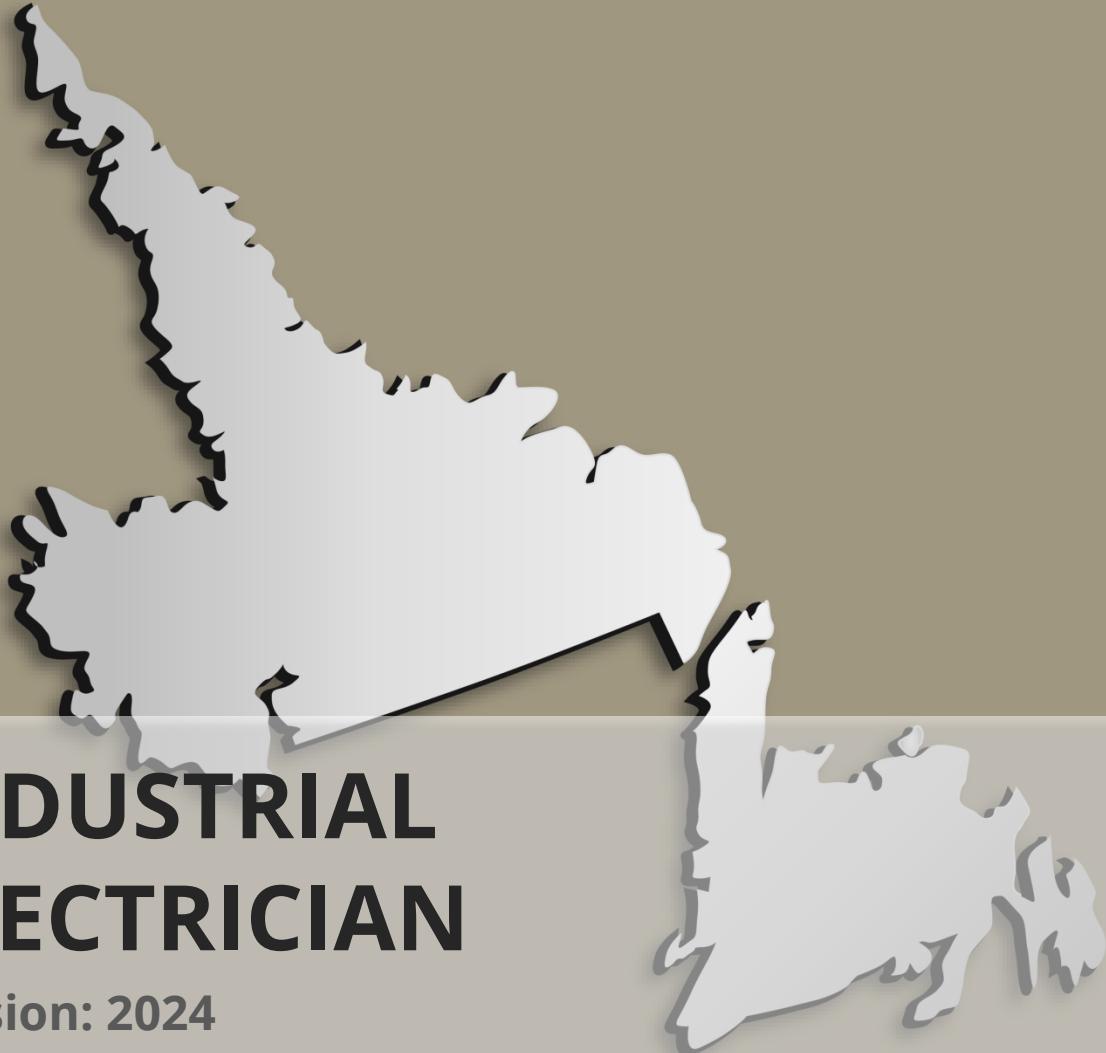


Atlantic Workforce Partnership



INDUSTRIAL ELECTRICIAN

Version: 2024

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COUNCIL OF
ATLANTIC PREMIERS
CONSEIL DES PREMIERS
MINISTRES DE L'ATLANTIQUE



Employment and
Social Development Canada

Emploi et
Développement social Canada

PLAN OF TRAINING

Atlantic Apprenticeship Curriculum Standard

Industrial Electrician

December 2024



Government of Newfoundland and Labrador
Department of Jobs, Immigration and Growth
Apprenticeship and Trades Certification Division

Approved by:

A handwritten signature in black ink that appears to read "Karen Hansen".

Chairperson, Provincial Apprenticeship and Certification Board

Date: Dec. 16, 2024

Preface

This Atlantic Apprenticeship Curriculum Standard is intended to assist instructional staff in the design and delivery of technical, in-class training in support of the Industrial Electrician programs.

This document contains all the technical training elements required to complete the Industrial Electrician apprenticeship programs and has been developed based on the 2021 Red Seal Occupational Standards (RSOS). The RSOS documents can be found on the Red Seal website (www.red-seal.ca).

Implementation of this AACS for Apprenticeship training is outlined in the following table.

Level	Implementation Effective
Level 1	2025-2026
Level 2	2026-2027
Level 3	2027-2028
Level 4	2028-2029

The above implementation schedule was current at time of printing. Please confirm with Apprenticeship Staff prior to commencing training.

