

Electricity

Strand 2: Technical Knowledge and Skills

2.A	Shop Safety and Regulations	
	Hours of Instruction	100
	Equipment Needed – (Must Meet Industry Standards)	
	Arc Flash PPE, Lock-Out Tag-Out Kit, various ladder types and sizes, Silica Dust Extraction System, Power Personnel Lift (A+)	
2.A.01	Describe and demonstrate safety techniques and methods with tools and shop procedures.	SKILL LEVEL
2.A.01.01	Describe and demonstrate safety procedures and techniques using hand and power tools.	B, E, A
2.A.01.02	Identify the hazard, recognize the practice, describe, and demonstrate methods of safely working with electricity.	B, E, A
2.A.01.03	Define Arc flash according to the National Fire Protection Association (NFPA-70 and NFPA 70E).	B, E, A
2.A.01.04	Explain and demonstrate electrical safety requirements per NFPA 70E.	B, E
2.A.01.05	Identify and demonstrate basic safety procedures that apply to ladder and power personnel lift safety.	B, E
2.A.01.06	Define a confined space and associated hazards.	B, E
2.A.01.07	Identify the hazards associated with “Hot Works” as it pertains to electricity. (using State Board of Examiners of Electricians provided instructional material)	E
	Performance Example:	
	Student will participate in daily /weekly “Toolbox Safety Talks” and will pass a written and performance test for all shop tools and equipment.	
2.B	Reading Technical Drawings and Blueprints	
	Hours of Instruction	75
2.B.01	Read and interpret prints.	SKILL LEVEL
2.B.01.01	Describe the basic layout of a set of prints as well as the importance of the accompanying job specifications document.	B, E
2.B.01.02	Identify and define basic print terms, abbreviations, line types, symbols, and notes.	B
2.B.01.03	Interpret and accurately follow drawing dimensions.	B, E
2.B.01.04	Convert measurements from a print using an architect’s scale.	B, E
2.B.01.05	Define and interpret floor plans, elevations, sections, details, ceiling plans, and finish schedules.	B, E
2.B.01.06	Discuss and demonstrate the use of estimating methods in pricing jobs using drawings/prints.	B, E, A

2.B.01.07	Use a drawing to design, develop and complete material sheets, indicating quantities and types of materials required for installation.	B, E
2.B.01.08	Use a Uniform Permit to discuss how state and/or local code requirements apply to prints.	B, E
2.B.01.09	Compare the layout on the drawing to the code required minimum requirements and identify omissions.	B, E
Performance Example: Student will perform shop/job site projects/work from given sets of prints/drawings. Student will develop a material sheet for given project/job. Student will develop a cost estimate from material sheet for given project/job. Student will prepare an application for a given electrical permit.		
2.C	Tools and Techniques in Fastening Objects	
	Hours of Instruction	75
	Equipment Needed – (Must Meet Industry Standards) Masonry Drilling Equipment, Silica Dust Extraction System, Power Tools	
2.C.01	Install different types of fasteners.	SKILL LEVEL
2.C.01.01	Explain and demonstrate the use of various trade related threaded and non-threaded fasteners.	B
2.C.01.02	Explain and demonstrate the use of and type of anchors.	B
Performance Example: Student will install an anchor in concrete in compliance with current OSHA and silica standards. Student will select and attach electrical equipment using proper fasteners and technique.		
2.C.02	Demonstrate inspection and use of fastening power tools according to current safety and industry standards.	SKILL LEVEL
2.C.02.01	Use and maintain fastening, sawing, drilling, and boring tools.	B
2.C.02.02	Use and maintain portable power tools.	B
Performance Example: Student will demonstrate the approved use and maintenance of power tools used to fasten boxes to concrete or masonry. Identify and demonstrate the use of the appropriate threaded, non-threaded fastener or anchor to fasten a box to a concrete or masonry surface. Student will explain the current OSHA silica standard.		
2.D	Concepts of Electrical Theory	
	Hours of Instruction	150
	Equipment Needed – (Must Meet Industry Standards) Oscilloscope, Digital Multi-Meter	
2.D.01	Explain basic concepts of AC/DC electrical theory.	SKILL LEVEL
2.D.01.01	Compare and distinguish between conductors and insulators.	B
2.D.01.02	Explain the relationship between voltage, current, and resistance.	B, E, A
2.D.01.03	Define the units of measurement that are used to measure the properties of electricity.	B, E, A
2.D.01.04	Calculate and apply an unknown value by using Ohms law formula.	B, E, A

