Massachusetts Department of Elementary & Secondary Education

Office for College, Career and Technical Education

Vocational Technical Education Framework

Construction Occupational Cluster

Electricity (VELEC)

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This document was prepared by the
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Notification in accordance with Chapter 30A of the General Laws.

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Acknowledgements

The Massachusetts Department of Elementary and Secondary Education awarded a multi-year contract to the Massachusetts Association of Vocational Administrators (MAVA) to launch the Statewide Vocational Technical Education Framework Revision Project, in consultation with the Office for College, Career and Technical Education. Through the collaborative efforts of many, vocational frameworks were revised to ensure curriculum alignment to current business and industry standards.

The Department of Elementary and Secondary Education wishes to thank all the groups that contributed to the development of these standards and all the teachers, administrators, and private sector advisory committee members who provided valuable employer validation of standards.

This updated Framework reflects current business and industry standards and includes the addition of the *Hours of Instruction*, *updates to Industry Recognized Credentials, Equipment,* and the *addition of Embedded Academic Performance Examples.*

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Hours of Instruction

Hours of Instruction have been provided for each framework standard to ensure that adequate instructional time is provided for students to attain complete and comprehensive knowledge of the subject matter.

	Schedule of Hours	
2.A	Shop Safety and Regulations	100
2.B	Reading Technical Drawings and Blueprints	75
2.C	Tools and Techniques in Fastening Objects	75
2.D	Concepts of electrical theory	150
2.E	Electrical test equipment	75
2.F	Massachusetts Electrical Code (MEC) and Code of Massachusetts Regulations MGL and (CMR).	200
2.G	Raceways, boxes, and fittings	275
2.H	Fundamentals of conductors and cables.	125
2.I	Power and distribution of electricity	150
2.J	Fundamentals of motors and motor controls	100
2.J	Fundamentals of motors and motor controls (+)	50
2.K	Fundamentals of grounding and bonding	125
2.L	Elementary use of luminaires and luminaire controls	75
2.M	Basic low voltage wiring	50
2.N	Inter-Connected Electric Power Production Sources (+)	50
	Total:	1575

The Massachusetts Board of State Examiners of Electricians APPROVED this DESE Chapter 74 Electricity Vocational Framework during their Public Board Meeting on February 22, 2021.

Overview & Organization of Strands

The Massachusetts Department of Elementary and Secondary Education understands the necessity of maintaining current Vocational Technical Education Frameworks which ensure that vocational technical students across the Commonwealth are taught the most rigorous and relevant standards aligned to the needs of business and industry.

This Revised Framework models the same format of all Massachusetts' Vocational Technical Education Frameworks and is organized into six strands. Standardized VTE Frameworks Strands 1, 4, 5, and 6 have been revised to ensure currency with industry standards.

Strand Two has been revised to include technical standards aligned to current business and industry standards, including new processes utilizing state-of-the-art equipment. The equipment necessary to deliver standards is also identified in this framework. To meet Chapter 74 vocational technical education standards, the equipment must meet industry standards.

Strand Three, Embedded Academic Knowledge and Skills, has been revised to clarify the direct connection of Core Academic Frameworks as they apply to Vocational Technical Education Frameworks.

Framework revision teams created Embedded Academic Performance Examples to provide specific learning scenarios which are typically utilized in VTE classrooms and labs to create real life learning experiences which provide students with knowledge attainment in Vocational Technical Education Frameworks and Academic Learning Standards. It is understood that most VTE learning experiences include Academic Knowledge attainment. The Performance Examples provided in this Framework are intended to provide awareness of these learning experience.

During Phase 3 of the 2021 Framework Revision Process, Strands One, Four, Five, and Six teams completed the revision of these strands. All Strand One, Four, Five and Six teams worked collaboratively with staff from the Department of Elementary and Secondary Education and the Advisors of the Massachusetts Career and Technical Student Organizations to crosswalk standards to national Career & Technical Student Organizations Curricula, as applicable. The Office for College, Career, and Technical Education contracted the MAVA Consultant Team to work closely with the office to complete all the work accomplished during the 2021 Framework Revision Project. A remarkable amount of work was accomplished through the efforts of numerous professionals who collaborated and diligently supported this work. The Office for College, Career, and Technical Education is grateful for all the support received from the field, particularly all the teachers (technical and academic), administrators, advisory committee members, business and industry representatives, the Division of Professional Licensure boards, the Massachusetts Association of

Vocational Administrators, the MAVA Consultants, and the Massachusetts Vocational Association, whose contributions were tremendous.