Granting of credit or permission to challenge level examinations for pre-employment or pre-apprenticeship training for the Industrial Electrician trades will be based on the content outlined in this standard. Training providers must contact their provincial apprenticeship authority for more information on the process and requirements for determining eligibility for credit towards an apprenticeship program.

Acknowledgements

The development of the Atlantic Apprenticeship Curriculum Standard (AACS) is an initiative of the Atlantic Apprenticeship Council's Atlantic Apprenticeship Harmonization Project (AAHP) through the Atlantic Workforce Partnership.

The AAHP was created in 2014 and funded through contributions from Employment and Social Development Canada (ESDC) and the four Atlantic Provinces. In 2023, Phase III of the AAHP concluded and the AAHP transitioned to a maintenance office supported by the four Atlantic Provinces. The Atlantic Apprenticeship Council would like to thank ESDC for the financial support provided to harmonize the 23 trades in Phase I, II and III of the AAHP.

Advisory committees, industry representatives, instructors and apprenticeship staff provided valuable input to the development of the trade Atlantic Apprenticeship Curriculum Standard (AACS) in 2017 and updating of the trade AACS in 2024. Without their dedication to quality apprenticeship training, this document could not have been produced. The Atlantic Apprenticeship Council wishes to acknowledge the contributions of the industry and instructional representatives who participated in the development of this document.

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User Guide

Atlantic Apprenticeship Curriculum Standards (AACS) are developed based on trade specific national occupational standards, such as the Red Seal Occupational Standard (RSOS), and industry consultation. This document represents the minimum content to be delivered as part of the harmonized Atlantic program for the Bricklayer trade.

The AACSs are deliberately constructed for ease of use and flexibility of structure to adapt to all delivery requirements. They detail units of training, unit outcomes and objectives. They do not impose a delivery model or teaching format.

Jurisdictions and/or training providers will select and develop delivery materials and techniques that accommodate a variety of learning styles and delivery patterns. The AACS does not dictate study materials, textbooks or learning activities to be used in delivery.

The document includes a Level Structure to facilitate mobility for apprentices moving from one jurisdiction to another.

Structure

The content of the AACS is divided into units. Unit codes are used as a means of identification and are not intended to convey the order of delivery. It is at the discretion of the training provider to deliver the content in the required logical sequence of delivery within the level. Jurisdictions are free to deliver units one at a time or concurrently within a level, provided all outcomes are met.

The Learning Outcomes describe what the apprentice should know or be able to do at the end of training. Wording of the Learning Outcomes, “Demonstrate knowledge of...” acknowledges the broad spectrum of ways in which knowledge can be assessed (i.e., practical projects, multiple choice testing, presentations, etc.) by instructional staff within the training.

Summative evaluation will be through a multiple-choice level exam administered through the jurisdictional Apprenticeship Authority.

User Guide (continued)

The Red Seal Occupational Standard (RSOS) to AACS comparison chart outlines the relation between each RSOS sub-task and the AACS units. RSOS references have also been detailed in each unit to highlight the direct link between the unit and relevant sub-tasks in the RSOS.

In the Level Structure section, the document identifies suggested hours to provide an indication of the time it should take to cover the material in the unit and is provided as a guide only. Adjustments to the suggested hours for each unit may be required to account for rate of apprentice learning, statutory holidays, storm days, registration, and examinations. These suggested hours detailed for each unit will represent both theory and practical training (if relevant) and for consistency will be based on a standard of 30 hours per week of training. The true length of time required to deliver an outcome successfully will depend upon the learning activities and teaching methods used.

There are two types of objectives found in the AACS document: theoretical and practical.

The theoretical objectives represent the material that is to be covered during the technical training to convey the required knowledge to the apprentice.

The practical objectives represent the tasks or skills that have been deemed by the Atlantic Trade Advisory Committee as critical for the apprentices to receive exposure to while attending technical training. For example, exposure could be done through instructor demonstration or individual or group performance of the skill or task. Training providers are encouraged to use practical demonstration and opportunities for hands-on learning whenever possible. Practical objectives are not intended to replace the on-the-job training component of the apprentice's program or to mirror or replace the logbook skills that are to be taught and evaluated in the workplace.

Detailed content for each objective has not been developed. Where detail is required for clarity, content has been provided. The AACS should be used in conjunction with the national standard for the trade – the Red Seal Occupational Standard (RSOS).

Glossary of Terms

These definitions are intended as a guide to how language is used in the document.

Adjust	To put in good working order; regulate; bring to a proper state or position.
Application	The use to which something is put and/or the circumstance in which an individual would use it.
Characteristic	A feature that helps to identify, tell apart or describe recognizably, a distinguishing mark or trait.
Component	A part that can be separated from or attached to a system, a segment or unit.
Define	To state the meaning of (a word, phrase, etc.).
Describe	To give a verbal account of; talk about in detail.
Explain	To make plain or clear; illustrate; rationalize.
Identify	To point out or name objectives or types.
Interpret	To translate information from observation, charts, tables, graphs, and written material.
Maintain	To keep in a condition of good repair or efficiency.
Method	A means or manner of doing something that has procedures attached to it.
Operate	How an object works; to control or direct the functioning of.
Procedure	A prescribed series of steps taken to accomplish an end.
Purpose	The reason for which something exists or is done, made or used.

