Module Overview

This module introduces the trainee to networks, the communication links between two or more intelligent devices or components within a computer system. The bus, or data bus, provides the communication pathway for all the devices within the network.

Prerequisites

Prior to training with this module, it is recommended that the trainee shall have successfully completed Core Curriculum; Electronic Systems Technician Level One; and Electronic Systems Technician Level Two.

Objectives

Upon completion of this module, the trainee will be able to do the following:

1. Describe the characteristics, connections, and uses for various types of data transmission media.
2. Explain the operating principles of network topologies.
3. Explain how information is transferred using different network topologies.
4. Explain device communication in an addressable network.
5. Describe the functions of routers.
6. Identify the protocols used with networks.
7. Explain power line carrier communications.

Performance Tasks

Under the supervision of the instructor, the trainee should be able to do the following:

1. Identify IP addresses of the devices on a network.
2. Demonstrate various procedures for troubleshooting media access problems to a network.
3. Design a basic network.
4. Demonstrate PC configuration of IP and serial connections.

Materials and Equipment

- Markers/chalk
- Pencils and scratch paper
- Whiteboard/chalkboard
- Multimedia projector and screen
- Computer
- Diagrams of various network topologies
- RS-232 cable
- USB cable
- Sufficient networked computers with Internet access
- Computers networked with peripheral devices
- Network router
- Computer equipped with LINUX®, UNIX®, or Mac OS® (if available)
- Access to a website
- Special receiver module for controlling lighting and appliances
- POE network switch
- Equipment and computers for setting up a network
- Module Examination*
- Performance Profile Sheets*

* Single-module AIG purchases include the printed exam and performance task sheet. If you have purchased the perfect-bound version of this title, download these materials from the IRC using your access code.
Safety Considerations

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. Review safety guidelines associated with working on electrical and electronic systems. Emphasize the importance of proper housekeeping.

Additional Resources

This module presents thorough resources for task training. The following resource material is suggested for further study.


Teaching Time for This Module

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 25 hours are suggested to cover *Buses and Networks*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Planned Time</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Session I.</strong> Introduction; Data Highway; Transfer Medium; OSI Model; Relating Network Protocols to the OSI Model</td>
<td></td>
</tr>
<tr>
<td>A. Introduction</td>
<td></td>
</tr>
<tr>
<td>1. History of Networking</td>
<td></td>
</tr>
<tr>
<td>B. The Data Highway</td>
<td></td>
</tr>
<tr>
<td>1. Serial Communication</td>
<td></td>
</tr>
<tr>
<td>2. Parallel Communication</td>
<td></td>
</tr>
<tr>
<td>3. Data Buses</td>
<td></td>
</tr>
<tr>
<td>C. Transfer Medium</td>
<td></td>
</tr>
<tr>
<td>D. OSI Reference Model</td>
<td></td>
</tr>
<tr>
<td>1. Protocols</td>
<td></td>
</tr>
<tr>
<td>E. Relating Network Protocols to the OSI Model</td>
<td></td>
</tr>
<tr>
<td>1. Network-LLC Service Interface</td>
<td></td>
</tr>
<tr>
<td>2. LLC-MAC Service Interface</td>
<td></td>
</tr>
<tr>
<td>3. Physical Medium Functions</td>
<td></td>
</tr>
<tr>
<td><strong>Session II.</strong> Network Topologies; Access Control; Security</td>
<td></td>
</tr>
<tr>
<td>A. Network Topologies</td>
<td></td>
</tr>
<tr>
<td>1. Star Topology</td>
<td></td>
</tr>
<tr>
<td>2. Ring Topology</td>
<td></td>
</tr>
<tr>
<td>3. Bus Topology</td>
<td></td>
</tr>
<tr>
<td>4. Hybrid Topologies</td>
<td></td>
</tr>
<tr>
<td>B. Network Access Control</td>
<td></td>
</tr>
<tr>
<td>1. Random Access</td>
<td></td>
</tr>
<tr>
<td>2. Polling</td>
<td></td>
</tr>
<tr>
<td>3. Dedicated Channel</td>
<td></td>
</tr>
<tr>
<td>4. Token Passing</td>
<td></td>
</tr>
<tr>
<td>C. Network Security</td>
<td></td>
</tr>
<tr>
<td>1. Firewalls</td>
<td></td>
</tr>
<tr>
<td>2. Antivirus Software</td>
<td></td>
</tr>
</tbody>
</table>
Session III. The Internet

A. The Internet
   1. Background
   2. Transmission Control Protocol/Internet Protocol (TCP/IP)
   3. Internet Application Protocols

B. Laboratory
   Have trainees identify IP addresses of the devices on a network. This laboratory corresponds to Performance Task 1.

Sessions IV and V. Ethernet

A. Ethernet

B. Laboratory
   Have trainees design a basic network. This laboratory corresponds to Performance Task 3.

Session VI. Microcomputer-Based LANs; Routers, Bridges, and Gateways

A. Microcomputer-Based LANs
   1. Basic Input/Output Systems (BIOS)
   2. Operating Systems
   3. Networking Software; Network Operating Systems
   4. Real-Time Performance Issues

B. Routers, Bridges, and Gateways
   1. Routers
   2. Bridges
   3. Gateways
   4. Repeaters

Session VII. Addressable Systems

A. Addressable Systems
   1. Analog Addressable Systems

B. Laboratory
   Have trainees demonstrate PC configuration of IP and serial connections. This laboratory corresponds to Performance Task 4.

Sessions VIII and IX. PLC Systems; POE Systems

A. Power Line Carrier (PLC) Systems

B. Power Over Ethernet (POE) Systems

C. Laboratory
   Have trainees demonstrate various procedures for troubleshooting media access problems to a network. This laboratory corresponds to Performance Task 2.

Session X. Review and Testing

A. Review

B. Module Examination
   1. Trainees must score 70% or higher to receive recognition from NCCER.
   2. Record the testing results on Training Report Form 200 and submit the results to the Training Program Sponsor.

C. Performance Testing
   1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements.
   2. Record the testing results on Training Report Form 200 and submit the results to the Training Program Sponsor.
Module Overview

This module introduces the trainee to the types of equipment and methods used in fiber optic cable installation.

