جامعة مولاي إسماعيل
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UNIVERSITÉ MOULAY ISMAÏL

كلية العلوم
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FACULTÉ DES SCIENCES

Course Optoelectronic

Parcours électronique S6
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Pr. Omar EL OUTASSI

Chapitre 7: : Optical fiber

- Optical Fiber
- Different types of Optical Fiber
- Application of Optical Fiber

Pr. Omar EL OUTASSI
o.eloutassi@umi.ac.ma

Introduction to Optical Fiber

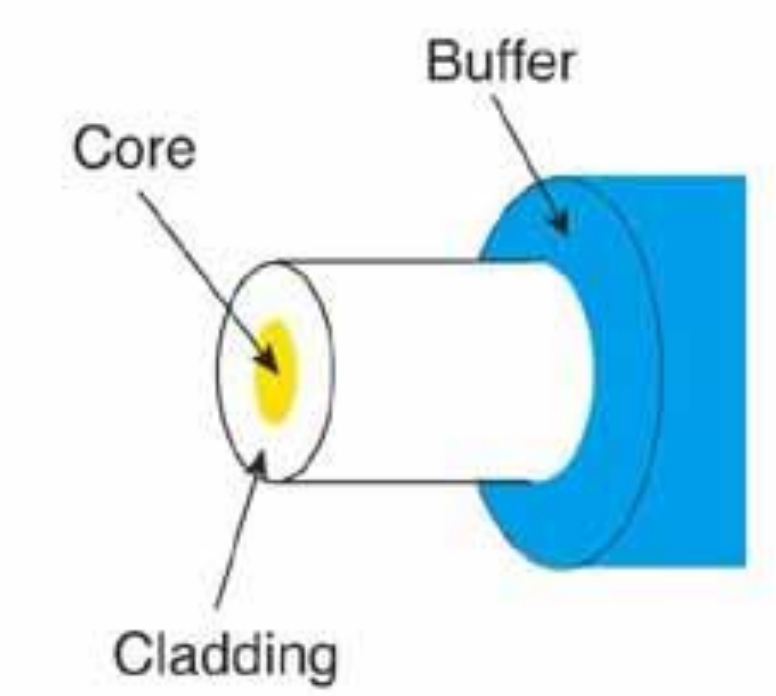
The Backbone of Modern Connectivity

- **Definition:** A thin, flexible filament made of high-quality glass (silica) or plastic designed to transmit data as pulses of light.

Pr. Omar EL OUTASSI
o.eloutassi@umi.ac.ma

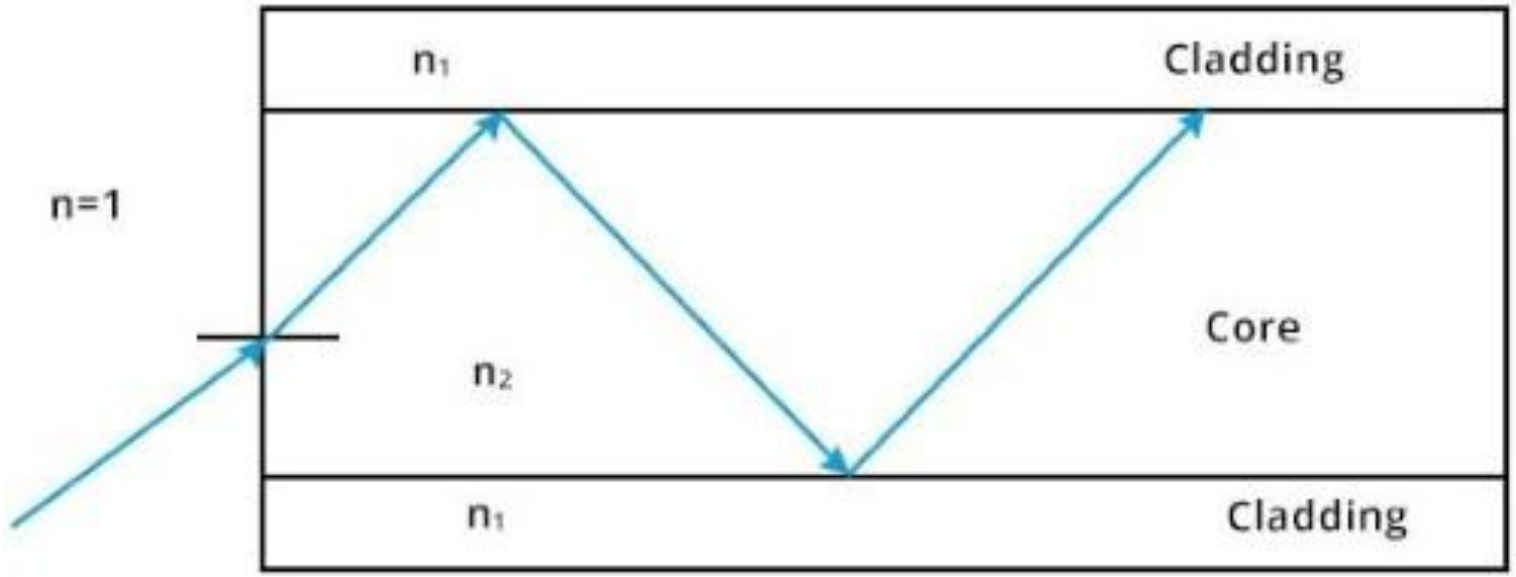
Introduction to Optical Fiber

- **Basic Structure:**
  - **Core:** The innermost thin glass center where light travels.
  - **Cladding:** Outer optical material that surrounds the core; it has a lower refractive index to keep light trapped inside.
  - **Buffer Coating:** Plastic coating that protects the fiber from damage and moisture.



