

IEC ELECTRICAL APPRENTICESHIP CURRICULUM

2020–2021 Edition

OBJECTIVES FOR YEAR 1

Lesson 101 - Orientation and Basic Principles

- 101.1 **DESCRIBE** and **EXPLAIN** the apprenticeship policies and procedures of the IEC chapter sponsoring your training program.
- 101.2 **LIST** and **EXPLAIN** the advantages of being part of the IEC apprenticeship program.
- 101.3 **DESCRIBE** and **EXPLAIN** the IEC 4-year electrical apprenticeship program.
- 101.4 **RECOGNIZE** basic electrical terms.
- 101.5 **RECOGNIZE** basic NEC® definitions (Article 100).

Lesson 102 - Tools, Fasteners, and Knots

- 102.1 **RECOGNIZE** hand tools used in the trade by identifying the “do’s and don’ts” of their use and care.
- 102.2 **RECOGNIZE** power tools used in the trade by identifying the “do’s and don’ts” of their use and care.
- 102.3 **DESCRIBE** torque wrenches and their use.
- 102.4 **RECALL** and **DEMONSTRATE** knowledge of electrical materials.
- 102.5 **RECOGNIZE** and **DEMONSTRATE** basic safe practices for using ropes, slings, straps, and other rigging equipment for material handling.

Lesson 103 - Introduction to Safety, Navigating the NEC® and EWR Plans

- 103.1 **STATE** and **EXPLAIN** the GHS symbols and requirements.
- 103.2 **RECOGNIZE** requirements of NFPA 70E® on flexible cords and cables, highlighting GFCI protection and electrical hazards.
- 103.3 **STATE** general safety considerations in electrical installations.
- 103.4 **OUTLINE** a basic understanding of the creation and organization of the NEC®.
- 103.5 **DESCRIBE** the components of plans and specifications.

Lesson 104 - Introduction to Electric Charges and Basic Math

- 104.1 **RECOGNIZE** the law of electric charges and theories of current flow.
- 104.2 **ILLUSTRATE** knowledge of basic mathematics.

Lesson 105 - Applied Math, Circuit Theory, Plans & Specs

- 105.1 **MASTER** whole numbers, decimals, percentages, averages, fractions, and linear measures necessary in solving problems encountered by electricians.
- 105.2 **MASTER** conversions between English and metric units, Fahrenheit and Celsius temperatures; and conduct conversions among metric prefixes.
- 105.3 **POSSESS** a fundamental awareness of resistance, power, and electrical circuits.
- 105.4 **DESCRIBE** the basic information available on the EWR plans and specifications.

Lesson 106 - Applied Math, Ohm’s Law, Electrical Symbols, and Boxes

- 106.1 **MASTER** ratios, proportions, squared and square root numbers, area, and volume by applying their uses as a means of solving problems encountered by electricians.
- 106.2 **RECOGNIZE** the relationship between voltage, current, and resistance as demonstrated in Ohm’s Law.
- 106.3 **CONTRAST** results of using different applied voltages and resistances as demonstrated in Ohm’s Law.
- 106.4 **RECOGNIZE** various outlet boxes by identifying each outlet box’s characteristics.
- 106.5 **DESCRIBE** symbols presented within the text.

Lesson 107 - Conduit Bending

- 107.1 **LABEL** the points on a hand bender and **LIST** terms used in conduit bending.
- 107.2 **OUTLINE** mathematical calculations and apply them to bending conduit.

Lesson 108 - Dwelling Circuit Requirements, Outlet Locations, and General Lighting Load

- 108.1 **DEFINE** circuit requirements in dwellings. **RECOGNIZE** the circuit requirement differences between a dwelling and a non-dwelling.
- 108.2 **DEFINE** outlet locations in dwellings. **RECOGNIZE** the outlet location differences between a dwelling and a non-dwelling.
- 108.3 **OUTLINE** NEC® calculation for the general lighting load.

Lesson 109 - Conductor Types, Ampacity, Overcurrent Protection, Type NM Cables, and Common Voltage Systems

- 109.1 **STATE** appropriate insulation and material characteristics according to conductor types.
- 109.2 **SELECT** OCPD and conductor size for given loads.
- 109.3 **LIST** nonmetallic cable (NM-B and NM-B-PCS) installation requirements.
- 109.4 **RECOGNIZE** voltages from common voltage systems listed in Annex V.

Lesson 110 - Voltage Drop, Cable, Conduit, and Tubing

- 110.1 **RECOGNIZE** and solve various single-phase voltage drop calculations using the K-method.
- 110.2 **LIST** cable installation requirements for Types AC and MC.
- 110.3 **LIST** conduit and tubing installation requirements.

Lesson 111 - Mid-Term Review and Exam

- 111 This lesson will determine your proficiency in the subject matter from the previous lessons.

Lesson 112 - Conductor Terminology, Switches, and Receptacles

- 112.1 **SELECT** between grounding, grounded, and ungrounded conductors.
- 112.2 **DESCRIBE** the NEC® requirements for switches.
- 112.3 **RECOGNIZE** the construction, operation, and connection of switches.
- 112.4 **RECOGNIZE** the construction and connection of receptacles by identifying each receptacle and its NEMA designation.
- 112.5 **DESCRIBE** the NEC® requirements for receptacles.

Lesson 113 - GFCI, AFCI, and Other Special-Purpose Receptacles

- 113.1 **RECOGNIZE** the purpose, operation, and installation of GFCI protective devices.
- 113.2 **RECOGNIZE** the purpose, operation, and installation of AFCI protective devices.
- 113.3 **RECOGNIZE** the purpose, operation, and installation of TVSS, SPD, IG, hospital grade, and ALCI protective devices.
- 113.4 **DESCRIBE** the NEC® requirements for GFCI, AFCI, TVSS, SPD, IG, ALCI, and hospital grade protective devices.
- 113.5 **DESCRIBE** receptacle/GFCI/AFCI functions (referencing EWR plan).

Lesson 114 - Luminaires, Ballasts, and Lamps

- 114.1 **RECOGNIZE** the purpose, operation, and installation of a luminaire. **DESCRIBE** thermal protection for luminaires.
- 114.2 **SELECT** ballast and lamp applications for luminaires.
- 114.3 **DESCRIBE** basic principles of lighting.
- 114.4 **DESCRIBE** the NEC® requirements for luminaires.

Lesson 115 - Box Fill and Introduction to Series Circuits (Front Bedroom)

- 115.1 **RECOGNIZE** lighting requirements in clothes closets and storage areas, per NEC®.
- 115.2 Using the EWR plans, **LOCATE** the circuits and outlets in the front bedroom, based on specifications.
- 115.3 **SELECT** Ohm's Law formulas for series circuits.
- 115.4 **OUTLINE** the minimum NEC® requirements for box fill.

Lesson 116 - Box Sizing and Series Circuits (Master Bedroom)

- 116.1 Using the EWR plans, **LOCATE** the circuits and outlets in the Master Bedroom based on specifications and NEC® requirements.
- 116.2 **SELECT** proper box sizing for receptacle outlet, switch outlet, lighting outlet, and fan outlet. **RECALL** box fill calculations.
- 116.3 **RECOGNIZE** individual and series-connected DC power sources.
- 116.4 **LABEL** "unknowns" for series circuits using Ohm's Law formulas.
- 116.5 **RECOGNIZE** and solve various single phase voltage drop calculations using the resistance method.