Prerequisites

Prior to training with this module, it is recommended that the trainee shall have successfully completed Core Curriculum; Electronic Systems Technician Level One; Electronic Systems Technician Level Two; and Electronic Systems Technician Level Three; Module 33301-11.

Objectives

Upon completion of this module, the trainee will be able to do the following:

1. Explain the basic principles of fiber optic systems.
2. Identify the uses of various types of fiber optic cables and devices.
3. Explain the features of fiber optic connectors and splices.
4. Describe the design, operation, and performance of a fiber optic system.
5. Explain the requirements for installation of fiber optic cabling and support equipment.
6. Perform a fiber optic termination.
7. Test a fiber optic link.

Performance Tasks

Under the supervision of the instructor, the trainee should be able to do the following:

1. Perform a fiber optic termination.
2. Test a fiber optic link.

Materials and Equipment

Markers/chalk
Pencils and scratch paper
Whiteboard/chalkboard
EST Level Three PowerPoint® Presentation Slides
Multimedia projector and screen
Computer
100- to 200-power microscope
Several pieces of optical fiber with the buffer removed from the ends
Selection of typical cables
Selection of different cables, including simplex, duplex, and multi-fiber
Ribbon cable
Several fibers with different color-coded coatings and buffers
LEDs
Several types of laser beams
One or more VCSELs
Examples of spliced or connected fibers
Examples of passive splitter configurations
Manufacturers’ spec sheets for fiber optic cables
Standard and duplex fiber optic cable samples
Selection of distribution hardware:
   - Rack box
   - Patch panel
   - Junction box
Parts and tools to terminate fiber optic cables
   - Fiber optic patch cable with connectors and pigtails
Selection of common connectors
Selection of older types of connectors
Samples of the most common connectors, including PCs, APCs, UPCs, and SPCs
Fiber optic stripping tools
Fiber optic strands
OTDR
Fiber cleavers

continued
Polishing paper and other supplies as required  
Splicing tools  
Mechanical splicing kit, if available  
Optical power meter

* Single-module AIG purchases include the printed exam and performance task sheet. If you have purchased the perfect-bound version of this title, download these materials from the IRC using your access code.

**Safety Considerations**

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. Review safety guidelines associated with working with fiber optic cable. Emphasize the importance of proper housekeeping.

**Additional Resources**

This module presents thorough resources for task training. The following resource material is suggested for further study.

* The Fiber Optic Association website (www.thefoa.org) contains a variety of information and links for fiber optic equipment, cables, and termination procedures.
* OSHA guidelines on laser hazards can be found at: www.osha.gov.

**Teaching Time for This Module**

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 25 hours are suggested to cover Fiber Optics. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Planned Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Session I. Introduction; Fiber Optics Theory</td>
<td></td>
</tr>
<tr>
<td>A. Introduction</td>
<td></td>
</tr>
<tr>
<td>1. Benefits</td>
<td></td>
</tr>
<tr>
<td>2. Applications</td>
<td></td>
</tr>
<tr>
<td>B. Fiber Optics Theory</td>
<td></td>
</tr>
<tr>
<td>1. Light Generation and Coupling</td>
<td></td>
</tr>
<tr>
<td>2. Light Transmission</td>
<td></td>
</tr>
<tr>
<td>3. Operational Considerations</td>
<td></td>
</tr>
</tbody>
</table>
Sessions II and III. Fiber Optic Components; Understanding Light Transmission

A. Fiber Optic Components
   1. Optical Fiber
   2. Cabling
   3. Types of Cables
   4. Cable Characteristics

B. Understanding Light Transmission
   1. Signal Types
   2. Speed
   3. Light Sources

Sessions IV and V. Receivers; Connectors, Splices, and Splitters; Installation

A. Receivers
   1. Basic Receiver Elements
   2. Speed

B. Connectors, Splices, and Splitters
   1. Connectors and Splices
   2. Connector Requirements
   3. Causes of Connection Losses
   4. Splices
   5. Splitters

C. Installation
   1. Direct and Indirect Burial Installation
   2. Aerial Installation
   3. Indoor Installation
   4. Tray and Duct Installation
   5. Conduit Installation
   6. Blown Fiber
   7. Pulling Fiber Optic Cables
   8. Enclosures and Organizers
   9. Distribution Hardware

Sessions VI–VIII. Terminating Optical Fiber Cable

A. Terminating Optical Fiber Cable
   1. Mechanical Considerations
   2. Basic Connector Structure
   3. Connector Installation: Field vs. Factory
   4. Fiber Connectors
   5. Connector Installation

B. Laboratory
   Have trainees perform a fiber optic termination. This laboratory corresponds to Performance Task 1.
Session IX. Splicing; Fiber Optic Testing

A. Splicing
   1. Applications of Fiber Splices
   2. Types of Splicing
   3. Splicing Issues

B. Fiber Optic Testing
   1. Optical Power Meter
   2. Insertion Loss Testing and Mode Control
   3. Fiber Loss Measurements
   4. Time and Frequency Domains
   5. Optical Time-Domain Reflectometry

C. Laboratory
   Have the trainees perform a light-loss test on a fiber optic link.
   This laboratory corresponds to Performance Task 2.

Session X. Review and Testing

A. Review

B. Module Examination
   1. Trainees must score 70% or higher to receive recognition from NCCER.
   2. Record the testing results on Training Report Form 200 and submit the
      results to the Training Program Sponsor.

C. Performance Testing
   1. Trainees must perform each task to the satisfaction of the instructor to receive
      recognition from NCCER. If applicable, proficiency noted during laboratory
      exercises can be used to satisfy the Performance Testing requirements.
   2. Record the testing results on Training Report Form 200 and submit the results
      to the Training Program Sponsor.
Module Overview

This module introduces the trainee to wireless communications, in which voice and data signals are carried through the air. Examples of wireless communications include radio, cell phones, wireless Internet, and television sets that receive signals through antennas.

Prerequisites

Prior to training with this module, it is recommended that the trainee shall have successfully completed Core Curriculum; Electronic Systems Technician Level One; Electronic Systems Technician Level Two; and Electronic Systems Technician Level Three; Modules 33301-11 and 33302-11.

Objectives

Upon completion of this module, the trainee will be able to do the following:

1. Describe the different types of wireless communication.
2. Describe the limitations of wireless communication.
3. Identify the basic components used in wireless systems and explain the function of each.
4. Identify the equipment used when testing and troubleshooting wireless communication systems.
5. Identify interfering factors in wireless communication systems.
6. Describe the placement and function of an antenna.

