

MODULE OVERVIEW

This module introduces the load calculations and *National Electrical Code*[®] (*NEC*[®]) requirements for branch and feeder circuits.

PREREQUISITES

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

OBJECTIVES

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

1. Calculate loads for single-phase and three-phase branch circuits.
2. Size branch circuit overcurrent protection devices (circuit breakers and fuses) for noncontinuous duty and continuous duty circuits.
3. Apply derating factors to size branch circuits.
4. Calculate ampacity for single-phase and three-phase loads.
5. Use load calculations to determine branch circuit conductor sizes.
6. Use *NEC Table 220.55* to calculate residential cooking equipment loads.
7. Select branch circuit conductors and overcurrent protection devices for electric heat, air conditioning equipment, motors, and welders.

PERFORMANCE TASKS

This is a knowledge-based module. There are no Performance Tasks.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen
Transparencies
Blank acetate sheets
Transparency pens
Whiteboard / chalkboard
Markers / chalk

Pencils and scratch paper
Appropriate personal protective equipment
Copy of the latest edition of the *National Electrical Code*[®]
Calculator
Module Examinations*

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

SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment.

ADDITIONAL RESOURCES

This module is intended to present thorough resources for task training. The following reference work is suggested for both instructors and motivated trainees interested in further study. This is optional material for continued education rather than for task training.

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

NOTE

NFPA 70[®], *National Electrical Code*[®], and *NEC*[®] are registered trademarks of the National Fire Protection Association, Inc., Quincy, MA 02269. All *National Electrical Code*[®] and *NEC*[®] references in this module refer to the 2008 edition of the *National Electrical Code*[®].

TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 17½ hours are suggested to cover *Load Calculations – Branch and Feeder Circuits*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources.

Topic	Planned Time
Session I. Introduction; Branch Circuit Ratings; Derating; Calculating Branch Circuit Ampacity	
A. Introduction	_____
B. Branch Circuit Ratings	_____
C. Derating	_____
1. Temperature Derating	_____
2. Voltage Drop Derating for Single-Phase Circuits	_____
3. Voltage Drop Derating for Three-Phase Circuits	_____
D. Calculating Branch Circuit Ampacity	_____
Session II. Lighting Loads; Receptacle Loads; Multi-Outlet Assemblies	
A. Lighting Loads	_____
1. Recessed Lighting	_____
2. Heavy-Duty Lamp Holder Outlets	_____
B. Receptacle Loads	_____
C. Multi-Outlet Assemblies	_____
Session III. Show Window Loads; Sign Load	
A. Show Window Loads	_____
B. Sign Load	_____
Session IV. Residential Branch Circuits; Commercial Kitchen Equipment	
A. Residential Branch Circuits	_____
1. Small Appliance Load	_____
2. Laundry Circuit	_____
3. Dryers	_____
4. Cooking Appliances	_____
B. Commercial Kitchen Equipment	_____
Session V. Water Heaters; Electric Heating Loads; Air Conditioning Loads	
A. Water Heaters	_____
B. Electric Heating Loads	_____
C. Air Conditioning Loads	_____
Session VI. Motor Loads; Welders	
A. Motor Loads	_____
B. Welders	_____
Session VII. Review and Testing	
A. Module Review	_____
B. Module Examination	_____
1. Trainees must score 70 percent or higher to receive recognition from the NCCER.	
2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.	

MODULE OVERVIEW

This module introduces the procedures for conductor selection and calculations using various tables in the *National Electrical Code*[®] (*NEC*[®]).

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Electrical Level One; Electrical Level Two; and Electrical Level Three, Module 26301-08.*

OBJECTIVES

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

1. Select electrical conductors for specific applications.
2. Calculate voltage drop in both single-phase and three-phase applications.
3. Apply *National Electrical Code*[®] (*NEC*[®]) regulations governing conductors to a specific application.
4. Calculate and apply *NEC*[®] tap rules to a specific application.
5. Size conductors for the load.
6. Derate conductors for fill, temperature, and voltage drop.
7. Select conductors for various temperature ranges and atmospheres.

PERFORMANCE TASKS

This is a knowledge-based module. There are no Performance Tasks.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen
Transparencies
Blank acetate sheets
Transparency pens
Whiteboard / chalkboard
Markers / chalk
Pencils and scratch paper

Appropriate personal protective equipment
Copy of the latest edition of the *National Electrical Code*[®]
One length each of various solid and stranded conductors
Module Examinations*

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

SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment.

ADDITIONAL RESOURCES

This module is intended to present thorough resources for task training. The following reference work is suggested for both instructors and motivated trainees interested in further study. This is optional material for continued education rather than for task training.