Lesson 117 - Lighting and Small Appliance Branch Circuits

- 117.1 Using the EWR plans, **LOCATE** the circuits and lighting in the bathrooms, hallways, foyer, and porch, based on specifications and NEC® requirements.
- 117.2 **DESCRIBE** installation for all indoor and outdoor lighting fixtures.
- 117.3 **RECOGNIZE** small-appliance branch circuit and receptacle outlet installation based on NEC® requirements.
- 117.4 **DRAW** a wiring diagram of cable layout and requirements for the kitchen small appliance circuits.

Lesson 118 - First Semester Final Exam

- 118 This lesson will determine your proficiency in the subject matter from the previous lessons.

Lesson 119 - Track Lighting, Dimmers, and Introduction to Parallel Circuits (Living Room)

- 119.1 **DESCRIBE** the NEC® requirements for track lighting.
- 119.2 **RECOGNIZE** the operation and connection of dimmers.
- 119.3 **ILLUSTRATE** the layout of the living room and the bedroom/study circuits using specifications and the NEC®.
- 119.4 **RECOGNIZE** parallel-connected DC power sources.
- 119.5 **SELECT** Ohm's Law formulas for parallel circuits.

Lesson 120 - Laundry and Bathroom Receptacles and Parallel Circuits

- 120.1 **DEFINE** the NEC® circuit and receptacle requirements for electrical clothes dryer outlets.
- 120.2 **DEFINE** the NEC® circuit and receptacle requirements for bathrooms, laundry room receptacles, and the installation requirements for exhaust and attic fans.
- 120.3 **FORMULATE** Ohm's Law while performing circuit calculations for parallel circuits.
- 120.4 **ILLUSTRATE** the layout of the laundry and attic and demonstrate an understanding of the layout using specifications and the NEC®.

Lesson 121 - Garage and Garage Door Circuits, Underground Installations, and Parallel Circuit Calculations

- 121.1 **DEFINE** NEC® requirements for branch circuit wiring protection for garages.
- 121.2 **DESCRIBE** underground requirements using conduit and nonmetallic cable.
- 121.3 **DESCRIBE** garage door opener circuitry including power and control wiring.
- 121.4 **SELECT** parallel circuit calculations for voltage, current, and power.

Lesson 122 - Appliance and Special Purpose Outlets

- 122.1 **RECOGNIZE** branch circuit installation for special purpose outlets based on NEC® requirements.
- 122.2 **RECOGNIZE** the NEC® requirements for water heaters and their related disconnecting means, grounding, and overcurrent protection.
- 122.3 **RECOGNIZE** the expected voltmeter measurements across open and closed switches.
- 122.4 Using the EWR plans, **LOCATE** the circuits and information concerning the pump and water heater.

Lesson 123 - Ranges, Ovens, Counter-Mounted Cooking Units, and Other Kitchen Appliances

- 123.1 **MATCH** circuit and receptacle installation for kitchen ranges, ovens, and counter-mounted cooking equipment based on NEC® requirements.
- 123.2 **MATCH** the NEC® requirements for circuit and receptacle installation for kitchen appliances such as dishwashers and food waste disposals.
- 123.3 **SELECT** between direct (hard-wired/permanent) connections and cord-and-plug connections for kitchen equipment. **DESCRIBE** NEC® requirements for appliance disconnecting means.

Lesson 124 - Bathrooms, Exhaust Fans, and Hydromassage Tubs

- 124.1 **RECOGNIZE** the circuit installation for ceiling heat/vent/light units in bathrooms based on NEC® requirements.
- 124.2 **STATE** the control circuit wiring for exhaust fans and hydromassage tubs, and identify the required GFCI protection for each.
- 124.3 Using the EWR plans, **LOCATE** the circuit installation for bathrooms based on NEC® requirements.

Lesson 125 - Heating and Air Conditioning

- 125.1 **RECOGNIZE** circuit installation for heating cable, electric furnaces, electric baseboard heaters, heat pumps, and air conditioners based on NEC® requirements.
- 125.2 **STATE** the NEC® requirements for Class 2 control circuit wiring.
- 125.3 **RECOGNIZE** the data located on the nameplate of HVAC equipment.

Lesson 126 - Residential Limited Energy Systems

- 126.1 **LIST** basic standard installation practices for limited energy residential systems based on NEC® requirements.
- 126.2 Using the EWR plans, **LOCATE** the circuits and information concerning low-voltage and fire alarm.

Lesson 127 - Mid-Term Review and Exam

- 127 This lesson will determine your proficiency in the subject matter from the previous lessons.

Lesson 128 - Multiwire Branch Circuits and Introduction to Combination Circuits (Recreation Room)

- 128.1 **RECOGNIZE** the method of installation of multiwire branch circuits according to NEC® standards.
- 128.2 **DEFINE** watt loss, voltage drop, and current flow in two-wire and three-wire circuits.
- 128.3 **SELECT** Ohm's Law formulas for combination circuits.
- 128.4 **DESCRIBE** the advantages of installing multiwire branch circuits and the effects on the connected loads when open neutrals occur.
- 128.5 **RECOGNIZE** features and voltage of multiple battery connections.

Lesson 129 - Combination Circuits, Conductor Ampacity Correction, and Conduit Fill (Workshop)

- 129.1 **FORMULATE** Ohm's Law while performing circuit calculations for combination circuits.
- 129.2 **SELECT** proper conduit size by utilizing tables 4 and 5 in the NEC®.
- 129.3 **STATE** conductor ampacity using correction and adjustment factors. **SELECT** maximum ratings of overcurrent protection for conductors.
- 129.4 **RECOGNIZE** requirements for receptacles in a dwelling unit basement.

Lesson 130 - Services and Service Equipment, and Cost of Electrical Power

- 130.1 **RECOGNIZE** the NEC® terminology and requirements for electrical service installations.
- 130.2 **DESCRIBE** the cost of using electricity through calculation.

Lesson 131 - Grounding and Bonding, Specialty Tools

- 131.1 **LIST** components of grounding and bonding.
- 131.2 **RECOGNIZE** the installation requirements for grounding and bonding as per the NEC®.
- 131.3 **RECOGNIZE** and **DEMONSTRATE** use of specialty tools.

Lesson 132 - Overcurrent Protection and Circuit Conditions

- 132.1 **RECOGNIZE** basic overcurrent device type, terminology and operation.
- 132.2 **RECOGNIZE** the NEC® requirements for ratings, sizing, and installation requirements of various OCPDs.
- 132.3 **RECOGNIZE** possible circuit conditions (normal, short-circuit, overload, open, ground-fault).
- 132.4 Using the EWR drawing set, **LOCATE** information concerning overcurrent protection.

Lesson 133 - Service Entrance Calculations

- 133.1 **SELECT** the size of the electrical service including conductors for a single-family dwelling.
- 133.2 Using the EWR drawing set, **LOCATE** information concerning the service calculation.