Performance Tasks

This is a knowledge-based module; there are no performance tasks.

Materials and Equipment

<table>
<thead>
<tr>
<th>Markers/chalk</th>
<th>Selection of diodes, including a laser diode and an IR LED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pencils and scratch paper</td>
<td>IR remote audio and video system</td>
</tr>
<tr>
<td>Whiteboard/chalkboard</td>
<td>Microwave oven and a working wireless LAN device</td>
</tr>
<tr>
<td>Multimedia projector and screen</td>
<td>RF analyzer</td>
</tr>
<tr>
<td>Computer</td>
<td>Several NEC® handbooks</td>
</tr>
<tr>
<td>Antenna manufacturer’s installation instructions</td>
<td>Antenna manufacturer’s installation instructions</td>
</tr>
<tr>
<td>A piece of waveguide</td>
<td>Module Examination*</td>
</tr>
<tr>
<td>A transmitter and a receiver</td>
<td></td>
</tr>
</tbody>
</table>

* Single-module AIG purchases include the printed exam and performance task sheet. If you have purchased the perfect-bound version of this title, download these materials from the IRC using your access code.

Safety Considerations

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. Review safety guidelines associated with working on electrical and electronic systems. Emphasize the importance of proper housekeeping.
This module presents thorough resources for task training. The following resource material is suggested for further study.


### Teaching Time for This Module

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 10 hours are suggested to cover *Wireless Communication.* You will need to adjust the time required for hands-on activity and testing based on your class size and resources.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Planned Time</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Session I. Introduction; Wireless Communication Principles; Radio Frequency (RF) Systems</strong></td>
<td></td>
</tr>
<tr>
<td>A. Introduction</td>
<td></td>
</tr>
<tr>
<td>B. Wireless Communication Principles</td>
<td></td>
</tr>
<tr>
<td>1. Modulation</td>
<td></td>
</tr>
<tr>
<td>2. Analog and Digital Signals</td>
<td></td>
</tr>
<tr>
<td>3. Multiplexing</td>
<td></td>
</tr>
<tr>
<td>C. Radio Frequency (RF) Systems</td>
<td></td>
</tr>
<tr>
<td>1. Transmitters</td>
<td></td>
</tr>
<tr>
<td>2. Receivers</td>
<td></td>
</tr>
<tr>
<td>3. Transceivers</td>
<td></td>
</tr>
<tr>
<td>4. Repeaters</td>
<td></td>
</tr>
<tr>
<td>5. Waveguide</td>
<td></td>
</tr>
<tr>
<td>6. Antennas</td>
<td></td>
</tr>
<tr>
<td>7. Voltage Standing Wave Ratio (VSWR)</td>
<td></td>
</tr>
<tr>
<td><strong>Session II. Infrared (IR) Systems; Wireless Computer Networks; Satellite Communications</strong></td>
<td></td>
</tr>
<tr>
<td>A. Infrared (IR) Systems</td>
<td></td>
</tr>
<tr>
<td>1. Basic IR Components</td>
<td></td>
</tr>
<tr>
<td>2. Remote Control Circuits</td>
<td></td>
</tr>
<tr>
<td>3. Remote Control Distribution Systems</td>
<td></td>
</tr>
<tr>
<td>4. RS-232 Data Transmission Interface Systems</td>
<td></td>
</tr>
<tr>
<td>B. Wireless Computer Networks</td>
<td></td>
</tr>
<tr>
<td>1. Background</td>
<td></td>
</tr>
<tr>
<td>2. Wireless LAN Equipment</td>
<td></td>
</tr>
<tr>
<td>3. Wireless Network Security</td>
<td></td>
</tr>
<tr>
<td>C. Satellite Communications</td>
<td></td>
</tr>
<tr>
<td>1. Satellite Communication System Overview</td>
<td></td>
</tr>
<tr>
<td>2. Areas of Service</td>
<td></td>
</tr>
<tr>
<td>3. Satellite Orbits</td>
<td></td>
</tr>
</tbody>
</table>
Session III. Test Equipment; Antenna Installation; Noise/Electromagnetic Interference

A. Test Equipment
   1. RF Field Strength Analyzer
   2. RF Analyzer/Standing Wave Meter
   3. RF Power Meter
   4. Satellite Tester

B. Antenna Installation
   1. Antenna Placement

C. Noise/Electromagnetic Interference

Session IV. Review and Testing

A. Review

B. Module Examination
   1. Trainees must score 70% or higher to receive recognition from NCCER.
   2. Record the testing results on Training Report Form 200 and submit the results to the Training Program Sponsor.
Module Overview

This module covers the tasks involved in planning a job from start to finish, including how to perform site surveys for both new and retrofit construction projects. The different kinds of drawings, specifications, and other documents commonly used while performing these tasks are also covered.

Prerequisites

Prior to training with this module, it is recommended that the trainee shall have successfully completed Core Curriculum; Electronic Systems Technician Level One; Electronic Systems Technician Level Two; and Electronic Systems Technician Level Three; Modules 33301-11 through 33303-11.

Objectives

Upon completion of this module, the trainee will be able to do the following:

1. Describe the general procedure or steps involved when estimating a job for the purpose of submitting a bid.
2. Describe the general procedure or steps required to properly plan and complete a job once a contract for the job has been awarded.
3. Interpret contractual documents, working drawings, and specifications pertaining to a job to determine the requirements and scope of the work.
4. Perform a site survey in order to establish or confirm the installed locations of new and/or existing equipment and the routing of the related cabling.
5. Develop a schedule for completing a job or task from start to finish that efficiently accomplishes the work and is also compatible with the work performed by other trades.
6. Recognize and interpret the various types of forms and other documentation used when estimating and planning a project.

Performance Tasks

Under the supervision of the instructor, the trainee should be able to do the following:

1. Interpret contract documents in order to determine the requirements for a selected job.
2. Perform a survey in order to accomplish the following:
   • Compare the working drawings for the site against the actual building structure to identify specific locations and the work to be performed there.
   • Confirm the installed locations of new and/or existing equipment and the routing of the related cabling.
   • Measure the routing and length of selected cable pathways and raceways to verify measurements shown on floor plans and/or estimate takeoff sheets.
3. Use task and labor hours data recorded on estimating forms and/or takeoff sheets for a selected job to develop a detailed schedule for accomplishing the job.