2.D.01.05	Define voltage and identify the ways in which it is produced.	B, E, A
2.D.01.06	Compare and distinguish between single-phase and three-phase systems.	E, A
	Performance Example: Student will describe the basic characteristics of a series/parallel and combination circuit. Student will calculate the voltage, amperage, resistance, and wattage of a circuit using Ohms law from given project.	
2.E	Electrical Test Equipment	
	Hours of Instruction	75
	Equipment Needed – (Must Meet Industry Standards)	
	Digital Multi-Meter, Circuit Tracer, Meg-Ohm-Meter, Clamp-on Amp Meter, Circuit Analyzer	
2.E.01	Use common meters and tools to measure electrical values, using industry standards	SKILL LEVEL
2.E.01.01	Perform measurement of current	B, E
2.E.01.02	Perform measurement of voltage.	B, E
2.E.01.03	Perform measurement of resistance.	B, E
2.E.01.04	Describe and demonstrate the operation of a circuit tracer.	B, E
2.E.01.05	Determine the continuity of a circuit.	B, E
	Performance Example: Student will describe and demonstrate the uses of Volt/Ohm and Ampere meters on given devices, including explaining and demonstrating safety practices and use of protective equipment.	
2.F	Massachusetts Electrical Code (MEC) and Code of Massachusetts Regulations MGL and (CMR).	
	Hours of Instruction	200
2.F.01	Explain the purpose and history of the National Electrical Code (NEC) and the Massachusetts Electrical Code (MEC) amendments.	SKILL LEVEL
2.F.01.01	Describe the layout of the Massachusetts Electrical Code (MEC).	B
2.F.01.02	Demonstrate how to navigate the MEC book.	B, E
2.F.01.03	Identify and summarize the MGL's and CMR's as they apply to the electrical trade.	B, E
2.F.01.04	Locate appropriate Massachusetts Electric Code Amendments (527 CMR 12).	B, E
	Performance Example: Student will describe the topic of each of the 9 chapters in the Massachusetts Electrical Code (MEC). Student will determine the appropriate article of the Massachusetts Electrical Code MEC for a specific wiring method and apply to given project. Student will describe the value of informational notes and explain how they apply to given project. Student will explain how changes to the MEC are identified. Describe the difference between the National Electrical Code and the Massachusetts Electrical Code.	
2.F.02	State appropriate Electrical Board of Examiners regulations (527 CMR and 237 CMR).	SKILL LEVEL
2.F.02.01	Describe the MEC Licensing requirements.	B