Glossary of Terms (continued)

Service	Routine inspection and replacement of worn or deteriorating parts.
	An act or business function provided to a customer in the course of an individual's profession (e.g., haircut).
Technique	Within a procedure, the manner in which technical skills are applied.
Test	v. To subject to a procedure that ascertains effectiveness, value, proper function, or other quality. n. A way of examining something to determine its characteristics or properties, or to determine whether it is working correctly.

Essential Skills Profiles/Skills for Success

Through extensive research, the Government of Canada and other national and international agencies have identified and validated key essential skills for the workplace. These skills are used in nearly every job and at different levels of complexity. They provide the foundation for learning all other skills and enable people to evolve with their jobs and adapt to workplace change. In response to the evolving labour market and changing skill needs, in 2021 the Government of Canada launched a new **Skills for Success** model: QR code #1 or web link below.

<https://www.canada.ca/en/services/jobs/training/initiatives/skills-success/new-model.html>

The Employment and Social Development Canada (ESDC) website provides information about the Skills for Success, including:

- a brief description of the skill;
- why the skill is important;
- tools to help you improve on each of the skills, and
- Videos to help you improve on each of the skills.

This information can be found at: QR code #2 or web link below.

<https://www.jobbank.gc.ca/essentialskills>

Skills for Success training tools can be found at: QR code #3 or web link below.

<https://www.canada.ca/en/services/jobs/training/initiatives/skills-success/tools.html>

The development and improvement of these Skills for Success is inherent throughout the apprenticeship training program as apprentices work towards achieving journeyperson status.



#1 The new Skills for Success model – Canada.ca



#2 Explore careers by essential skills – Job Bank



#3 Assessment and training tools – Canada.ca

Level Structure

Level 1 – 10 Weeks

Unit Code	Unit Title	Suggested Hours	Page Number
ELE-100	Safety	6	22
ELE-105	Tools and Equipment	6	25
ELE-110	Access Equipment	6	26
ELE-115	Hoisting, Lifting and Rigging	6	27
ELE-120	Support Components	6	29
ELE-125	Trade Documentation	6	31
MENT-700	Mentoring I	6	32
ELE-135	Drawings, Schematics and Specifications I	12	34
ELE-140	Worksite Preparation and Organization	6	36
ELE-145	DC Theory	30	38
ELE-150	DC Circuits	30	40
ELE-155	Single-Phase AC Theory	18	41
ELE-160	Single-Phase AC Circuits I	30	43
ELE-165	Introduction to the Canadian Electrical Code	6	45
ELE-170	Grounding and Bonding Systems I	6	46
ELE-175	Single-Phase Services	18	48
ELE-180	Single-Phase Power Distribution Equipment	18	50
ELE-185	Conductors and Cables	18	52
ELE-190	Conduit, Tubing and Fittings	12	54
ELE-195	Raceways	6	56
ELE-196	Boxes and Enclosures	12	58
ELE-197	Wiring Devices	6	60
ELE-198	Luminaires and Lighting Controls	24	62
ELE-199	Introduction to Communication Systems	6	65

Level Structure (continued)

Level 2 – 9 Weeks

Unit Code	Unit Title	Suggested Hours	Page Number
ELE-220	Job Planning	6	68
ELE-225	Voltage Drop and Power Loss	30	69
ELE-230	Environmental and Hazardous Installations	24	70
ELE-235	DC Generating and Conversion Systems	15	72
ELE-240	Single-Phase AC Circuits II	27	74
ELE-245	Protection Devices	24	76
ELE-250	Extra-Low Voltage Transformers	6	79
ELE-255	Low-Voltage Single-Phase Transformers	12	81
ELE-260	Renewable Energy and Storage Systems I	9	83
ELE-265	Exit and Emergency Lighting Systems	12	85
ELE-270	Heating, Ventilation and Air-Conditioning Systems	15	87
ELE-275	Heating, Ventilation and A/C System Controls	12	89
ELE-280	Electric Heating Systems	12	91
ELE-285	Electric Heating System Controls	12	93
ELE-290	Cathodic Protection Systems	6	95
ELE-295	DC Motors I	12	97
ELE-296	Motor Starters I	6	99
ELE-297	Motor Control Devices I	12	101
ELE-298	Drawings, Schematics and Specifications II	12	103
ELE-299	Lightning Protection Systems	6	104

Level 3 – 8 Weeks

Unit Code	Unit Title	Suggested Hours	Page Number
ELE-320	Three-Phase Theory	30	108
ELE-325	Ground Fault Protection and Detection Systems I	12	110
ELE-330	Three-Phase Services	12	112
ELE-335	Three-Phase Power Distribution Equipment	18	114
ELE-340	AC Generating Systems	18	116
ELE-345	Low-Voltage Three-Phase Transformers	18	118
ELE-350	High-Voltage Transformers	12	121
ELE-355	Motor Starters II	18	123
ELE-360	Motor Control Devices II	24	126
ELE-365	Single-Phase Motors I	18	128
ELE-370	Three-Phase Motors I	18	130
ELE-375	DC Motors II	12	132
ELE-380	AC Drives	18	133
ELE-385	DC Drives	12	135

Level Structure (continued)