Materials and Equipment

Markers/chalk
Pencils and scratch paper
Whiteboard/chalkboard
Multimedia projector and screen
Computer
Appropriate personal protective equipment
Complete set of construction drawings
Examples of as-built drawings
Examples of CSI-formatted specifications
Copy of a typical scope of work
Examples of typical contract documents:
  Addenda
  Liens
  Stop-work orders
  RFs
  Change orders
  Project logs
  Punch list

continued
Support equipment for site survey:
- Ladders
- Flashlight
- Measuring device (wheel/50' tape/laser)
- Handheld tape recorder
- Still or video camera
- Architect's rule
Examples of graphic-type and text-type project schedules
Examples of typical purchase orders
Examples of typical material safety data sheets
Personal computer with project scheduling software (optional)

* Single-module AIG purchases include the printed exam and performance task sheet. If you have purchased the perfect-bound version of this title, download these materials from the IRC using your access code.

**Safety Considerations**

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. Review safety guidelines associated with working on electrical and electronic systems. Emphasize the importance of proper housekeeping.

**Additional Resources**

This module presents thorough resources for task training. The following resource material is suggested for further study.


**Teaching Time for This Module**

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 15 hours are suggested to cover *Site Survey, Project Planning, and Documentation*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

**Topic** | **Planned Time**
--- | ---

**Session I. Introduction; The Job Estimating and Bidding Process; Review of Job Requirements; Job Planning After the Contract Award**

A. Introduction

B. The Job Estimating and Bidding Process

C. Review of Job Requirements
   1. Construction Drawings
   2. Specifications
   3. Scope of Work
   4. Exclusions

D. Laboratory
   - Have trainees interpret contract documents to determine the requirements for a selected job. This laboratory corresponds to Performance Task 1.

E. Job Planning After the Contract Award
Sessions II and III. New Construction Site Survey, Planning, and Documentation

A. New Construction Site Survey, Planning, and Documentation

B. Laboratory
   Have trainees perform a site survey. This laboratory corresponds to Performance Task 2.

Session IV. Scheduling the Work; Acquiring the Needed Materials/Equipment; Assigning the Installation Crew

A. Scheduling the Work

B. Acquiring the Needed Materials/Equipment

C. Assigning the Installation Crew

D. Laboratory
   Have trainees use task and labor hours data recorded on estimating forms and/or takeoff sheets for a selected job to develop a detailed schedule for accomplishing the job. This laboratory corresponds to Performance Task 3.

Session V. Completing the Installation; Incorporating Quality Control/Acceptance Tests; Completing the Punch List; Completing the Job; Retrofitting Installations; Additional Documentation

A. Completing the Installation

B. Incorporating Quality Control/Acceptance Tests

C. Completing the Punch List

D. Completing the Job

E. Retrofitting Installations

F. Additional Documentation

Session VI. Review and Testing

A. Review

B. Module Examination
   1. Trainees must score 70% or higher to receive recognition from NCCER.
   2. Record the testing results on Training Report Form 200 and submit the results to the Training Program Sponsor.

C. Performance Testing
   1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements.
   2. Record the testing results on Training Report Form 200 and submit the results to the Training Program Sponsor.
Module Overview

Today’s leaders face a complex and challenging workforce, and having a capable leader is essential to the success of any team. This module introduces the trainee to the principles of leadership. Trainees will learn about:

- The construction industry today
- Business organizations
- Team building
- Gender and minority issues
- Communication
- Motivation
- Problem solving
- Decision making
- Safety
- Project control

Prerequisites

There are no prerequisites for this course.

Objectives

Upon completion of this course, the trainee will be able to:

1. Discuss current issues and organizational structure in industry today.
2. Understand and incorporate leadership skills into work habits, including communications, motivation, team building, problem solving, and decision-making skills.
3. Demonstrate an awareness of safety issues, including the cost of accidents and safety regulations.
4. Identify a crew leader’s typical safety responsibilities.
5. Show a basic understanding of the planning process, scheduling, and cost and resource control.

Performance Tasks

Under the supervision of the instructor, the trainee should be able to do the following:

1. Develop an estimate for a given work activity.
2. Develop and present a look-ahead schedule.

Note to Instructors

If you are training under an Accredited NCCER Sponsor, note that you may be eligible for dual credentials for successful completion of Fundamentals of Crew Leadership. When submitting the Form 200, indicate completion of the two module numbers that apply to Fundamentals of Crew Leadership – 46101-11 (from NCCER’s Contren® Management Series) and the applicable craft module (if used as part of a craft training program) and transcripts will be issued to you accordingly.
Materials and Equipment

Markers/chalk
Pencils and scratch paper
Whiteboard/chalkboard
*Fundamentals of Crew Leadership* PowerPoint®
Multimedia projector and screen
Computer
Several construction job descriptions, including
  one that is very vague and one that is overly
detailed
Several MSDSs appropriate to the craft
Original and as-built drawings of the same proj-
duct
A redline drawing
Sufficient copies of a roofing formwork detail
drawing
Sufficient copies of the worksheet with entries

Examples of schedules:*
  Bar chart
  Network schedule
  Short-term or look-ahead schedule
  Two or three typical job schedules
  Two job plans and pictures of each site
Construction drawings of a work platform with
  a concrete footing, including specifications, to
be built on site:
  Materials cost list including lumber, concrete,
  and hardware
  Labor cost list including concrete finishers, car-
 penters, and masonry workers
  Photographs of the planned site
  Set of construction drawings
  Module Examinations*
  Performance Profile Sheets*

* Because this module may be used for different industries, materials such as project schedules should
  be appropriate to the craft where possible.
** Use your access code to download this exam from the IRC.

Additional Resources

This module presents thorough resources for task training. The following resource material is suggested
for further study.