The ***Strand Two Team*** maintained the structure the 2013 framework that includes topic headings, standards and objectives, and performance examples. The Strand Two Framework now includes Hours of Instruction, as well as identifying Basic, Essential, Advanced and Advanced (A+) skill standards that are coded B, E, A and A+.

The ***Strand Three Team*** provided embedded academics performance examples that were developed to reflect the Standards for Literacy in Content Areas, the Standards for Mathematical Practice, the High School Science & Engineering Practices, and the Digital Literacy & Computer Science Practices.

Skill Standard Levels

The 2021 Framework identifies vocational competencies in three skill levels; basic, essential and advanced. **See below for more information.**

B = Basic Standards: Fundamental Skills All Chapter 74 state-approved vocational programs are required to deliver basic standards.

E = Essential Standards: Knowledge and Skills required for industry licensure and credentials. All Chapter 74 state-approved vocational programs are required to deliver essential standards.

A = Advanced Standards: Higher-level knowledge and skills beyond essential entry level employment standards. All Chapter 74 state-approved vocational programs are required to deliver advanced standards.

A+ = Advanced Plus (A+): Denotes Advanced Standards - highest level of supplemental training

- **Advanced (A+) Skills Standards** are identified in Strand Two by a plus sign (A+). Although these standards are not required, they are provided as suggestions that districts may choose to use to increase the depth of a particular topic, or add additional topics, particularly for advanced students or for those seniors who do not participate in cooperative education. Advanced (A+) standards are identified with the use of a plus sign (A+).

It is not required that all students achieve "advanced (A+) level standards", however, all Chapter 74 state-approved programs must have the capacity to deliver all three skill levels; Basic, Essential, and Advanced.

Definitions - Equipment

Simulator – a computer or application designed to provide a realistic operation of an industry standard or control, not to include educational trainers.
Educational Trainer - equipment which is designed strictly for educational purposes. Trainers cannot be a substitute or replacement for industry standard equipment.
Industry Standard Equipment – current and relevant equipment used in the industry relating to the standard functioning and implementation of operations in the respective fields of production, not to be confused with educational trainers.

Industry Standard - a set of criteria within an industry relating to the standard functioning and carrying out of operations in their respective fields of production. It is the generally accepted requirements followed by the members of an industry.
Software - current and relevant software used in the industry relating to the standard functioning and implementation of operations in the respective fields of production.

Organization of Framework – Strand 2

The Vocational Technical Education Frameworks contain knowledge and skills covering all aspects of industry, reflected in six strands: Safety and Health, Technical, Embedded Academics, Employability, Management and Entrepreneurship, and Technological.

Standards and objectives are grouped under topic headings, which are displayed in bold. Each standard is followed by a performance example.

In the excerpt below, 2.M is the topic; 2.M.01 is the first standard and 2.M.01.01 and 2.M.01.02 are the objectives under that standard. Topic 2.N.01.01, 2.N.01.02 and 2.N.01.03 indicate Advanced (A+) Skill Levels as defined on a previous page of this framework.

Strand 2 also includes Hours of Instruction, Equipment Needed, and Skill Levels.

2.M	**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
	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).	
2.N	**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+

	Performance Example: Students will identify components of a photovoltaic system.	

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
	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	
2.I.02	**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
	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.	
2.I.03	**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
	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.	
2.J	**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
	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.	
2.M	**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
	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).	
2.N	**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+
	Performance Example: Students will identify components of a photovoltaic system.	
2.N.02	**Energy Storage Systems**	**SKILL LEVEL**
2.N.02.01	Size, select and install storage system. (as per MEC)	A+
	Performance Example: Students will identify the components associated with an energy storage system.	
2.N.03	**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.	

Strand 3: Embedded Academics

Embedded Academics Grades 9 –14 for Chapter 74 Vocational Technical Education Programs

Due to the thoughtful planning that went into the revisions of the English Language Arts & Literacy (2017), Mathematics (2017), Science and Technology Engineering (2016), and Digital Literacy Frameworks (2016), the current Vocational Technical Education Frameworks can move forward with a new level of embedded academics that are more content focused and more meaningful to students as they attain transferrable skills. Core content area experts carefully developed the literacy standards and academic practices in the aforementioned Massachusetts Frameworks documents which are highlighted. The Standards for Literacy in Content Areas, the Standards for Mathematical Practice, the High School Science & Engineering Practices, and the Digital Literacy & Computer Science Practices complement but do not take the place of the grade-level or course-level content standards in any of the discipline-specific Vocational Technical Education Frameworks.

