Lesson Plans for Module 26201-17

ALTERNATING CURRENT

Module One (26201-17) describes AC circuits and explains how to apply Ohm’s law to solve for unknown circuit values. It also explains how to make power calculations in AC circuits and describes various types of transformers and how they operate.

Objectives

<table>
<thead>
<tr>
<th>Learning Objective 1</th>
<th>Learning Objective 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Identify AC waveforms.</td>
<td>• Make power calculations in AC circuits.</td>
</tr>
<tr>
<td>a. Define the terminology of sine waves.</td>
<td>a. Calculate true power.</td>
</tr>
<tr>
<td>b. Define AC phase relationships.</td>
<td>b. Calculate apparent power.</td>
</tr>
<tr>
<td>c. Identify nonsinusoidal waveforms.</td>
<td>c. Calculate reactive power.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Learning Objective 2</th>
<th>Learning Objective 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Determine unknown values in AC circuits.</td>
<td>• Identify transformers and explain how they operate.</td>
</tr>
<tr>
<td>a. Find unknown values in purely resistive AC circuits.</td>
<td>a. Identify the basic components in a transformer.</td>
</tr>
<tr>
<td>b. Find unknown values in inductive AC circuits.</td>
<td>b. Identify transformer operating characteristics.</td>
</tr>
<tr>
<td>c. Find unknown values in capacitive AC circuits.</td>
<td>c. Calculate turns and voltage ratios.</td>
</tr>
<tr>
<td>d. Find unknown values in combination circuits.</td>
<td>d. Identify various types of transformers and their applications.</td>
</tr>
</tbody>
</table>

Performance Tasks

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

Note

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Teaching Time: 17.5 hours
(Seven 2.5-Hour Sessions)
Session time may be adjusted to accommodate your class size, schedule, and teaching style.

Before You Begin

As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the PowerPoint® presentations and Performance Profile Sheets from www.nccerirc.com. For information and updates about accessing the Module Examinations, visit www.nccer.org/testing. The passing score for submission into NCCER’s Registry is 70% or above for the written examination; performance testing is graded pass or fail.
**Safety Considerations**
This module provides an overview of AC circuits, how to determine unknown circuit values, and how to make power calculations in AC circuits. It also describes various types of transformers and how they operate. Trainees should be reminded about the importance of wearing the proper PPE, following safe practices, and giving due respect to any hazards that may be present while working with or in the vicinity of AC circuits. Instructors must ensure that trainees clearly understand these safety considerations and clarify any weaknesses to ensure future trainee safety. Remind trainees that the safety procedures on each job site may be more stringent than OSHA or NEC® requirements.

**Classroom Equipment and Materials**
- Whiteboard and markers
- Pencils and paper
- Electrical Level Two PowerPoint® Presentation Slides
- DVD player
- LCD projector and screen
- Computer
- Internet access during class (optional)
- Module Review answer key
- Module Examinations
- Capacitors
- Transformers

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


Online resources are available for trainees who would like more information on alternating current. A search for additional information may be assigned as homework to interested trainees.

Instructors should view any videos that may be identified in the lesson plan before using them to ensure their suitability. The videos can provide teachable moments in both proper and improper work processes and behaviors. Be prepared to stop the videos at appropriate times to point out and discuss both proper and improper conduct and techniques.

Instructors are also encouraged to locate additional audiovisual aids available on the internet, make personal videos, and take still pictures related to the subject matter and add them to the PowerPoint® presentations throughout the program.
Session Outline for Module 26201-17

ALTERNATING CURRENT

The Lesson Plan for this module is divided into seven 2.5-hour sessions. This time includes 10 minutes for administrative tasks and a 10-minute break per session.

**SESSION ONE**

Session One covers Sections 1.0.0 through 1.3.0 and describes how to identify AC waveforms.
1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with alternating current and AC circuits.
3. Describe terminology associated with sine waves.
4. Describe AC phase relationships.
5. Identify nonsinusoidal waveforms.

**SESSION TWO**

Session Two covers Sections 2.0.0 through 2.2.3, and explains how to determine unknown values in purely resistive AC circuits and inductive AC circuits.
1. Show the Session Two PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with determining unknown values in purely resistive AC circuits and inductive AC circuits.
3. Find unknown values in purely resistive AC circuits.
4. Find unknown values in inductive AC circuits.

**SESSION THREE**

Session Three covers Sections 2.3.0 through 2.3.5, and describes how to determine unknown values in capacitive AC circuits.
1. Show the Session Three PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with determining unknown values in capacitive AC circuits.
3. Find unknown values in capacitive AC circuits.

**SESSION FOUR**

Session Four covers Sections 2.4.0 through 2.4.4, and describes how to determine unknown values in combination circuits.
1. Show the Session Four PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with determining unknown values in combination circuits.
3. Find unknown values in combination circuits.

**SESSION FIVE**

Session Five covers Sections 3.0.0 through 3.5.0, and describes how to calculate true power, apparent power, reactive power, and power factor, and how to use the power triangle to determine unknown values in AC circuits.
1. Show the Session Five PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with calculating true power, apparent power, reactive power, and power factor, and using the power triangle to determine unknown values in AC circuits.
3. Describe how to calculate true power.
4. Describe how to calculate apparent power.
5. Describe how to calculate reactive power.
6. Describe how to calculate power factor.
7. Describe how to use the power triangle to determine unknown values.
Session Outline for Module 26201-17

ALTERNATING CURRENT

SESSION SIX

Session Six covers Sections 4.0.0 through 4.4.4, and describes how to identify transformers and explain how they operate.

1. Show the Session Six PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with transformer types and operation.
3. Identify the basic components in a transformer.
4. Identify transformer operating characteristics.
5. Describe how to calculate turns and voltage ratios.
6. Identify various types of transformers and their applications.

SESSION SEVEN

Session Seven is a review and testing session. Have trainees complete the module Review Questions and Supplemental Exercises. Alternatively, these may be assigned as homework at the end of Session Six. Go over the module Review Questions and Supplemental Exercises in class prior to the exam and answer any questions that the trainees may have.

1. Have trainees complete the Module Examination.
2. Submit the results to your Training Program Sponsor through the Registry System.
Module Two (26202-17) describes AC and DC motors, including their components, circuits, and connections.

### Objectives

#### Learning Objective 1
- Identify direct current (DC) motors and describe their operating characteristics.
  a. Understand how DC motors operate.
  b. Identify types of DC motors.

#### Learning Objective 2
- Identify alternating current (AC) motors and describe their operating characteristics.
  a. Understand how AC motors operate.
  b. Identify three-phase induction motors.
  c. Identify synchronous motors.
  d. Identify single-phase induction motors.

#### Learning Objective 3
- Identify variable-speed drives and describe their operating characteristics.
  a. Identify types of adjustable speed loads.
  b. Identify types of motor speed control.
  c. Identify braking methods.

#### Learning Objective 4
- Identify motor enclosures, frame designations, and operating characteristics.
  a. Identify types of motor enclosures.
  b. Identify NEMA frame designations.
  c. Identify motor operating characteristics using nameplate data.

#### Learning Objective 5
- Identify the connections and terminal markings for AC motors.
  a. Identify the terminals of wye-connected motors.
  b. Identify the terminals of delta-connected motors.

#### Learning Objective 6
- Identify the NEC® requirements for motors.
  a. Identify NEC® installation requirements.
  b. Identify NEC® motor protection requirements.

### Performance Tasks

#### Performance Task 1 (Learning Objectives 1 and 2)
- Identify various types of motors and their application(s).

#### Performance Task 2 (Learning Objective 4)
- Collect data from a motor nameplate.

#### Performance Task 3 (Learning Objective 5)
- Connect the terminals for a dual-voltage motor.

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**Teaching Time: 20 hours**

(Eight 2.5-Hour Sessions)

Session time may be adjusted to accommodate your class size, schedule, and teaching style.