  National Institute of Occupational Safety and Health (NIOSH), www.cdc.gov/niosh.
  NCCER Publications:
    • *Your Role in the Green Environment*
    • *Sustainable Construction Supervisor*
  Occupational Safety and Health Administration (OSHA), www.osha.gov.
Teaching Time for This Module

An outline for use in developing your lesson plan is presented below. This course is designed to be taught in one of two formats: two 8-hour sessions (such as all-day workshops) or eight 2-hour sessions (such as after-work training seminars). Because of this, each session below has a suggested time period of two hours. If leading 8-hour sessions, simply teach four of these 2-hour sessions both times your class meets. All instructors will need to adjust the time required for participant activities and testing based on class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Planned Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Session I. Section One – The Basics</td>
<td></td>
</tr>
<tr>
<td>A. Industry Today</td>
<td></td>
</tr>
<tr>
<td>1. The Need for Training</td>
<td></td>
</tr>
<tr>
<td>2. Impact of Technology</td>
<td></td>
</tr>
<tr>
<td>B. Gender and Cultural Issues</td>
<td></td>
</tr>
<tr>
<td>1. Communication Styles of Men and Women</td>
<td></td>
</tr>
<tr>
<td>2. Language Barriers</td>
<td></td>
</tr>
<tr>
<td>3. Cultural Differences</td>
<td></td>
</tr>
<tr>
<td>4. Sexual Harassment</td>
<td></td>
</tr>
<tr>
<td>5. Gender and Minority Discrimination</td>
<td></td>
</tr>
<tr>
<td>C. Business Organizations</td>
<td></td>
</tr>
<tr>
<td>1. Division of Responsibility</td>
<td></td>
</tr>
<tr>
<td>2. Authority, Responsibility, and Accountability</td>
<td></td>
</tr>
<tr>
<td>3. Job Descriptions</td>
<td></td>
</tr>
<tr>
<td>4. Policies and Procedures</td>
<td></td>
</tr>
<tr>
<td>Session II. Section Two – Leadership Skills, Part One</td>
<td></td>
</tr>
<tr>
<td>A. Introduction to Leadership</td>
<td></td>
</tr>
<tr>
<td>B. The Shift in Work Activities</td>
<td></td>
</tr>
<tr>
<td>C. Becoming a Leader</td>
<td></td>
</tr>
<tr>
<td>1. Characteristics of a Leader</td>
<td></td>
</tr>
<tr>
<td>2. Functions of a Leader</td>
<td></td>
</tr>
<tr>
<td>3. Leadership Styles</td>
<td></td>
</tr>
<tr>
<td>4. Ethics in Leadership</td>
<td></td>
</tr>
<tr>
<td>D. Communication</td>
<td></td>
</tr>
<tr>
<td>1. Verbal Communication</td>
<td></td>
</tr>
<tr>
<td>2. Nonverbal Communication</td>
<td></td>
</tr>
<tr>
<td>3. Written or Visual Communication</td>
<td></td>
</tr>
<tr>
<td>4. Communication Issues</td>
<td></td>
</tr>
<tr>
<td>E. Motivation</td>
<td></td>
</tr>
<tr>
<td>1. Employee Motivators</td>
<td></td>
</tr>
<tr>
<td>2. Motivating Employees</td>
<td></td>
</tr>
<tr>
<td>F. Team Building</td>
<td></td>
</tr>
<tr>
<td>1. Successful Teams</td>
<td></td>
</tr>
<tr>
<td>2. Building Successful Teams</td>
<td></td>
</tr>
</tbody>
</table>
Session III. Section Two – Leadership Skills, Part Two; Section Three – Safety, Part One

A. Getting the Job Done
   1. Delegating
   2. Implementing Policies and Procedures

B. Problem Solving and Decision Making
   1. Decision Making vs. Problems Solving
   2. Types of Decisions
   3. Problem Solving
   4. Special Leadership Problems

C. Safety Overview
   1. Accident Statistics

D. Costs of Accidents
   1. Insured Costs
   2. Uninsured Costs

E. Safety Regulations
   1. Workplace Inspections
   2. Penalties for Violations

Session IV. Section Three – Safety, Part Two

A. Employer Safety Responsibilities
   1. Safety Program

B. Crew Leader Involvement in Safety
   1. Safety Training Sessions
   2. Inspections
   3. First Aid
   4. Fire Protection and Prevention
   5. Substance Abuse
   6. Job-Related Accident Investigations

C. Promoting Safety
   1. Safety Training Sessions
   2. Safety Contests
   3. Incentives and Awards
   4. Publicity

Session V. Section Four – Project Control, Part One

A. Project Control Overview
   1. Development Phase
   2. Planning Phase
   3. Construction Phase

B. Project Delivery Systems
   1. General Contracting
   2. Design-Build
   3. Construction Management

C. Cost Estimating and Budgeting
   1. The Estimating Process

D. Laboratory
   Have the trainees develop an estimate for the work activity. This laboratory corresponds to Performance Task 1.
Session VI. Section Four – Project Control, Part Two

A. Planning
   1. Why Plan?
   2. Stages of Planning

B. Laboratory
   Have the trainees develop and present a look-ahead schedule based on one of the plans. This laboratory corresponds to Performance Task 2.

C. The Planning Process
   1. Establish a Goal
   2. Identify the Work to Be Done
   3. Identify Tasks to Be Performed
   4. Communicating Responsibilities
   5. Follow-Up Activities

D. Planning Resources
   1. Safety Planning
   2. Materials Planning
   3. Site Planning
   4. Equipment Planning
   5. Tool Planning
   6. Labor Planning

Session VII. Section Four – Project Control, Part Three

A. Scheduling
   1. The Scheduling Process
   2. Bar Chart Schedule
   3. Network Schedule
   4. Short-Term Scheduling
   5. Updating a Schedule

B. Cost Control
   1. Assessing Cost Performance
   2. Field Reporting System
   3. Crew Leader’s Role in Cost Control

C. Resource Control
   1. Materials Control
   2. Equipment Control
   3. Tool Control
   4. Labor Control

D. Production and Productivity

Session VIII. Review; Testing

A. Module Review

B. Module Examination
   1. Trainees must score 70 percent or higher to receive recognition from NCCER.
   2. Record the testing results on Training Report Form 200, and submit the results to the Training Program Sponsor.

C. Performance Testing
   1. Trainee must perform each task to the satisfaction of the instructor to receive recognition from NCCER.
   2. Record the training results on Training Report Form 200, and submit the results to the Training Program Sponsor.
Module Overview

This module introduces the trainee to the various types of equipment racks used to house electronic equipment. The module also covers grounding and ventilation requirements for racks and rack-mounted equipment.