Lesson 134 - Swimming Pools, Spas, and Hot Tubs

- 134.1 **RECOGNIZE** electrical hazards associated with pools, spas, and hot tubs.
- 134.2 **DESCRIBE** installation of electrical wiring for swimming pools, spas, and hot tubs based on NEC® requirements.
- 134.3 **LIST** bonding and grounding requirements for swimming pools, spas, and hot tubs based on information provided during class discussions and education materials.
- 134.4 Using the EWR drawing set, **LOCATE** information concerning the swimming pool.

Lesson 135 - Home Automation, Standby Power, and Photovoltaic Systems

- 135.1 **RECOGNIZE** structured wiring and wireless technology installations.
- 135.2 **RECOGNIZE** residential standby power systems, the NEC® requirements for installation, and the inherent safety issues.
- 135.3 **RECOGNIZE** solar photovoltaic system installation and NEC® requirements.

Lesson 136 - Second Semester Final Exam

- 136 This lesson will determine your proficiency in the subject matter from the previous lessons.

OBJECTIVES FOR YEAR 2

Lesson 201 - NEC® Scope, Definitions, Working Spaces, and Branch Circuits; Haz. Locations; Voltage Systems

- 201.1 **POSSESS** an understanding of the creation, format, structure, and practical application of the *National Electrical Code*® (NEC®). **IDENTIFY** the scope, purpose, arrangement, and enforcement of the NEC® as contained in NEC® 90.
- 201.2 **RECALL** definitions of electrical terms and equipment in order to adequately prepare for the study, interpretation, and application of the NEC® Article 100.
- 201.3 **RECALL** the requirements for electrical installations of equipment and conductors according to Article 110 of the NEC®.
- 201.4 **RECOGNIZE** voltages and properties of various electrical systems. (See Y2 Annex V.)
- 201.5 **RECALL** branch circuit requirements as contained in NEC® 210 including GFCI and AFCI protection, ratings, and required outlets.
- 201.6 **IDENTIFY** the branch circuits, working spaces, and related scenarios found on the BCES prints.
- 201.7 **DEFINE** classification and divisions of hazardous locations as described in NEC® 500.

Lesson 202 - Service Calculations and Class 1 Installations

- 202.1 **IDENTIFY** and **APPLY** requirements for service and calculations.
- 202.2 **CONTRAST** service conductor size and rating requirements for dwelling vs. non-dwellings as per NEC® 310.12 and 310.16.
- 202.3 **FORMULATE** the service calculations for specific equipment found on the BCES prints.
- 202.4 **DEFINE** specific installation criteria for Class 1 installations as described in NEC® 501.

Lesson 203 - Services and Class 2 Installations

- 203.1 **IDENTIFY** the key components for electrical services.
- 203.2 **POSSESS** a fundamental understanding of the clearances and other requirements for overhead services.
- 203.3 **POSSESS** a fundamental understanding of the clearances and other requirements for underground services.
- 203.4 **IDENTIFY** the requirements for service equipment.
- 203.5 **IDENTIFY** the requirements for service equipment as found on the BCES prints.
- 203.6 **DEFINE** specific installation criteria for Class 2 installations as described in NEC® 502.

Lesson 204 - Conductor and Overcurrent Protection; Class 3 Installations

- 204.1 **IDENTIFY** the characteristics and installation practices of bare and insulated conductors.
- 204.2 **POSSESS** a fundamental understanding of ampacity, termination, insulation ratings, ambient temperature, and other adjustment factors of circuit conductors.
- 204.3 **MASTER** the purpose and selection of fuses and circuit breakers for the protection of conductors and equipment.
- 204.4 **IDENTIFY** the characteristics of branch circuits, feeders, and taps.
- 204.5 **INDICATE** practical application of OCPDs.
- 204.6 **IDENTIFY** the requirements for overcurrent protection as found on the BCES prints.
- 204.7 **DEFINE** specific installation criteria for Class 3 installations as described in NEC® 503.

Lesson 205 - Grounding Terminology, Equipment Grounding Conductors, and Commercial Garage Installations

- 205.1 **IDENTIFY** grounding terminology and functionality.
- 205.2 **MASTER** the purpose, installation, and sizing of equipment grounding conductors.
- 205.3 **IDENTIFY** the components of the grounding system and equipment grounding conductors found on the BCES prints.
- 205.4 **DEFINE** specific installation criteria for commercial garage installations as described in NEC® 511.

Lesson 206 - Grounding Electrode System, Main Bonding Jumper, and Motor Fuel Dispensing Facilities

- 206.1 **ILLUSTRATE** the components of a grounding electrode system. **MASTER** the installation of grounding electrodes and the sizing of the grounding electrode conductors.
- 206.2 **MASTER** the installation and sizing of the main bonding jumper for simple services (under 1100KCMIL).
- 206.3 **IDENTIFY** the components of the grounding system, grounding electrode system, and main bonding jumper found on the BCES prints.
- 206.4 **DEFINE** specific installation criteria for motor fuel dispensing facilities as described in NEC® 514.

Lesson 207 - Ohm's Law Review, Article 300, Aircraft Hangar, and Bulk-Storage Facilities

- 207.1 **RECALL** Ohm's Law as it relates to practical applications.
- 207.2 **STATE** the general requirements and installation practices for all wiring methods as described in NEC® Article 300.
- 207.3 **RECALL** the requirements for underground installations.
- 207.4 **IDENTIFY** the underground wiring method requirements found on the BCES prints.
- 207.5 **DEFINE** specific installation criteria for aircraft hangar and bulk-storage plant installations as described in NEC® 513 and 515.

Lesson 208 - Conduit Fill, Box Fill, Pull Box Sizing, Raceway and Cable Support; Spray Applications

- 208.1 **RECALL** support methods for various raceways and cables.
- 208.2 **FORMULATE** cross-sectional area and other calculations for raceways and wireways.
- 208.3 **FORMULATE** volume calculations for outlet, device, and junction boxes.
- 208.4 **FORMULATE** calculations for pull box sizing.
- 208.5 **IDENTIFY** the wiring method requirements found on the BCES prints.
- 208.6 **DEFINE** specific installation criteria for spray application, dipping, coating, and printing processes using flammable or combustible materials as described in NEC® Article 516.

Lesson 209 - First Semester Mid-Term Review and Exam

- 209 This lesson will determine your proficiency in the subject matter from the previous lessons.

Lesson 210 - Switches, Switchboards, and Panelboards and Health Care Facilities

- 210.1 **MASTER** general requirements for switches (NEC® 404).
- 210.2 **RECOGNIZE** characteristics of switchboards and panelboards as per NEC® 408.
- 210.3 **IDENTIFY** the switches, switchboards, and panelboard requirements found on the BCES prints.
- 210.4 **DEFINE** key terms of health care facilities described in NEC® 517 Part I.

Lesson 211 - Flexible Cords, Luminaires, Receptacles, Appliances, and Health Care Facilities

- 211.1 **DEFINE** the rating, installation, and overcurrent protection requirements for flexible cords.
- 211.2 **IDENTIFY** the location, support, grounding, and installation requirements for luminaires.
- 211.3 **RECOGNIZE** the type, grounding, and installation requirements for receptacles, cord, connectors, and attachment plugs.
- 211.4 **IDENTIFY** the branch circuit ratings, overcurrent protection, disconnect means, markings, and installation requirements for appliances.
- 211.5 **IDENTIFY** luminaire and appliance requirements found on the BCES prints.
- 211.6 **DESCRIBE** wiring and protection fundamentals found in NEC® 517 Part II.