**Before You Begin**

As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the PowerPoint® presentations and Performance Profile Sheets from [www.nccerirc.com](http://www.nccerirc.com). For information and updates about accessing the Module Examinations, visit [www.nccer.org/testing](http://www.nccer.org/testing). The passing score for submission into NCCER’s Registry is 70% or above for the written examination; performance testing is graded pass or fail.
Safety Considerations
This module provides an overview of different types of AC and DC motors and their operating characteristics. It describes various methods of motor control, different types of motor enclosures, and the information that is commonly found on motor nameplates. The connections and terminal markings for AC motors and the NEC® requirements for motor installation and protection are also examined. Trainees should be reminded about the importance of wearing the proper PPE, following safe practices, and giving due respect to any hazards that may be present while working with or in the vicinity of AC and DC motors. Instructors must ensure that trainees clearly understand these safety considerations and clarify any weaknesses to ensure future trainee safety. Remind trainees that the safety procedures on each job site may be more stringent than OSHA or NEC® requirements.

Classroom Equipment, Materials, and Resources
Whiteboard and markers
Pencils and paper
Electrical Level Two PowerPoint® Presentation Slides
DVD player
LCD projector and screen
Computer
Internet access during class (optional)
DC motors, including shunt-wound, series, and compound
Several AC motors, including some squirrel cage motors
Capacitor-type induction motor
Shaded-pole induction motor
Multiple-speed induction motors
Split-phase induction motors
Variable-speed drives
Motor nameplates

NEC® installation requirements for motors
NEC® motor protection requirements
Ohmmeter
Module Review answer key
Module Examinations
Performance Profile Sheets
Standard eye protection
Work gloves
Proper footwear as designated by the instructor or training facility provider
Hearing protection as designated by the instructor or training facility provider
Several DC motors
Several AC motors
Several dual-voltage motors

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


An IEC Metric Motor Dimension chart can be found at [http://www.electricmotorservice.net/iechart.pdf](http://www.electricmotorservice.net/iechart.pdf).


There are a number of online resources available for trainees who would like more information on alternating current. A search for additional information may be assigned as homework to interested trainees.

Instructors should view any videos that may be identified in the lesson plan before using them to ensure their suitability. The videos can provide teachable moments in both proper and improper work processes and behaviors. Be prepared to stop the videos at appropriate times to point out and discuss both proper and improper conduct and techniques.

Instructors are also encouraged to locate additional audiovisual aids available on the internet, make personal videos, and take still pictures related to the subject matter and add them to the PowerPoint® presentations throughout the program.
The Lesson Plan for this module is divided into eight 2.5-hour sessions. This time includes 10 minutes for administrative tasks and a 10-minute break per session.

**Session Outline for Module 26202-17**

**MOTORS: THEORY AND APPLICATION**

**Session One**
Session One covers Sections 1.0.0 through 1.2.3 and describes how to identify direct current (DC) motors and describe their operating characteristics.
1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with DC and AC motor operation.
3. Describe how DC motors operate.
4. Identify types of DC motors.

**Session Two**
Session Two covers Sections 2.0.0 through 2.2.2, and begins an examination of alternating current (AC) motors and their operating characteristics.
1. Show the Session Two PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with AC motors and how they operate.
3. Describe how AC motors operate.
4. Identify three-phase induction motors.

**Session Three**
Session Three covers Sections 2.3.0 through 2.4.6, and completes the examination of alternating current (AC) motors and their operating characteristics.
1. Show the Session Three PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with identifying synchronous and single-phase induction motors.
3. Identify synchronous motors.
4. Identify single-phase induction motors.

**Session Four**
Session Four covers Sections 3.0.0 through 3.3.2, and describes how to identify variable-speed drives and their operating characteristics.
1. Show the Session Four PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with variable-speed drives and their operating characteristics.
3. Identify types of adjustable speed loads.
4. Identify types of motor speed control.
5. Identify braking methods.
Module Three (26203-17) describes the principles of human vision and the characteristics of light. It describes how to identify and install incandescent, LED, fluorescent, and HID lamps and ballasts. It also examines how to select and install various types of lighting fixtures and lighting controls.

Objectives

Learning Objective 1
• Explain the relationship between human vision and light.
  a. Identify how the human eye operates.
  b. Identify the characteristics of light.

Learning Objective 2
• Identify and install lamps and ballasts.
  a. Identify and install lamps.
  b. Identify and install ballasts.

Learning Objective 3
• Select and install lighting fixtures for various applications.
  a. Identify lighting fixtures and their applications.
  b. Store and handle lamps and lighting fixtures.
  c. Install lighting fixtures.

Learning Objective 4
• Select lighting controls for various applications.
  a. Select occupancy sensors.
  b. Select photosensors.
  c. Use lighting timers.
  d. Program energy management systems.

Performance Tasks

Performance Task 1 (Learning Objective 2)
• Properly select and install lamps into lighting fixtures.

Performance Task 2 (Learning Objective 3)
• Install one or more of the following lighting fixtures and their associated lamps:
  – Surface-mounted
  – Recessed
  – Suspended
  – Track-mounted

Note
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Teaching Time: 15 hours
(Six 2.5-Hour Sessions)
Session time may be adjusted to accommodate your class size, schedule, and teaching style.

Before You Begin
As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the PowerPoint® presentations and Performance Profile Sheets from www.nccerirc.com. For information and updates about accessing the module examinations, visit www.nccer.org/testing. The passing score for submission into NCCER’s Registry is 70% or above for the module examination; performance testing is graded pass or fail.
Safety Considerations
Emphasize the importance of wearing the proper PPE, following safe practices, and giving due respect to any hazards that may be present while working with or in the vicinity of electrical wiring. Trainees must clearly understand these considerations to ensure their safety in the future. Remind trainees that the safety procedures on a particular job site may be more stringent than OSHA or NEC® requirements.

Equipment, Materials, and Resources
Whiteboard and markers
Pencils and paper
Electrical Level Two PowerPoint® Presentation Slides
DVD player
LCD projector and screen
Computer
Internet access during class (optional)
Module Examinations
Performance Profile Sheets
Prism
Lamp manufacturers’ catalogs
Various types of halogen lamps
LED lamps
Fluorescent lamps
CFLs
HID lamps
Various types of ballasts
Outlet boxes for surface-mounted fixtures
Various fixture mounting assemblies and manufacturer’s instructions
Different types of lighting fixtures, including:
- Surface-mounted
- Recessed
- Suspended
- Track-mounted
Hangers and supports used with suspended lighting fixtures
Components for a typical track lighting installation
Occupancy sensors
Photosensors
Timers
Module Review answer key
Standard eye protection
Work gloves
Hard hat
Proper footwear as designated by the instructor or training facility provider
Hearing protection as designated by the instructor or training facility provider

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


Online resources are available for trainees who would like more information on electric lighting. A search for additional information may be assigned as homework to interested trainees.

Instructors should view any videos that may be identified in the lesson plan before using them to ensure their suitability. The videos can provide teachable moments in both proper and improper work processes and behaviors. Be prepared to stop the videos at appropriate times to point out and discuss both proper and improper conduct and techniques.

Instructors are also encouraged to locate additional audiovisual aids available on the internet, make personal videos, and take still pictures related to the subject matter and add them to the PowerPoint® presentations throughout the program.
Session Outline for Module 26203-17

ELECTRIC LIGHTING

The Lesson Plan for this module is divided into six 2.5-hour sessions. This time includes 10 minutes for administrative tasks and a 10-minute break per session.

**SESSION ONE**

Session One covers Sections 1.0.0 through 2.1.7. It explains the relationship between human vision and light, and describes how to identify and install various types of lamps.