Level 4 Industrial – 12 Weeks

Unit Code	Unit Title	Suggested Hours	Page Number
MENT-701	Mentoring II	6	138
IEL-405	Ground Fault Protection and Detection Systems II	3	139
IEL-410	Power Conditioning, Uninterruptible Power Supply (UPS) and Surge Suppression Systems	18	140
IEL-415	High-Voltage Equipment	18	142
IEL-420	High-Voltage Cables	12	145
IEL-425	Renewable Energy and Storage Systems II	12	147
IEL-430	Single-Phase Motors II	6	150
IEL-435	DC Motors III	6	151
IEL-440	Three-Phase Motors II	9	152
IEL-445	Commissioning and Decommissioning	18	153
IEL-450	Fire Alarm Systems	12	155
IEL-455	Security and Surveillance Systems	6	158
IEL-460	Communication Systems (Voice/Data/Video and Closed-Circuit Television)	6	160
IEL-465	Communication Systems (Public Address and Intercom Systems)	6	162
IEL-470	Communication Systems (Nurse Call Systems)	6	164
IEL-475	Building Automation and Control Systems	12	166
IEL-480	Predictive/Preventative Maintenance	12	169
IEL-485	Automated Control Systems	60	171
IEL-490	Pneumatic Control Systems	18	174
IEL-491	Hydraulic Systems and Control Devices	12	176
IEL-492	Discrete and Analog Devices	30	178
IEL-493	Process Control	30	181
IEL-494	Other Fixed Equipment and Controls	12	183
IEL-495	Program Review	30	185

2021 RSOS Sub-Task to AACS Unit Comparison

RSOS Sub-Task		AACS Unit	
Task 1 – Performs safety-related functions.			
1.01	Maintains safe work environment.	ELE-100	Safety
		ELE-230	Environmental and Hazardous Installations
1.02	Uses personal protective equipment (PPE) and safety equipment.	ELE-100	Safety
1.03	Performs lock-out and tag-out procedures.	ELE-100	Safety
1.04	Identifies environmental conditions.	ELE-230	Environmental and Hazardous Installations
Task 2 – Uses tools and equipment.			
2.01	Uses common and specialty tools and equipment.	ELE-105	Tools and Equipment
2.02	Uses access equipment.	ELE-110	Access Equipment
2.03	Uses rigging, hoisting and lifting equipment.	ELE-115	Hoisting, Lifting and Rigging
Task 3 – Organizes work.			
3.01	Interprets plans, drawings and specifications.	ELE-135	Drawings, Schematics and Specifications I
		ELE-298	Drawings, Schematics and Specifications II
3.02	Identifies hazardous locations.	ELE-100	Safety
		ELE-230	Environmental and Hazardous Installations
3.03	Organizes materials and supplies.	ELE-140	Worksite Preparation and Organization
3.04	Plans project tasks and procedures.	ELE-140	Worksite Preparation and Organization
		ELE-220	Job Planning
3.05	Prepares specific location in facility.	ELE-140	Worksite Preparation and Organization
		ELE-230	Environmental and Hazardous Installations
3.06	Finalizes required documentation.	ELE-125	Trade Documentation
Task 4 – Fabricates and installs support components.			
4.01	Fabricates support structures.	ELE-120	Support Components

RSOS Sub-Task		AACS Unit	
4.02	Installs brackets, hangers and fasteners.	ELE-120	Support Components
4.03	Installs seismic restraint systems.	ELE-120	Support Components
Task 5 – Commissions and decommissions electrical systems.			
5.01	Commissions systems.	ELE-175	Single-Phase Services
		ELE-180	Single-Phase Power Distribution Equipment
		ELE-445	Commissioning and Decommissioning
5.02	Performs shutdown and startup procedures.	ELE-175	Single-Phase Services
		ELE-180	Single-Phase Power Distribution Equipment
		ELE-445	Commissioning and Decommissioning
5.03	Decommissions systems.	ELE- 175	Single-Phase Services
		ELE-180	Single-Phase Power Distribution Equipment
		ELE-445	Commissioning and Decommissioning
Task 6 – Uses communication and mentoring techniques.			
6.01	Uses communication techniques.	MENT-700	Mentoring I
		MENT-701	Mentoring II
6.02	Uses mentoring techniques.	MENT-700	Mentoring I
		MENT-701	Mentoring II
Task 7 – Installs and maintains utility and non-utility supply services and metering equipment.			
7.01	Installs single-phase utility and non-utility supply services and metering equipment.	ELE-175	Single-Phase Services
7.02	Maintains single-phase utility and non-utility supply services and metering equipment.	ELE-175	Single-Phase Services
7.03	Installs three-phase utility and non-utility supply services and metering equipment.	ELE-330	Three-Phase Services