Lesson 212 - Introduction to AC Theory and Places of Assembly

- 212.1 **DESCRIBE** and **EXPLAIN** the terms used for electrical charges, magnetism, and electromagnetism.
- 212.2 **RECOGNIZE** basics of AC power, AC generation, frequency, voltage, and current.
- 212.3 **DEFINE** inductance and capacitance, and **MATCH** symbols and formulas for inductors and capacitors.
- 212.4 **DEFINE** requirements for special occupancies described in NEC® Articles 518–530.

Lesson 213 - AC Theory – Inductive and Capacitive Reactance: Miscellaneous Buildings

- 213.1 **DEFINE** and **COMPUTE** inductive reactance and capacitive reactance in an AC circuit.
- 213.2 **DESCRIBE** and **PREDICT** the leading and lagging effects on the voltage and current relationship when inductive reactance and capacitive reactance are present in an AC circuit.
- 213.3 **DEFINE** requirements for special occupancies described in NEC® Articles 545–555.

Lesson 214 - AC Theory: Impedance and Power Factor; Temporary Installation

- 214.1 **DEFINE** and **COMPUTE** impedance in series and parallel RLC circuits.
- 214.2 **IDENTIFY** the relationship between true power, apparent power, and power factor.
- 214.3 **DEFINE** requirements for temporary installations as described in NEC® 590.

Lesson 215 - Single-Phase Transformers: Introduction, Types and Applications, Single-Voltage Calculations and Connections

- 215.1 **DESCRIBE** the basic transformer terms and theory.
- 215.2 **MASTER** calculations for single-phase, single-voltage transformers.
- 215.3 **RECOGNIZE** transformer applications and use.
- 215.4 **LIST** transformer types as per NEC® 450 part II. **DESCRIBE** general information and special considerations for dry-type transformers.
- 215.5 **SELECT** single-phase transformer connection diagrams. **MASTER** connections for single-phase, single-voltage primary transformers.
- 215.6 **LOCATE** code requirements for transformers as per Article 450 parts II and III.

Lesson 216 - Single-Phase Transformers: Dual-Voltage, Fault-Current, Code Calculations

- 216.1 **MASTER** connections for single-phase, dual-voltage transformers (series and parallel coils).
- 216.2 **RECOGNIZE** how to avoid overloading and properly **CHOOSE** a single-phase transformer.
- 216.3 **RECOGNIZE** grounding, testing, and troubleshooting of single-phase transformers.
- 216.4 **DESCRIBE** single-phase transformer secondary fault current calculations.
- 216.5 **IDENTIFY** code requirements for transformers as per Article 450 part I.

Lesson 217 - First Semester Exam Review

- 217 This lesson will provide a review of the subject matter from previous lessons.

Lesson 218 - First Semester Exam

- 218 This lesson will determine your proficiency in the subject matter from the previous lessons.

Lesson 219 - Three-Phase Power Generation, Transmission, and Distribution; Introduction to Three-Phase Ohm's Law

- 219.1 **DESCRIBE** three-phase power generation, **RECOGNIZE** delta and wye voltage systems, and **DEFINE** three-phase Ohm's law formulas.
- 219.2 **SELECT** three-phase transformer bank ratings.
- 219.3 **RECOGNIZE** methods and components utilized in the transmission and distribution of power from various types of power plants.

Lesson 220 - 3Ø Transformers: Delta-Delta

- 220.1 **RECOGNIZE** and **EXPLAIN** 3Ø, three-wire, closed-delta secondary outputs, capacities, and connections. **IDENTIFY** proper primary tap connections and **PERFORM** calculations.
- 220.2 **RECOGNIZE** and **EXPLAIN** 3Ø, four-wire, closed-delta secondary outputs, capacities, and connections. **PERFORM** current and power calculations.
- 220.3 **RECOGNIZE** and **EXPLAIN** 3Ø, three-wire and four-wire, open-delta secondary outputs, capacities, and connections. **PERFORM** current and power calculations.

Lesson 221 - 3Ø Transformers: Delta-Wye

- 221.1 **RECOGNIZE** and **EXPLAIN** 3Ø, four-wire, wye secondary outputs, capacities, and connections for transformers and connected loads.
- 221.2 **PERFORM** current, power, and tap calculations.

Lesson 222 - Non-Linear Loads: 3Ø Fault Currents and Voltage Drop

- 222.1 **RECOGNIZE** and **EXPLAIN** terms, symptoms, and solutions associated with non-linear loads.
- 222.2 **FORMULATE** three-phase and single-phase bolted-fault currents.
- 222.3 **FORMULATE** three-phase and single-phase voltage drop.

Lesson 223 - Transformers: NEC® Requirements

- 223.1 **RECALL** various types of transformers and their construction.
- 223.2 **IDENTIFY** NEC® and manufacturer's transformer installation requirements.
- 223.3 **IDENTIFY** NEC® requirements for transformer vaults.
- 223.4 **MASTER** the NEC® requirements for the protection of transformers and primary conductors against overcurrent.
- 223.5 **MASTER** the NEC® requirements for the protection of transformer secondary conductors (taps) against overcurrent.

Lesson 224 - Buck-Boost Transformers: Single- and Three-Phase Connections and Applications

- 224.1 **RECOGNIZE** and **EXPLAIN** additive and subtractive polarity and the output voltages of buck-boost transformers.
- 224.2 **RECOGNIZE** and **CHOOSE** applications involving buck-boost transformers. Perform the calculations for determining the output voltages and capacities of these transformers.
- 224.3 **DESCRIBE** and **EXPLAIN** compensation and back-feeding of small transformers.

Lesson 225 - Buck-Boost Transformers: Calculations and Selection

- 225.1 **COMPUTE** the output voltage when supply voltages are other than the table values.
- 225.2 **CHOOSE** buck-boost transformers to deliver required voltage and power to single- and three-phase loads.

Lesson 226 - Generators, Transfer Switches, and Emergency Systems

- 226.1 **DESCRIBE** and **EXPLAIN** the basic principles and purpose of standby generator sets.
- 226.2 **DESCRIBE** and **EXPLAIN** installation requirements for transfer switches, generators, and emergency systems.
- 226.3 **RECOGNIZE** the four different categories of patient care areas in a health care facility and the three types of branch circuit classifications on the essential electrical system.
- 226.4 **IDENTIFY** the requirements for generators and emergency systems as found in the BCES.

Lesson 227 - Second Semester Mid-Term Review and Exam

- 227 This lesson will determine your proficiency in the subject matter from the previous lessons.

Lesson 228 - Electric Motors: DC and AC Single-Phase

- 228.1 **DESCRIBE** and **EXPLAIN** the operation, construction, and required connections for DC motors.
- 228.2 **DESCRIBE** and **EXPLAIN** the operation, construction, and required connections for single-phase AC motors.

