# Program Information

## Lesson:

### *Fiber Optic Network Design*

## Training:

## Fiber Optics

## Time frame:

### 60 minutes

# Instruction Section

## Learning Objectives:

# Define fiber optic network design.

# Identify what is involved in fiber optic network design.

# Explain how a project develops from idea to installation.

# Discuss how to choose equipment and components for the network.

# Describe how to plan for and complete an installation.

## 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 Network Design (<https://www.thefoa.org/tech/ref/basic/design.html>)

## Reference Guide: Link Loss Budget (<https://www.thefoa.org/tech/lossbudg.htm>)

## Reference Guide: Project Paperwork (<https://www.thefoa.org/tech/ref/install/paperwork.html>)

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

## [FOA Lecture 9: Fiber Optic Network Design, Part 1](http://www.youtube.com/watch?v=4yKrZ3kXM04&list=PLC7CC6B17EF009849&index=18&feature=plpp_video)

## [FOA Lecture 10: Fiber Optic Network Design Part 2](http://www.youtube.com/watch?v=LKi7f2ty7jw&list=PLC7CC6B17EF009849&index=17&feature=plpp_video)

## [FOA Lecture 11: Fiber Optic Network Design Part 3](http://www.youtube.com/watch?v=Pyi4jxHDLP4&feature=plcp&context=C3b71f8eUDOEgsToPDskIyVZw1Wg6BkJ3Swm2VJzi4)

## [FOA Lecture 26: Loss Budgets](http://www.youtube.com/watch?v=as6AXnGjdUE)

## Instructional Activities:

# Explain that by the end of the session, learners will have a comprehensive understanding of fiber optic network design, including the planning, components, and execution of a network project.

# Activity 1: Understanding Fiber Optic Network Design:

# Ask participants to work together to define fiber optic design and explain its importance.

# Sample answers may include: Fiber optic network design involves planning and implementing a network that uses fiber optic cables to transmit data. It requires understanding both technical specifications and practical considerations

# Discuss technical specifications such as bandwidth, distance, and data rate with the group.

#  Ask participants to discuss practical considerations such as cost, installation environment, and future scalability in projects.

# Activity 2: Fiber Optic Network Case Study

1. Have participants split into small groups, then present the case study from the Case Study 1 Worksheet:
	1. **Scenario:** A university is upgrading its network to support high-speed internet and advanced technologies across its campus. The project involves designing and installing a fiber optic network to connect academic buildings, residential halls, and administrative offices.
2. Ask participants to consider the case study and discuss potential answers for the tasks on the worksheet.
3. Allow groups to share their findings and discuss differences between the group answers.

# Activity 3: Components of Fiber Optic Network Design

1. Discuss the following key components of fiber optic network design with the group.
	1. Fiber optic cables: Singlemode vs multi-mode
	2. Connectors and splices: Types and methods
	3. Equipment: Transmitters, receivers, and amplifiers
	4. Support structures: Racks, trays, and enclosures
2. Explain to participants that they will explore the decision-making process for selecting the appropriate equipment and components in fiber optic network design by working in small groups to consider the following scenario:
	1. **Scenario:** Your team has been assigned to design a fiber optic network for a new office building that will support both high-speed data transfer and video conferencing capabilities. The network needs to connect multiple floors and accommodate future expansion.
3. Ask the groups to discuss factors to consider when choosing between singlemode and multi-mode fiber for the network. What are advantages and disadvantages to each?
4. Which types of fiber optic connectors (SC, LC, ST, MTP/MPO) do they feel would be most suitable for this office building? Explain their choices based on network needs to the group.
5. What criteria should be used to select the switches and routers for the network?
6. How do the groups feel they should design the network to accommodate for future growth?
7. Facilitate a class-wide discussion on the different choices and trade-offs. Compare the groups’ approaches and highlight key considerations for selecting equipment and components in fiber optic network design.

# Activity 4: What a Designer Needs to Know

1. Ask participants to list factors they feel are important for network designers to understand.
	1. Answers may include: Network bandwidth requirements, site conditions, and standards and regulations.
2. Present the prompt, “What knowledge or skills might be lacking in your current role that are crucial for network design?” to the group.
3. Address any participant questions or concerns that are raised after participants discuss their thoughts.

# Activity 5: From Idea to Installation

1. With the whole group, discuss the various stages of project development; initiation, planning, design, and implementation.
2. Divide participants into small groups, assigning each group a stage of project development from the Project Development Handout.
3. Have the groups define, list key activities, and give examples for their stage of development.
4. Have groups share their findings, encouraging all participants to take notes on the findings from each group on the Handout.
5. Discuss key considerations during each stage of the project development process.
6. Engage participants in a discussion on how effective stakeholder engagement can impact the success of a fiber optic project.

