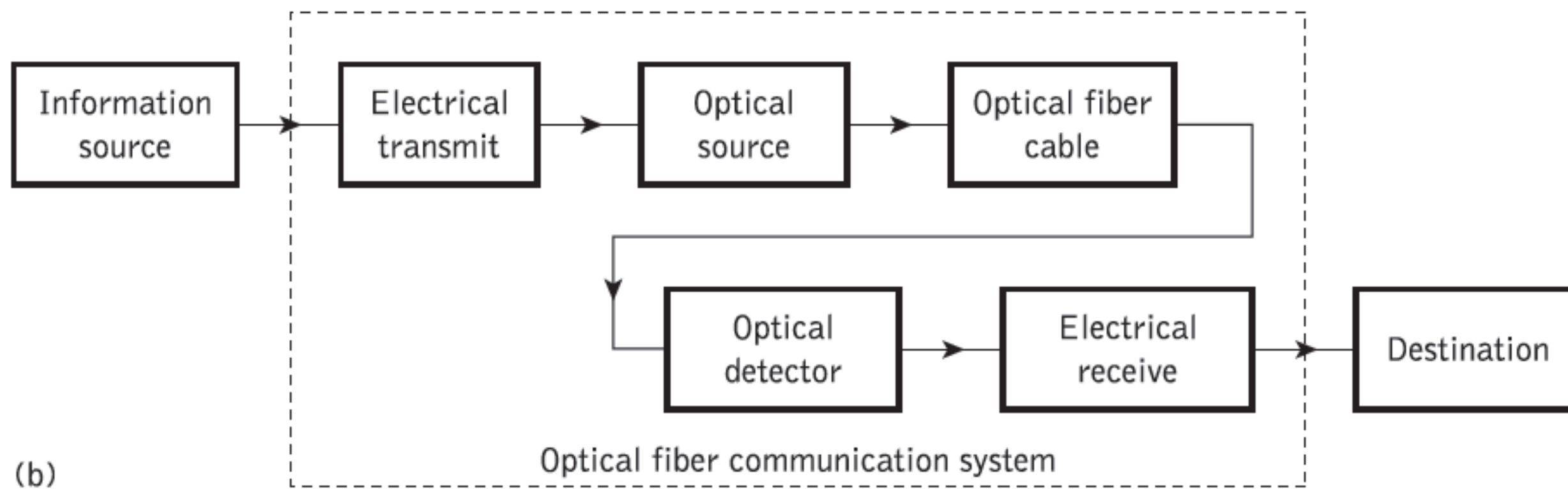
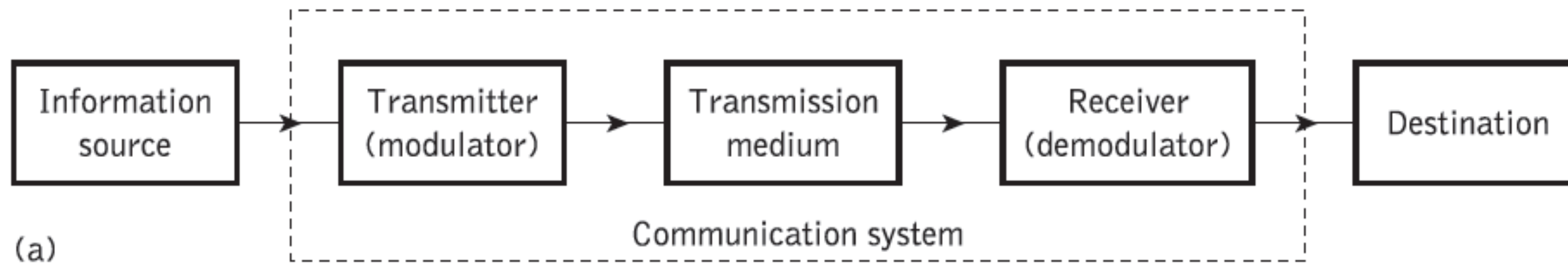
Special cable- light carrying cable

