# Program Information

## Lesson:

### *Fiber Optic Cables*

## Training:

## Fiber Optics

## Time frame:

### 60 minutes

# Instruction Section

## Learning Objectives:

# Identify the types of fiber optic cables and their applications.

# Discuss the specifications for fiber optic cables.

# Identify the differences between outside plant (OSP) and premises cables.

# Explore fiber optic cable design.

## Assessment Tools/Methods:

# Participants should be assessed based on participation in group discussions and activities.

## Learner Prior Knowledge:

## Prior to class, participants will need to read:

## Reference Guide: Fiber Optic Cable (<https://www.thefoa.org/tech/ref/basic/cable.html>)

## Reference Guide: Virtual Hands-On Fiber Optic Cable Prep (<https://www.thefoa.org/tech/ref/cable/Cables/Cables.htm>)

## Prior to class, the participants will need to watch:

## [Fiber Optic Cable, Part 1 Introduction](http://www.youtube.com/watch?v=98tjpKHDgSM)

## [Fiber Optic Cable, Part 2, Zipcord](http://www.youtube.com/watch?v=imZWHNqbFYE)

## [Fiber Optic Cable, Part 3 Distribution Cable](http://www.youtube.com/watch?v=V0EeHsYDXdQ)

## [Fiber Optic Cable, Part 4 Breakout Cable](http://www.youtube.com/watch?v=wei4U-dXG7w)

## [Fiber Optic Cable, Part 5 Loose Tube Cable](http://www.youtube.com/watch?v=VrcJKJhKpc0)

## [Fiber Optic Cable, Part 6, Armored Cable](http://www.youtube.com/watch?v=DdmxQSkssNI)

## Instructional Activities:

# Begin with a brief introduction to fiber optic cables, emphasizing their importance in modern telecommunications and data transmission.

# Activity 1: Cable Types and Applications:

# Divide participants into small groups. Assign each group one of the following cable types: zipcord, distribution, loose tube, breakout.

# Have the groups discuss the following:

# Their assigned cable type’s structure.

# Identify and discuss the specific applications and environments suitable for their cable type.

# Ask them to consider factors like installation environment, moisture, tension, flexibility, and protection.

#  Have each group present their findings to the whole group.

# Activity 2: Fiber Optic Cable Specifications and Design

1. Review specifications for fiber optic cable by asking participants the following questions.
	1. What is the range of core sizes for single-mode and multi-mode fiber? *8-10 microns for SMF; 50 or 62.5 microns for MMF*
	2. What is attenuation? *The loss of signal strength over distance, measured in dB/km.*
	3. What is bandwidth? *The data-carrying capacity, typically higher in SMF.*
	4. What jacket material is typically used? *PVC for indoor, PE for outdoor.*
2. Discuss the key design features of fiber optic cables using the provided information, include participants in discussion as topics are presented.
	1. Strength Members: Materials like aramid yarn or steel are used to provide tensile strength and protect the fibers from mechanical stress. Examples: Kevlar (aramid yarn) is commonly used because of its high tensile strength and light weight.
	2. Buffer Coatings: Primary coatings are applied directly to the fiber to protect it from moisture and physical damage. Secondary coatings (or buffers) add an additional layer of protection. Examples: UV-cured acrylate coatings for primary protection; thermoplastic materials for secondary coatings.
	3. Jacket Types: Jackets protect the cable from environmental factors like moisture, chemicals, and physical damage. Examples: PVC, LSZH (Low Smoke Zero Halogen), polyethylene.
	4. Water Blocking: Techniques to prevent water ingress in OSP cables include using water-swellable tapes, gels, or powders. Importance: Water ingress can cause attenuation and long-term damage to the fibers.
	5. Cable Construction
		1. Loose Tube vs. Tight-Buffered: Loose tube cables have fibers housed in tubes that are filled with a gel or water-blocking material. Tight-buffered cables have fibers coated with a buffer coating for direct termination.
		2. Simplex vs. Duplex: Simplex cables contain a single fiber. Duplex cables contain two fibers, often used for bi-directional communication.
		3. Ribbon Cable Design: Ribbon cables contain multiple fibers arranged in a flat, ribbon-like structure. Advantages: High packing density, easy mass fusion splicing.
3. Highlight why these features are important for ensuring cable performance and reliability.
4. Engage participants in a discussion about the practical implications of these design features.