# Activity 6: Planning and Completing an Installation

1. Ask participants to discuss why key aspects of the installation planning are important.
	1. Site preparation: Ensure the site is ready for installation.
	2. Scheduling: Coordinate with other contractors and stakeholders.
	3. Safety: Follow safety protocols and standards.
2. Provide participants with the Fiber Optic Network Design Installation Checklist.
3. Ask them to review and identify any additional items or steps that should be included on the checklist.
4. Discuss with the group the importance of following a procedure when planning and completing an installation.
5. Ask participants to work in small groups one final time to work through the Case Study 2 Handout.
6. Following group work time, talk through each section with the participants answering any questions or clarifications they may have.
7. Wrap up the lesson by reviewing the importance of the steps and stages of network design.

##  Resources:

# Whiteboard, markers or display to record discussion points

# Case Study 1 Worksheet

# Fiber Optic Network Design Installation Checklist

# Case Study 2 Worksheet

# Reflection Section

Think about the most challenging project you've managed. How did you handle the critical steps and considerations, and how would those strategies translate to designing and implementing a fiber optic network, from site surveys to staff training?

*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.*

# Case Study 1 Worksheet

Use the tasks below as prompts to consider in the fiber optic network design.

**Scenario:** A university is upgrading its network to support high-speed internet and advanced technologies across its campus. The project involves designing and installing a fiber optic network to connect academic buildings, residential halls, and administrative offices.

**Tasks:**

1. **Planning:**
	* Assess the campus layout and current infrastructure.
	* Determine bandwidth requirements for academic and administrative purposes.
	* Plan for future expansion and scalability.
2. **Design:**
	* Choose appropriate fiber types for different areas (e.g., single-mode for long-distance links, multi-mode for shorter, intra-building connections).
	* Design the network topology, including cable routes and equipment locations.
	* Select equipment (e.g., switches, routers) and components (e.g., connectors, splices).
3. **Implementation:**
	* Install fiber optic cables, ensuring proper routing and securing.
	* Connect and test all components.
	* Validate performance and address any issues.

**Discussion Questions:**

* What specific design considerations are important for connecting multiple buildings on a campus?
* How would the design approach differ between high-demand academic buildings and lower-demand residential halls?

# Fiber Optic Network Design Installation Checklist

**1. Planning Stage**

* **Define Requirements:**
	+ Network capacity (bandwidth)
	+ Distance and coverage area
	+ Future scalability and expansion needs
* **Assess Site:**
	+ Physical layout
	+ Existing infrastructure
	+ Environmental conditions (temperature, humidity)
* **Create Initial Design:**
	+ Preliminary network layout
	+ Cable routing and placement
	+ Equipment placement

**2. Design Stage**

* **Detailed Planning:**
	+ Finalize network layout and component selection
	+ Define detailed specifications for cables, connectors, and equipment
* **Choose Components:**
	+ Fiber types (single-mode, multi-mode)
	+ Connectors (SC, LC, ST, MTP/MPO)
	+ Equipment (transceivers, switches, routers)
* **Create Detailed Drawings:**
	+ Network topology diagrams
	+ Cable routing plans
	+ Equipment placement diagrams

**3. Implementation Stage**

* **Site Preparation:**
	+ Ensure site readiness (cleared pathways, access to power)
	+ Coordinate with other contractors or stakeholders
* **Installation:**
	+ Route and secure cables
	+ Install connectors and splices
	+ Mount and connect equipment
* **Testing:**
	+ Perform initial testing (continuity, signal strength)
	+ Validate performance against specifications

**4. Post-Installation Stage**

* **Final Adjustments:**
	+ Address any issues identified during testing
	+ Optimize network performance
* **Documentation:**
	+ Update network diagrams
	+ Document installation details and test results
* **Training and Handover:**
	+ Provide training to end-users or maintenance personnel
	+ Handover documentation and equipment

# Case Study 2 Worksheet

Use the information from the Fiber Optic Network Installation Checklist to help your group determine answers to the questions for each section relating to the scenario.

**Scenario:** A mid-sized technology company plans to install a fiber optic network to connect multiple office buildings within their campus. The project aims to enhance data communication, increase internet speeds, and ensure reliable connectivity across all departments. The company has decided to hire a team of fiber optic technicians to manage the project from initiation to maintenance.