RSOS Sub-Task		AACS Unit	
7.04	Maintains three-phase utility and non-utility supply services and metering equipment.	ELE-330	Three-Phase Services
Task 8 – Installs and maintains protection devices.			
8.01	Installs overcurrent protection devices.	ELE-175	Single-Phase Services
		ELE-245	Protection Devices
8.02	Maintains overcurrent protection devices.	ELE-175	Single-Phase Services
		ELE-245	Protection Devices
8.03	Installs ground fault, arc fault and surge protection devices.	ELE-175	Single-Phase Services
		ELE-245	Protection Devices
		ELE-299	Lightning Protection Devices
8.04	Maintains ground fault, arc fault and surge protection devices.	ELE-175	Single-Phase Services
		ELE-245	Protection Devices
8.05	Installs under- and over-voltage protection devices.	ELE-180	Single-Phase Power Distribution Equipment
		ELE-245	Protection Devices
8.06	Maintains under- and over-voltage protection devices.	ELE-180	Single-Phase Power Distribution Equipment
		ELE-245	Protection Devices
Task 9 – Installs and maintains low-voltage distribution systems.			
9.01	Installs low-voltage distribution equipment.	ELE-180	Single-Phase Power Distribution Equipment
		ELE-335	Three-Phase Power Distribution Equipment
9.02	Maintains low-voltage distribution equipment.	ELE-180	Single-Phase Power Distribution Equipment
		ELE-335	Three-Phase Power Distribution Equipment
Task 10 – Installs and maintains power conditioning systems.			
10.01	Installs power conditioning systems.	IEL-410	Power Conditioning, Uninterruptible Power Supply (UPS) and Surge Suppression Systems
10.02	Maintains power conditioning systems.	IEL-410	Power Conditioning, Uninterruptible Power Supply (UPS) and Surge Suppression Systems
Task 11 – Installs and maintains bonding and grounding, and ground-fault protection and detection systems.			
11.01	Installs grounding systems.	ELE-170	Grounding and Bonding Systems I

RSOS Sub-Task		AACS Unit	
		ELE-235	DC Generating and Conversion Systems
		ELE-340	AC Generating Systems
11.02	Maintains grounding systems.	ELE-170	Grounding and Bonding Systems I
11.03	Installs bonding systems.	ELE-170	Grounding and Bonding Systems I
		ELE-235	DC Generating and Conversion Systems
		ELE-340	AC Generating Systems
11.04	Maintains bonding systems.	ELE-170	Grounding and Bonding Systems I
11.05	Installs ground-fault protection and detection systems.	ELE-325	Ground Fault Protection and Detection Systems I
11.06	Maintains ground-fault protection and detection systems.	ELE-245	Protection Devices
		IEL-405	Ground Fault Protection and Detection Systems II
Task 12 – Installs and maintains power generation and conversion systems.			
12.01	Installs alternating current (AC) generating systems.	ELE-340	AC Generating Systems
12.02	Maintains AC generating systems.	ELE-340	AC Generating Systems
12.03	Installs direct current (DC) generating and conversion systems.	ELE-235	DC Generating and Conversion Systems
12.04	Maintains DC generating and conversion systems.	ELE-235	DC Generating and Conversion Systems
Task 13 – Installs and maintains renewable energy generating and energy storage systems.			
13.01	Installs renewable energy generating and energy storage systems.	ELE-260	Renewable Energy and Storage Systems I
		IEL-425	Renewable Energy and Storage Systems II
13.02	Maintains renewable energy generating and energy storage systems.	IEL-425	Renewable Energy and Storage Systems II
Task 14 – Installs and maintains high-voltage systems.			
14.01	Installs high-voltage systems.	IEL-415	High-Voltage Equipment
		IEL-420	High-Voltage Cables
14.02	Maintains high-voltage systems.	IEL-415	High-Voltage Equipment
		IEL-420	High-Voltage Cables
Task 15 – Installs and maintains transformers.			
15.01	Installs extra-low voltage transformers.	ELE-250	Extra-Low Voltage Transformers

RSOS Sub-Task		AACS Unit	
15.02	Maintains extra-low voltage transformers.	ELE-250	Extra-Low Voltage Transformers
15.03	Installs low-voltage single-phase transformers.	ELE-255	Low-Voltage Single-Phase Transformers
15.04	Maintains low-voltage single-phase transformers.	ELE-255	Low-Voltage Single-Phase Transformers
15.05	Installs low-voltage three-phase transformers.	ELE-345	Low-Voltage Three-Phase Transformers
15.06	Maintains low-voltage three-phase transformers.	ELE-345	Low-Voltage Three-Phase Transformers
15.07	Installs high-voltage transformers.	ELE-350	High-Voltage Transformers
15.08	Maintains high-voltage transformers.	ELE-350	High-Voltage Transformers
Task 16 – Installs and maintains raceways, cables, conductors and enclosures.			
16.01	Installs conductors and cables.	ELE-185	Conductors and Cables
		ELE-230	Environmental and Hazardous Installations
16.02	Maintains conductors and cables.	ELE-185	Conductors and Cables
		ELE-230	Environmental and Hazardous Installations
16.03	Installs conduit, tubing and fittings.	ELE-190	Conduit, Tubing and Fittings
		ELE-230	Environmental and Hazardous Installations
16.04	Installs raceways.	ELE-195	Raceways
		ELE-230	Environmental and Hazardous Installations
16.05	Installs boxes and enclosures.	ELE-196	Boxes and Enclosures
		ELE-230	Environmental and Hazardous Installations
16.06	Maintains conduit, tubing, fittings raceways, boxes and enclosures.	ELE-190	Conduit, Tubing and Fittings
		ELE-195	Raceways
		ELE-196	Boxes and Enclosures
		ELE-230	Environmental and Hazardous Locations
Task 17 – Installs and maintains branch circuitry and devices.			
17.01	Installs luminaires.	ELE-198	Luminaires and Lighting Controls
17.02	Maintains luminaires.	ELE-198	Luminaires and Lighting Controls
17.03	Installs wiring devices.	ELE-197	Wiring Devices
17.04	Maintains wiring devices.	ELE-197	Wiring Devices