# Activity 3: Case Study and Real-World Examples

# Follow the instructions on the Real-World Examples/Case Study Instructor Handout to present examples and discussion prompts to the group. Note: Participants can view the examples and case study on the Real-World Examples/Case Study Handout.

# After reading and discussing the examples, ask the participants if there are any other questions or clarifications needed before moving on.

# Ask the participants to work in their small groups, then discuss the case study from the handout.

# Have groups answer the discussion and analysis points and then prepare a summary of their findings.

# Ask groups to share their findings with the whole group; then compare the different solutions found.

# Activity 4: Discussion Prompts

1. Wrap up the lesson with group discussions on the following prompts. Note: Sample answers have been provided on the Discussion Prompt Instructor Handout.
	1. Prompt 1: Discuss the advantages and disadvantages of single-mode versus multi-mode fiber in various applications. What factors influence the choice between the two?
	2. Prompt 2: Compare and contrast the use of fiber optics in telecommunications and internet services. How do these applications differ in their requirements and benefits?
	3. Prompt 3: Explain the importance of attenuation and dispersion in fiber optic communications. How can these issues be mitigated?
	4. Prompt 4: How do different wavelengths impact the performance and use of fiber optic cables? Discuss the significance of 850 nm, 1310 nm, and 1550 nm wavelengths.
	5. Prompt 5: What are the key considerations in deploying fiber optic networks for premises networks, such as universities or hospitals? Discuss the logistical and technical challenges.
	6. Prompt 6: How does FTTH technology improve the quality of life for residents? What are the economic and social implications of widespread FTTH adoption?
2. Before dismissal, answer any remaining questions or concerns from the group.

##  Resources:

# Whiteboard, markers or display to record discussion points

# Real-World Examples/Case Study Participant Handout

# Real-World Examples/Case Study Instructor Handout

# Discussion Prompt Instructor Handout

# Reflection Section

Consider the comprehensive overview of the various types of fiber optic cables, their specific applications, and the critical design features discussed in this lesson. How will you utilize this material in your future work? What questions do you still have regarding the material?

*This lesson is supplemental to the Fiber Optics lesson within FOA's Fiber U curriculum and not part of the FOA required curriculum to obtain the Certified Premises Cabling Technician certification. If interested in becoming an approved school and/or obtaining a certification, please contact FOA at* [*thefoa.org/contact-foa.html*](https://www.thefoa.org/contact-foa.html)*.*

*Note: AI, specifically ChatGPT 3.5, was used to generate scenarios for this contextualized lesson plan.*

# Real-World Examples/Case Study Participant Handout

**Real-World Examples:**

1. Telecommunications:
	* Example: Verizon's deployment of fiber optic networks for 5G connectivity. Fiber optics are essential for the high-speed, low-latency connections required by 5G technology.
	* Discussion Prompt: How does fiber optics enhance the capabilities of modern telecommunications?
2. Internet Services:
	* Example: Google Fiber providing gigabit internet services in select cities. Fiber optics enable incredibly fast internet speeds, supporting high-bandwidth activities like streaming and online gaming.
	* Discussion Prompt: What are the benefits of fiber optic internet services over traditional broadband?
3. CATV:
	* Example: Comcast is using fiber optics to deliver high-definition television and on-demand services. Fiber optics offer high capacity and reliability for cable television providers.
	* Discussion Prompt: How do fiber optics improve the quality and reliability of cable television services?
4. Premises Networks:
	* Example: University campuses are using fiber optics to connect multiple buildings and support high-speed data transfer for academic and research purposes.
	* Discussion Prompt: What advantages do fiber optics offer for large premises networks like universities and hospitals?