1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with electric lighting.
3. Describe how the human eye functions.
4. Identify the characteristics of light.
5. Explain the operation of incandescent lamps.
6. Describe how to choose light emitting diode (LED) lamps for various applications.
7. Describe how to choose fluorescent lamps for various applications.
8. Describe how to choose high-intensity discharge (HID) lamps for various applications.
9. Identify lamp color rendering and color temperature characteristics.
10. Explain how to install lamps.

**SESSION TWO**

Session Two covers Sections 2.2.0 through 3.2.0. It explains how to identify and install ballasts, and how to select lighting fixtures for various applications.

1. Show the Session Two PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with various types of ballasts and lighting fixtures.
3. Identify and install fluorescent lighting fixture ballasts.
4. Identify and install HID lighting fixture ballasts.
5. Identify lighting fixtures and their applications.
6. Describe how to store and handle lamps and lighting fixtures.
Session Three covers Sections 3.3.0 through 3.3.5, and explains how to install various types of lighting fixtures.

1. Show the Session Three PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with installation procedures for different types of lighting fixtures.
3. Describe how to install surface-mounted lighting fixtures.
4. Describe how to install recessed lighting fixtures.
5. Describe how to install suspended lighting fixtures.
6. Describe how to install track lighting fixtures.
7. Explain how to make electrical connections to lighting fixtures.

Session Five is set aside for lab work needed to satisfy the module performance tasks. You can allocate lab time for these activities based on class size and available facilities. One approach would be to have some trainees complete one performance task while others work on the other performance task.

1. Have the trainees demonstrate how to properly select and install lamps into lighting fixtures.
2. Have the trainees demonstrate how to install one or more of the following lighting fixtures and their associated lamps:
   - Surface-mounted
   - Recessed
   - Suspended
   - Track-mounted

Upon completion of the lab work, ask the trainees to complete the module Review Questions and Supplemental Exercises before the upcoming review and testing session.

Session Four covers Sections 4.0.0 through 4.4.0, and describes how to select lighting controls for various applications.

1. Show the Session Four PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with various types of lighting control devices.
3. Explain how to select occupancy sensors.
4. Explain how to select photosensors.
5. Describe how to use lighting sensors.
6. Describe how to program energy management systems.

Session Six is a review and testing session. Go over the module Review Questions and Supplemental Exercises in class before the exam and answer any questions that the trainees may have.

1. Administer the Module Examination and any outstanding performance testing.
2. Submit the results to your Training Program Sponsor through the Registry System.
Module Four (26204-17) describes how to calculate and make conduit bends using mechanical, hydraulic, and electric benders.

### Objectives

**Learning Objective 1**
- Identify the NEC® requirements for conduit bends.
  - a. Identify the minimum radius requirements for various types of conduit.
  - b. Calculate the number of bends per run.

**Learning Objective 2**
- Use equations to find bend distances.
  - a. Use right-angle mathematics to find bend distances.
  - b. Use the circumference of a circle to determine bend distances.

**Learning Objective 3**
- Use mechanical benders.
  - a. Chart a mechanical bender.
  - b. Make mechanical bends.

**Learning Objective 4**
- Use electric and hydraulic conduit benders.
  - a. Use electric conduit benders.
  - b. Use hydraulic conduit benders.

**Learning Objective 5**
- Install PVC conduit.
  - a. Join PVC conduit.
  - b. Bend PVC conduit.

### Performance Tasks

**Performance Task 1 (Learning Objectives 1–4)**
- Use an electric or hydraulic bender to bend a stub-up to a precise distance above the deck.

**Performance Task 2 (Learning Objectives 1–4)**
- Make an offset in a length of conduit to clear an obstruction with 1” (25 mm) clearance between the pipe and the obstruction.

**Performance Task 3 (Learning Objectives 1–4)**
- Make a saddle in a length of conduit to cross a pipe with 1” (25 mm) clearance between the pipe and the conduit.

### Note

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### Teaching Time: 15 hours

(Six 2.5-Hour Sessions)

Session time may be adjusted to accommodate your class size, schedule, and teaching style.

### Before You Begin

As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

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


There are a number of online resources available for trainees who would like more information on conduit bending. A search for additional information may be assigned as homework to interested trainees.

Instructors should view any videos that may be identified in the lesson plan before using them to ensure their suitability. The videos can provide teachable moments in both proper and improper work processes and behaviors. Be prepared to stop the videos at appropriate times to point out and discuss both proper and improper conduct and techniques.

Instructors are also encouraged to locate additional audiovisual aids available on the internet, make personal videos, and take still pictures related to the subject matter and add them to the PowerPoint® presentations throughout the program.
The Lesson Plan for this module is divided into six 2.5-hour sessions. This time includes 10 minutes for administrative tasks and a 10-minute break per session.

**SESSION ONE**

Session One covers Sections 1.0.0 through 2.2.3. It identifies the NEC® requirements for conduit bends and describes how to use mathematical equations to determine bend distances.

1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with conduit bending.
3. Identify the NEC® requirements for conduit bends.
4. Identify the minimum radius requirements for various types of conduit.
5. Calculate the number of bends per run.
6. Use equations to find bend distances.
7. Use right-angle mathematics to find bend distances.
8. Use the circumference of a circle to determine bend distances.

**SESSION TWO**

Session Two covers Sections 3.0.0 through 4.1.3, and explains how to use mechanical and electric conduit benders.

1. Show the Session Two PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with the procedures for bending conduit using mechanical and electric benders.
3. Chart a mechanical bender.
4. Make mechanical bends.
5. Use electric conduit benders.
Session Outline for Module 26204-17

CONDUIT BENDING

SESSION THREE

Session Three covers Sections 4.2.0 through 4.2.6 and describes how to use hydraulic conduit benders.

1. Show the Session Three PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with how to bend conduit using a hydraulic bender.
3. Use hydraulic conduit benders.

SESSION SIX

Session Six covers Sections 5.0.0 through 5.2.0, and describes how to install PVC conduit. It also serves as a review and testing session.

1. Show the Session Six PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with installing PVC conduit.
3. Join PVC conduit.
4. Bend PVC conduit.
5. Go over the module Review Questions in class before the exam and answer any questions that the trainees may have.
6. Administer the Module Examination and any outstanding performance testing, and submit the results to your Training Program Sponsor through the Registry System.

SESSIONS FOUR AND FIVE

These sessions are set aside for lab work needed to satisfy the module performance tasks. The lab includes the following activities:

1. Use an electric or hydraulic bender to bend a stub-up to a precise distance above the deck.
2. Make an offset in a length of conduit to clear an obstruction with 1” (25 mm) clearance between the pipe and the obstruction.
3. Make a saddle in a length of conduit to cross a pipe with 1” (25 mm) clearance between the pipe and the conduit.

You can allocate lab time for these activities based on class size and available facilities. One approach would be to have some trainees work on one activity while others work on a different activity.

Upon completion of the lab work, ask the trainees to complete the module Review Questions before the upcoming review and testing session.
Module Five (26205-17) describes how to size and install pull and junction boxes. It also identifies various specialty enclosures, including conduit bodies, FS and FD boxes, and handholes.

### Objectives

#### Learning Objective 1
- Identify boxes and fittings.
  - Select pull and junction boxes.
  - Select and install fittings.

#### Learning Objective 2
- Size pull and junction boxes.
  - Size pull and junction boxes for systems under 1,000V.
  - Size pull and junction boxes for systems over 1,000V.

#### Learning Objective 3
- Identify specialty enclosures.
  - Identify conduit bodies and other cast enclosures.
  - Select and install handholes.