2.F.02.02	Describe the continuing education renewal requirements.	B, E
	Performance Example: Student will describe what licensed electricians must do to renew their license.	
2.F.03	State the requirements of the MEC and tables.	SKILL LEVEL
2.F.03.01	Determine conductor requirements.	B, E, A
2.F.03.02	Determine raceway requirements.	B, E
2.F.03.03	Determine electrical box requirements.	B, E
2.F.03.04	Describe the purpose of ground-fault circuit interrupters (GFCI) and arc-fault circuit interrupters (AFCI) and indicate where they must be installed.	B, E
2.F.03.05	Identify the circuit loads, number of circuits required, and installation requirements.	E, A
2.F.03.06	Compute branch circuit loads and define branch circuit requirements.	E, A
	Performance Example: Student will calculate a branch circuit load from a given project.	
2.G	Raceways, Boxes, and Fittings	
	Hours of Instruction	275
	Equipment Needed – (Must Meet Industry Standards) Knock-Out Punch Kit, Power Threader, Power electric hydraulic Bender, PVC Bender, Mechanical Ratchet Bender, Portable Band Saw	
2.G.01	Installation of raceways and fittings.	SKILL LEVEL
2.G.01.01	Select various types and sizes of raceways, fittings, and supports.	B, E
2.G.01.02	Perform various methods of bending raceway.	B, E, A
2.G.01.03	Cut, ream and thread raceways.	B, E
2.G.01.04	Describe the purpose of conduit bodies.	B, E
2.G.01.05	Install raceways and fittings on various surfaces.	B, E
	Performance Example: Student will size and install a raceway for given project.	
2.G.02	Install electrical boxes.	SKILL LEVEL
2.G.02.01	Describe the different types of nonmetallic and metallic boxes.	B, E
2.G.02.02	Explain how boxes are selected and installed.	B, E, A
2.G.02.03	Install boxes on various surfaces.	B, E
	Performance Example: Student will install a box on a finished surface from a given project. Student will install a box in a finished surface from a given project. Student will identify the requirements for boxes and support luminaires. Student will identify the requirements for boxes that support paddle fans. Student will perform box fill calculations on a given project.	
2.H	Fundamentals of conductors and cables.	
	Hours of Instruction	125
	Equipment Needed – (Must Meet Industry Standards) Wire Puller Machine, Electric Wire Stripper, Electric Ratchet Cutters, Torque Setting Tools, Hydraulic Crimping Equipment	

2.H.01	Installation of conductors.	SKILL LEVEL
2.H.01.01	Describe and use the various sizes and gauges of wire in accordance with American Wire Gauge (AWG) standards.	B, E
2.H.01.02	Identify and use insulation types according to conditions and applications.	B, E, A
2.H.01.03	List voltage ratings of conductors.	B, E
2.H.01.04	Read and identify markings on conductors.	B, E
2.H.01.05	Select electrical conductors for specific applications.	B, E, A
2.H.01.06	Demonstrate how to size conductors for a load.	B, E, A
2.H.01.07	Demonstrate and explain the purpose of adjusting and correcting for selection of conductors.	E, A
2.H.01.08	Describe the different conductors.	B, E
2.H.01.09	Describe the color coding of insulation.	B, E
2.H.01.10	Demonstrate the use of equipment and procedure for pulling wire through raceways.	B, E
	Performance Example: Student will calculate wire size, identify application, and install through a raceway.	
2.H.02	Perform conductor terminations.	SKILL LEVEL
2.H.02.01	Prepare conductor ends for terminations and splices.	B, E
2.H.02.02	Select and install lugs and connectors onto conductors.	B, E
2.H.02.03	Describe and apply splicing techniques.	B, E
2.H.02.04	Splice conductors using solderless connectors.	B, E
2.H.02.05	Demonstrate how to use hand and power crimping tools.	B, E
2.H.02.06	Describe and apply crimping techniques.	B, E
2.H.02.07	Insulate a splice joint.	B, E
	Performance Example: Student will splice various solderless connections to different size wire for given project.	
2.H.03	Install cables.	SKILL LEVEL
2.H.03.01	Identify and apply different cable markings.	B, E
2.H.03.02	Secure and support cables.	B, E
2.H.03.03	Terminate cables using proper fittings.	B, E
2.H.03.04	Prepare cables for installation.	B, E
	Performance Example: Student will prepare conductor for termination, strip appropriate insulation from end of conductor, bend conductor end to terminate under terminal, and torque terminal to manufacturers' specifications on a given project.	
2.I	Power and Distribution of Electricity	
	Hours of Instruction	150
	Equipment Needed – (Must Meet Industry Standards) Service Equipment, Distribution Transformers, Panelboards	
2.I.01	Install electrical services.	SKILL LEVEL
2.I.01.01	Describe how to determine electric service requirements for dwellings.	B, E, A