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

NOTE

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TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 15 hours are suggested to cover *Conductor Selection and Calculations*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources.

Topic	Planned Time
Session I. Introduction; Compact Conductors	
A. Introduction	_____
B. Compact Conductors	_____
Session II. Conductor Applications	
A. Conductor Applications	_____
1. Branch Circuits	_____
2. Conductor Protection	_____
a. Location of Overcurrent Protection in Circuits	_____
Session III. Properties of Conductors	
A. Properties of Conductors	_____
1. Identifying Conductors	_____
a. Color Coding	_____
b. Changing Colors	_____
Session IV. Voltage Drop	
A. Voltage Drop	_____
1. Wire Sizes Based on Resistance	_____
a. Circular Mil-Unit of Conductor Area	_____
b. Conversion of Square Mils to Circular Mils	_____
2. Resistance of Conductors	_____
3. Resistance of Copper per Mil Foot	_____
Session V. Voltage Drop Equations	
A. Voltage Drop Equations	_____
1. Equations for Voltage Drop Using Conductor Area or Conductor Resistance	_____
2. Use of Voltage Drop Equations	_____
3. Miscellaneous Voltage Drop Equations	_____
Session VI. Review and Testing	
A. Module Review	_____
B. Module Examination	_____
1. Trainees must score 70 percent or higher to receive recognition from the NCCER.	_____
2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.	_____

MODULE OVERVIEW

This module builds on the information and lighting principles previously covered in the *Electrical Level Two* module, *Electric Lighting*. It describes specific applications for the different designs of incandescent, fluorescent, LED, induction, and HID lighting fixtures. It also provides an overview of the major applications and requirements for lighting systems, as well as an introduction to special wiring systems and dimming systems.

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Electrical Level One; Electrical Level Two; and Electrical Level Three*, Modules 26301-08 and 26302-08.

OBJECTIVES

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

1. Explain how the lighting terms lumen, candlepower, and footcandle relate to one another.
2. Classify lighting fixtures by type and application.
3. Identify the general lighting pattern produced by each type of fixture.
4. Identify the lighting requirements associated with lighting systems used in selected applications such as office buildings, schools, theaters, hazardous areas, etc.
5. Identify various dimming systems and their components.
6. Use manufacturers' lighting fixture catalogs to select the appropriate lighting fixtures for specific lighting applications.

PERFORMANCE TASKS

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

1. Using manufacturers' catalogs, select the appropriate lighting fixtures for specific lighting situations.
2. While touring selected structures to observe their lighting systems:
 - Identify the various types of lighting fixtures used.
 - Explain the specific purpose(s) served by the different fixtures.
 - Identify the lighting system class of service.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen
Transparencies
Blank acetate sheets
Transparency pens
Whiteboard / chalkboard
Markers / chalk
Pencils and scratch paper
Appropriate personal protective equipment
Copy of the latest edition of the *National Electrical Code*[®]
Light meter
Examples of lighting fixture manufacturers' catalogs

Assortment of incandescent, halogen, fluorescent, and HID lighting fixtures, including:

- Surface-mounted
- Recessed
- Suspended
- Track-mounted

Assortment of incandescent, fluorescent, and HID dimming controls and ballasts
Module Examinations*
Performance Profile Sheets*

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

SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment.

ADDITIONAL RESOURCES

This module is intended to present thorough resources for task training. The following reference works are suggested for both instructors and motivated trainees interested in further study. These are optional materials for continued education rather than for task training.

Lighting Handbook. New York, NY: Illuminating Engineering Society of North America (IESNA), 2000.
National Electrical Code® Handbook, Latest Edition. Quincy, MA: National Fire Protection Association.

NOTE

NFPA 70®, *National Electrical Code®*, and NEC® are registered trademarks of the National Fire Protection Association, Inc., Quincy, MA 02269. All *National Electrical Code®* and NEC® references in this module refer to the 2008 edition of the *National Electrical Code®*.

TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 12½ hours are suggested to cover *Practical Applications of Lighting*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources. Because laboratories often correspond to Performance Tasks, the proficiency of the trainees may be noted during these exercises for Performance Testing purposes.