### Performance Tasks

#### Performance Task 1 (Learning Objective 1)
- Identify various NEMA boxes.

#### Performance Task 2 (Learning Objective 2)
- Properly select, install, and support pull and junction boxes over 100 cu in (1,650 cu cm) in size.

#### Performance Task 3 (Learning Objective 3)
- Identify various conduit bodies and fittings.

### Note

NFPA 70®, National Electrical Code® and NEC® are registered trademarks of the National Fire Protection Association, Quincy, MA.

**Teaching Time: 12.5 hours**

(Five 2.5-Hour Sessions)

Session time may be adjusted to accommodate your class size, schedule, and teaching style.

### Before You Begin

As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the PowerPoint® Presentations and Performance Profile Sheets from [www.nccerirc.com](http://www.nccerirc.com). For information and updates about accessing the Module Examinations, visit [www.nccer.org/testing](http://www.nccer.org/testing). The passing score for submission into NCCER’s Registry is 70% or above for the written examination; performance testing is graded pass or fail.
**Safety Considerations**

This module identifies different types of conduit boxes, fittings, and specialty enclosures. It describes how to select and install pull and junction boxes for various applications, and it examines conduit bodies, FS and FD boxes, and handholes. Trainees should be reminded about the importance of wearing the proper PPE, following safe practices, and giving due respect to any hazards that may be present while working with or in the vicinity of electrical wiring. Instructors must ensure that trainees clearly understand these safety considerations and clarify any weaknesses to ensure future trainee safety. Remind trainees that the safety procedures on each job site may be more stringent than OSHA or NEC requirements.

**Classroom Equipment and Materials**

<table>
<thead>
<tr>
<th>Whiteboard and markers</th>
<th>Compression fittings</th>
<th>Battery-powered knockout kit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pencils and paper</td>
<td>Setscrew fittings</td>
<td>Hydraulic knockout kit</td>
</tr>
<tr>
<td><em>Electrical Level Two PowerPoint</em> Presentation Slides</td>
<td>Threaded fittings</td>
<td>Various conduit bodies</td>
</tr>
<tr>
<td>DVD player</td>
<td>Combination couplings</td>
<td>Pulling elbows</td>
</tr>
<tr>
<td>LCD projector and screen</td>
<td>Threadless metal conduit couplings</td>
<td>Entrance ells</td>
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<td>Computer</td>
<td>Locknuts</td>
<td>Moguls</td>
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<td>Internet access during class (optional)</td>
<td>Bushings</td>
<td>Handholes</td>
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<td>Various NEMA classifications of pull</td>
<td>Myers hub</td>
<td>Module Review answer key</td>
</tr>
<tr>
<td>and junction boxes</td>
<td>Knockout punches</td>
<td>Module Examinations</td>
</tr>
</tbody>
</table>

**Additional Resources**

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


Online resources are available for trainees who would like more information on pull and junction boxes. A search for additional information may be assigned as homework to interested trainees.

Instructors should view any videos that may be identified in the lesson plan before using them to ensure their suitability. The videos can provide teachable moments in both proper and improper work processes and behaviors. Be prepared to stop the videos at appropriate times to point out and discuss both proper and improper conduct and techniques.

Instructors are also encouraged to locate additional audiovisual aids available on the internet, make personal videos, and take still pictures related to the subject matter and add them to the PowerPoint presentations throughout the program.
The Lesson Plan for this module is divided into five 2.5-hour sessions. This time includes 10 minutes for administrative tasks and a 10-minute break per session.

**SESSION ONE**

Session One covers Sections 1.0.0 through 1.2.3 and identifies various conduit boxes and fittings.

1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with pull and junction boxes.
3. Describe how to select pull and junction boxes.
4. Describe how to select and install fittings.

**SESSION TWO**

Session Two covers Sections 2.0.0 through 2.2.0 and explains how to size pull and junction boxes. The end of the session is devoted to a laboratory and the completion of Performance Task 2.

1. Show the Session Two PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with the procedures for sizing pull and junction boxes for systems under 1,000V and over 1,000V.
3. Explain how to size pull and junction boxes for systems under 1,000V.
4. Explain how to size pull and junction boxes for systems over 1,000V.
5. Trainees practice and/or complete the tasks associated with Performance Task 2 to conclude the session.

**SESSION THREE**

Session Three covers Sections 3.0.0 through 3.2.2 and describes how to identify specialty enclosures, and how to select and install handholes.

1. Show the Session Three PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with how to identify specialty enclosures.
3. Explain how to identify conduit bodies and other cast enclosures.
4. Explain how to select and install handholes.

**SESSION FOUR**

This session is set aside for lab work needed to satisfy Performance Task 1 and Performance Task 3. Note that there is no PowerPoint® presentation associated with this session. The lab includes the following activities:

1. Identify various NEMA boxes.
2. Identify various conduit bodies and fittings.

You can allocate lab time for these activities based on class size and available facilities. One approach would be to have some trainees work on one activity while others work on a different activity.

Upon completion of the lab work, ask the trainees to complete the module Review Questions and Supplemental Exercises prior to the upcoming review and testing session.
Session Outline for Module 26205-17

PULL AND JUNCTION BOXES

Session Five

Session Five is a review and testing session. Go over the module Review Questions and Supplemental Exercises in class prior to the exam and answer any questions that the trainees may have.

1. Administer the Module Examination and any outstanding performance testing.
2. Submit the results to your Training Program Sponsor through the Registry System.
Module Six (26206-17) describes how to prepare conduit for conductors. It also explains how to set up and complete a cable-pulling operation.

### Objectives

**Learning Objective 1**
- Install cable in conduit systems.
  - a. Plan the installation.
  - b. Identify a pulling location and set up the cable reels.
  - c. Prepare raceways for conductors.
  - d. Install a pull line.
  - e. Prepare the cable ends for pulling.
  - f. Select cable-pulling equipment.

**Learning Objective 2**
- Set up for high-force cable pulling.
  - a. Set up the feeding end.
  - b. Support conductors.
  - c. Pull cable in cable trays.

**Learning Objective 3**
- Identify cable limitations when pulling.
  a. Calculate the allowable tension on pulling devices.
  b. Calculate the allowable tension on conductors.
  c. Calculate the sidewall loading.

### Performance Tasks

**Performance Task 1 (Learning Objective 3)**
- Prepare multiple conductors for pulling in a raceway system.

**Performance Task 2 (Learning Objective 3)**
- Prepare multiple conductors for pulling using a wire-pulling basket.

### Note
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### Teaching Time: 10 hours
(Four 2.5-Hour Sessions)
Session time may be adjusted to accommodate your class size, schedule, and teaching style.

### Prerequisites
Core Curriculum.

### Before You Begin
As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the PowerPoint® presentations and Performance Profile Sheets from www.nccerirc.com. For information and updates about accessing the module examinations, visit www.nccer.org/testing. The passing score for submission into NCCER’s Registry is 70% or above for the module examination; performance testing is graded pass or fail.
Safety Considerations
Emphasize the importance of wearing the proper PPE, following safe practices, and giving due respect to any hazards that may be present while working with or in the vicinity of electrical wiring. Trainees must clearly understand these considerations to ensure their safety in the future. Remind trainees that the safety procedures on a particular job site may be more stringent than OSHA or NEC® requirements.

Equipment, Materials, and Resources
Whiteboard and markers
Pencils and paper
*Electrical Level Two* PowerPoint® Presentation Slides
DVD player
LCD projector and screen
Computer
Internet access during class (optional)
Various sizes of electrical cable
Cable strippers
Fish tape
Basket grips
Multiple conductors
Wire-pulling basket
Wire lubricant
Various types of cable pullers
Cable length meters
Circuit testers
Manufacturers’ catalogs for cable supports
Manufacturers’ literature with maximum pulling tension information
Module Review answer key
Module Examinations
Performance Profile Sheets
Standard eye protection
Work gloves
Hard hat
Proper footwear as designated by the instructor or training facility provider
Hearing protection as designated by the instructor or training facility provider

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


There are a number of online resources available for trainees who would like more information on conductor installations. A search for additional information may be assigned as homework to interested trainees.