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



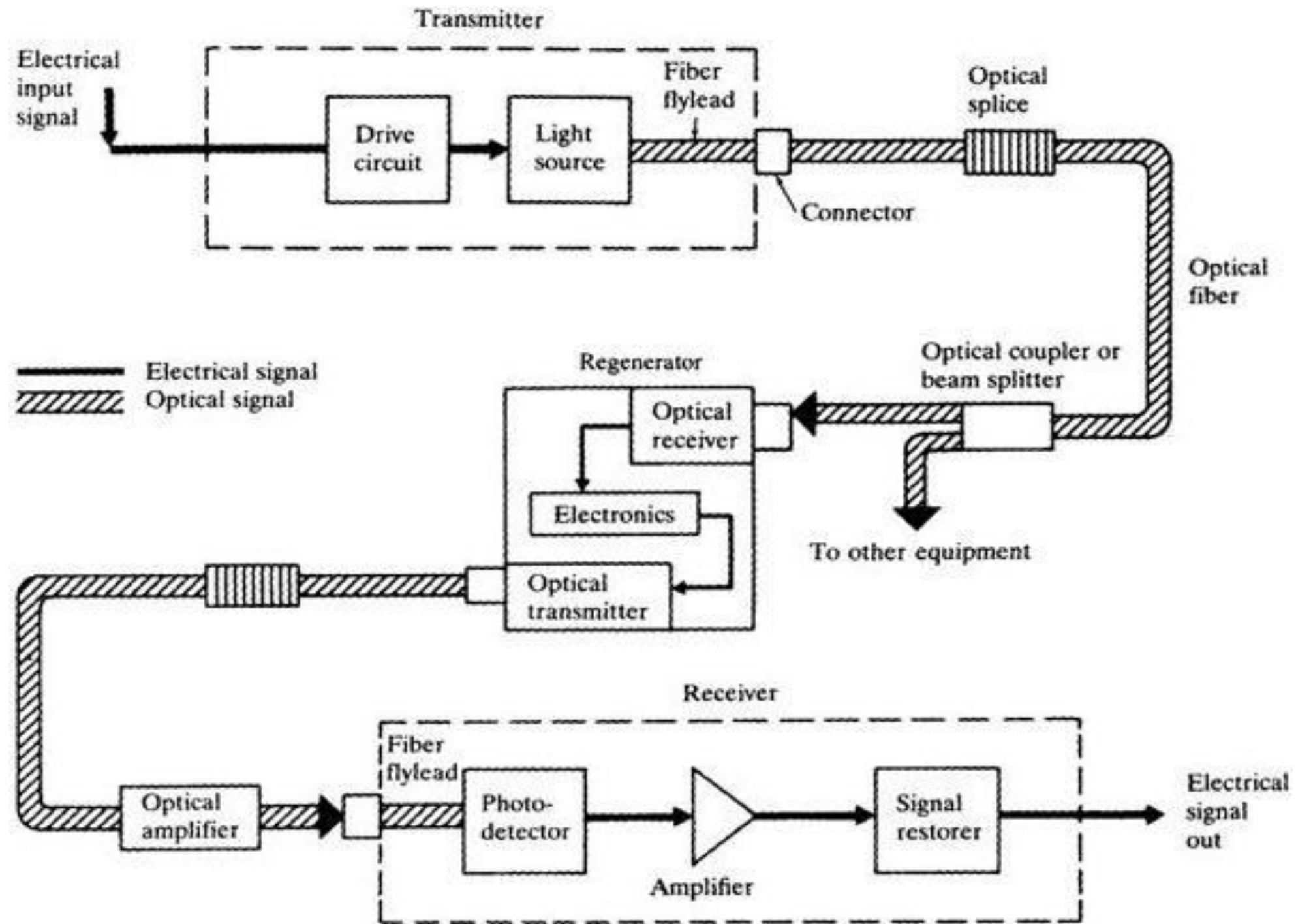


# General Communication System





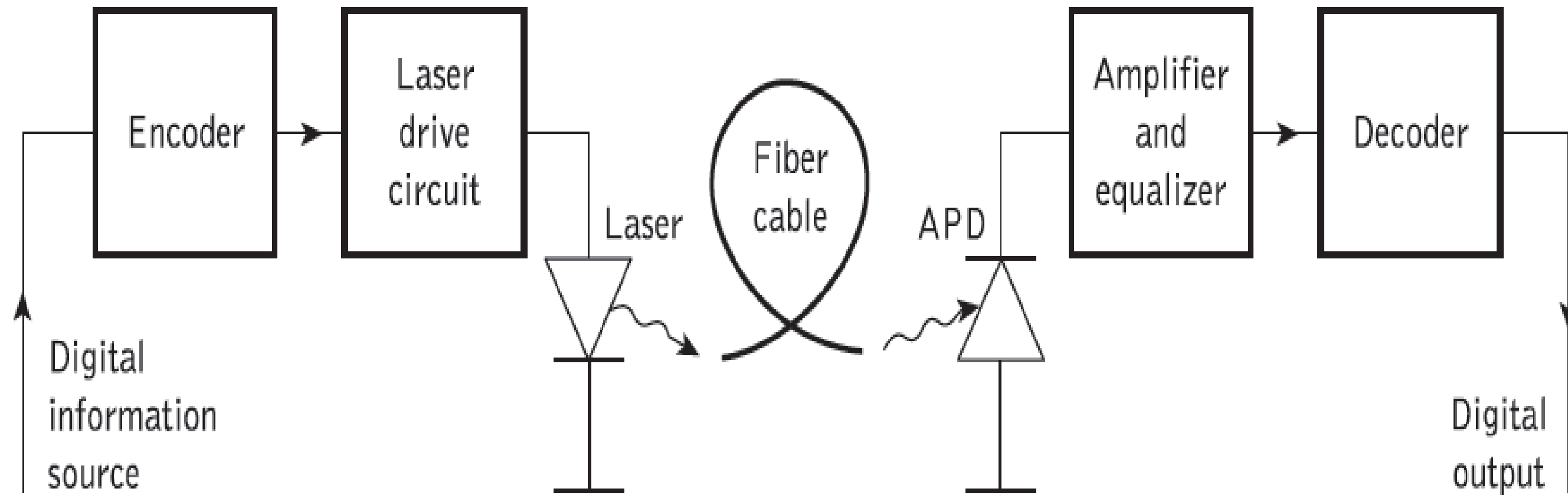
# Optical Fiber Comm. Link







# 