**Case Study:**

Case Study: Fiber to the Home Deployment

Scenario: The city of Techville is planning to deploy Fiber to the Home (FTTH) to provide high-speed internet to a new residential development called Green Acres. The current infrastructure primarily relies on older copper-based connections that struggle to meet the growing demand for bandwidth-intensive applications like video streaming, online gaming, and remote work. The city has decided that upgrading to FTTH will address these needs and future-proof the community’s internet capabilities.

Background Information: Techville's existing internet infrastructure consists mostly of DSL and coaxial cable, offering limited speeds and unreliable performance during peak usage times. With the rapid growth of Green Acres and the increasing number of tech-savvy residents, the need for a robust, high-speed internet solution has become apparent. FTTH is seen as the ideal solution, promising symmetrical gigabit speeds, low latency, and high reliability. The city anticipates significant benefits, including enhanced quality of life for residents, improved business operations, and increased property values due to superior connectivity.

Discussion Points to Summarize:

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1. OSP vs. Premises Cables: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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# Real-World Examples/Case Study Participant Handout

 **Group Discussion:**

* After reading and discussing the real-world examples, divide participants into small groups.
* Give the participants a brief overview of the case study found on the Participant Handout.
* Ask groups to discuss and identify the types of fiber optic cables suitable for this deployment. Consider factors such as distance, data rates, and environmental conditions
* Have them compare the differences between OSP and premises cables in the context of this deployment, and decide which types would be used at different stages (e.g., from the central office to the neighborhood, and within individual homes).

 **Scenario Analysis:**

* Each group should analyze the specifications required for the fiber optic cables, such as core size, cladding diameter, attenuation, and bandwidth.
* Discuss the cable design features that would be important for the deployment, such as strength members, buffer coatings, jacket materials, and water-blocking techniques.

 **Presentation and Feedback:**

* Have each group present their findings and proposed solutions to the rest of the class.
* Encourage other participants to ask questions and provide feedback on the proposed solutions.
* Facilitate a discussion on the challenges and considerations involved in the FTTH deployment, highlighting the importance of selecting the right cables and designs for different parts of the network.

# Discussion Prompt Instructor Handout

**Prompt 1: Discuss the advantages and disadvantages of single-mode versus multi-mode fiber in various applications. What factors influence the choice between the two?**

**Sample Answer**: Single-mode fiber is ideal for long-distance communication and high-bandwidth applications because of its low attenuation and high capacity. This makes it suitable for telecommunications and long-haul internet backbone connections. However, it is more expensive due to the precision required in its manufacturing and installation.

Multi-mode fiber, on the other hand, is less costly and easier to work with, making it a good choice for shorter distances, such as within buildings or campuses. It is commonly used in LANs, data centers, and other short-range networking applications. However, it has higher attenuation and dispersion rates, which limit its effectiveness over longer distances.

The choice between single-mode and multi-mode fiber depends on factors such as the required transmission distance, budget, bandwidth needs, and the specific application environment.

**Prompt 2: Compare and contrast the use of fiber optics in telecommunications and internet services. How do these applications differ in their requirements and benefits?**

**Sample Answer**: In telecommunications, fiber optics are used to transmit voice, video, and data over long distances with minimal signal loss. The high bandwidth and low attenuation characteristics of fiber optics make them ideal for the backbone infrastructure of telecommunication networks. The reliability and capacity of fiber optics support the growing demand for high-speed communication.

In internet services, fiber optics provide the backbone for data transmission, supporting high-speed internet access and enabling broadband services like FTTH (Fiber to the Home). Fiber optics allow for greater data transfer rates and more reliable connections compared to traditional copper cables. This is crucial for supporting modern applications that require large amounts of data, such as streaming services, online gaming, and cloud computing.

While both applications benefit from the high capacity and low latency of fiber optics, telecommunications often focus on long-distance transmission and network reliability, whereas internet services prioritize high-speed access and data volume.