Topic	Planned Time
Session I. Introduction; Lumens, Candlepower; Footcandles; Classification of Lighting Fixtures	
A. Introduction	_____
B. Lumens, Candlepower, and Footcandles	_____
C. Classification of Lighting Fixtures	_____
Session II. Practical Applications of Lighting Fixtures	
A. Practical Applications of Lighting Fixtures	_____
1. Incandescent Lighting Fixtures	_____
2. Fluorescent Lighting Fixtures	_____
3. High-Intensity Discharge (HID) Lighting Fixtures	_____
4. Outdoor Lighting Fixtures	_____
5. Emergency and Exit Lighting Fixtures	_____
6. Induction Lighting Systems	_____
7. Light-Emitting Diode (LED) Technology	_____
8. Hazardous and Adverse Location Lighting Fixtures	_____
9. Vandal-Resistant Lighting Fixtures	_____
10. Lighting Fixture Illumination Control	_____
B. Laboratory	_____
Under your supervision, have the trainees use manufacturers' catalogs to select the appropriate lighting fixtures for specific lighting situations. This laboratory corresponds to Performance Task 1.	

Session III. Applications of Lighting

A. Applications of Lighting

1. Office Buildings
2. Schools
3. Retail Store Merchandise Areas
4. Health Care Facilities
5. Theaters and Auditoriums
6. Industrial Locations
7. Outdoor Lighting
8. Sports Lighting

Session IV. Special-Purpose Wiring Systems Used for Lighting; Dimming

A. Special-Purpose Wiring Systems Used for Lighting

1. Manufactured System Wiring
2. Lighting Trolley Busways
3. Strut-Type Channel Systems

B. Dimming

1. Incandescent Lamps
2. Fluorescent Lamps
3. HID Lamps
4. Dimmer Control Racks

Session V. Review and Testing

A. Module Review

B. Module Examination

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

C. Performance Testing

1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from the NCCER.
2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.

MODULE OVERVIEW

This module introduces the *National Electrical Code*[®] (NEC[®]) requirements and installation procedures related to electrical equipment installed in hazardous locations.

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Electrical Level One; Electrical Level Two; and Electrical Level Three*, Modules 26301-08 through 26303-08.

OBJECTIVES

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

1. Define the various classifications of hazardous locations.
2. Describe the wiring methods permitted for branch circuits and feeders in specific hazardous locations.
3. Select seals and drains for specific hazardous locations.
4. Select wiring methods for Class I, Class II, and Class III hazardous locations.
5. Follow *National Electrical Code*[®] (NEC[®]) requirements for installing explosionproof fittings in specific hazardous locations.

PERFORMANCE TASKS

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

1. Using two rigid metal conduit nipples, a sealing fitting, three pieces of No. 12 THHN conductors, and a packing fiber/sealing kit, perform the following operations:
 - Secure one conduit nipple in each end of the seal.
 - Make sure the required amount of threads are engaged.
 - Pull the three THHN conductors through the nipples and seal so that about 6" is protruding from each nipple.
 - Pack the fiber as per the instructions furnished with the sealing kit.
 - Mix the sealing compound.
 - Position the unit in the required location and pour in the sealing compound.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen	Sealoff fittings, packing fiber, and sealing compound
Transparencies	Short conduit nipples
Markers/chalk	No. 12 THHN conductors
Blank acetate sheets	Various types of explosionproof fittings
Transparency pens	Various types of sealing fittings used in hazardous locations, including those with drains
Pencils and scratch paper	Portable conduit threader
Overhead projector and screen	Module Examinations*
Whiteboard/chalkboard	Performance Profile Sheets*
Appropriate personal protective equipment	
Copy of the latest edition of the <i>National Electrical Code</i> [®]	

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

SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment.

ADDITIONAL RESOURCES

This module is intended to present thorough resources for task training. The following reference works are suggested for both instructors and motivated trainees interested in further study. These are optional materials for continued education rather than for task training.

Code Digest. Latest Edition. Syracuse, NY: Cooper Crouse-Hinds.

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

NOTE

NFPA 70[®], *National Electrical Code[®]*, and NEC[®] are registered trademarks of the National Fire Protection Association, Inc., Quincy, MA 02269. All *National Electrical Code[®]* and NEC[®] references in this module refer to the 2008 edition of the *National Electrical Code[®]*.

TEACHING TIME FOR THIS MODULE

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

Topic	Planned Time
Session I. Introduction	
A. Introduction	_____
1. Class I Locations	_____
2. Class II Locations	_____
3. Class III Locations	_____
4. Applications	_____
Session II. Prevention of External Ignition/Explosion	
A. Prevention of External Ignition/Explosion	_____
1. Sources of Ignition	_____
2. Combustion Principles	_____
Session III. Explosionproof Equipment	
A. Explosionproof Equipment	_____
1. Intrinsically Safe Equipment	_____
2. Explosionproof Conduit and Fittings	_____
3. Seals and Drains	_____
Session IV. Laboratory	
A. Laboratory	_____
Have the trainees practice installing sealoff fittings and pouring seals. Note the proficiency of each trainee. This laboratory corresponds to Performance Task 1.	
Session V. Garages and Similar Locations; Airport Hangars; Hospitals; Petrochemical Hazardous Locations; Manufacturers' Data	
A. Garages and Similar Locations	_____
B. Airport Hangars	_____
C. Hospitals	_____
D. Petrochemical Hazardous Locations	_____
E. Manufacturers' Data	_____

Session VI. Review and Testing

A. Module Review

B. Module Examination

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

C. Performance Testing

1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from the NCCER.
2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.