RSOS Sub-Task		AACS Unit	
Task 18 – Installs and maintains heating, ventilating and air-conditioning (HVAC) electrical components.			
18.01	Connects power to HVAC systems and associated equipment.	ELE-270	Heating, Ventilation and Air-Conditioning Systems
18.02	Installs HVAC controls.	ELE-275	Heating, Ventilation and Air-Conditioning System Controls
18.03	Maintains HVAC electrical components.	ELE-270	Heating, Ventilation and Air-Conditioning Systems
		ELE-275	Heating, Ventilation and Air-Conditioning System Controls
Task 19 – Installs and maintains electric heating systems and controls.			
19.01	Installs electric heating systems and controls.	ELE-280	Electric Heating Systems
		ELE-285	Electric Heating System Controls
19.02	Maintains electric heating systems and controls.	ELE-280	Electric Heating Systems
		ELE-285	Electric Heating System Controls
Task 20 – Installs and maintains exit and emergency lighting systems.			
20.01	Installs exit and emergency lighting systems.	ELE-265	Exit and Emergency Lighting Systems
20.02	Maintains exit and emergency lighting systems.	ELE-265	Exit and Emergency Lighting Systems
Task 21 – Installs and maintains cathodic protection systems.			
21.01	Installs cathodic protection systems.	ELE-290	Cathodic Protection Systems
21.02	Maintains cathodic protection systems.	ELE-290	Cathodic Protection Systems
Task 22 – Installs and maintains motor starters and control devices.			
22.01	Installs motor starters.	ELE-296	Motor Starters I
		ELE-355	Motor Starters II
22.02	Maintains motor starters.	ELE-296	Motor Starters I
		ELE-355	Motor Starters II
22.03	Installs motor control devices.	ELE-297	Motor Control Devices I
		ELE-355	Motor Control Devices II
22.04	Maintains motor control devices.	ELE-297	Motor Control Devices I
		ELE-360	Motor Control Devices II
Task 23 – Installs and maintains drives.			
23.01	Installs alternating current (AC) drives.	ELE-380	AC Drives

RSOS Sub-Task		AACS Unit	
23.02	Maintains alternating current (AC) drives.	ELE-380	AC Drives
23.03	Installs direct current (DC) drives.	ELE-385	DC Drives
23.04	Maintains direct current (DC) drives.	ELE-385	DC Drives
Task 24 – Installs and maintains other fixed equipment and associated controls.			
24.01	Installs other fixed equipment and associated controls.	IEL-494	Other Fixed Equipment and Controls
24.02	Maintains other fixed equipment and associated controls.	IEL-494	Other Fixed Equipment and Controls
Task 25 – Installs and maintains motors.			
25.01	Installs single-phase motors.	ELE-365	Single-Phase Motors I
25.02	Maintains single-phase motors.	IEL-430	Single-Phase Motors II
25.03	Installs three-phase motors.	ELE-370	Three-Phase Motors I
25.04	Maintains three-phase motors.	IEL-440	Three-Phase Motors II
25.05	Installs direct current (DC) motors.	ELE-295	DC Motors I
		ELE-375	DC Motors II
25.06	Maintains direct current (DC) motors.	ELE-295	DC Motors I
		IEL-435	DC Motors III
Task 26 – Installs and maintains signaling systems.			
26.01	Installs fire alarm systems.	IEL-450	Fire Alarm Systems
26.02	Maintains fire alarm systems.	IEL-450	Fire Alarm Systems
26.03	Installs security and surveillance systems.	IEL-455	Security and Surveillance Systems
26.04	Maintains security and surveillance systems.	IEL-455	Security and Surveillance Systems
Task 27 – Installs and maintains communication systems.			
27.01	Installs communication systems.	ELE-199	Introduction to Communication Systems
		IEL-460	Communication Systems (Voice/Data/Video and Closed-Circuit Television)
		IEL-465	Communication Systems (Public Address and Intercom Systems)
		IEL-470	Communication Systems (Nurse Call Systems)
27.02	Maintains communication systems.	IEL-460	Communication Systems (Voice/Data/Video and Closed-Circuit Television)

RSOS Sub-Task		AACS Unit	
		IEL-465	Communication Systems (Public Address and Intercom Systems)
		IEL-470	Communication Systems (Nurse Call Systems)
Task 28 – Installs and maintains building automation systems.			
28.01	Installs building automation systems.	IEL-475	Building Automation and Control Systems
28.02	Maintains building automation systems.	IEL-475	Building Automation and Control Systems
Task 29 – Installs and maintains process control systems.			
29.01	Installs discrete input/output (I/O) devices.	IEL-492	Discrete and Analog Devices
29.02	Maintains discrete input/output (I/O) devices.	IEL-492	Discrete and Analog Devices
29.03	Installs analog input/output (I/O) devices.	IEL-492	Discrete and Analog Devices
29.04	Maintains analog input/output (I/O) devices.	IEL-492	Discrete and Analog Devices
Task 30 – Installs, programs and maintains automated control systems.			
30.01	Installs automated control systems.	IEL-485	Automated Control Systems
30.02	Maintains automated control systems.	IEL-485	Automated Control Systems
		IEL-493	Process Control
30.03	Programs automated control systems.	IEL-485	Automated Control Systems
30.04	Optimizes system performance.	IEL-485	Automated Control Systems
		IEL-493	Process Control
Task 31 – Installs and maintains pneumatic and hydraulic control systems.			
31.01	Installs pneumatic control systems.	IEL-490	Pneumatic Control Systems
31.02	Maintains pneumatic control systems.	IEL-490	Pneumatic Control Systems
31.03	Installs hydraulic control systems.	IEL-491	Hydraulic Systems and Control Devices
31.04	Maintains hydraulic control systems.	IEL-491	Hydraulic Systems and Control Devices