Introduction to Optical Fiber

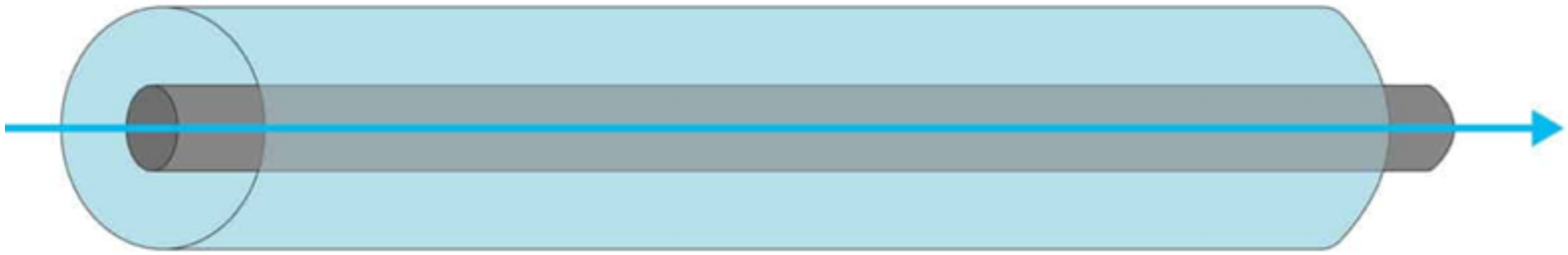
- **Fundamental Principle:** Operates on **Total Internal Reflection (TIR)**. When light hits the boundary between the core and cladding at a specific angle, it reflects back into the core rather than passing through.



Different Types of Optical Fiber

Classification by Mode of Propagation and Refractive Index

- **Single-Mode Fiber (SMF):**

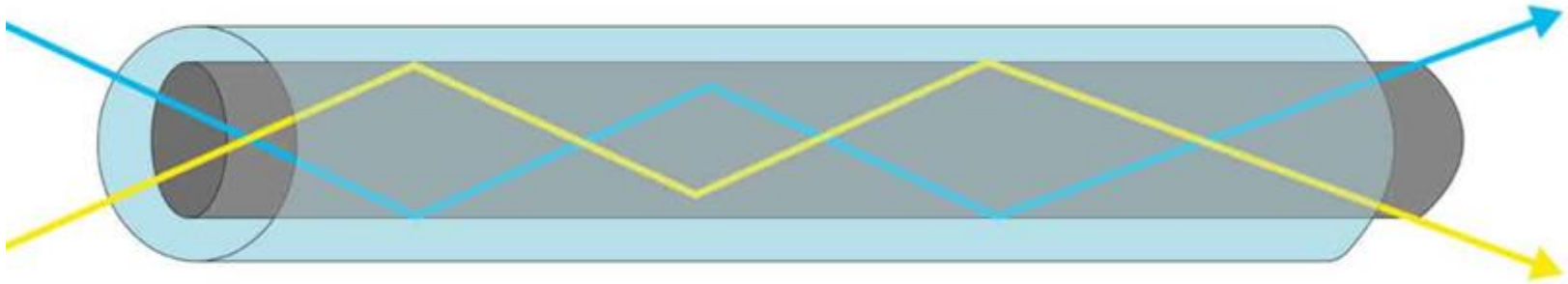


  - **Core Size:** Very small (approx. 9 microns).
  - **Characteristics:** Carries light in a single path (mode). It eliminates modal dispersion.
  - **Best For:** Long-distance communication (e.g., transoceanic cables and 2026-standard 5G/6G backhauls).