Instructors should view any videos that may be identified in the lesson plan before using them to ensure their suitability. The videos can provide teachable moments in both proper and improper work processes and behaviors. Be prepared to stop the videos at appropriate times to point out and discuss both proper and improper conduct and techniques.

Instructors are also encouraged to locate additional audiovisual aids available on the internet, make personal videos, and take still pictures related to the subject matter and add them to the PowerPoint® presentations throughout the program.
Session Outline for Module 26206-17

CONDUCTOR INSTALLATIONS

The Lesson Plan for this module is divided into four 2.5-hour sessions.
This time includes 10 minutes for administrative tasks and a 10-minute break per session.

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**SESSION ONE**

Session One covers Sections 1.0.0 through 1.6.3 and describes how to prepare for and install cable in conduit systems.

1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with preparing for and installing cable in conduit.
3. Describe how to plan for a cable installation.
4. Identify a pulling location and set up the cable reels.
5. Explain how to prepare raceways for conductors.
6. Describe how to install a pull line.
7. Explain how to prepare the cable ends for pulling.
8. Describe how to select cable-pulling equipment.

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**SESSION TWO**

Session Two covers Sections 2.0.0 through 2.3.0 and explains how to set up for high-force cable pulling.

1. Show the Session Two PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to differentiate between a small-scale cable-pulling exercise and a high-force cable-pulling exercise.
3. Describe how to set up the feeding end.
4. Describe how to support conductors.
5. Describe how to pull cable in cable trays.

---

**SESSION THREE**

Session Three covers Sections 3.0.0 through 3.3.0 and describes how to identify cable limitations when pulling. The end of the session is devoted to a laboratory and the completion of Performance Tasks 1 and 2.

1. Show the Session Three PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with limitations that must be taken into consideration when pulling cable.
3. Explain how to calculate the allowable tension on pulling devices.
4. Explain how to calculate the allowable tension on conductors.
5. Explain how to calculate the sidewall loading.
6. Have trainees practice and/or complete the tasks associated with Performance Tasks 1 and 2 to conclude the session.

Upon completion of the lab work, ask the trainees to complete the module Review Questions and Supplemental Exercises before the upcoming review and testing session.

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**SESSION FOUR**

Session Four is a review and testing session. Go over the module Review Questions and Supplemental Exercises in class before the exam and answer any questions that the trainees may have.

1. Administer the Module Examination and any outstanding performance testing.
2. Submit the results to your Training Program Sponsor through the Registry System.
Module Seven (26207-17) describes various types of cable tray, supports, and associated fittings. It also explains how to determine the loads on a cable tray and calculate fill per NEC® requirements.

Objectives

Learning Objective 1
• Identify cable tray components.
  a. Select cable tray fittings.
  b. Identify cable tray supports.

Learning Objective 2
• Calculate the load on a cable tray.
  a. Determine the load on supports.
  b. Identify types of failure under load.
  c. Identify installation requirements for cable tray.

Learning Objective 3
• Determine cable tray fill.
  a. Determine the number of conductors allowed in cable tray operating at 2,000V or less.
  b. Identify derating factors for cable tray conductors.

Performance Tasks

Performance Task 1 (Learning Objective 2)
• Generate a list of materials for a cable tray layout. List all the components required, including the fasteners required to complete the system.

Performance Task 2 (Learning Objective 2)
• Join two straight, ladder-type cable tray sections together.

Note
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Teaching Time: 7.5 hours
(Three 2.5-Hour Sessions)
Session time may be adjusted to accommodate your class size, schedule, and teaching style.

Before You Begin
As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the PowerPoint® presentations and Performance Profile Sheets from www.nccerirc.com. For information and updates about accessing the Module Examinations, visit www.nccer.org/testing. The passing score for submission into NCCER’s Registry is 70% or above for the module examination; performance testing is graded pass or fail.
Safety Considerations

Emphasize the importance of wearing the proper PPE, following safe practices, and giving due respect to any hazards that may be present while working with or in the vicinity of electrical wiring. Trainees must clearly understand these considerations to ensure their safety in the future. Remind trainees that the safety procedures on a particular job site may be more stringent than OSHA or NEC requirements.

Equipment, Materials, and Resources

<table>
<thead>
<tr>
<th>Whiteboard and markers</th>
<th>Samples (or photos) of failed cable tray</th>
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<tbody>
<tr>
<td>Pencils and paper</td>
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<tr>
<td>Electrical Level Two PowerPoint® Presentation Slides</td>
<td>Various sections of cable under 4/0 AWG</td>
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<tr>
<td>DVD player</td>
<td>Various sections of multiconductor cable</td>
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<tr>
<td>LCD projector and screen</td>
<td>Module Review answer key</td>
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<td>Computer</td>
<td>Module Examinations</td>
</tr>
<tr>
<td>Internet access during class (optional)</td>
<td>Performance Profile sheets</td>
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<td>Sections of various types of cable tray</td>
<td>Standard eye protection</td>
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<td>Cable tray fittings and connectors</td>
<td>Work gloves</td>
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<td>Cable tray covers</td>
<td>Hard hat</td>
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<td>Proper footwear as designated by the instructor or training facility provider</td>
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<tr>
<td>Swivel plates</td>
<td>Hearing protection as designated by the instructor or training facility provider</td>
</tr>
<tr>
<td>Various types of cable tray supports</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.


There are a number of online resources available for trainees who would like more information on cable trays. A search for additional information may be assigned as homework to interested trainees.

Instructors should view any videos that may be identified in the lesson plan before using them to ensure their suitability. The videos can provide teachable moments in both proper and improper work processes and behaviors. Be prepared to stop the videos at appropriate times to point out and discuss both proper and improper conduct and techniques.

Instructors are also encouraged to locate additional audiovisual aids available on the internet, make personal videos, and take still pictures related to the subject matter and add them to the PowerPoint® presentations throughout the program.
Session Outline for Module 26207-17

CABLE TRAY

The Lesson Plan for this module is divided into three 2.5-hour sessions. This time includes 10 minutes for administrative tasks and a 10-minute break per session.

SESSION ONE

Session One covers Sections 1.0.0 through 1.2.6. It describes what cable tray is, identifies NEC® requirements that pertain to cable tray, and identifies cable tray components.

1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with cable tray components and installation.
3. Explain how to select cable tray fittings.
4. Describe how to identify cable tray supports.

SESSION TWO

Session Two covers Sections 2.0.0 through 2.3.2, and explains how to calculate the load on a cable tray. The end of the session is devoted to a laboratory and the completion of Performance Tasks 1 and 2.

1. Show the Session Two PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with factors that affect the load capacity of cable tray.
3. Explain how to determine the load on supports.
4. Describe how to identify types of failure under load.
5. Describe installation requirements for cable tray.
6. Have trainees practice and/or complete the tasks associated with Performance Tasks 1 and 2 to conclude the session.

SESSION THREE

Session Three covers Sections 3.0.0 through 3.2.0 and describes how to determine cable tray fill. It also serves as a review and testing session. Go over the module Review Questions and Supplemental Exercises in class before the exam and answer any questions before administering the exam.

1. Show the Session Three PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with determining the number of conductors allowed in cable tray.
3. Explain how to determine the number of conductors allowed in cable tray operating at 2,000V or less.
4. Describe how to identify derating factors for cable tray conductors.
5. Administer the Module Examination and any outstanding performance testing, and submit the results to your Training Program Sponsor through the Registry System.
Lesson Plans for Module 26208-17

**CONDUCTOR TERMINATIONS AND SPLICES**

Module Eight (26208-17) explains how to prepare cable ends for terminations and splices. It also describes how to train cable at termination points and describes crimping techniques.