Level 1

Unit Code	Unit Title	Suggested Hours	Page Number
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Learning Outcomes:

- Demonstrate knowledge of personal protective equipment (PPE) and safety equipment, their applications, maintenance and procedures for use.
- Demonstrate knowledge of safe work practices.
- Demonstrate knowledge of regulatory requirements pertaining to safety, PPE and safety equipment.
- Demonstrate knowledge of procedures to lock-out and tag-out equipment.
- Demonstrate knowledge of safety checks of equipment.
- Demonstrate knowledge of procedures for voltage testing.

IEL 2021 Red Seal Occupational Standard Reference:

- 1.01 Maintains safe work environment.
- 1.02 Uses personal protective equipment (PPE) and safety equipment.
- 1.03 Performs lock-out and tag-out procedures.
- 3.02 Identifies hazardous installation. (Introduction)

Suggested Hours:

6 Hours

Theoretical Objectives:

1. Identify hazards and briefly describe safe work practices.
 - i) arc flashes/blast
 - ii) liquid spills (flammable, corrosive, toxic)
 - iii) electric shocks
 - iv) combustible dust
 - v) ionizing radiation (including ultraviolet C)
 - vi) open holes
 - vii) confined space
 - viii) fire
 - ix) tripping hazards
 - x) overhead work
 - xi) working at heights
 - xii) hazardous locations
2. Identify and interpret workplace health and safety regulations pertaining to safety, PPE and safety equipment.
 - i) occupational health and safety (OHS)
 - ii) fall protection

- iii) confined spaces
- iv) workplace hazardous materials information system (WHMIS)
- v) safety data sheets (SDS)/globally harmonized system of classification and labelling of chemicals (GHS)

3. Identify and interpret the regulatory requirements pertaining to hazards and emergency situations.

- i) hazards
- ii) emergency situations

4. Identify types of personal protective equipment (PPE) and safety equipment and describe their applications, limitations and procedures for use.

- i) PPE
 - shock hazard PPE
 - arc flash hazard PPE
 - hard hats
 - safety glasses
 - safety footwear
 - gloves
 - hearing protection
 - respiratory protection
- ii) safety equipment
 - fall protection (fall arrest and fall restraint)
 - confined space equipment
 - lock-out and tag-out
 - fire extinguishers
 - first aid equipment
 - eye wash stations
 - signage
 - fume and toxic gas detectors

5. Describe the procedures used to maintain and store PPE and safety equipment.

6. Describe containment methods for designated substances.

- i) asbestos
- ii) lead
- iii) mercury
- iv) silica

7. Describe lock-out and tag-out procedures and legislation governing minimum standards.

8. Describe safety checks to be performed to ensure zero energy state.

9. Describe the procedures for voltage testing.

10. Describe the procedures used to determine if testing equipment is matched to voltage and energy rating.

Practical Objectives:

N/A

Learning Outcomes:

- Demonstrate knowledge of tools and equipment, their applications, maintenance and procedures for use.
- Demonstrate knowledge of limitations and ratings of electrical measuring equipment.
- Demonstrate knowledge of certification requirements to operate powder-actuated tools.

IEL 2021 Red Seal Occupational Standard Reference:

2.01 Uses common and specialty tools and equipment.

Suggested Hours:

6 Hours

Theoretical Objectives:

1. Define terminology associated with tools and equipment.
2. Identify hazards and describe safe work practices pertaining to the use of tools and equipment.
3. Identify types of tools and equipment and describe their applications and procedures for use.
 - i) standard tools
 - ii) power tools and equipment
 - iii) specialty tools and equipment
 - iv) measuring equipment
4. Identify electrical measuring equipment for various ratings and describe their limitations.
5. Identify categories of electrical measuring equipment.
6. Describe certification requirements to operate powder-actuated tools.
7. Describe the procedures used to inspect, maintain and store tools and equipment.

Practical Objectives:

N/A

ELE-110

Access Equipment

Learning Outcomes:

- Demonstrate knowledge of access equipment, its applications, maintenance and procedures for use.
- Demonstrate knowledge of regulatory requirements pertaining to access equipment.

IEL 2021 Red Seal Occupational Standard Reference:

2.02 Uses access equipment.

Suggested Hours:

6 Hours

Theoretical Objectives:

1. Define terminology associated with access equipment.
2. Identify hazards and describe safe work practices pertaining to access equipment.
3. Interpret codes, regulations and standards pertaining to access equipment.
 - i) inspection documentation
 - ii) training and certification
4. Identify types of access equipment and describe their characteristics, applications and limitations.
 - i) ladders
 - ii) scissor-lifts
 - iii) scaffolding
 - iv) articulating booms
5. Describe the procedures used to inspect, maintain and store access equipment.