MODULE OVERVIEW

This module covers the procedures used when sizing and selecting overcurrent protection, along with the applicable *National Electrical Code*[®] (*NEC*[®]) requirements.

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Electrical Level One; Electrical Level Two; and Electrical Level Three*, Modules 26301-08 through 26304-08.

OBJECTIVES

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

1. Apply the key *National Electrical Code*[®] (*NEC*[®]) requirements regarding overcurrent protection.
2. Check specific applications for conformance to *NEC*[®] sections that cover short circuit current, fault currents, interrupting ratings, and other sections relating to overcurrent protection.
3. Determine let-through current values (peak and rms) when current-limiting overcurrent devices are used.
4. Select and size overcurrent protection for specific applications.

PERFORMANCE TASKS

This is a knowledge-based module. There are no Performance Tasks.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen	Copy of the latest edition of the <i>National Electrical Code</i> [®]
Transparencies	
Markers/chalk	Various types of circuit breakers
Blank acetate sheets	Various types of fuses, including electronic fuses
Transparency pens	Sample fuse blocks and holders with nonrejection bases
Pencils and scratch paper	Sample fuse blocks and holders with rejection clips that accept only Class R fuses
Overhead projector and screen	Module Examinations*
Whiteboard/chalkboard	
Appropriate personal protective equipment	

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

SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment.

ADDITIONAL RESOURCES

This module is intended to present thorough resources for task training. The following reference work is suggested for both instructors and motivated trainees interested in further study. This optional material is for continued education rather than for task training.

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

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TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 25 hours are suggested to cover *Overcurrent Protection*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources.

Topic	Planned Time
Session I. Introduction	
A. Introduction	_____
1. Fault Currents	_____
Session II. Fuses	
A. Fuses	_____
1. Types of Fuses	_____
2. Voltage Rating	_____
3. Ampere Rating	_____
4. Interrupting Rating	_____
5. Selective Coordination	_____
6. Current Limitation	_____
Session III. Operating Principles of Fuses	
A. Operating Principles of Fuses	_____
1. Nontime-Delay Fuses	_____
2. Dual-Element, Time-Delay Fuses	_____
Session IV. UL Fuse Classes	
A. UL Fuse Classes	_____
1. Branch Circuit Listed Fuses	_____
2. Medium-Voltage Fuses	_____
3. Current-Limiting Fuses	_____
4. Fuses for Selective Coordination	_____
5. Fuse Time-Current Curves	_____
Session V. Motor Overload and Short Circuit Protection	
A. Motor Overload and Short Circuit Protection	_____
Session VI. Circuit Breakers	
A. Circuit Breakers	_____
1. Interrupting Capacity Rating	_____
Session VII. Circuit Protection	
A. Circuit Protection	_____
1. Lighting/Appliance Branch Circuits	_____
Session VIII. Short Circuit Calculations	
A. Short Circuit Calculations	_____
1. Basic Short Circuit Calculation Procedure	_____
2. Practical Application	_____
3. Peak Let-Through Charts	_____

Session IX. Troubleshooting and Testing Circuit Breakers and Fuses

A. Troubleshooting and Testing Circuit Breakers and Fuses

- 1. Circuit Breakers
- 2. Fuses

Session X. Review and Testing

A. Module Review

B. Module Examination

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

MODULE OVERVIEW

This module introduces the methods and procedures related to distribution equipment, including grounding, switchboard testing and maintenance, ground fault sensing, and interpreting electrical drawings.

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Electrical Level One; Electrical Level Two; and Electrical Level Three*, Modules 26301-08 through 26305-08.

OBJECTIVES

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

1. Describe the purpose of switchgear.
2. Describe the four general classifications of circuit breakers and list the major circuit breaker ratings.
3. Describe switchgear construction, metering layouts, wiring requirements, and maintenance.
4. List *National Electrical Code*[®] (*NEC*[®]) requirements pertaining to switchgear.
5. Describe the visual and mechanical inspections and electrical tests associated with low-voltage and medium-voltage cables, metal-enclosed busways, and metering and instrumentation.
6. Describe a ground fault relay system and explain how to test it.