Lesson 229 - Electric Motors: Polyphase

- 229.1 **DESCRIBE** and **EXPLAIN** three-phase operation of wound-rotor, synchronous, and squirrel-cage induction motors.

- 229.2 **RECOGNIZE** and **DEMONSTRATE** proper connections of wye- and delta-wound squirrel-cage induction motors. **DEMONSTRATE** marking the leads of unmarked 9-lead motors.
- 229.3 **RECOGNIZE** enclosure types and nameplate information for three-phase motors.

Lesson 230 - Motors: General Knowledge and Sizing Branch Circuit Conductors

- 230.1 **SELECT** proper size branch circuit conductors for single-phase motors.
- 230.2 **SELECT** proper size branch circuit conductors for three-phase motors.
- 230.3 **SELECT** proper size flexible cord conductors for motors.
- 230.4 **MASTER** adjustment factors for motor branch circuits due to voltage drop, ambient temperature and/or multiple conductors in a raceway.

Lesson 231 - Motor Branch Circuit Overcurrent Protective Devices: Short-Circuit and Ground-Fault Protection

- 231.1 **SELECT** proper size short-circuit and ground-fault protection for single-phase motor branch circuits.
- 231.2 **SELECT** proper size short-circuit and ground-fault protection for poly-phase motor branch circuits.

Lesson 232 - Motor: Overload Protection, Disconnects, Starters, and EGCs

- 232.1 **LIST** the function of thermal overloads contained within a motor starter.
- 232.2 **SELECT** the minimum NEMA size motor starter required using various manufacturer's tables.
- 232.3 **SELECT** thermal overload protection for installation in a motor starter using various manufacturer's tables.
- 232.4 **RECOGNIZE** the devices that can be used as a disconnecting means for a motor. **LIST** standard sizes and ratings of safety switches.
- 232.5 **SELECT** a safety switch to be used as a motor disconnecting means based on the circuit and motor requirements.
- 232.6 **CONTRAST** the minimum equipment grounding conductor size for motor branch circuit installations and branch circuit installations.
- 232.7 **RECALL** and **FORMULATE** sizing of ungrounded conductors, short-circuit and ground-fault protection, EGC, and conduit for motor branch circuits.

Lesson 233 - Locked Rotor Current and Phase Loss for Motors; A/C and Refrigeration Equipment; Fire Pumps

- 233.1 **DESCRIBE** the fundamentals of motor locked rotor current. **COMPUTE** approximate locked rotor current when a motor starts or stalls.
- 233.2 **INDICATE** the effects of phase loss on a motor. **FORMULATE** the approximate circuit current when a motor single-phases.
- 233.3 **FORMULATE** the minimum size for conductors, safety switches, and OCPDs used for air conditioning and refrigeration equipment branch circuits.
- 233.4 **RECOGNIZE** the purpose of a fire suppression system and the NEC® requirements for fire pumps.

Lesson 234 - Motor Feeder Conductors, OCPDs, and Tap Conductors

- 234.1 **FORMULATE** proper size motor feeder conductors.
- 234.2 **FORMULATE** proper size motor feeder OCPDs.
- 234.3 **FORMULATE** proper size motor feeder tap conductors.

Lesson 235 - Second Semester Final Exam Review

- 235 This lesson will determine your proficiency in the subject matter from the previous lessons.

Lesson 236 - Second Semester Final Exam

- 236 This lesson will determine your proficiency in the subject matter from the previous lessons.

OBJECTIVES FOR YEAR 3

Lesson 301 - Practical Guide to OSHA and NFPA 70E®

301.1 **RECALL** the important key safety requirements relative to OSHA and NFPA 70E®.

Lesson 302 - Introduction to Grounding and Bonding

302.1 **REVIEW** definitions for grounding and bonding.

302.2 **EXPLAIN** the path taken by fault current and **PREDICT** its effect on OCPD operation.

302.3 **ANALYZE** normal circuits, overloaded circuits, ground-faulted circuits, and short circuits.

302.4 **SHOW** shock hazards which occur when the human body becomes part of an electrical circuit. Using Ohm's Law, **COMPUTE** shock current.

Lesson 303 - General Requirements for Grounding and Bonding

303.1 **REVIEW** grounding and bonding terms referenced in NEC® Articles 100 and 250.

303.2 **MASTER** general grounding and bonding requirements.

303.3 **IDENTIFY** the components of an effective ground-fault current path.

303.4 **IDENTIFY** objectionable currents and proper grounding and bonding methods.

Lesson 304 - System Grounding: Grounded Conductors, Systems Required to be Grounded, and Systems Not Permitted to be Grounded

304.1 **REVIEW** the various common AC voltage systems. Determine which ARE REQUIRED to be grounded, which conductors are to be grounded, and which conductors are to be protected by overcurrent devices.

304.2 **EXPLAIN** a separately derived system.

304.3 **REVIEW** the various common AC voltage systems. Determine which systems and branch circuits are not required or are not permitted to be grounded.

304.4 **DESCRIBE** and **EXPLAIN** installation requirements and properly size grounded conductors.

Lesson 305 - System Grounding: Separately Derived Systems, Main Bonding Jumpers, and System Bonding Jumpers

305.1 **RECALL** and **EXPLAIN** the function, installation requirements, and sizing of main and system bonding jumpers.

305.2 **ASSESS** grounding and installation requirements for separately derived systems.

305.3 **ASSESS** the grounding requirements for two or more buildings or structures supplied by feeders or branch circuits.

305.4 **ASSESS** the grounding requirements for portable and vehicle-mounted generators and high-impedance grounded neutral systems.

Lesson 306 - Grounding Electrode Systems and Grounding Electrode Conductors

306.1 **EXPLAIN** general requirements for the grounding electrode system. **CHOOSE** which types of electrodes are permitted and the correct installation of the electrodes.

306.2 **REVIEW** requirements for grounding electrode conductors.

306.3 **REVIEW** sizing for grounding electrode conductors.

Lesson 307 - Supply-Side and Load-Side

- 307.1 **DEMONSTRATE** the requirements for supply-side bonding jumpers including materials used, installation, and sizing.
- 307.2 **DEMONSTRATE** the requirements for load-side bonding jumpers including materials used, installation, and sizing.

Lesson 308 - Equipment Grounding and Equipment Grounding Conductors

- 308.1 **IDENTIFY** effective equipment grounding and recognize the difference between short circuit and ground fault.
- 308.2 **REVIEW** grounding requirements for fastened-in-place equipment.
- 308.3 **REVIEW** sizing for equipment grounding conductors.

Lesson 309 - Grounding of Specific Equipment and Conditions

- 309.1 **RECOGNIZE** and list the ways to install and connect the equipment grounding conductor focusing on abnormal conditions (NEC® Article 250 Part VII).
- 309.2 **SHOW** the normally non-current-carrying metal parts of equipment and identify its supports that are required to be connected to the equipment grounding conductor of a circuit. Explain why this connection is necessary.
- 309.3 **LOCATE** and **APPLY** the provisions for grounding in Chapter 5 and 6 of the NEC®.

Lesson 310 - First Semester Mid-Term Review and Exam

- 310 This lesson will determine your proficiency in the subject matter from the previous lessons.