Prerequisites

Prior to training with this module, it is recommended that the trainee shall have successfully completed Core Curriculum; Electronic Systems Technician Level One; Electronic Systems Technician Level Two; and Electronic Systems Technician Level Three; Modules 33301-11 through 33304-11 and 46101-11.

Objectives

Upon completion of this module, the trainee will be able to do the following:

1. Identify various types of electronic equipment racks.
2. Select the appropriate rack for a given application.
3. Establish proper grounding of racks to ensure personnel safety and minimize signal interference.
4. Explain proper ventilation techniques to avoid overheating of rack-mounted electronic equipment.
5. Describe the installation practices for rack-mounted equipment.
6. Prepare a rack layout drawing.
7. Calculate power requirements and heat dissipation requirements for a rack installation.
8. Assemble a rack, including lacing rails.
9. Populate a rack with equipment.

Performance Tasks

Under the supervision of the instructor, the trainee should be able to do the following:

1. Select a rack unit for a given application.
2. Prepare a rack layout drawing.
3. Calculate power requirements and Btu dissipation for a rack installation.
4. Properly install electronic equipment in a rack.
5. Assemble a rack, including lacing rails.

Materials and Equipment

Markers/chalk
Pencils and scratch paper
Whiteboard/chalkboard
EST Level Three PowerPoint® Presentation Slides
Multimedia projector and screen
Computer
Appropriate personal protective equipment
Rack layout drawing
Sample Btu calculations
Sketches of racks containing power strips
Equipment racks
Examples of cable management devices
Examples of a system installation

Examples of rack accessories, including:
- Rack support base
- Casters
- Mounting hardware
- Rack ears
- Power strips
- Hair dryer

Lightweight plastic bags
Rack-mount equipment, including:
- Blank panels
- Ventilating fans
- Cable/wire management devices
- Sufficient racks
- Module Examinations*
- Performance Profile Sheets*

* Single-module AIG purchases include the printed exam and performance task sheet. If you have purchased the perfect-bound version of this title, download these materials from the IRC using your access code.
Safety Considerations

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. Review safety guidelines associated with working on electrical and electronic systems. Emphasize the importance of proper housekeeping.

Additional Resources

This module presents thorough resources for task training. The following resource material is suggested for further study.


Teaching Time for This Module

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 17½ hours are suggested to cover Rack Systems. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Planned Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sessions I and II. Introduction; Types of Racks; Rack Dimensions; Power and Grounding</td>
<td></td>
</tr>
<tr>
<td>A. Introduction</td>
<td></td>
</tr>
<tr>
<td>B. Types of Racks</td>
<td></td>
</tr>
<tr>
<td>C. Laboratory</td>
<td></td>
</tr>
<tr>
<td>Have the trainees select a rack unit for a given application. This laboratory corresponds to Performance Task 1.</td>
<td></td>
</tr>
<tr>
<td>D. Rack Dimensions</td>
<td></td>
</tr>
<tr>
<td>E. Power and Grounding</td>
<td></td>
</tr>
<tr>
<td>1. Power</td>
<td></td>
</tr>
<tr>
<td>2. Grounding</td>
<td></td>
</tr>
<tr>
<td>Session III. Rack Ventilation and Cooling</td>
<td></td>
</tr>
<tr>
<td>A. Rack Ventilation and Cooling</td>
<td></td>
</tr>
<tr>
<td>1. Heat Load Calculation</td>
<td></td>
</tr>
<tr>
<td>2. Laboratory</td>
<td></td>
</tr>
<tr>
<td>Have trainees calculate power requirements and Btu dissipation for a rack installation. This laboratory corresponds to Performance Task 3.</td>
<td></td>
</tr>
<tr>
<td>3. Rack Ventilation</td>
<td></td>
</tr>
<tr>
<td>4. Heat Exchangers and Air Conditioners</td>
<td></td>
</tr>
</tbody>
</table>
Sessions IV–VI. Installation Practices
A. Installation Practices
   1. Installation Hardware and Accessories
   2. Laboratory
      Have trainees prepare rack layout drawings. This laboratory corresponds to Performance Task 2.
   3. Cable Management
   4. Earthquake Protection
   5. Laboratory
      Have the trainees assemble a rack, including lacing rails, and install electronic equipment. This laboratory corresponds to Performance Tasks 4 and 5.

Session VII. Review and Testing
A. Review
B. Module Examination
   1. Trainees must score 70% or higher to receive recognition from NCCER.
   2. Record the testing results on Training Report Form 200 and submit the results to the Training Program Sponsor.
C. Performance Testing
   1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements.
   2. Record the testing results on Training Report Form 200 and submit the results to the Training Program Sponsor.
Module Overview

This module explains the commissioning process used to verify the correct operation of a system following installation. The module also provides guidance to technicians who must train user personnel in the operation of the system.

Prerequisites

Prior to training with this module, it is recommended that the trainee shall have successfully completed Core Curriculum; Electronic Systems Technician Level One; Electronic Systems Technician Level Two; and Electronic Systems Technician Level Three; Modules 33301-11 through 33304-11, 46101-11, and 33305-11.

Objectives

Upon completion of this module, the trainee will be able to do the following:
1. Describe the phases of the system commissioning process and explain how they apply to the commissioning of specific types of electronic systems.
2. Explain how to develop a user training course.
3. Demonstrate or describe how to prepare for and conduct user training.

Performance Task

Under the supervision of the instructor, the trainee should be able to do the following:
1. Prepare and conduct a user training session.

Materials and Equipment

Markers/chalk
Pencils and scratch paper
Whiteboard/chalkboard
Multimedia projector and screen

Computer
Commissioning report
Module Examination*
Performance Profile Sheets*

* Single-module AIG purchases include the printed exam and performance task sheet. If you have purchased the perfect-bound version of this title, download these materials from the IRC using your access code.

Safety Considerations

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. Review safety guidelines associated with working on electrical and electronic systems. Emphasize the importance of proper housekeeping.
Additional Resources

This module presents thorough resources for task training. The following resource material is suggested for further study.