PERFORMANCE TASKS

This is a knowledge-based module. There are no Performance Tasks.

MATERIALS AND EQUIPMENT LIST

Transparencies	Appropriate personal protective equipment
Markers/chalk	Molded case breaker
Blank acetate sheets	Copy of the latest edition of the <i>National Electrical Code</i> [®]
Transparency pens	Manufacturer's literature for various types of distribution equipment
Pencils and scratch paper	Module Examinations*
Overhead projector and screen	
Whiteboard/chalkboard	

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

SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment.

ADDITIONAL RESOURCES

This module is intended to present thorough resources for task training. The following reference work is suggested for both instructors and motivated trainees interested in further study. This is optional material for continued education rather than for task training.

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

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TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 12½ hours are suggested to cover *Distribution Equipment*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources.

Topic	Planned Time
Session I. Introduction; Voltage Classifications; Switchboards; Switchgear	
A. Introduction	_____
B. Voltage Classifications	_____
C. Switchboards	_____
D. Switchgear	_____
Session II. Switchboard Testing and Maintenance; NEC® Requirements; Ground Faults	
A. Switchboard Testing and Maintenance	_____
B. NEC® Requirements	_____
C. Ground Faults	_____
Session III. HVL Switches, Bolted Pressure Switches, Transformers	
A. HVL Switches	_____
B. Bolted Pressure Switches	_____
C. Transformers	_____
Session IV. Instrument Transformers; Circuit Breakers; Electrical Drawing Identification	
A. Instrument Transformers	_____
B. Circuit Breakers	_____
C. Electrical Drawing Identification	_____
Session V. Electrical Prints; Manufacturer Drawings; Panelboards; Review and Testing	
A. Electrical Prints	_____
B. Manufacturer Drawings	_____
C. Panelboards	_____
D. Module Review	_____
E. Module Examination	_____
1. Trainees must score 70 percent or higher to receive recognition from the NCCER.	
2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.	

MODULE OVERVIEW

This module introduces the methods and procedures used in selecting and wiring transformers.

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Electrical Level One; Electrical Level Two; and Electrical Level Three*, Modules 26301-08 through 26306-08.

OBJECTIVES

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

1. Describe transformer operation.
2. Explain the principle of mutual induction.
3. Describe the operating characteristics of various types of transformers.
4. Connect a multi-tap transformer for the required secondary voltage.
5. Explain *National Electrical Code*[®] (*NEC*[®]) requirements governing the installation of transformers.
6. Compute transformer sizes for various applications.
7. Connect a control transformer for a given application.
8. Describe how current transformers are used in conjunction with watt-hour meters.

PERFORMANCE TASKS

This is a knowledge-based module. There are no Performance Tasks.

MATERIALS AND EQUIPMENT LIST

Transparencies	Samples of transformer cores, including:
Markers/chalk	Mitered
Blank acetate sheets	Butt
Transparency pens	Wound
Pencils and scratch paper	Iron filings
Overhead projector and screen	Multi-tap control transformers
Whiteboard/chalkboard	Control cable
Appropriate personal protective equipment	Volt-ohm-milliammeter (VOM)
Copy of the latest edition of the <i>National Electrical Code</i> [®]	Tools necessary for making transformer wiring connections
Samples of various types of transformers	Module Examinations*

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

SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment.

ADDITIONAL RESOURCES

This module is intended to present thorough resources for task training. The following reference work is suggested for both instructors and motivated trainees interested in further study. This is optional material for continued education rather than for task training.

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

NOTE

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TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 12½ hours are suggested to cover *Transformers*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources.

Topic	Planned Time
Session I. Introduction; Transformer Basics; Transformer Construction; Transformer Taps	
A. Introduction	_____
B. Transformer Basics	_____
1. Inductive	_____
2. Magnetic Flux	_____
C. Transformer Construction	_____
1. Cores	_____
D. Transformer Taps	_____
Session II. Basic Transformer Connections; Autotransformers	
A. Basic Transformer Connections	_____
1. Single Phase	_____
2. Three-Phase	_____
3. Parallel-Operated Transformers	_____
B. Autotransformers	_____
Session III. Transformer Data; Control Transformers; NEC[®] Requirements	
A. Transformer Data	_____
B. Control Transformers	_____
C. NEC [®] Requirements	_____
1. Overcurrent Protection	_____
2. Grounding	_____
Session IV. Power Factor; Vectors	
A. Power Factor	_____
B. Vectors	_____
Session V. Troubleshooting; Transformer Maintenance	
A. Troubleshooting	_____
B. Transformer Maintenance	_____
Session VI. Review and Testing	
A. Module Review	_____
B. Module Examination	_____
1. Trainees must score 70 percent or higher to receive recognition from the NCCER.	
2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.	