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**

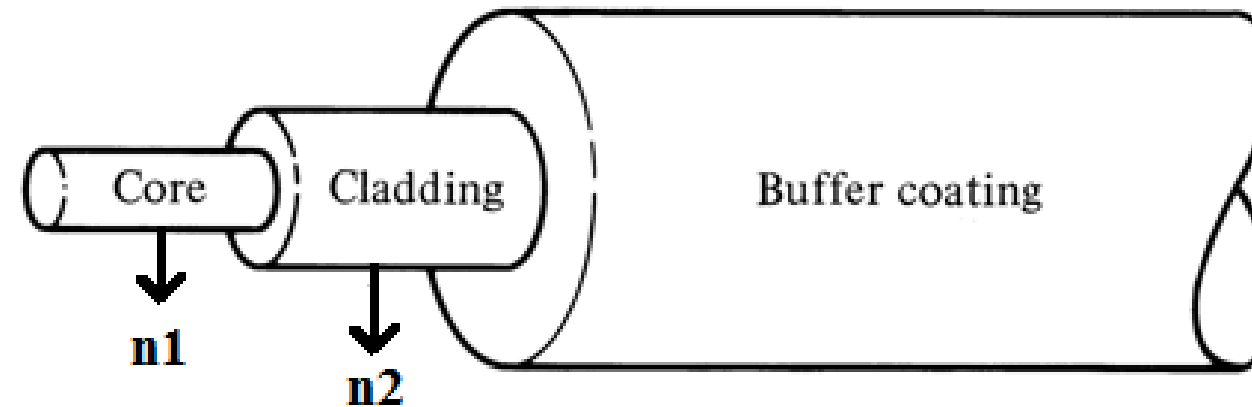
- ◆ Single solid dielectric cylinder
- ◆ Refractive index –  $n_1$

■ **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...)