**1. Initiation: Identifying Needs and Feasibility**

**Objective:** Determine the necessity and feasibility of the project.

**Steps:**

* **Needs Assessment:** Conduct interviews with department heads to understand data communication requirements.
* **Feasibility Study:** Evaluate the technical and financial feasibility of the project.
	+ **Technical Feasibility:** Assess the current infrastructure and determine if it can support the new fiber optic network.
	+ **Financial Feasibility:** Estimate the budget for the project, including equipment, labor, and other resources.
* **Stakeholder Approval:** Present the findings to stakeholders and secure approval for the project.

**Discussion Points:**

* What key factors should be considered in the needs assessment? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* How do you determine the technical and financial feasibility of a fiber optic network project?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**2. Planning: Designing Network Layout and Setting Up Timelines**

**Objective:** Develop a comprehensive project plan.

**Steps:**

* **Site Survey:** Conduct a detailed site survey to map out the network layout.
	+ **Considerations:** Building locations, existing pathways, potential obstacles, and future expansion plans.
* **Network Design:** Create a preliminary network design, including cable routes, connection points, and equipment locations.
* **Timeline Development:** Set up a realistic project timeline with milestones.
	+ **Example Milestone:** Completion of site survey, delivery of materials, and installation phases.
* **Resource Allocation:** Identify and allocate resources, including personnel, equipment, and budget.
	+ **Tools:** Project management software to track progress and manage tasks.

**Discussion Points:**

* What are the critical elements to consider when conducting a site survey?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* How do you ensure the project timeline is realistic and achievable?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**3. Design: Finalizing Network Design and Calculating Loss Budget**

**Objective:** Develop a detailed network design and loss budget.

**Steps:**

* **Detailed Network Design:** Finalize the network design, including fiber types, connector types, and equipment specifications.
* **Loss Budget Calculation:** Calculate the total optical loss for the network to ensure it meets performance standards.
	+ **Considerations:** Connector losses, splice losses, cable attenuation, and margin for future expansions.
* **Compliance Check:** Ensure the design complies with industry standards and regulations.

**Discussion Points:**

* What factors influence the loss budget in a fiber optic network?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* How can you ensure that the network design complies with industry standards?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**4. Implementation: Installing Cables and Configuring Equipment**

**Objective:** Execute the installation of the fiber optic network.

**Steps:**

* **Pre-Installation Checklist:** Verify all materials and equipment are ready for installation.
* **Cable Installation:** Follow best practices for laying cables, including proper handling and routing.
* **Splicing and Termination:** Perform splicing and termination of fiber optic cables.
	+ **Tools:** Fusion splicer, mechanical splicer, and termination kits.
* **Equipment Configuration:** Install and configure network equipment, such as switches, routers, and transceivers.
* **Quality Assurance:** Conduct initial tests to verify installation quality and performance.

**Discussion Points:**

* What are the key steps in the cable installation process?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* How do you ensure the quality and reliability of splicing and termination?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**5. Handover: Final Tests and Staff Training**

**Objective:** Complete the project and prepare the staff for operation.

**Steps:**

* **Final Testing:** Perform comprehensive tests to verify network performance and reliability.
	+ **Example Tests:** Optical Time-Domain Reflectometer (OTDR) testing, insertion loss testing, and end-to-end testing.
* **Documentation:** Compile all project documentation, including network diagrams, test results, and compliance reports.
* **Training:** Conduct training sessions for the staff on network operation and maintenance.
	+ **Training Topics:** Basic network troubleshooting, equipment operation, and safety practices.
* **Project Handover:** Officially hand over the network to the client with a final report.

**Discussion Points:**

* What are the essential tests to conduct during the final testing phase?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* How can you ensure that the staff is adequately trained to operate and maintain the network?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**6. Maintenance: Regular Checks and Upgrades**

**Objective:** Ensure ongoing network performance and plan for future upgrades.

**Steps:**

* **Scheduled Maintenance:** Develop a maintenance schedule for regular checks and preventive measures.
	+ **Example Task:** Monthly inspection of cable integrity and equipment performance.
* **Performance Monitoring:** Implement monitoring tools to track network performance and detect issues.
	+ **Tools:** Network monitoring software and periodic performance audits.
* **Upgrades and Expansion:** Plan for future upgrades and network expansion based on organizational needs.
	+ **Example Plan:** Outline steps for adding new connections or upgrading equipment as technology evolves.

**Discussion Points:**

* What are the key components of a regular maintenance schedule?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* How can you effectively plan for network upgrades and expansions?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_