MODULE OVERVIEW

This module covers the applicable *National Electrical Code*[®] (NEC[®]) requirements and general installation considerations for commercial electrical services.

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Electrical Level One; Electrical Level Two; and Electrical Level Three*, Modules 26301-08 through 26307-08.

OBJECTIVES

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

1. Describe various types of electric services for commercial and industrial installations.
2. Read electrical diagrams describing service installations.
3. Select service-entrance equipment for various applications.
4. Explain the role of the *National Electrical Code*[®] in service installations.
5. Install main disconnect switches, panelboards, and overcurrent protection devices.
6. Identify the *National Electrical Code*[®] requirements and purposes of service grounding.
7. Describe single-phase service connections.
8. Describe both wye- and delta-connected three-phase services.

PERFORMANCE TASKS

This is a knowledge-based module. There are no Performance Tasks.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen	Samples of common service components, including:
Transparencies	Service disconnect
Markers/chalk	Meter
Blank acetate sheets	Transformers
Transparency pens	Wireways
Pencils and scratch paper	Gutters
Overhead projector and screen	Weatherhead and service mast
Whiteboard/chalkboard	Panelboards
Appropriate personal protective equipment	Module Examinations*
Copy of the latest edition of the <i>National Electrical Code</i> [®]	

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

SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment.

ADDITIONAL RESOURCES

This module is intended to present thorough resources for task training. The following reference work is suggested for both instructors and motivated trainees interested in further study. This is optional material for continued education rather than for task training.

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

NOTE

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TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2 ½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 10 hours are suggested to cover *Commercial Electrical Services*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources.

Topic	Planned Time
Session I. Introduction; Drawings and Specifications; General Installation Considerations	
A. Introduction	_____
B. Drawings and Specifications	_____
C. General Installation Considerations	_____
Session II. Service Components	
A. Service Components	_____
1. Service Disconnecting Means	_____
2. Metering	_____
3. Current Transformers	_____
4. Metal Wireways	_____
5. Bussed Gutters	_____
6. Weatherhead and Service Mast	_____
7. Panelboards	_____
Session III. NEC[®] Requirements; Typical Installations	
A. NEC [®] Requirements	_____
B. Typical Installations	_____
Session IV. Review and Testing	
A. Module Review	_____
B. Module Examination	_____
1. Trainees must score 70 percent or higher to receive recognition from the NCCER.	
2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.	

MODULE OVERVIEW

This module introduces the calculations used to size motor branch and feeder circuits, overcurrent protection, and disconnects.

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Electrical Level One; Electrical Level Two; and Electrical Level Three*, Modules 26301-08 through 26308-08.

OBJECTIVES

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

1. Size branch circuits and feeders for electric motors.
2. Size and select overcurrent protective devices for motors.
3. Size and select overload relays for electric motors.
4. Size and select devices to improve the power factor at motor locations.
5. Size motor short circuit protectors.
6. Size multi-motor branch circuits.
7. Size motor disconnects.

PERFORMANCE TASKS

This is a knowledge-based module. There are no Performance Tasks.

MATERIALS AND EQUIPMENT LIST

Transparencies	Various types of disassembled motors, including: Squirrel cage Wound-rotor Synchronous
Markers / chalk	
Blank acetate sheets	
Transparency pens	Various types of circuit breakers
Pencils and scratch paper	
Overhead projector and screen	Motor short circuit protector
Whiteboard / chalkboard	Devices used to provide motor overload protection, including: Overload relays Fuses Circuit breakers
Appropriate personal protective equipment	
Copy of the latest edition of the <i>National Electrical Code</i> [®]	Module Examinations*
Various types of fuses, including: Nontime-delay Dual-element, time-delay fuses	

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

SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment.

ADDITIONAL RESOURCES

This module is intended to present thorough resources for task training. The following reference work is suggested for both instructors and motivated trainees interested in further study. This is optional material for continued education rather than for task training.

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

NOTE

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TEACHING TIME FOR THIS MODULE

An outline for use in developing your lesson plan is presented below. Note that each Roman numeral in the outline equates to one session of instruction. Each session has a suggested time period of 2½ hours. This includes 10 minutes at the beginning of each session for administrative tasks and one 10-minute break during the session. Approximately 12½ hours are suggested to cover *Motor Calculations*. You will need to adjust the time required for hands-on activity and testing based on your class size and resources.