### Objectives

**Learning Objective 1**
- Strip and train conductors.
  - Strip small conductors.
  - Strip large conductors.
  - Bend cable and train conductors.

**Learning Objective 2**
- Make wire connections.
  - Install various types of connectors.
  - Make aluminum connections.
  - Install control and signal cables.

**Learning Objective 3**
- Reinsulate electrical connections.
  - Tape electrical connections.
  - Install heat-shrink insulators.
  - Use motor connection kits.

### Performance Tasks

**Performance Task 1** (Learning Objectives 1 and 2)
- Terminate conductors using selected crimp-type and mechanical-type terminals and connectors.

**Performance Task 2** (Learning Objectives 1 and 2)
- Terminate conductors on a terminal strip.

**Performance Task 3** (Learning Objective 3)
- Insulate selected types of wire splices and/or install a motor connection kit.

### Note
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### Teaching Time: 7.5 hours
(Three 2.5-Hour Sessions)
Session time may be adjusted to accommodate your class size, schedule, and teaching style.

### Before You Begin
As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the PowerPoint® presentations and Performance Profile Sheets from www.nccerirc.com. For information and updates about accessing the module examinations, visit www.nccer.org/testing. The passing score for submission into NCCER’s Registry is 70% or above for the module examination; performance testing is graded pass or fail.

26208-17 Conductor Terminations and Splices
Safety Considerations
Emphasize the importance of wearing the proper PPE, following safe practices, and giving due respect to any hazards that may be present while working with or in the vicinity of electrical wiring. Trainees must clearly understand these considerations to ensure their safety in the future. Remind trainees that the safety procedures on a particular job site may be more stringent than OSHA or NEC® requirements.

Equipment, Materials, and Resources
- Whiteboard and markers
- Pencils and paper
- Electrical Level Two PowerPoint® Presentation Slides
- DVD player
- LCD projector and screen
- Computer
- Internet access during class (optional)
- An assortment of small and large conductors (solid and stranded)
- Common wire strippers for small conductors
- Production-grade wire strippers
- Ratchet-type strippers for large conductors
- Heavy-duty strippers for large conductors
- Round cable slitting and ringing tool
- Ratchet bender
- Hydraulic bender
- Crimp-on connectors (color coded)
- Mechanical connectors
- Aluminum conductor connectors
- Hand-operated crimping tools
- Hydraulic crimping tools
- Cordless crimping tools
- Corded crimping tools
- Universal crimping tools
- Type MC cable
- Weatherproof connectors for Type MC cable
- Control and signal cable
- Terminal blocks
- Electrical tape
- Heat-shrink insulators
- Motor connection kits
- Heat gun
- Module Review answer key
- Module Examinations
- Performance Profile Sheets
- Standard eye protection
- Work gloves
- Hard hat
- Proper footwear as designated by the instructor or training facility provider
- Hearing protection as designated by the instructor or training facility provider
- Type MC cable
- Weatherproof connectors for Type MC cable
- Control and signal cable
- Terminal blocks
- Electrical tape
- Heat-shrink insulators
- Motor connection kits
- Heat gun
- Module Review answer key
- Module Examinations
- Performance Profile Sheets
- Standard eye protection
- Work gloves
- Hard hat
- Proper footwear as designated by the instructor or training facility provider
- Hearing protection as designated by the instructor or training facility provider

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


There are a number of online resources available for trainees who would like more information on conductor terminations and splicing. A search for additional information may be assigned as homework to interested trainees.

Instructors should view any videos that may be identified in the lesson plan before using them to ensure their suitability. The videos can provide teachable moments in both proper and improper work processes and behaviors. Be prepared to stop the videos at appropriate times to point out and discuss both proper and improper conduct and techniques.

Instructors are also encouraged to locate additional audiovisual aids available on the internet, make personal videos, and take still pictures related to the subject matter and add them to the PowerPoint® presentations throughout the program.
Session Outline for Module 26208-17

CONDUCTOR TERMINATIONS AND SPLICES

The Lesson Plan for this module is divided into three 2.5-hour sessions. This time includes 10 minutes for administrative tasks and a 10-minute break per session.

**SESSION ONE**

Session One covers Sections 1.0.0 through 1.3.2. It describes tools and techniques for stripping and training conductors.

1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with preparing and making conductor terminations and splices.
3. Explain how to strip small conductors.
4. Explain how to strip large conductors.
5. Describe how to bend cable and train conductors.

**SESSION TWO**

Session Two covers Sections 2.0.0 through 2.3.4, and explains how to make wire connections. The end of the session is devoted to a laboratory and the completion of Performance Tasks 1 and 2.

1. Show the Session Two PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with making wire connections.
3. Explain how to install various types of connectors.
4. Describe how to make aluminum connections.
5. Explain how to install control and signal cables.
6. Have trainees practice and/or complete the tasks associated with Performance Task 1 and 2 to conclude the session.

**SESSION THREE**

Session Three covers Sections 3.0.0 through 3.3.0 and describes how to reinsulate electrical connections. The end of the session is devoted to a laboratory and the completion of Performance Task 3. It also serves as a review and testing session. Go over the module Review Questions and Supplemental Exercises in class prior to the exam and answer any questions that the trainees may have.

1. Show the Session Three PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with reinsulating electrical connections.
3. Explain how to tape electrical connections.
4. Describe how to install heat-shrink insulators.
5. Describe how to use motor connection kits.
6. Have trainees practice and/or complete the tasks associated with Performance Task 3.
7. Administer the Module Examination and any outstanding performance testing, and submit the results to your Training Program Sponsor through the Registry System.
Lesson Plans for Module 26209-17

GROUNDING AND BONDING

Module Nine (26209-17) describes the grounding and bonding requirements of NEC Article 250. It also explains how to size the main and system bonding jumpers as well as the grounding electrode conductor for various AC systems.

### Objectives

**Learning Objective 1**
- Identify grounding requirements and applications.
  a. Identify the purpose of grounding and bonding.
  b. Identify the grounding requirements for various systems.

**Learning Objective 2**
- Identify service grounding methods.
  a. Size and install a grounding electrode conductor.
  b. Select other electrodes.

**Learning Objective 3**
- Size and select equipment grounding.
  a. Size an equipment grounding conductor.
  b. Ground an enclosure.

**Learning Objective 4**
- Bond service equipment.
  a. Size the main bonding jumper.
  b. Bond multiple service disconnects.
  c. Bond enclosures and equipment.

**Learning Objective 5**
- Ground and bond separately derived systems.
  a. Ground separately derived systems.
  b. Install grounding at more than one building.

**Learning Objective 6**
- Test for effective grounds.
  a. Measure earth resistance using the fall-of-potential method.
  b. Complete a three-point test.

### Performance Tasks

**Performance Task 1 (Learning Objective 2)**
- Size the minimum required grounding electrode conductor for a 200A service fed by 3/0 copper.

**Performance Task 2 (Learning Objective 2)**
- Using the proper fittings, connect one end of a No. 4 AWG bare copper grounding wire to a length of 3/4" (MD 21) galvanized water pipe and the other end to the correct terminal in a main panelboard.

**Performance Task 3 (Learning Objective 3)**
- Install two lengths of Type NM cable in a switch box using Type NM cable clamps:
  - Strip the ends of the cable to conform with National Electrical Code® requirements.
  - Secure the cable in the switch box and tighten the cable clamps.
  - Connect and secure the equipment grounding conductors according to NEC® requirements, and secure to the switch box with either a ground clip or a grounding screw.