2.I.01.02	Describe and demonstrate the grounding requirements for services.	B, E, A
2.I.01.03	Calculate and size service-entrance equipment.	B, E, A
2.I.01.04	Install main disconnect switches, panelboards, and overcurrent protection devices.	B, E, A
2.I.02	Performance Example: Student will calculate the service size for a residential dwelling. Student will select proper wire size and develop a material list for the service size calculated. Student will select and describe (or demonstrate) the proper grounding method for the service calculated	
	Size and install overcurrent protection.	SKILL LEVEL
	2.I.02.01 Articulate the importance and necessity of overcurrent protection in electrical circuits.	B, E
	2.I.02.02 Define the terms associated with fuses and circuit breakers.	B, E
	2.I.02.03 Describe the operation of a circuit breaker and fuse.	B, E
	2.I.02.04 Select the most suitable overcurrent device for the application.	B, E, A
	2.I.02.05 Describe the operation of single-element and time-delay fuses.	B, E, A
2.I.03	Performance Example: Student will explain the use of time delay fuses. Student will explain how a circuit breaker operates. Student will select the proper breaker for a specific application. Student will describe the safety risks associated with improper overcurrent replacement.	
	Size and install transformers.	SKILL LEVEL
	2.I.03.01 Compute transformer sizes for various applications.	E, A
	2.I.03.02 Identify and define different types of transformers.	B, E, A
	2.I.03.03 Describe the purpose and methods of grounding transformers.	E
	2.I.03.04 Identify power transformer connections.	E, A
	2.I.03.05 Calculate and install overcurrent protection for transformers.	E, A
2.J	Performance Example: Student will calculate the loads for a single-family dwelling from given project. Student will size the main overcurrent protective device from given project. Student will install the main overcurrent device in its proper location from given specifications.	
	Fundamentals of motors and motor controls	
	Hours of Instruction	50
	Equipment Needed – (Must Meet Industry Standards) Single and 3-Phase Motors, Combination Motor Starters, Adjustable Speed Drives (A+), Programmable Logic Controllers and Associated Software (A+)	
2.J.01	Install motors and motor controls.	SKILL LEVEL
2.J.01.01	Define terms relating to motors.	E, A
2.J.01.02	Explain and demonstrate how the direction of a three-phase motor is reversed.	E, A
2.J.01.03	Describe the methods for determining various motor connections.	E, A

	2.J.01.04	Draw basic wiring schematic w/controls.	A
	2.J.01.05	Describe the operating principles of motor and motor controls.	A
	2.J.01.06	Demonstrate the operating principles of motor controls and control circuits.	A
	2.J.01.07	Interpret motor control diagrams and schematics.	A
	2.J.01.08	Size and select thermal overload relays and other protective devices for motor controls.	A
	2.J.01.09	Describe the operating principles of contactors and relays.	E, A
	2.J.01.10	Describe manual, automatic, and semi-automatic control circuits.	E, A
	2.J.01.11	Identify and state the functions of limit switches and relays.	E, A
	2.J.01.12	Size and install adjustable speed drives.	A+
	2.J.01.13	Develop and install a basic programmable logic control circuit.	A+
	Performance Example: Student will draw a schematic diagram for a stop/start motor control circuit. Student will draw a ladder diagram for a given application. Student will install wiring for a given project based on a diagram.		
2.K	Fundamentals of grounding and bonding		
	Hours of Instruction		125
	Equipment Needed – (Must Meet Industry Standards) Exothermic Welding Kit, Hydraulic Crimper		
2.K.01	Size and install grounding and bonding system.		SKILL LEVEL
	2.K.01.01	Distinguish between a short circuit and a ground fault.	E
	2.K.01.02	Distinguish between system grounding and equipment grounding.	E
	2.K.01.03	Explain and demonstrate the function of the grounding electrode system and determine which grounding electrodes shall be used.	E
	2.K.01.04	Size the equipment grounding conductor for raceways and equipment.	E
	2.K.01.05	Explain and demonstrate the function of the main bonding jumper in the grounding system and size the main bonding jumper for various applications.	E, A
	2.K.01.06	Demonstrate effectively grounded and its importance in clearing ground faults and short circuits.	E
	2.K.01.07	Explain the terms ground, grounded conductor, bonding conductor, equipment grounding conductor, supplemental ground, supplementary ground, and installation requirements.	B, E
	Performance Example: Student will size a grounding electrode conductor for a 100 amp service and install a grounding electrode. Student will size and install an equipment grounding conductor for a specific application.		
2.L	Elementary use of luminaires and luminaire controls		
	Hours of Instruction		75
	Equipment Needed – (Must Meet Industry Standards) Various Ladder types and sizes, Power Personnel Lift (A+), Power Tools		
2.L.01	Install various lighting and luminaire controls.		SKILL LEVEL