Topic	Planned Time
Session I. Introduction; Motor Basics	
A. Introduction	_____
B. Motor Basics	_____
1. Stator Windings	_____
2. Special Connections	_____
Session II. Calculating Motor Circuit Conductors	
A. Calculating Motor Circuit Conductors	_____
1. Wound-Rotor Motors	_____
2. Conductors for DC Motors	_____
3. Conductors for Miscellaneous Motor Applications	_____
Session III. Motor Protective Devices; Circuit Breakers	
A. Motor Protective Devices	_____
B. Circuit Breakers	_____
1. Application of MCPs	_____
2. Motor Short Circuit Protectors	_____
Session IV. Multi-Motor Branch Circuits; Equipment Grounding Conductors for Motor Feeder and Branch Circuits; Power Factor Correction at Motor Terminals	
A. Multi-Motor Branch Circuits	_____
B. Equipment Grounding Conductors for Motor Feeder and Branch Circuits	_____
C. Power Factor Correction at Motor Terminals	_____
Session V. Review and Testing	
A. Module Review	_____
B. Module Examination	_____
1. Trainees must score 70 percent or higher to receive recognition from the NCCER.	
2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.	

MODULE OVERVIEW

This module covers the procedures used when selecting, installing, and maintaining cable systems for voice, data, and video systems.

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Electrical Level One; Electrical Level Two; and Electrical Level Three*, Modules 26301-08 through 26309-08.

OBJECTIVES

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

1. Define the different categories for voice-data-video (VDV) cabling systems.
2. Install raceways, boxes, and enclosures for VDV systems.
3. Interpret and apply *NEC*[®] requirements for installing and grounding VDV systems.
4. Explain the requirements for firestopping.

PERFORMANCE TASKS

This is a knowledge-based module. There are no Performance Tasks.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen	Samples of:
Transparencies	Fiber-optic cable
Markers/chalk	Coaxial cable
Blank acetate sheets	UTP cable
Transparency pens	Coax F-type connector terminations
Pencils and scratch paper	Innerduct
Overhead projector and screen	Various types of coax stripping tools
Whiteboard/chalkboard	Module Examinations*
Appropriate personal protective equipment	
Copy of the latest edition of the <i>National Electrical Code</i> [®]	

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

SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment.

ADDITIONAL RESOURCES

This module is intended to present thorough resources for task training. The following reference works are suggested for both instructors and motivated trainees interested in further study. These are optional materials for continued education rather than for task training.

Cisco Home Technology Integration Fundamentals and Certification, 2004. Engelwood, CO: Upper Saddle River, NJ: Pearson Education, Inc.

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

The Cabling Handbook, 2nd Edition. 2000. Upper Saddle River, NJ: Pearson Education, Inc.

TIA/EIA Telecommunications Building Wiring Standards, Latest Edition. Engelwood, CO: Global Engineering Documents.

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TEACHING TIME FOR THIS MODULE

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

Topic	Planned Time
Session I. Introduction; Structured Cabling Systems	
A. Introduction	_____
B. Structured Cabling Systems	_____
1. Campus Backbone Subsystem	_____
2. Equipment/Telecom Room Subsystem	_____
3. Riser Subsystem	_____
4. Horizontal Subsystem	_____
5. Work Area Subsystem	_____
Session II. UTP and Coax Cable Terminations	
A. UTP and Coax Cable Terminations	_____
1. UTP Jack and Plug Terminations	_____
2. RG6 Coax F-Type Terminations	_____
Session III. Fiber-Optic Installation Considerations; Grounding and Bonding; Testing	
A. Fiber-Optic Installation Considerations	_____
1. Tray and Duct Installation	_____
2. Conduit Installation	_____
3. Splice Closures/Organizers	_____
4. Distribution Hardware	_____
5. Patch Panels	_____
6. Outlet Boxes	_____
B. Grounding and Bonding	_____
C. Testing	_____
Session IV. Review and Testing	
A. Module Review	_____
B. Module Examination	_____
1. Trainees must score 70 percent or higher to receive recognition from the NCCER.	
2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.	

MODULE OVERVIEW

This module introduces the methods and procedures used in selecting and wiring motor controls.

PREREQUISITES

Prior to training with this module, it is recommended that the trainee shall have successfully completed *Core Curriculum; Electrical Level One; Electrical Level Two; and Electrical Level Three*, Modules 26301-08 through 26310-08.