Lesson 311 - Printreading: Project Design, Development, and Specifications

- 311.1 **IDENTIFY** and **EXPLAIN** the process a project undertakes from the customer's concept through the selection of the architectural firm overseeing the design and development of the project.
- 311.2 **RECALL** "specifications." **SHOW** the purpose and formats of specifications.
- 311.3 **IDENTIFY** and **USE** the BCES specifications to understand requirements of Sections 16050 through 16080 (submittals, O&M, testing, site, and general provisions).
- 311.4 **IDENTIFY** and **USE** the BCES specifications to understand requirements of Sections 16114 through 16520 (electrical materials and installation).
- 311.5 **IDENTIFY** and **USE** the BCES specifications to understand requirements of Sections 16712 through 16741 (low voltage systems materials and installation).

Lesson 312 - Printreading: Site, Civil, Survey, and Structural Drawings

- 312.1 **LOCATE** and **USE** site, civil, and survey drawings for the proper layout and installation of the electrical equipment.
- 312.2 **LOCATE** and **USE** structural drawings for the proper layout and installation of the electrical equipment.

Lesson 313 - Printreading: Architectural Drawings—Lines, Dimensions, and Wall Types

- 313.1 Utilizing architectural drawings, **IDENTIFY** and **USE** various linetypes (column lines, control lines, match lines). **FIND** exact and scaled drawing dimensions.
- 313.2 **EXPLAIN** techniques used to lay out a wall on a jobsite.
- 313.3 **IDENTIFY** and **EXPLAIN** various common wall types and their components.
- 313.4 **LOCATE** and **SHOW** various BCES wall types and their components.

Lesson 314 - Printreading: Architectural Drawings—Schedules, Details, and Coordination

- 314.1 Using BCES schedules as an example, (wall finishes, ceiling heights, door and window, etc.) **RECOGNIZE** and **ANALYZE** when this information affects an electrical installation.
- 314.2 Using BCES details as an example, **RECOGNIZE** and **ANALYZE** when this information affects an electrical installation.
- 314.3 Using BCES drawings as an example, **DEMONSTRATE** architectural coordination with other trades.

Lesson 315 - Printreading: “MEP,” “E,” and “P” Drawings

- 315.1 Using BCES “MEP” drawings as an example, **RECOGNIZE** and **ANALYZE** when this information affects an electrical installation.
- 315.2 Using BCES “Mechanical, Electrical, and Plumbing” drawings as an example, **RECOGNIZE** and **ANALYZE** when this information affects an electrical installation.

Lesson 316 - Leadership: Foreman Training

- 316.1 **DESCRIBE** and **EXPLAIN** individuals (persons) and their responsibilities required to complete a project.
- 316.2 **RECOGNIZE** and **ANALYZE** foreman selection criteria.
- 316.3 **DESCRIBE** and **ANALYZE** the responsibilities and duties of a foreman.
- 316.4 **RECOGNIZE** and **PREDICT** challenges a foreman may face on the job.
- 316.5 **STATE** and **DEMONSTRATE** examples of job documentation (paperwork) and its importance.

Lesson 317 - First Semester Exam Review

- 317 This lesson will provide a review of the subject matter from the previous lessons.

Lesson 318 - First Semester Exam

- 318 This lesson will determine your proficiency in the subject matter from the previous lessons.

Lesson 319 - Test Instruments and Test Instrument Safety

- 319.1 **MASTER** the proper and safe usage of a volt-ohm-ampere meter to evaluate electrical circuits and components. **EXPLAIN** functions and characteristics of a meter.
- 319.2 **USE** and correctly interpret information on a digital and analog meter display. **LIST** examples of electrical test instruments and **DEMONSTRATE** their uses.
- 319.3 **DEMONSTRATE** safe test instrument habits by using proper PPE and procedures.

Lesson 320 - Toggle Switch, Push Button, and Basic Load Symbols—Introduction to Ladder Diagrams

- 320.1 **RECOGNIZE** correct symbology and operation for toggle switches, push buttons, and basic loads.
- 320.2 **WRITE** simple ladder diagrams using toggle switch and pilot light symbols. **LABEL** ladder diagrams.

Lesson 321 - Introduction to Contactors and Relays

- 321.1 **RECOGNIZE** and **EXPLAIN** the magnetic solenoid action required to operate magnetic control devices. **USE** correct solenoid symbology in ladder logic diagrams.
- 321.2 **RECOGNIZE** the purpose and function of contactors and relays. **SHOW** what happens to contacts when the coils are energized.

Lesson 322 - Applications Using Contactors and Relays

322.1 **LABEL** connection terminals on various relays and contactors. **MASTER** connection of relays and contactors to electrical circuitry.

Lesson 323 - Manual and Automatic Control Devices

323.1 **RECOGNIZE** correct symbology and operation for manual control devices (pushbuttons, joysticks, foot switches, and selector switches).

323.2 **RECOGNIZE** correct symbology and operation for automatic control devices (limit, pressure, temperature, float, flow, photocell, and time switches).

323.3 **REVIEW** NEMA enclosure classifications as they apply to environmental conditions.

Lesson 324 - Ladder Diagram Applications

324.1 **ILLUSTRATE** including line numbering, numerical cross-referencing, and wire numbering.

Lesson 325 - Automatic-Control Practical Applications

325.1 **IDENTIFY** circuit components from the work description.

325.2 **ILLUSTRATE** each rung in the diagram.

325.3 **ILLUSTRATE** complete ladder diagram by combining rungs.

325.4 **CONSTRUCT** the project. (Those classes without access to physical labs should refer to the special instructions within this section.)

Lesson 326 - Magnetic Motor Starters

326.1 **RECOGNIZE** the purpose and function of motor starters.

326.2 **LABEL** connection terminals on motor starters. **MASTER** connection of motor starters to electrical circuitry. **SHOW** what happens to contacts (holding, auxiliary) when the coils are energized.

326.3 **PREDICT** meter measurements within control circuits.

Lesson 327 - Magnetic Motor Starters and Pilot Devices: Practical-Application Emphasis on Holding Contacts

327.1 **IDENTIFY** circuit components from the work description.

327.2 **ILLUSTRATE** each rung in the diagram.

327.3 **ILLUSTRATE** complete ladder diagram by combining rungs.

327.4 **CONSTRUCT** the project. (Those classes without access to physical labs should refer to the special instructions within this section.)

Lesson 328 - Mid-Term Review and Exam

328 This lesson will determine your proficiency in the subject matter from the previous lessons.

Lesson 329 - Motor Overload Protection, Motor Power Connections, and Practice Scenarios

329.1 **RECALL** the purpose and function of motor overloads.

329.2 **DEMONSTRATE** motor power connections as required for the available circuit voltage.

329.3 **PREDICT** performance for complex control circuits under varying conditions.

Lesson 330 - Magnetic Motor Starters: Practical-Application

- 330.1 **IDENTIFY** circuit components from the work description.
- 330.2 **ILLUSTRATE** each rung in the diagram.
- 330.3 **ILLUSTRATE** a complete ladder diagram by combining rungs.
- 330.4 **CONSTRUCT** the project. (Those classes without access to physical labs should refer to the special instructions within this section.)