**Performance Task 4 (Learning Objective 3)**
- Size the minimum required equipment grounding conductor in each conduit for a 400A feeder gap using two parallel runs of 3/0 copper.

**Performance Task 5 (Learning Objective 5)**
- Size the minimum required bonding jumper for a copper water pipe near a separately derived system (transformer) where the secondary conductors are 500 kcmil copper.

### Note

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### Teaching Time: 15 hours

(Six 2.5-Hour Sessions)
Session time may be adjusted to accommodate your class size, schedule, and teaching style.
Before You Begin
As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the PowerPoint® presentations and Performance Profile Sheets from www.nccerirc.com. For information and updates about accessing the module examinations, visit www.nccer.org/testing. The passing score for submission into NCCER’s Registry is 70% or above for the module examination; performance testing is graded pass or fail.

Safety Considerations
Emphasize the importance of wearing the proper PPE, following safe practices, and giving due respect to any hazards that may be present while working with or in the vicinity of electrical wiring. Trainees must clearly understand these considerations to ensure their safety in the future. Remind trainees that the safety procedures on a particular job site may be more stringent than OSHA or NEC® requirements.

Classroom Equipment and Materials, and Resources

- Whiteboard and markers
- Pencils and paper
- Electrical Level Two PowerPoint® Presentation Slides
- DVD player
- LCD projector and screen
- Computer
- Internet access during class (optional)
- Adequate copies of all appropriate NEC® requirements, sections, and tables
- No. 4 AWG bare copper grounding wire
- ¾” (MD 21) galvanized water pipe
- A main panelboard
- All necessary tools for making connections
- Flexible metal conduit
- Liquidtight flexible metal conduit
- Grounding clips and/or grounding screws
- Grounding receptacles
- Type NM cable
- Switch boxes
- Type NM cable clamps
- An earth ground resistance tester
- Module Review answer key
- Module Examinations
- Performance Profile Sheets
- Standard eye protection
- Work gloves
- Hard hat
- Proper footwear as designated by the instructor or training facility provider
- Hearing protection as designated by the instructor or training facility provider

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


There are a number of online resources available for trainees who would like more information on grounding and bonding. A search for additional information may be assigned as homework to interested trainees.

Instructors should view any videos that may be identified in the lesson plan before using them to ensure their suitability. The videos can provide teachable moments in both proper and improper work processes and behaviors. Be prepared to stop the videos at appropriate times to point out and discuss both proper and improper conduct and techniques.

Instructors are also encouraged to locate additional audiovisual aids available on the Internet, make personal videos, and take still pictures related to the subject matter and add them to the PowerPoint® presentations throughout the program.
Session Outline for Module 26209-17

GROUNDING AND BONDING

The Lesson Plan for this module is divided into six 2.5-hour sessions. This time includes 10 minutes for administrative tasks and a 10-minute break per session.

**Session One**

Session One covers Sections 1.0.0 through 1.2.5. It identifies grounding requirements and applications.

1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with the use of grounding and bonding.
3. Identify the purpose of grounding and bonding.
4. Identify the grounding requirements for various systems.

**Session Two**

Session Two covers Sections 2.0.0 through 2.2.0, and identifies service grounding methods. The end of the session is devoted to a laboratory and the completion of Performance Tasks 1 and 2.

1. Show the Session Two PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with sizing a grounding electrode conductor.
3. Describe how to size and install a grounding electrode conductor.
4. Explain how to select other electrodes.
5. Have trainees practice and/or complete the tasks associated with Performance Tasks 1 and 2 to conclude the session.

**Session Three**

Session Three covers Sections 3.0.0 through 3.2.2 and describes how to size and select equipment grounding. The end of the session is devoted to a laboratory and the completion of Performance Tasks 3 and 4.

1. Show the Session Three PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with equipment grounding.
3. Explain how to size an equipment grounding conductor.
4. Describe how to ground an enclosure.
5. Have trainees practice and/or complete the tasks associated with Performance Tasks 3 and 4 to conclude the session.
Session Outline for Module 26209-17

**GROUNDING AND BONDING**

### Session Four

Session Four covers Sections 4.0.0 through 5.2.0. It explains how to bond service equipment and how to ground and bond separately derived systems. The end of the session is devoted to a laboratory and the completion of Performance Task 5.

1. Show the Session Four PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with bonding service equipment.
3. Describe how to size the main bonding jumper.
4. Explain how to bond multiple service disconnects.
5. Explain how to bond enclosures and equipment.
6. Describe how to ground separately derived systems.
7. Explain how to install grounding at more than one building.
8. Have trainees practice and/or complete the tasks associated with Performance Task 5 to conclude the session.

### Session Five

Session Five covers Sections 6.0.0 through 6.2.0, and describes how to test for effective grounds.

1. Show the Session Five PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with testing for effective grounds.
3. Explain how to measure earth resistance using the fall-of-potential method.
4. Describe how to complete a three-point test.

### Session Six

Session Six is a review and testing session. Go over the module Review Questions and Supplemental Exercises in class before the exam and answer any questions that the trainees may have.

Administer the Module Examination and any outstanding performance testing, and submit the results to your Training Program Sponsor through the Registry System.
Module Ten (26210-17) describes the operating principles of circuit breakers and fuses. It also explains how to select and install overcurrent devices.

Objectives

Learning Objective 1
• Identify the function of overcurrent protective devices.
  a. Identify types of overcurrent conditions.
  b. Identify NEC® requirements for overcurrent protective devices.

Learning Objective 2
• Size and select circuit breakers.
  a. Identify circuit breaker components.
  b. Identify circuit breaker types and ratings.

Learning Objective 3
• Size and select fuses.
  a. Identify fuse types and markings.
  b. Size fuses.
  c. Coordinate the operation of overcurrent protective devices.

Performance Tasks

Performance Task 1 (Learning Objectives 1–3)
• Identify the following on one or more circuit breaker(s) and fuse(s):
  – Number of poles
  – Load rating
  – Voltage rating
  – Amperage interrupting rating

Note
NFPA 70®, National Electrical Code® and NEC® are registered trademarks of the National Fire Protection Association, Quincy, MA.

Teaching Time: 12.5 hours
(Five 2.5-Hour Sessions)
Session time may be adjusted to accommodate your class size, schedule, and teaching style.

Before You Begin
As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the PowerPoint® presentations and Performance Profile Sheets from www.nccerirc.com. For information and updates about accessing the module examinations, visit www.nccer.org/testing. The passing score for submission into NCCER’s Registry is 70% or above for the module examination; performance testing is graded pass or fail.
Safety Considerations
Emphasize the importance of wearing the proper PPE, following safe practices, and giving due respect to any hazards that may be present while working with or in the vicinity of electrical wiring. Trainees must clearly understand these considerations to ensure their safety in the future. Remind trainees that the safety procedures on a particular job site may be more stringent than OSHA or NEC® requirements.

Classroom Equipment and Materials
Whiteboard and markers
Pencils and paper
*Electrical Level Two PowerPoint® Presentation Slides
DVD player
LCD projector and screen
Computer
Internet access during class (optional)

A fuse box with fuses (if no example is available in the facility)
Copies of the NEC® requirements for overcurrent protection
Various sizes and types of circuit breakers
GFCI devices
Various Edison-base fuses

Various Type S fuses
Various sizes and types (single-element and dual-element) of cartridge fuses
Module Review answer key
Module Examinations
Performance Profile Sheets

Equipment and Materials for Laboratories and Performance Testing
Standard eye protection
Proper footwear as designated by the instructor or training facility provider
Hearing protection as designated by the instructor or training facility provider

Work gloves

Hard hat

GFCI devices

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

*Lessons in Electric Circuits, Volume IV* (free online textbook), [www.allaboutcircuits.com](http://www.allaboutcircuits.com)


There are a number of online resources available for trainees who would like more information on circuit breakers and fuses. A search for additional information may be assigned as homework to interested trainees.

