

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

Learning Objective 1

- Identify AC waveforms.
 - a. Define the terminology of sine waves.
 - b. Define AC phase relationships.
 - c. Identify nonsinusoidal waveforms.

Learning Objective 2

- Determine unknown values in AC circuits.
 - a. Find unknown values in purely resistive AC circuits.
 - b. Find unknown values in inductive AC circuits.
 - c. Find unknown values in capacitive AC circuits.
 - d. Find unknown values in combination circuits.

Learning Objective 3

- Make power calculations in AC circuits.
 - a. Calculate true power.
 - b. Calculate apparent power.
 - c. Calculate reactive power.
 - d. Calculate power factor.
 - e. Use the power triangle to determine unknown values.

Learning Objective 4

- Identify transformers and explain how they operate.
 - a. Identify the basic components in a transformer.
 - b. Identify transformer operating characteristics.
 - c. Calculate turns and voltage ratios.
 - d. Identify various types of transformers and their applications.

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	DVD player	Module Review answer key
Pencils and paper	LCD projector and screen	Module Examinations
Electrical LevelTwo PowerPoint [®]	Computer	Capacitors
Presentation Slides	Internet access during class (optional)	Transformers

Additional Resources

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

Introduction to Electric Circuits. Latest Edition. New York, NY: Peason Education, Inc.

Principles of Electric Circuits, Thomas L. Floyd. Latest Edition. New York, NY: Pearson Education, Inc.

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.



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.



MOTORS: THEORY AND APPLICATION

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.

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.

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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	<i>NEC</i> [®] installation requirements for motors
Pencils and paper	<i>NEC</i> [®] motor protection requirements
Electrical Level Two PowerPoint [®] Presentation Slides	Ohmmeter
DVD player	Module Review answer key
LCD projector and screen	Module Examinations
Computer	Performance Profile Sheets
Internet access during class (optional)	Standard eye protection
DC motors, including shunt-wound, series, and compound	Work gloves
Several AC motors, including some squirrel cage motors	Proper footwear as designated by the instructor or training facility provider
Capacitor-type induction motor	Hearing protection as designated by the instructor or training facility provider
Shaded-pole induction motor	Several DC motors
Multiple-speed induction motors	Several AC motors
Split-phase induction motors	Several dual-voltage motors
Variable-speed drives	
Motor nameplates	

Additional Resources

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

Electric Motors and Drives: Fundamentals, Types, and Applications. 4th Edition. Austin Hughes and Bill Drury. Waltham, MA: Newnes.

An IEC Metric Motor Dimension chart can be found at <http://www.electricmotorservice.net/iechart.pdf>.

An NEMA Electrical Motor Frame Dimensions chart is available from the Engineering Toolbox at http://www.engineeringtoolbox.com/nema-electrical-motor-frame-dimensions-d_1504.html.

National Electrical Code[®] Handbook, Latest Edition. Quincy, MA: National Fire Protection Association.

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.

MOTORS: THEORY AND APPLICATION

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 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.

ELECTRIC LIGHTING

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.

Lighting Handbook, Latest Edition. New York: Illuminating Engineering Society of North America (IESNA).

National Electrical Code[®] Handbook, Latest Edition. Quincy, MA: National Fire Protection Association.

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.

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.



ELECTRIC LIGHTING

SESSION THREE

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 FOUR

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 timers.
6. Describe how to program energy management systems.

SESSION FIVE

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 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.

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



CONDUIT BENDING

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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Safety Considerations

This module identifies the *NEC*[®] requirements for conduit bends and describes mathematical equations that can be used to determine bend distances and angles. It explains how to use mechanical, electric, and hydraulic conduit benders and how to make concentric, offset, and saddle bends. It also describes how to join and bend PVC conduit. 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

Whiteboard and markers	Offsets	Straightedges
Pencils and paper	Saddles	PVC conduit
<i>Electrical Level Two</i> PowerPoint [®]	Kicks	PVC cement
Presentation Slides	Mechanical conduit benders	Heating units for bending PVC conduit
DVD player	Bending protractors	PVC plugs
LCD projector and screen	Manufacturers' bending charts	Module Review answer key
Computer	Electric conduit bender	Module Examinations
Internet access during class (optional)	Hydraulic conduit bender	Performance Profile Sheets
Elbows	Magnetic angle finder	
	Ample and suitable conduit	

Equipment and Materials for Laboratories and Performance Testing

Standard eye protection	Hearing protection as designated by the instructor or training facility provider
Work gloves	
Proper footwear 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.

Benfield Conduit Bending Manual, 2nd Edition. Overland Park, KS: EC&M Books.

National Electrical Code[®] Handbook, Latest Edition. Quincy, MA: National Fire Protection Association.

Tom Henry's Conduit Bending Package (includes video, book, and bending chart). Winter Park, FL: Code Electrical Classes, Inc.

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.

CONDUIT BENDING

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.



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.

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.

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.

PULL AND JUNCTION BOXES

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.
 - a. Select pull and junction boxes.
 - b. Select and install fittings.

Learning Objective 2

- Size pull and junction boxes.
 - a. Size pull and junction boxes for systems under 1,000V.
 - b. Size pull and junction boxes for systems over 1,000V.