Teaching Time for This Module

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 20 hours are suggested to cover *System Commissioning and User Training.* You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Planned Time</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Session I. Introduction; Commissioning Process Overview</strong></td>
<td></td>
</tr>
<tr>
<td>A. Introduction</td>
<td>________</td>
</tr>
<tr>
<td>B. Commissioning Process Overview</td>
<td>________</td>
</tr>
<tr>
<td>1. Pre-Installation Activities</td>
<td>________</td>
</tr>
<tr>
<td>2. Commissioning Plan Preparation</td>
<td>________</td>
</tr>
<tr>
<td>3. Installation Activities</td>
<td>________</td>
</tr>
<tr>
<td>4. Functional Performance Testing Activities</td>
<td>________</td>
</tr>
<tr>
<td>5. User Training and Documentation</td>
<td>________</td>
</tr>
<tr>
<td>6. System Acceptance</td>
<td>________</td>
</tr>
<tr>
<td>7. Post-Acceptance Activities</td>
<td>________</td>
</tr>
<tr>
<td><strong>Session II. Commissioning Demonstration</strong></td>
<td></td>
</tr>
<tr>
<td>A. Commissioning Demonstration</td>
<td>________</td>
</tr>
<tr>
<td>1. Perform a walk-through of a commissioning procedure for a selected system.</td>
<td></td>
</tr>
<tr>
<td><strong>Session III. User Training, Part One</strong></td>
<td></td>
</tr>
<tr>
<td>A. User Training</td>
<td>________</td>
</tr>
<tr>
<td>1. Determining the Scope of the Training</td>
<td>________</td>
</tr>
<tr>
<td>2. Instructor Preparation</td>
<td>________</td>
</tr>
<tr>
<td>3. Trainee Qualifications</td>
<td>________</td>
</tr>
<tr>
<td>4. Equipment/System Preparation</td>
<td>________</td>
</tr>
<tr>
<td>5. Conduct the Training</td>
<td>________</td>
</tr>
<tr>
<td><strong>Sessions IV through VII. User Training, Part Two</strong></td>
<td></td>
</tr>
<tr>
<td>A. User Training</td>
<td>________</td>
</tr>
<tr>
<td>1. On-the-Job Learning</td>
<td>________</td>
</tr>
<tr>
<td>2. Course Closure</td>
<td>________</td>
</tr>
<tr>
<td>B. Laboratory</td>
<td>________</td>
</tr>
<tr>
<td>Have trainees prepare and conduct a user training session. This laboratory corresponds to Performance Task 1.</td>
<td></td>
</tr>
</tbody>
</table>

---

*Additional Resources*

This module presents thorough resources for task training. The following resource material is suggested for further study.


**Teaching Time for This Module**

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 20 hours are suggested to cover *System Commissioning and User Training.* You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Planned Time</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Session I. Introduction; Commissioning Process Overview</strong></td>
<td></td>
</tr>
<tr>
<td>A. Introduction</td>
<td>________</td>
</tr>
<tr>
<td>B. Commissioning Process Overview</td>
<td>________</td>
</tr>
<tr>
<td>1. Pre-Installation Activities</td>
<td>________</td>
</tr>
<tr>
<td>2. Commissioning Plan Preparation</td>
<td>________</td>
</tr>
<tr>
<td>3. Installation Activities</td>
<td>________</td>
</tr>
<tr>
<td>4. Functional Performance Testing Activities</td>
<td>________</td>
</tr>
<tr>
<td>5. User Training and Documentation</td>
<td>________</td>
</tr>
<tr>
<td>6. System Acceptance</td>
<td>________</td>
</tr>
<tr>
<td>7. Post-Acceptance Activities</td>
<td>________</td>
</tr>
<tr>
<td><strong>Session II. Commissioning Demonstration</strong></td>
<td></td>
</tr>
<tr>
<td>A. Commissioning Demonstration</td>
<td>________</td>
</tr>
<tr>
<td>1. Perform a walk-through of a commissioning procedure for a selected system.</td>
<td></td>
</tr>
<tr>
<td><strong>Session III. User Training, Part One</strong></td>
<td></td>
</tr>
<tr>
<td>A. User Training</td>
<td>________</td>
</tr>
<tr>
<td>1. Determining the Scope of the Training</td>
<td>________</td>
</tr>
<tr>
<td>2. Instructor Preparation</td>
<td>________</td>
</tr>
<tr>
<td>3. Trainee Qualifications</td>
<td>________</td>
</tr>
<tr>
<td>4. Equipment/System Preparation</td>
<td>________</td>
</tr>
<tr>
<td>5. Conduct the Training</td>
<td>________</td>
</tr>
<tr>
<td><strong>Sessions IV through VII. User Training, Part Two</strong></td>
<td></td>
</tr>
<tr>
<td>A. User Training</td>
<td>________</td>
</tr>
<tr>
<td>1. On-the-Job Learning</td>
<td>________</td>
</tr>
<tr>
<td>2. Course Closure</td>
<td>________</td>
</tr>
<tr>
<td>B. Laboratory</td>
<td>________</td>
</tr>
<tr>
<td>Have trainees prepare and conduct a user training session. This laboratory corresponds to Performance Task 1.</td>
<td></td>
</tr>
</tbody>
</table>
Session VIII. Review and Testing

A. Review

B. Module Examination
   1. Trainees must score 70% or higher to receive recognition from NCCER.
   2. Record the testing results on Training Report Form 200 and submit the results to the Training Program Sponsor.

C. Performance Testing
   1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements.
   2. Record the testing results on Training Report Form 200 and submit the results to the Training Program Sponsor.
Module Overview

This module provides information and instructions for maintenance and repair of low-voltage systems and equipment. A systematic approach and component-level troubleshooting are covered, as well as methods of identifying common types of repairs. Information and general guidelines for various preventive maintenance tasks are also covered.

Prerequisites

Prior to training with this module, it is recommended that the trainee shall have successfully completed Core Curriculum; Electronic Systems Technician Level One; Electronic Systems Technician Level Two; and Electronic Systems Technician Level Three; Modules 33301-11 through 33304-11, 46101-11, 33305-11, and 33306-11.

Objectives

Upon completion of this module, the trainee will be able to do the following:

1. Explain the difference between maintenance and repair.
2. Identify the common causes of system and equipment failures.
3. Use electrostatic discharge (ESD) control devices and techniques when handling ESD-sensitive equipment and components.
4. Use manufacturers’ troubleshooting aids to identify system problem(s).
5. Isolate computer-related problems to hardware or software.
6. Isolate common faults in wiring and equipment.
7. Identify common preventive maintenance measures.
8. Identify and explain preventive maintenance and inspection schedules.