2.L.01.01	Identify and apply basic occupancy sensors, photoelectric sensors, and dimmers used to control lighting circuits and describe how each device operates.	E, A
2.L.01.02	Identify different kinds of lamps and define the advantages and disadvantages of each type.	B, E
2.L.01.03	Identify and install various types of luminaires.	B, E, A
2.L.01.04	Classify luminaires by layout, location, fixture type, and type of service.	E, A
2.L.01.05	Demonstrate and state the functions and rating of single-pole, double pole, three-way, four-way, and dimmer switches.	B, E
2.L.01.06	Describe and demonstrate the installation and layout of lighting outlets.	E
2.L.01.07	Describe how wiring devices are selected and installed.	E
2.M	Performance Example: Student will identify and define industry terminology for lighting. Student will select and install lamps into luminaires. Student will recognize and install various types of luminaires. Student will select the appropriate luminaires for given lighting applications using manufactures' lighting catalogs.	
	Basic low voltage wiring	
	Hours of Instruction	50
	Equipment Needed – (Must Meet Industry Standards) Fire Alarm Equipment, Security Alarm Equipment, Network Data Cable Certifier, Network Interface Equipment, Camera System Equipment	
	2.M.01 Explain and apply operating principles of fire, and security alarm systems, camera systems and network cabling.	SKILL LEVEL
2.M.01.01	Identify the components of fire alarm systems, security alarm systems, camera systems and network cabling.	E, A
2.M.01.02	Identify and install Class 1, 2, and 3 low voltage systems.	B, E, A
2.M.01.03	Prepare, install, and terminate low voltage cable and devices.	B, E, A
2.N	Performance Example: Student will identify and install various components of fire and security alarm systems from given project. Student will define the various codes and regulations related to alarm systems (i.e., NFPA 72).	
	Inter-Connected Electric Power Production Sources	
	Hours of Instruction	50
	Equipment Needed – (Must Meet Industry Standards) Photovoltaic Panels (A+), Inverters (A+), Mounting Systems (A+), Energy Storage Equipment (A+), Generators (A+), Transfer Equipment (A+)	
	2.N.01 Photovoltaic Systems	SKILL LEVEL
2.N.01.01	Size and install inverters.	A+
2.N.01.02	Size, select and install photovoltaic panels.	A+
2.N.01.03	Select and install support systems.	A+
2.N.02	Performance Example: Students will identify components of a photovoltaic system.	
	Energy Storage Systems	SKILL LEVEL

2.N.02.01	Size, select and install storage system. (as per MEC)	A+
2.N.03	Performance Example: Students will identify the components associated with an energy storage system.	
	Standby Systems	SKILL LEVEL
2.N.03.01	Size, select and install standby system. (as per MEC)	A+
	Performance Example: Students will identify the components associated with a standby system.	