**Prompt 3: Explain the importance of attenuation and dispersion in fiber optic communications. How can these issues be mitigated?**

**Sample Answer**: Attenuation and dispersion are critical factors in fiber optic communications. Attenuation refers to the loss of signal strength as light travels through the fiber, which can limit the transmission distance. Dispersion causes the spreading of light pulses, leading to potential signal overlap and degradation, which can affect data integrity and bandwidth.

Mitigating attenuation involves using high-quality fibers with low attenuation rates and employing signal boosters or amplifiers at intervals to maintain signal strength over long distances. Using wavelengths with lower attenuation rates, such as 1550 nm, also helps reduce signal loss.

To mitigate dispersion, dispersion-shifted fibers or techniques like dispersion compensation can be used. Maintaining proper fiber installation and minimizing bends and splices can also help reduce dispersion effects. By addressing these issues, the performance and reliability of fiber optic communication systems can be significantly improved.

**Prompt 4: How do different wavelengths impact the performance and use of fiber optic cables? Discuss the significance of 850 nm, 1310 nm, and 1550 nm wavelengths.**

**Sample Answer**: Different wavelengths impact the performance of fiber optic cables in terms of attenuation and dispersion. The 850 nm wavelength is commonly used in multi-mode fibers for short-distance applications, such as within buildings or data centers, due to its compatibility with cheaper light sources like LEDs.

The 1310 nm wavelength is often used in single-mode fibers for intermediate-distance transmission. It has relatively low attenuation and is less affected by dispersion, making it suitable for metropolitan area networks and shorter long-haul applications.

The 1550 nm wavelength is preferred for long-distance single-mode fiber applications, such as undersea cables and long-haul telecommunications. This wavelength has the lowest attenuation and can support high data rates over extended distances. Additionally, the use of erbium-doped fiber amplifiers (EDFAs) is most effective at 1550 nm, allowing for signal boosting without electronic conversion.

Understanding these wavelength characteristics helps in designing and optimizing fiber optic communication systems for specific applications and distances.

**Prompt 5: What are the key considerations in deploying fiber optic networks for premises networks, such as universities or hospitals? Discuss the logistical and technical challenges.**

**Sample Answer**: Deploying fiber optic networks for premises networks like universities or hospitals involves several key considerations. Logistically, it requires careful planning to minimize disruption during installation. This includes coordinating with facility management, planning for trenching or conduit placement, and ensuring compliance with building codes and regulations.

Technically, the network design must consider the required bandwidth, distance between network nodes, and future scalability. Selecting the appropriate type of fiber (single-mode or multi-mode) based on the application and distance is crucial. Additionally, ensuring proper termination and splicing techniques is important to maintain signal integrity.

Challenges include managing the physical installation in existing buildings, where running new cables can be difficult and costly. Ensuring compatibility with existing network infrastructure and devices is also important. Moreover, providing redundancy and ensuring network security are critical in environments where network reliability is paramount, such as in hospitals.

Addressing these considerations and challenges is essential for successful deployment and operation of fiber optic networks in such environments.

**Prompt 6: How does FTTH technology improve the quality of life for residents? What are the economic and social implications of widespread FTTH adoption?**

**Sample Answer**: FTTH (Fiber to the Home) technology significantly improves the quality of life for residents by providing high-speed internet access directly to their homes. This enables faster download and upload speeds, more reliable connections, and the ability to support multiple high-bandwidth applications simultaneously, such as streaming, online gaming, teleworking, and smart home technologies.

Economically, widespread FTTH adoption can drive innovation and growth by enabling businesses to operate more efficiently and facilitating the development of new services and industries. It can attract investment and improve property values in connected areas. Additionally, FTTH infrastructure can create jobs related to network deployment, maintenance, and support.

Socially, FTTH enhances access to education, healthcare, and government services by enabling remote learning, telemedicine, and e-government initiatives. It can bridge the digital divide, providing underserved communities with the same opportunities as urban areas. Improved connectivity fosters social inclusion and allows residents to stay connected with family and friends, regardless of geographical distance.

Overall, FTTH adoption has far-reaching positive impacts on both individuals.