Mathematics, science, technology, reading, writing, speaking, and listening skills and standards focus on understanding and practicing discipline-specific literacy, math, STE, and communication skills, using resources and characteristics of specific Vocational Technical Education programs. The philosophy of the embedded academics is not to have vocational teachers become traditional content teachers of English, science, and mathematics but is intended to reinforce the concept that it is the responsibility of all teachers to embed rich academic experiences in Vocational Technical Education.

This will ensure that students recognize the transferrable skills that are essential for success in 21st century careers and in college. In rigorous Vocational Technical Education, students have hands-on and real-world experiences which develop relevant connections both from academic areas to Vocational Technical areas and vice versa.

The performance examples included in Strand Three are models developed using the portrait from the English Language Arts & Literacy (2017) of Students Who Are Ready for College, Careers, and Civic Participation. The examples illustrate how individual vocational teachers may use academic practices and literacy standards from the Massachusetts Frameworks listed above to seamlessly embed and explicitly teach relevant academics through Vocational Technical Education.

Vocational Technical Education of the past and of the 21st century naturally embed the elements of the portrait of Students Who are Ready for College, Careers, and Civic Participation through the hands-on and real-world experiences that students engage in throughout their tenure as Vocational Technical students. The following guidelines and practices that are collated in this document for easy reference are directly from the English Language Arts & Literacy (2017), Mathematics (2017), Science & Technology Engineering (2016), and Digital Literacy Frameworks (2016).

Electrical Performance Task 1

In the role of a master electrician working at an amusement theme park, the student is responsible for the installation of the largest roller coaster on the East Coast. The roller coaster power requirements exceed the electrical power of the premises. As the master electrician, the student will calculate the electrical requirements for the attraction, coordinate with the power utility, and organize the shut down and start up procedures for installation. Utilizing the Massachusetts Electrical Code and working with the local authority having jurisdiction, the master electrician will coordinate the installation of underground transformer vaults, conductors, conduits, distribution equipment and control systems.

Embedded Math:

[SMP.1]	Make sense of problems and persevere in solving them.
[SMP.4]	Model with mathematics.
[SMP.5]	Use appropriate tools strategically.
[SMP.6]	Attend to precision.

Embedded Science & Engineering:

[SEP.2]	Developing and using models.
[SEP.3]	Planning and carrying out investigations.
[SEP.4]	Analyzing and interpreting data.

Embedded Digital Literacy:

[DLCS.4]	Analyzing
[DLCS.5]	Communicating
[DLCS.6]	Collaborating
[DLCS.7]	Researching

Embedded Reading in Science & Technical Subjects:

[RCA-ST.11-12.4] Determine the meaning of general academic vocabulary as well as symbols, notation, key terms, and other domain specific words and phrases as they are used in a specific scientific or technical context relevant to electrical texts and topics.

[RCA-ST.11-12.7] Integrate and evaluate multiple sources of information presented in diverse formats and media (i.e. quantitative data, video, multimedia) to address a question or solve a problem.

[RCA-ST.11-12.9] Synthesize information from a range of sources (i.e. texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

Embedded Writing in Content Areas:

[WCA.11-12.1a] Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims/critiques, reasons, and evidence.

Vocational Technical Education Standards:

[2.B.01.01] Describe the basic layout of a set of prints as well as the importance of the accompanying job specifications document.

[2.B.01.02] Identify and define basic print terms, abbreviations, line types, symbols, and notes.

[2.B.01.03] Interpret and accurately follow drawing dimensions.

[2.B.01.04] Convert measurements from a print using an architect's scale.

[2.B.01.05] Define and interpret floor plans, elevations, sections, details, ceiling plans, and finish schedules.

[2.F.01.01] Describe the layout of the Massachusetts Electrical Code (MEC).

[2.F.01.02] Demonstrate how to navigate the MEC book.

[2.F.01.03] Identify and summarize the MGL`s and CMR`s as they apply to the electrical trade.

[2.F.01.04] Locate appropriate Massachusetts Electric Code Amendments (527CMR12).

[2.I.01.02] Describe and demonstrate the grounding requirements for services.

[2.I.01.03] Calculate and size service-entrance equipment.

[2.I.01.04] Install main disconnect switches, panelboards, and overcurrent protection devices.