Lesson 331 - Motor Reversing: Controllers and Connections

- 331.1 **DESCRIBE** and **USE** manual devices (drum switches, manual starters) to reverse the rotation of motors. **ILLUSTRATE** the ladder diagrams for these circuits.
- 331.2 **DESCRIBE** and **USE** magnetic motor starters to reverse the rotation of motors. **ILLUSTRATE** the ladder diagrams for these circuits.
- 331.3 **PREDICT** meter measurements within reversing motor control circuits.

Lesson 332 - Magnetic Motor Starters: Practical-Application Emphasis on Reversing Motors

- 332.1 **IDENTIFY** circuit components from the work description.
- 332.2 **ILLUSTRATE** each rung in the diagram.
- 332.3 **ILLUSTRATE** a complete ladder diagram by combining rungs.
- 332.4 **CONSTRUCT** the project. (Those classes without access to physical labs should refer to the special instructions within this section.)

Lesson 333 - Latching Relays, Alternating Relays, and Jogging Circuits

- 333.1 **DESCRIBE** the operation and function of latching relays and **APPLY** an interpretation of circuit diagrams using latching relays.
- 333.2 **DESCRIBE** the operation and function of alternating relays and **APPLY** an interpretation of circuit diagrams using alternating relays.
- 333.3 **DESCRIBE** and **USE** jogging circuits.

Lesson 334 - Magnetic Motor Starters: Practical-Application Emphasis on Multimotor Equipment

- 334.1 **IDENTIFY** circuit components from the work description.
- 334.2 **ILLUSTRATE** each rung in the diagram.
- 334.3 **ILLUSTRATE** a complete ladder diagram by combining rungs.
- 334.4 **CONSTRUCT** the project. (Those classes without access to physical labs should refer to the special instructions within this section.)

Lesson 335 - Final Exam Review

- 335 This lesson will determine your proficiency in the subject matter from the previous lessons.

Lesson 336 - Final Exam

- 336 This lesson will determine your proficiency in the subject matter from the previous lessons.

OBJECTIVES FOR YEAR 4

Lesson 401 - Energized Electrical Work Relative to NFPA 70E®

- 401.1 **DEMONSTRATE** a broad understanding on working on or near energized electrical equipment as explained by OSHA and NFPA 70E®.

Lesson 402 - Power Distribution Systems and Phase-Loss Monitors

- 402.1 **EXPLAIN** the transmission and distribution processes, and **SHOW** the equipment required, for the delivery of energy from a generating station to the end user's equipment.
- 402.2 **IDENTIFY** and **ANALYZE** circuit problems that can cause equipment damage. Discuss the features of phase-loss monitors.

Lesson 403 - Solid-State Relays and Phase-Loss Lab

- 403.1 **IDENTIFY** the basic types of solid-state relays and **INDICATE** their characteristics in comparison to electromechanical relays.
- 403.2 **CONSTRUCT** a control panel circuit for a motor protected with a phase-failure relay.

Lesson 404 - Timing Relays: On-Delay, Interval, and Recycle

- 404.1 **CONTRAST** timing relays with non-timing relays. **LIST** the types of timers available, identify timing modes, and recognize the symbols used for timing relay contacts in ladder diagrams.
- 404.2 **SELECT** and **ILLUSTRATE** the operation of ON-DELAY timing relays.
- 404.3 **SELECT** and **ILLUSTRATE** the operation of interval and recycle (repeat) timing relays.

Lesson 405 - Timing Relays: Practical Application of On-Delay, Recycle, and Interval Timers

- 405.1 **IDENTIFY** circuit components and sequence of operation from the work description.
- 405.2 **ILLUSTRATE** each rung in the diagram.
- 405.3 **ILLUSTRATE** complete ladder diagram by combining rungs.
- LAB **CONSTRUCT** the project. (Those classes without access to physical labs should refer to the special instructions within this section.)

Lesson 406 - Timing Relays: Off-Delay, One-Shot, and Multifunction

- 406.1 **SELECT** and **ILLUSTRATE** the operation of OFF-DELAY timing relays.
- 406.2 **SELECT** and **ILLUSTRATE** the operation of one-shot timing relays.
- 406.3 **SELECT** and **ILLUSTRATE** the operation of multifunction timing relays.

Lesson 407 - Timing Relays: Practical Application of Off-Delay, One-Shot, and Multifunction Timers

- 407.1 **IDENTIFY** circuit components and sequence of operation from the work description.
- 407.2 **ILLUSTRATE** each rung in the diagram.
- 407.3 **ILLUSTRATE** a complete ladder diagram by combining rungs.
- 407.4 **CONSTRUCT** the project. (Those classes without access to physical labs should refer to the special instructions within this section.)

Lesson 408 - Counters and Sensors

- 408.1 **DESCRIBE** and **DEMONSTRATE** the basic operation and uses for counters.
- 408.2 **LIST** and **DEMONSTRATE** sensors in control circuits.

Lesson 409 - Mid-Term Review and Exam

409 This lesson will determine your proficiency in the subject matter from the previous lessons.

Lesson 410 - Motor Starting Methods

- 410.1 **RECOGNIZE** and **EXPLAIN** why full-voltage starting methods are not suitable for all motor applications.
- 410.2 **LIST** and **DEMONSTRATE** the various reduced-voltage starting methods.
- 410.3 **DESCRIBE** and **CHOOSE** between various solid-state (including soft start) motor starting methods.

Lesson 411 - Motor Drives—Accelerating and Decelerating Methods

- 411.1 **LIST** and **EXPLAIN** the available types and basic operation of motor drives.
- 411.2 **LIST** and **EXPLAIN** the various accelerating and decelerating methods for all motors.
- 411.3 **DESCRIBE** and **APPLY** speed control methods for various classifications of motor loads.

Lesson 412 - Introduction to Programmable Controllers

- 412.1 **RECOGNIZE** and **EXPLAIN** the basic operation and use of programmable controllers.
- 412.2 **RECOGNIZE** programmable controller components and **EXPLAIN** their operation. **USE** basic programming symbols and logic functions.
- 412.3 **DEMONSTRATE** basic programmable controller applications.
- 412.4 **EXPLAIN** basic troubleshooting steps for programmable controllers.

Lesson 413 - Advanced Lab—Automatic Car Wash

- 413.1 **IDENTIFY** circuit components and sequence of operation from the work description.
- 413.2 **ILLUSTRATE** each rung in the diagram.

Lesson 414 - Energy Management and Building Automation Including Latching Relays

- 414.1 **LIST** methods utilized to conserve the usage of a facility's electric energy consumption.
- 414.2 **EXPLAIN** building management systems as used for automation, energy conservation, and redundant equipment systems.
- 414.3 **IDENTIFY** and **USE** a mechanically held (latching) relay. **EXPLAIN** how these lighting contactors are used with building automation systems.

Lesson 415 - Fire Suppression Systems and Advanced Lab

- 415.1 **IDENTIFY** the purpose, circuit components, and sequence of operation for fire suppression (Ansul) systems.
- 415.2 **ILLUSTRATE** a complete ladder diagram for the fire suppression system.
- 415.3 **CONSTRUCT** the project. (Those classes without access to physical labs should refer to the special LAB instructions within this section).