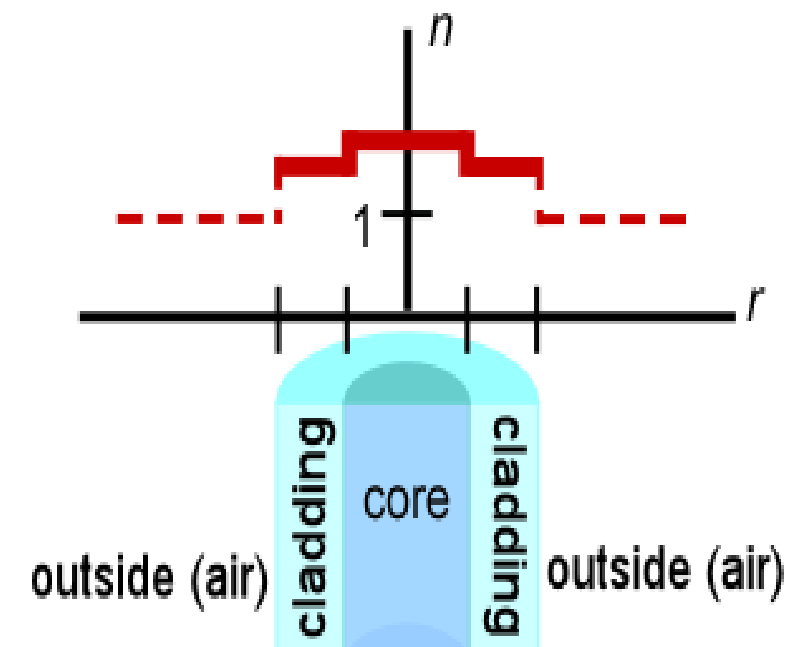
# FIBER TYPES



✓ 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.