Electrical Performance Task 2

The student, in the role of an electrical engineer, has been assigned to investigate energy audits at Logan International Airport Terminal C. The audit has determined that the motors on the escalators need to be replaced with energy efficient motors and drives. The electrical engineer has been tasked with designing and sizing the motors and drives and coordinating with outside contractors to replace all existing escalators in Terminal C. The electrical engineer will design the motor and drive system and create installation specifications that comply with the Massachusetts Electrical Code. As the electrical engineer, the student will coordinate with the authority having jurisdiction and the installation contractor utilizing the specifications for the installation of the new equipment.

Embedded Math:

[SMP.1]	Make sense of problems and persevere in solving them.
[SMP.4]	Model with mathematics.
[SMP.5]	Use appropriate tools strategically.
[SMP.6]	Attend to precision.

Embedded Science & Engineering:

[SEP.2]	Developing and using models.
[SEP.3]	Planning and carrying out investigations.
[SEP.4]	Analyzing and interpreting data.

Embedded Digital Literacy:

[DLCS.3]	Abstracting
[DLCS.4]	Analyzing
[DLCS.5]	Communicating

[DLCS.6] Collaborating

Embedded Reading in Science & Technical Subjects:

[RCA-ST.11-12.4] Determine the meaning of general academic vocabulary as well as symbols, notation, key terms, and other domain specific words and phrases as they are used in specific or technical context relevant to electrical texts and topics.

[RCA-ST.11-12.7] Integrate and evaluate multiple sources of information presented in diverse formats and media (i.e. quantitative data, video, multimedia) in order to address a question or solve a problem.

[RCA-ST.11-12.9] Synthesize information from a range of sources (i.e. texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

Embedded Writing in Content Areas:

[WCA.11-12.1a] Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims/critiques, reasons, and evidence.

[WCA.11-12.9] Draw evidence from informational texts to support analysis, interpretation, reflection, and research. (See grades 11–12 Reading Standard 1 for more on the use of textual evidence.)

Vocational Technical Education Standards:

[2.B.01.01] Describe the basic layout of a set of prints as well as the importance of the accompanying job specifications document.

[2.B.01.02] Identify and define basic print terms, abbreviations, line types, symbols and notes.

[2.J.01.03] Describe the methods for determining various motor connections.

[2.J.01.04] Draw basic wiring schematic w/controls.

[2.J.01.05] Describe the operating principles of motor and motor controls.

[2.J.01.07] Interpret motor control diagrams and schematics.

[2.J.01.08] Size and select thermal overload relays and other protective devices for motor controls.

[2.J.01.09] Describe the operating principles of contactors and relays.

[2.J.01.10] Describe manual, automatic and semi-automatic control circuits.

[2.J.01.11] Identify and state the functions of limit switches and relays.

[2.J.01.12] Size and install adjustable speed drives.

Electrical Performance Task 3

The student will act in the role of a residential electrician. The electrician will perform a layout and installation of a row of recessed lighting in a living space, including installation of the control device. The electrician will follow the parameters outlined from the client from verbal and written instructions, while referencing and applying applicable codes and manufacturer specifications. The electrician will recommend to the client lighting that will suit their needs, identify, and calculate proper spacing of the fixtures to balance the light, and identify and install appropriate control devices. The electrician must reference and apply appropriate installation methods to correctly install the components to both client and industry standards. In addition, the electrician must identify and maintain safety procedures through a hazard risk analysis of the tasks that will protect them prior to, during, and after the installation process. After installation of all associated equipment, the electrician will perform pre-energizing safety checks prior to testing functionality.

Embedded Math:

[SMP.4]	Model with mathematics.
[SMP.5]	Use appropriate tools strategically.
[SMP.6]	Attend to precision.

Embedded Science & Engineering:

[SEP.1]	Asking questions (for science) & defining problems (for engineering).
[SEP.4]	Analyzing and interpreting data.
[SEP.8]	Obtaining, evaluating, and communicating information.

Embedded Digital Literacy:

[DLCS.4]	Analyzing
[DLCS.5]	Communicating
[DLCS.6]	Collaborating
[DLCS.7]	Researching

Embedded Reading in Science & Technical Subjects:

[RCA-ST.11-12.2]	Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
[RCA-ST.11-12.3]	Follow precisely a complex multi-step procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
[RCA-ST.11-12.4]	Determine the meaning of general academic vocabulary as well as symbols, notation, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to electrical texts and topics.
[RCA-ST.11-12.9]	Synthesize information from a range of sources (i.e., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

Embedded Writing in Content Areas:

[WCA.11-12.9]	Draw evidence from informational texts to support analysis, interpretation, reflection, and research. (See grades 11–12 Reading Standard 1 for more on the use of textual evidence.)