Lesson 416 - Preventive Maintenance and Troubleshooting

- 416.1 **OUTLINE** and **EXPLAIN** the purpose and methods utilized for preventive and predictive maintenance systems.
- 416.2 **OUTLINE** and **EXPLAIN** the processes utilized to troubleshoot equipment.
- 416.3 **OUTLINE** and **EXPLAIN** the processes utilized to troubleshoot control circuits.
- 416.4 **OUTLINE** and **EXPLAIN** the processes utilized to troubleshoot power circuits.

Lesson 417 - First Semester Exam Review

417 This lesson will provide a review of the subject matter from the previous lessons.

Lesson 418 - First Semester Final Exam

418 This lesson will determine your proficiency in the subject matter from the previous lessons.

Lesson 419 - Introduction, Definitions, and Boxes

- 419.1 **REVIEW** the use, format, structure, outline, and practical application of the NEC®.
- 419.2 **REVIEW** definitions used in the NEC®.
- 419.3 **REVIEW** NEC® requirements for the use and installation of boxes and enclosures.
- 419.4 **REVIEW** box-fill and box-sizing calculations.

Lesson 420 - Cable Types and Flexible Cords: General Installation Requirements

- 420.1 **REVIEW** NEC® requirements for the general installation of any cable.
- 420.2 **REVIEW** NEC® requirements for the use of specific cable wiring methods.
- 420.3 **REVIEW** NEC® requirements for underground installations.

Lesson 421 - Raceways and Conductors

- 421.1 **REVIEW** NEC® requirements for the general installation of any raceway.
- 421.2 **REVIEW** NEC® requirements for the use of specific raceway and other wiring methods.
- 421.3 **REVIEW** raceway fill calculations.
- 421.4 **REVIEW** NEC® requirements for the general use and installation of any conductor.
- 421.5 **REVIEW** ampacity correction factor calculations for conductors.

Lesson 422 - Dwelling Units: General Provisions

- 422.1 **REVIEW** NEC® branch circuit ratings in dwellings.
- 422.2 **REVIEW** NEC® requirements for the location and installation of general receptacles in dwellings.
- 422.3 **REVIEW** NEC® requirements for the location and installation of general lighting outlets in dwellings.
- 422.4 **REVIEW** NEC® calculations for general lighting load and general purpose receptacles.

Lesson 423 - Dwelling Units: Specific Provisions

- 423.1 **REVIEW** NEC® circuit ratings and calculations for fixed appliances.
- 423.2 **REVIEW** NEC® installation requirements for fixed appliances in dwellings.
- 423.3 **REVIEW** NEC® requirements for specific lighting outlets and luminaires in dwellings.

Lesson 424 - Services: Equipment and Working Space

- 424.1 **REVIEW** NEC® requirements for services and service equipment.
- 424.2 **REVIEW** NEC® requirements for clearances and working space.
- 424.3 **REVIEW** NEC® requirements for panelboards, switchboards, transformers, generators, and busways.
- 424.4 **REVIEW** NEC® requirements for fuses and circuit breakers.

Lesson 425 - Commercial Installations

- 425.1 **PERFORM** voltage drop calculations and other electrical calculations.
- 425.2 **REVIEW** NEC® requirements for commercial branch circuits and outlets.
- 425.3 **REVIEW** NEC® requirements for use and installation of commercial luminaires.

Lesson 426 - Hazardous Locations and Health Care Facilities

- 426.1 **REVIEW** NEC® classes and divisions for hazardous locations.
- 426.2 **REVIEW** NEC® requirements for specific hazardous locations.
- 426.3 **REVIEW** NEC® definitions and wiring for health care facilities.
- 426.4 **REVIEW** NEC® requirements for health care electrical systems.
- 426.5 **REVIEW** NEC® requirements for health care equipment.

Lesson 427 - Mid-Term Review and Exam

- 427 This lesson will determine your proficiency in the subject matter from the previous lessons.

Lesson 428 - Miscellaneous Occupancies and Special Equipment

- 428.1 **REVIEW** NEC® requirements for occupancies designated in Articles 518–540.
- 428.2 **REVIEW** NEC® requirements for occupancies designated in Articles 545–590.
- 428.3 **REVIEW** NEC® requirements for swimming pools, spas, and fountains.
- 428.4 **REVIEW** NEC® requirements for special equipment in Articles 600–685 and 695.

Lesson 429 - Alternative Energy Sources and Emergency Power Systems

- 429.1 **IDENTIFY** and **EXPLAIN** the different types of emergency systems.
- 429.2 **RECOGNIZE** and **EXPLAIN** different energy storage systems.
- 429.3 **RECOGNIZE** and **EXPLAIN** NEC® requirements for renewable energy generation.
- 429.4 **RECOGNIZE** and **EXPLAIN** NEC® requirements for interconnection of energy systems.

Lesson 430 - Motors and Power Quality

- 430.1 **CHOOSE** motor branch circuit conductors.
- 430.2 **CHOOSE** motor branch circuit short-circuit and ground-fault protection rating.
- 430.3 **CHOOSE** motor branch circuit overload protection rating. **RECALL** and **EXPLAIN** power quality issues, their causes and effects in electrical systems, and how to reduce their impact.
- 430.4 **REVIEW** hermetic motor installation requirements.
- 430.5 **REVIEW** sources of poor power quality and mitigating solutions.

Lesson 431 - Service and Load Calculations

- 431.1 **REVIEW** NEC® requirements for one-family and multifamily dwelling service calculations.
- 431.2 **REVIEW** NEC® requirements for commercial occupancy service calculations.

Lesson 432 - BCES Application and Grounding & Bonding Requirements

- 432.1 **FIND** information on BCES plans.
- 432.2 **COMPUTE** connected and demanded loads using BCES plans.
- 432.3 **REVIEW** NEC® requirements for grounding and bonding of services and service equipment.

Lesson 433 - Fire Alarm Systems—Introduction and Overview

- 433.1 **DESCRIBE** and **APPLY** the basic functions of a fire alarm system.
- 433.2 **LIST** and **EXPLAIN** the basic types, functions, and proper locations for fire alarm initiation and notification devices.
- 433.3 **LIST** and **EXPLAIN** the wire types used in fire alarm systems.
- 433.4 **LIST** and **EXPLAIN** the different types of fire alarm systems.
- 433.5 **RECOGNIZE** and **EXPLAIN** the safety precautions for working on existing fire alarm systems.

Lesson 434 - Introduction to Limited Energy/Low-Voltage Systems

- 434.1 **RECOGNIZE** and **EXPLAIN** the basic functions of limited energy/low-voltage systems.
- 434.2 **RECOGNIZE** and **EXPLAIN** types of coaxial cable, connectors, and terminations.
- 434.3 **RECOGNIZE** and **EXPLAIN** types of structured cable, connectors, terminal blocks, and terminations.
- 434.4 **RECOGNIZE** and **EXPLAIN** types of fiber, fiber connectors, and terminations.
- 434.5 **REVIEW** NEC® requirements for special conditions and communications systems.

Lesson 435 - Final Exam Review

- 435 This lesson will provide a review of the subject matter from the previous lessons.

Lesson 436 - Second Semester Final Exam

- 436 This lesson will determine your proficiency in the subject matter from the previous lessons.