Instructors should view any videos that may be identified in the lesson plan before using them to ensure their suitability. The videos can provide teachable moments in both proper and improper work processes and behaviors. Be prepared to stop the videos at appropriate times to point out and discuss both proper and improper conduct and techniques.

Instructors are also encouraged to locate additional audiovisual aids available on the internet, make personal videos, and take still pictures related to the subject matter and add them to the PowerPoint® presentations throughout the program.
Session One covers Sections 1.0.0 through 1.2.0. It describes the function of overcurrent protective devices, identifies types of overcurrent conditions, and identifies critical NEC® requirements for overcurrent protective devices.

1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with common overcurrent protective devices.
3. Identify and describe types of overcurrent conditions.
4. Identify and describe NEC® requirements for overcurrent protective devices.

Session Two covers Sections 2.0.0 through 2.2.4 and explains how to size and select circuit breakers.

1. Show the Session Two PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with circuit breaker current ratings and how they relate to sizing and selecting breakers.
3. Describe how to identify circuit breaker components.
4. Explain how to identify circuit breaker types and ratings.

Session Three covers Sections 3.0.0 through 3.3.0 and describes how to size and select fuses.

1. Show the Session Three PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with various sizes and types of fuses.
3. Describe how to identify fuse types and markings.
4. Explain how to size fuses.
5. Describe how to coordinate the operation of overcurrent protective devices.

Session Four

This session is set aside for lab work needed to satisfy Performance Task 1. Note that there is no PowerPoint® presentation associated with this session. The lab includes the following activity:

Identify the following on one or more circuit breaker(s) and fuse(s):

- Number of poles
- Load rating
- Voltage rating
- Amperage interrupting rating

You can allocate lab time for this activity based on class size and available facilities. One approach would be to have multiple workstations to enable more than one trainee to complete the task at the same time.

Upon completion of the lab work, ask the trainees to complete the module Review Questions and Supplemental Exercises before the upcoming review and testing session.
SESSION FIVE

Session Five is a review and testing session. Go over the module Review Questions and Supplemental Exercises in class before the exam and answer any questions that the trainees may have.

1. Administer the Module Examination and any outstanding performance testing.
2. Submit the results to your Training Program Sponsor through the Registry System.
Module Eleven (26211-17) describes the operating principles of contactors and relays, including both mechanical and solid-state devices. It also explains how to select and install relays and troubleshoot control circuits.

Objectives
Learning Objective 1
• Identify magnetic and mechanically held contactors.
  a. Select lighting contactors.
  b. Make forward and reverse motor contactor connections.
  c. Select mechanically held contactors.
Learning Objective 2
• Select and troubleshoot relays.
  a. Select control relays.
  b. Select timers and timing relays.
  c. Select solid-state relays.
  d. Select overload relays.
  e. Troubleshoot relays.
Learning Objective 3
• Install low-voltage remote control switching systems.
  a. Identify remote control switching system components and operating characteristics.
  b. Plan and install a remote control switching system.
Performance Task
Performance Task 1 (Learning Objective 3)
• Mount and connect a 120V lighting contactor with a three-wire pushbutton control.

Note
NFPA 70®, National Electrical Code® and NEC® are registered trademarks of the National Fire Protection Association, Quincy, MA.

Teaching Time: 12.5 hours
(Five 2.5-Hour Sessions)
Session time may be adjusted to accommodate your class size, schedule, and teaching style.

Before You Begin
As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the PowerPoint® presentations and Performance Profile Sheets from www.nccerirc.com. For information and updates about accessing the module examinations, visit www.nccer.org/testing. The passing score for submission into NCCER’s Registry is 70% or above for the module examination; performance testing is graded pass or fail.
Safety Considerations
Emphasize the importance of wearing the proper PPE, following safe practices, and giving due respect to any hazards that may be present while working with or in the vicinity of electrical wiring. Trainees must clearly understand these considerations to ensure their safety in the future. Remind trainees that the safety procedures on a particular job site may be more stringent than OSHA or NEC® requirements.

Classroom Equipment and Materials
- Whiteboard and markers
- Pencils and paper
- Electrical Level Two PowerPoint® Presentation Slides
- DVD player
- LCD projector and screen
- Computer
- Internet access during class (optional)
- Magnetic contactors
- Mechanically held contactors
- Lighting contactors
- Relays
- Control relays
- Timers and timing relays
- Solid-state relays
- Thermal overload relays
- Magnetic overload relays
- Pneumatic timers
- Components of a low-voltage remote control switching system including:
  - Low-voltage relays
  - Transformers
  - Low-voltage switches
  - Master sequencer(s)
  - Drawings and schematics of low-voltage remote control switching systems
  - Module Review answer key
  - Module Examinations
  - Performance Profile Sheets

Equipment and Materials for Laboratories and Performance Testing
- Standard eye protection
- Work gloves
- Hard hat
- Proper footwear as designated by the instructor or training facility provider
- Hearing protection as designated by the instructor or training facility provider

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


There are a number of online resources available for trainees who would like more information on control systems. A search for additional information may be assigned as homework to interested trainees.

Instructors should view any videos that may be identified in the lesson plan before using them to ensure their suitability. The videos can provide teachable moments in both proper and improper work processes and behaviors. Be prepared to stop the videos at appropriate times to point out and discuss both proper and improper conduct and techniques.

Instructors are also encouraged to locate additional audiovisual aids available on the internet, make personal videos, and take still pictures related to the subject matter and add them to the PowerPoint® presentations throughout the program.
Session Outline for Module 26211-17

Control Systems and Fundamental Concepts

The Lesson Plan for this module is divided into five 2.5-hour sessions. This time includes 10 minutes for administrative tasks and a 10-minute break per session.

**SESSION ONE**

Session One covers Sections 1.0.0 through 1.3.0 and identifies magnetic and mechanically held contactors.

1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with contactors.
3. Describe how to select lighting contactors.
4. Explain how to make forward and reverse motor contactor connections.
5. Describe how to select mechanically held contactors.

**SESSION TWO**

Session Two covers Sections 2.0.0 through 2.5.0 and explains how to select and troubleshoot relays.

1. Show the Session Two PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with different types of relays.
3. Explain how to select control relays.
4. Explain how to select timers and timer relays.
5. Explain how to select solid-state relays.
6. Explain how to select overload relays.
7. Describe how to troubleshoot relays.

**SESSION THREE**

Session Three covers Sections 3.0.0 through 3.2.2 and describes how to install low-voltage remote control switching systems.

1. Show the Session Three PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to familiarize themselves with low-voltage remote control switching systems.
3. Explain how to identify remote control switching system components and operating characteristics.
4. Describe how to plan and install a remote control switching system.

**SESSION FOUR**

This session is set aside for lab work needed to satisfy Performance Task 1. Note that there is no PowerPoint® presentation associated with this session. The lab includes the following activities:

1. Mount and connect a 120V lighting contactor with a three-wire pushbutton control.

You can allocate lab time for these activities based on class size and available facilities. One approach would be to have multiple workstations to enable more than one trainee to complete the task at the same time.

Upon completion of the lab work, ask the trainees to complete the module Review Questions and Supplemental Exercises prior to the upcoming review and testing session.
Session Outline for Module 26211-17

CONTROL SYSTEMS AND FUNDAMENTAL CONCEPTS

SESSION FIVE

Session Five is a review and testing session. Go over the module Review Questions and Supplemental Exercises in class prior to the exam and answer any questions that the trainees may have.

1. Administer the Module Examination and any outstanding performance testing.
2. Submit the results to your Training Program Sponsor through the Registry System.