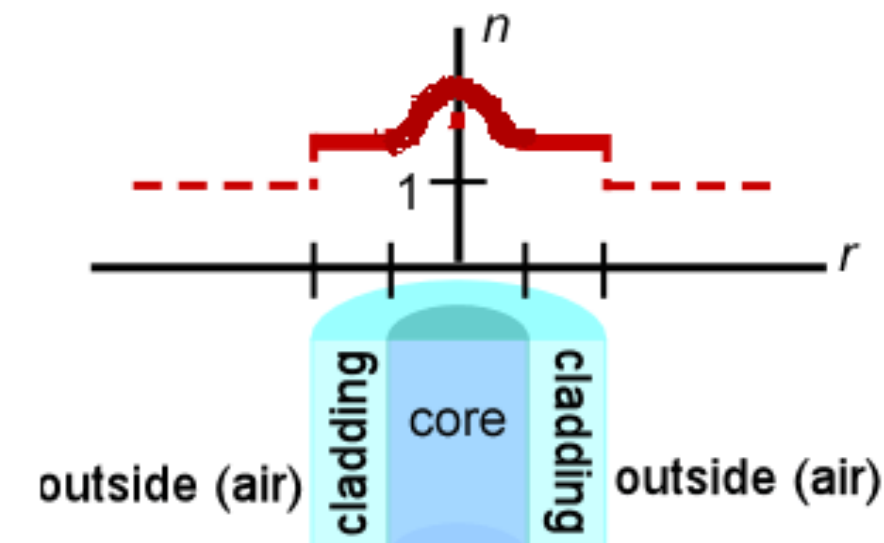


# FIBER TYPES



- **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

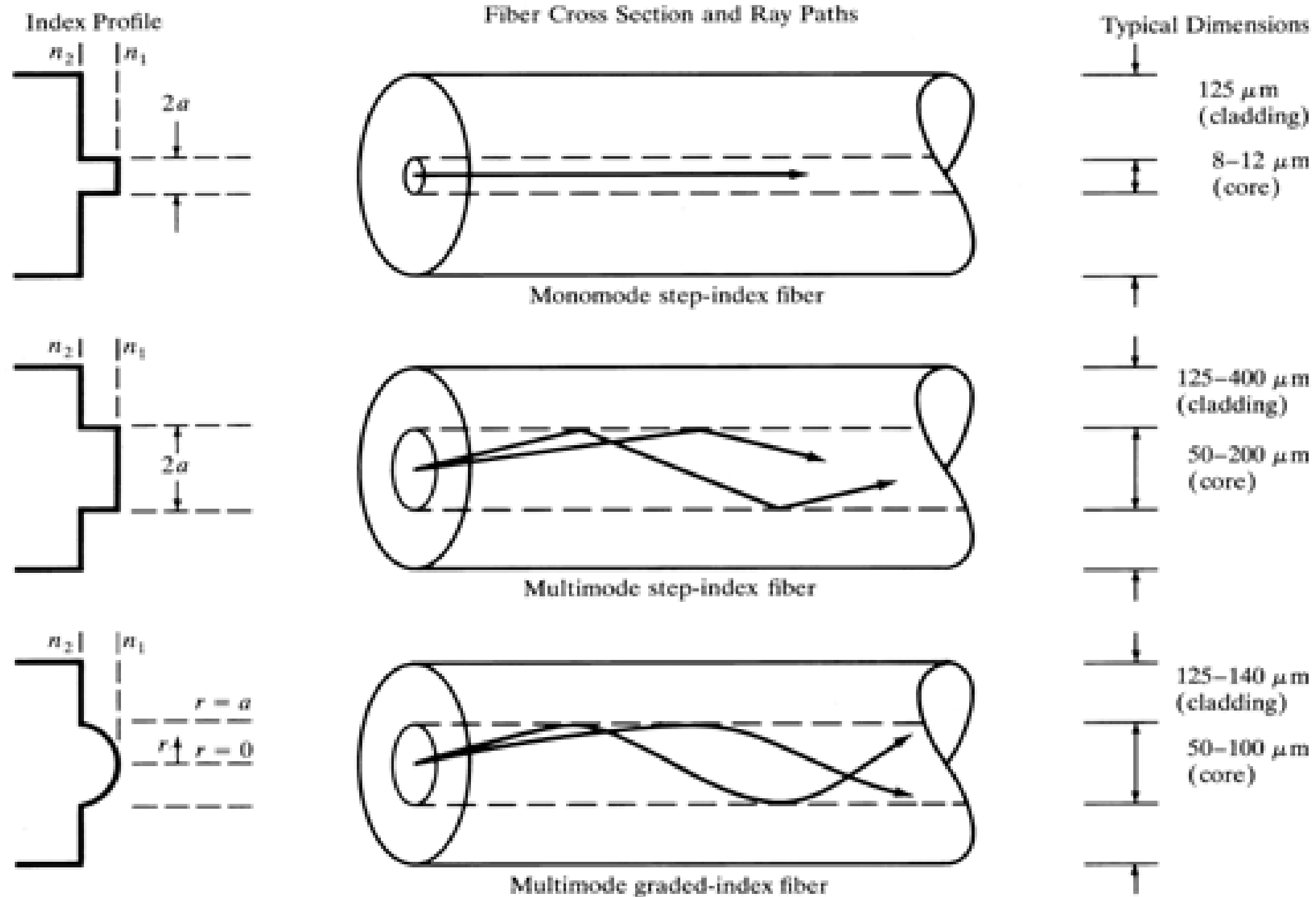
- ▶ Core radius is small.
- ▶ Supports one mode of propagation.
- ▶ Optical source- LASER.
- ▶ The launching of optical power into fiber is difficult as the core radius is small.
- ▶ Supports larger bandwidth.
- ▶ Intermodal dispersion is absent.
- ▶ Used for long distance communication.

## 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





**THANK YOU**