Vocational Technical Education Standards:

[2.L.01.03]	Identify and install various types of luminaires.
[2.L.01.04]	Classify luminaires by layout, location, fixture type, and type of service.
[2.L.01.06]	Describe and demonstrate the installation and layout of lighting outlets.
[2.L.01.07]	Describe how wiring devices are selected and installed.
[2.L.01.08]	Student will draw a schematic diagram for a stop/start motor control circuit.

Appendices

Disclaimer: Reference in the Appendices Section to any specific commercial products, processes, or services, or the use of any trade, firm or corporation name is for the information and convenience of the public and does not constitute endorsement or recommendation by the Massachusetts Department of Elementary and Secondary Education or the Massachusetts Association of Vocational Administrators.

Appendix A

Industry Recognized Credentials (IRCs)

An **Industry** R**ecognized Credential** is verification of an individual's qualification or competence. An authoritative third party issues the credential. **IRCs** are valued in the labor market and are a validation of an individual's knowledge and skill.
Industry-recognized credentials are accepted by multiple employers across an industry. They are often endorsed by recognized trade associations or organizations representing a significant part of an industry or sector.
IRCs are identified as either **"Essential"** or **"Optional"**.

Essential IRCs indicate credentials that are in high demand by employers.
School districts that offer VTE programs with **"Essential"** IRCs must ensure that adequate time and resources are available for students to be instructed in the standards necessary to be prepared for the certification examination, as well as, provide opportunities for students to obtain these certifications.

Optional IRCs provide credentials that enhance employment opportunities.

Electrical IRCs (Industry Recognized Credentials)	Essential	Optional	Hours of Instruction needed to attain this Credential
Credit toward Massachusetts Electrician License (Work) 237 CMR 13.00	X		Up to 2000 hours
Credit toward Massachusetts Electrician License (Theory) 237 CMR 13.00	X		Up to 300 hours
Hot Work Safety	X		Varies by Provider
OSHA Construction, Safety & Health - 10 Hr (OSHA C10)	X		10
OSHA Construction, Safety & Health - 30 Hr (OSHA C30)		X	30
American Red Cross CPR/AED Certification		X	4
American Red Cross First Aid (First Aid)		X	2
Lead-Safe Renovation, Repair and Painting		X	Varies by Provider
OSHA Permit Required Confined Space *		X	16
Aerial Work Platform Training *		X	Varies by Provider
Confined Space Awareness *		X	Varies by Provider
Silica Dust Training *		X	Varies by Provider
Powder Actuated Tools *		X	Varies by Provider
Arc Flash Training (NFPA 70E) *		X	Varies by Provider
Asbestos Awareness Training *		X	Varies by Provider
Ladder Safety *		X	Varies by Provider
Fall Protection *		X	Varies by Provider

*** Resource Options for IRC Certification Training**

Aerial Work Platform Training	Aerial and Scissors Lifts On-line course	OSHA On-Line Education Center (valid for 3 years) https://www.oshaeducationcenter.com/
Confined Space Awareness	Confined Space Entry	https://www.osha.com/courses/confined-space-entry-training.html
Silica Dust Training	Silica Training	https://www.compliancetrainingonline.com/construction_silica.cfm
		https://www.silica-training.com/
Powder Actuated Tools	Powder Actuated Tools (Direct Fastening)	https://www.hilti.com/content/hilti/W1/US/en/services/contractor-services/certification-and-training.html
Arc Flash Training NFPA 70e	Arc Flash Training NFPA 70e	http://www.bostonsafetytraining.com/electrical-safety-training-system

Ladder Safety	Ladder Safety	https://go.bluevolt.com/Werner/s/coursedetail/101290/werner---ladder---core-training
Asbestos Awareness Training	Asbestos Awareness Training 2-hour OSHA	https://www.hazmatschool.com/osha-asbestos-awareness-training-1360/
Fall Protection	Fall Protection	https://go.bluevolt.com/Werner/s/coursedetail/101290/werner---ladder---core-training
Massachusetts State Training Provider List		https://www.mass.gov/files/documents/2017/12/06/safety-training-providers-list.pdf

DESE Statewide Articulation Agreement

ARTICULATION AGREEMENT

Between

Massachusetts Community Colleges

And

Massachusetts Chapter 74 State-Approved

for more information, click

http://www.masscc.org/partnerships-initiatives/voc-schools-articulation-agreements

Student Organizations

- SkillsUSA www.maskillsusa.org