Different Types of Optical Fiber

Classification by Mode of Propagation and Refractive Index

- **Multi-Mode Fiber (MMF):**

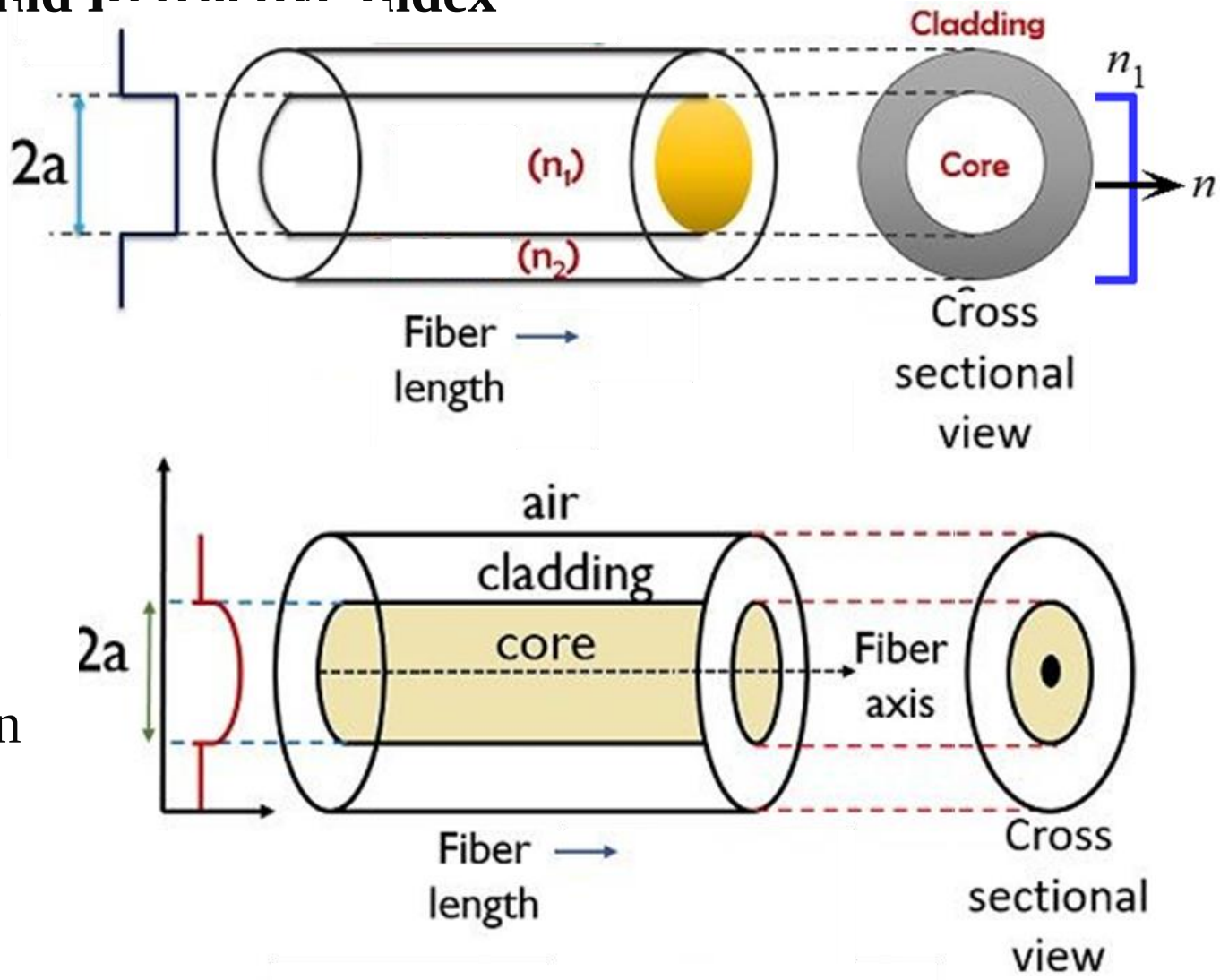


  - **Core Size:** Larger (50 to 62.5 microns).
  - **Characteristics:** Allows multiple paths of light to travel simultaneously.
  - **Best For:** Short distances, such as Local Area Networks (LANs) and data centers.

Different Types of Optical Fiber

Classification by Mode of Propagation and Refractive Index

- **Step-Index vs. Graded-Index Fiber**
  - **Step-Index:** Sharp boundary between core and cladding refractive indices.
  - **Graded-Index:** Refractive index decreases gradually from the center to the edge, reducing signal distortion in multi-mode fibers.



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Applications of Optical Fiber

- **Telecommunications & Internet:**
  - Providing high-speed "Fiber to the Home" (FTTH) and enabling the massive bandwidth required for cloud computing and AI processing.
- **Medical Field:**
  - **Endoscopy:** Flexible fiber bundles allow doctors to view internal organs without invasive surgery.
  - **Laser Surgeries:** Used to deliver precise laser energy for tissue cutting or eye surgery.
- **Military & Aerospace:**
  - Used for secure communication (difficult to tap) and high-performance wiring in aircraft to reduce weight.
- **Industrial Sensing:**
  - **Fiber Optic Sensors:** Used to monitor temperature, pressure, and structural integrity in bridges, pipelines, and smart buildings.
- **Broadcasting:**
  - High-definition (8K and beyond) signal transmission for live sporting events and digital cable TV.

Advantages of Optical Fiber

Why Light Beats Electricity

- **Immense Bandwidth:** Can carry significantly more data than copper cables over the same diameter.
- **Low Attenuation:** Signal loss is minimal, allowing data to travel for kilometers without needing boosters.
- **Electromagnetic Immunity:** Since it transmits light, it is completely immune to electrical interference (EMI) or lightning strikes.
- **Security:** Extremely difficult to "tap" or intercept data without being detected, making it ideal for government and financial sectors.
- **Lightweight & Compact:** Thinner and lighter than traditional metal wiring, saving space in urban infrastructure.

End chapter 7

Video
https://www.youtube.com/watch?v=Yxt72aDjFgY