Learning Objective 3

- Identify specialty enclosures.
 - a. Identify conduit bodies and other cast enclosures.
 - b. 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

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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 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

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

Additional Resources

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

National Electrical Code[®] Handbook, Latest Edition. Quincy, MA: National Fire Protection Association.

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.

Session Outline for Module 26205-17

PULL AND JUNCTION BOXES

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.



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.



Lesson Plans for Module 26206-17

CONDUCTOR INSTALLATIONS

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

Additional Resources

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

Cable Installation Manual, Latest Edition. New York: Cablec Corp.

National Electrical Code[®] Handbook, Latest Edition. Quincy, MA: National Fire Protection Association.

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.

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.

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.

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.



Lesson Plans for Module 26207-17

CABLE TRAY

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

Whiteboard and markers

Pencils and paper

Electrical Level Two PowerPoint[®] Presentation Slides

DVD player

LCD projector and screen

Computer

Internet access during class (optional)

Sections of various types of cable tray

Cable tray fittings and connectors

Cable tray covers

Splice plates

Swivel plates

Various types of cable tray supports

Samples (or photos) of failed cable tray

Various sections of cable over 4/0 AWG

Various sections of cable under 4/0 AWG

Various sections of multiconductor cable

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.

Cooper Industries Cable Tray Manual (pdf). www.cooperindustries.com.

Metal Cable Tray Systems, NEMA VE 1-2009. www.nema.org.

National Electrical Code[®] Handbook, Latest Edition. Quincy, MA: National Fire Protection Association.

Paralleled Phase Conductors in Cable Trays Provide Copper Savings. Cable Tray Institute Bulletin. www.cabletrays.org.

Safely Installing, Maintaining and Inspecting Cable Trays. Safety and Health Information Bulletin. www.osha.org.

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.

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.



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.
 - a. Strip small conductors.
 - b. Strip large conductors.
 - c. Bend cable and train conductors.

Learning Objective 2

- Make wire connections.
 - a. Install various types of connectors.
 - b. Make aluminum connections.
 - c. Install control and signal cables.

Learning Objective 3

- Reinsulate electrical connections.
 - a. Tape electrical connections.
 - b. Install heat-shrink insulators.
 - c. 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.



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

Additional Resources

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

ANSI C119.6-2011, American National Standard for Electric Connectors—Non-Sealed, Multiport Connector Systems Rated 600V or Less for Aluminum and Copper Conductors. www.ansi.org.

National Electrical Code[®] Handbook, Latest Edition. Quincy, MA: National Fire Protection Association.

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.

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 Tasks 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.



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 $\frac{3}{4}$ " (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

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

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	$\frac{3}{4}$ " (MD 21) galvanized water pipe	An earth ground resistance tester
Pencils and paper	A main panelboard	Module Review answer key
<i>Electrical Level Two</i> PowerPoint®	All necessary tools for making connections	Module Examinations
Presentation Slides	Flexible metal conduit	Performance Profile Sheets
DVD player	Liquidtight flexible metal conduit	Standard eye protection
LCD projector and screen	Grounding clips and/or grounding screws	Work gloves
Computer	Grounding receptacles	Hard hat
Internet access during class (optional)	Type NM cable	Proper footwear as designated by the instructor or training facility provider
Adequate copies of all appropriate NEC® requirements, sections, and tables	Switch boxes	Hearing protection as designated by the instructor or training facility provider
No. 4 AWG bare copper grounding wire	Type NM cable clamps	

Additional Resources

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

National Electrical Code® Handbook, Latest Edition. Quincy, MA: National Fire Protection Association.

Ugly's Electrical Desk Reference, Latest Edition. Burlington, MA: Jones and Bartlett Learning.

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.

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.



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.

CIRCUIT BREAKERS CIRCUIT BREAKERS AND FUSES

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	A fuse box with fuses (if no example is available in the facility)	Various Type S fuses
Pencils and paper		Various sizes and types (single-element and dual-element) of cartridge fuses
<i>Electrical Level Two</i> PowerPoint [®]	Copies of the <i>NEC</i> [®] requirements for overcurrent protection	Module Review answer key
Presentation Slides	Various sizes and types of circuit breakers	Module Examinations
DVD player	GFCl devices	Performance Profile Sheets
LCD projector and screen	Various Edison-base fuses	
Computer		
Internet access during class (optional)		

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		

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

National Electrical Code[®] Handbook, Latest edition. Quincy, MA: National Fire Protection Association.

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.

CIRCUIT BREAKERS CIRCUIT BREAKERS AND FUSES

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 1.2.0. 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

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

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.

CIRCUIT BREAKERS AND FUSES

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.



CONTROL SYSTEMS AND FUNDAMENTAL CONCEPTS

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

Equipment and Materials for Laboratories and Performance Testing

Standard eye protection	Hard hat	Hearing protection as designated by the instructor or training facility provider
Work gloves	Proper footwear 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.

Lessons in Electric Circuits, Volume IV (free online textbook). www.allaboutcircuits.com

National Electrical Code[®] Handbook, Latest Edition. Quincy, MA: National Fire Protection Association.

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.

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.



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.