Performance Tasks

Under the supervision of the instructor, the trainee should be able to do the following:

1. Use ESD control devices and techniques when handling and troubleshooting ESD-sensitive equipment or components.
2. Use manufacturers’ troubleshooting aids to identify system problem(s).
3. Determine if a power supply is good or bad.
4. Determine if a printed circuit board is good or bad.
5. Isolate the cause of a computer-related problem to the hardware or software.
6. Isolate common faults in copper and fiber optic cable wired networks.

Materials and Equipment

| Markers/chalk | Test equipment, as applicable: |
| Pencils and scratch paper | Multimeter (DMM/VOM) |
| Whiteboard/chalkboard | Clamp-on ammeter |
| EST Level Three PowerPoint® Presentation Slides | Oscilloscope and probes |
| Multimedia projector and screen | Handheld cable tester |
| Computer | Toner/wand |
| Appropriate personal protective equipment | Air-filled plastic bag |
| Copy of the National Electrical Code® | Telephone test set |
| ESD grounding wrist strap | Certification test set |
| ESD control devices, including: | Cable tracer |
| ESD isolation containers | Optical light source and power meter |
| ESD ionizer | Fiber optic cable |
| ESD-sensitive printed circuit boards | Time-domain reflectometer (TDR) |
Optical time-domain reflectometer (OTDR)
Optical fiber flashlight
Low-intensity laser
Megohmmeter
Frequency meter/counter
Miscellaneous test adapters, leads, and cables
Examples of service manuals
Maintenance manuals for low-voltage systems and equipment
Manufacturers’ troubleshooting aids
Several power supplies, some good and some bad
Several PC boards, some good and some bad

Schematic with both NO and NC contacts
Several computers with hardware problems in some and software problems in others
Computer networks, including:
  - Copper cable-wired network
  - Fiber optic cable-wired network
Examples of testing and inspection forms
Several electronic system manufacturer’s manuals
Isopropyl alcohol and a clean, lint-free cloth
Module Examination*
Performance Profile Sheets*

* Single-module AIG purchases include the printed exam and performance task sheet. If you have purchased the perfect-bound version of this title, download these materials from the IRC using your access code.

**Safety Considerations**

Ensure that the trainees are equipped with appropriate personal protective equipment and know how to use it properly. Review safety guidelines associated with working on electrical and electronic systems. Emphasize the importance of proper housekeeping.

**Additional Resources**

This module presents thorough resources for task training. The following resource material is suggested for further study.


**Teaching Time for This Module**

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 20 hours are suggested to cover Maintenance and Repair. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Planned Time</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sessions I and II. Introduction; Maintenance Versus Repair; Causes of Failures; Test Equipment; Common Causes of Electrical Equipment Faults</strong></td>
<td></td>
</tr>
<tr>
<td>A. Introduction</td>
<td>____________</td>
</tr>
<tr>
<td>B. Maintenance Versus Repair</td>
<td>____________</td>
</tr>
<tr>
<td>C. Causes of Failure</td>
<td>____________</td>
</tr>
<tr>
<td>1. Environmental Conditions</td>
<td>____________</td>
</tr>
<tr>
<td>2. Improper Installation</td>
<td>____________</td>
</tr>
<tr>
<td>3. Poor Power Quality</td>
<td>____________</td>
</tr>
<tr>
<td>4. Electrostatic Discharge</td>
<td>____________</td>
</tr>
<tr>
<td>5. Laboratory</td>
<td>____________</td>
</tr>
</tbody>
</table>

Have trainees use ESD control devices and techniques when handling or troubleshooting ESD-sensitive equipment or components. This laboratory corresponds to Performance Task 1.
6. Operator Error
D. Test Equipment
E. Common Causes of Electrical Equipment Faults
   1. Short Circuits
   2. Open Circuits
   3. Ground Faults
   4. Mechanical Failures

Session III. Using a Systematic Approach to Troubleshooting; Customer Interface;
   Physical Examination of the System; Basic System Analysis;
   Use of Manufacturers’ Troubleshooting Aids
A. Using a Systematic Approach to Troubleshooting
B. Customer Interface
C. Physical Examination of the System
D. Basic System Analysis
E. Use of Manufacturers’ Troubleshooting Aids
   1. Wiring Diagrams
   2. Troubleshooting Tables and Fault Isolation Diagrams
   3. Diagnostic Equipment and Tests
F. Laboratory
   Have trainees use manufacturers’ troubleshooting aids to identify system
   problem(s). This laboratory corresponds to Performance Task 2.

Sessions IV–VII. Fault Isolation in the System/Unit Problem Area
A. Fault Isolation in the System/Unit Problem Area
   1. Troubleshooting Input Power and Power Supply Circuits
   2. Laboratory
      Have trainees determine if a power supply is good or bad. This laboratory
      corresponds to Performance Task 3.
   3. Troubleshooting Control/Sensor Circuits
   4. Troubleshooting Central Processing Circuits
   5. Laboratory
      Have trainees determine if a printed circuit board is good or bad. This laboratory
      corresponds to Performance Task 4.
   6. Troubleshooting Computer-Related Problems
   7. Laboratory
      Have trainees isolate the cause of a computer-related problem to the
      hardware or software. This laboratory corresponds to Performance Task 5.
   8. Troubleshooting and Testing Copper Cable
   9. Laboratory
      Have trainees isolate common faults in copper cable-wired networks. This laboratory
      corresponds to part of Performance Task 6.
10. Troubleshooting and Testing Fiber Optic Cable
11. Laboratory
    Have trainees isolate common faults in fiber optic cable-wired networks. This laboratory
    corresponds to part of Performance Task 6.
12. Testing After Repair
Session VII. Preventive Maintenance; Inspecting and Testing Forms

A. Preventive Maintenance
   1. Inspection
   2. Cleaning
   3. Lubrication
   4. Testing and Adjustment

B. Inspecting and Testing Forms

Session VIII. Review and Testing

A. Review

B. Module Examination
   1. Trainees must score 70% or higher to receive recognition from NCCER.
   2. Record the testing results on Training Report Form 200 and submit the results to the Training Program Sponsor.

C. Performance Testing
   1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from NCCER. If applicable, proficiency noted during laboratory exercises can be used to satisfy the Performance Testing requirements.
   2. Record the testing results on Training Report Form 200 and submit the results to the Training Program Sponsor.