OBJECTIVES

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

1. Identify contactors and relays both physically and schematically and describe their operating principles.
2. Identify pilot devices both physically and schematically and describe their operating principles.
3. Interpret motor control wiring, connection, and ladder diagrams.
4. Select and size contactors and relays for use in specific electrical motor control systems.
5. Select and size pilot devices for use in specific electrical motor control systems.
6. Connect motor controllers for specific applications according to *National Electrical Code*[®] (*NEC*[®]) requirements.

PERFORMANCE TASK

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

1. Make all connections for a magnetic motor controller, controlled by two pushbutton stations, including the connections for holding the circuit interlock.

MATERIALS AND EQUIPMENT LIST

Overhead projector and screen	Assorted manufacturer's motor control device catalogs/data sheets
Transparencies	Examples of wiring diagrams
Markers/chalk	Examples of circuit schedules/wire lists
Blank acetate sheets	Examples of control ladder diagrams
Transparency pens	Examples of logic diagrams
Pencils and scratch paper	Open-frame electromechanical power relays
Overhead projector and screen	Miniature electromechanical plug-in relays
Whiteboard/chalkboard	Assorted NEMA and IEC magnetic and manual contactors and motor starters
Appropriate personal protective equipment	Melting-alloy thermal overload relays
Copy of the latest edition of the <i>National Electrical Code</i> [®]	Bimetallic overload relays
Assorted wire and connectors necessary for making control circuit wiring connections	Magnetic overload relays

Contactor/motor starter accessories including:

- Power-pole adder kit
- Timer attachment
- Fuse kit
- Transient suppression module
- Internal auxiliary contacts
- Control transformers
- Pushbutton switches
- Push-pull pushbutton switches
- Selector switches
- Pilot lights
- Assorted pushbutton stations
- Temperature switches
- Pressure switches

- Mechanical limit switches
- Flow switches
- Float switches
- Foot switches
- Jogging and plugging switches
- Inductive and capacitive proximity sensors
- Photoelectric switches/sensors
- Drum switches
- Assorted NEMA enclosures
- 240V motor
- Tools necessary for making wiring connections
- Module Examinations*
- Performance Profile Sheets*

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

SAFETY CONSIDERATIONS

Ensure that the trainees are equipped with appropriate personal protective equipment.

ADDITIONAL RESOURCES

This module is intended to present thorough resources for task training. The following reference works are suggested for both instructors and motivated trainees interested in further study. These are optional materials for continued education rather than for task training.

Electrical Motor Controls, Gary Rockis and Glen Mazur. Homewood, IL: American Technical Publishers, Inc., 1997.

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

NFPA 70E Recommended Practice for Electrical Equipment Maintenance. Quincy, MA: National Fire Protection Association, 2004.

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TEACHING TIME FOR THIS MODULE

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Topic	Planned Time
Session I. Introduction; Electromechanical Relays; Magnetic Contactors; Overload Protection	
A. Introduction	_____
B. Electromechanical Relays	_____
C. Magnetic Contactors	_____
D. Overload Protection	_____

Session II. Magnetic and Manual Motor Starters; Control Transformers and Pilot Devices

A. Magnetic and Manual Motor Starters

- 1. Nonreversing and Reversing Magnetic Motor Starters
- 2. NEMA Magnetic Contactors/Motor Starters
- 3. IEC Magnetic Contactors/Motor Starters
- 4. Manual Motor Starters
- 5. Accessories

B. Control Transformers and Pilot Devices

- 1. Pushbutton and Selector Switches; Pilot Lights
- 2. Temperature and Pressure Switches
- 3. Mechanical Limit Switches
- 4. Flow, Float, and Foot Switches
- 5. Jogging and Plugging Switches
- 6. Proximity and Photoelectric Switches/Sensors

Session III. Drum Switches; Enclosures; Diagrams

A. Drum Switches

B. Enclosures

C. Diagrams

- 1. Relating Diagrams to Equipment Wiring and Operation

Session IV. NEC® Regulations for the Installation of Motor Control Circuits and Connecting Motor Controllers for Specific Applications

A. NEC® Regulations for the Installation of Motor Control Circuits

B. Connecting Motor Controllers for Specific Applications

C. Laboratory

Under your supervision, have the trainees make all connections for a magnetic motor controller, controlled by two pushbutton stations, including the connections for holding the circuit interlock. This laboratory corresponds with Performance Task 1.

Session V. Review and Testing

A. Module Review

B. Module Examination

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

C. Performance Testing

- 1. Trainees must perform each task to the satisfaction of the instructor to receive recognition from the NCCER.
- 2. Record the testing results on Craft Training Report Form 200, and submit the results to the Training Program Sponsor.