Practical Objectives:

N/A

Learning Outcomes:

- Demonstrate knowledge of hoisting, lifting and rigging equipment, their applications, limitations and procedures for use.
- Demonstrate knowledge of regulatory requirements pertaining to hoisting, lifting and rigging equipment.
- Demonstrate knowledge of basic hoisting and lifting operations.

IEL 2021 Red Seal Occupational Standard Reference:

2.03 Uses rigging, hoisting and lifting equipment.

Suggested Hours:

6 Hours

Theoretical Objectives:

1. Define terminology associated with hoisting, lifting and rigging equipment.
2. Identify hazards and describe safe work practices pertaining to hoisting, lifting and rigging.
 - i) overhead hazards
 - ii) dropped loads
 - iii) damaged rigging hardware
 - iv) congested worksites
 - v) confined spaces
 - vi) open trenches
3. Interpret codes, regulations and standards pertaining to hoisting, lifting and rigging.
 - i) inspection documentation
 - ii) training and certification
4. Identify types of rigging equipment and accessories and describe their applications and procedures for use.
5. Identify types of hoisting and lifting equipment and accessories and describe their applications and procedures for use.
6. Describe the procedures used to inspect, maintain and store hoisting, lifting and rigging equipment.

7. Identify types of knots, hitches, splices and bends and describe their applications and procedures to tie them.
8. Describe considerations when rigging material or equipment for lifting.
 - i) load characteristics
 - ii) working load limit (WLL)
 - iii) equipment and accessories
 - iv) environmental factors
 - v) anchor points
 - vi) sling angles
9. Describe methods to communicate during hoisting, lifting and rigging operations.
 - i) hand signals
 - ii) electronic communications
 - iii) audible/visual

Practical Objectives:

1. Tie common knots.

Learning Outcomes:

- Demonstrate knowledge of procedures to fabricate support structures.
- Demonstrate knowledge of brackets, hangers and fasteners, their characteristics and applications.
- Demonstrate knowledge of procedures to install brackets, hangers and fasteners.
- Demonstrate knowledge of measurement and layout techniques.
- Demonstrate knowledge of seismic restraint systems, their characteristics and applications.
- Demonstrate knowledge of procedures to install seismic restraint systems.

IEL 2021 Red Seal Occupational Standard Reference:

- 4.01 Fabricates support structures.
- 4.02 Installs brackets, hangers and fasteners.
- 4.03 Installs seismic restraint systems.

Suggested Hours:

6 Hours

Theoretical Objectives:

1. Define terminology associated with support components.
2. Identify hazards and describe safe work practices pertaining to support structures.
3. Create, interpret and extract information pertaining to support structures from sketches, drawings and specifications.
4. Identify support materials, their characteristics and applications.
 - i) wood
 - ii) steel
 - iii) aluminum
5. Identify tools and equipment used to fabricate and install support components and describe their applications and procedures for use.
6. Describe the procedures used to fabricate support structures.

7. Identify types of brackets, hangers and fasteners and describe their characteristics and applications.
 - i) brackets
 - channel
 - angle
 - T
 - L
 - floor
 - ceiling
 - ii) hangers
 - trapezes
 - pipe clamps
 - beam clamps
 - iii) fasteners
 - spring nuts
 - bolts
 - screws
 - concrete anchors
8. Describe the procedures used to secure brackets, hangers and fasteners to structure.
9. Identify building materials and describe their characteristics and applications.
 - i) steel
 - ii) concrete
 - iii) brick
 - iv) block
 - v) wood
10. Identify measurement and layout techniques used to ensure brackets, hangers and fasteners are positioned and mounted.
11. Identify types of seismic restraint systems and describe their characteristics and applications.
 - i) chains
 - ii) cables
 - iii) rods
 - iv) galvanized cable
 - v) stainless steel cable
 - vi) thimbles and clamps
12. Describe the procedures used to mount and secure seismic restraint systems to structures.

Practical Objectives:

N/A

Learning Outcomes:

- Demonstrate knowledge of trade documentation, its purpose and use.
- Demonstrate knowledge of procedures to complete and interpret documentation.

IEL 2021 Red Seal Occupational Standard Reference:

3.06 Finalizes required documentation.

Suggested Hours:

6 Hours

Theoretical Objectives:

1. Identify types of trade documentation and describe their applications.
 - i) work orders
 - ii) invoices
 - iii) reports
 - iv) logs
 - v) labels
 - vi) maintenance sheets
2. Describe the purpose of starting up, shutting down, commissioning and decommissioning and the types of systems and equipment requiring it.
3. Identify types of reference materials and sources of information and describe their applications.
 - i) technical manuals
 - ii) manufacturers' specifications
 - iii) equipment parameters
 - iv) drawings and schematics
 - v) regulations and standards
 - vi) permits
 - vii) material take-off lists
4. Describe the procedures used to finalize documentation.

Practical Objectives:

N/A

Learning Outcomes:

- Demonstrate knowledge of effective communication practices as a learner.
- Demonstrate knowledge of strategies for learning skills in the workplace.

IEL 2021 Red Seal Occupational Standard Reference:

6.01 Uses communication techniques.
6.02 Uses mentoring techniques.

Suggested Hours:

6 hours

Theoretical Objectives:

1. Describe the importance of one's own individual experiences.
2. Identify behaviours that demonstrate positive learning experiences.
3. Identify the benefits of workplace mentoring for the apprentice, mentor and employer.
4. Identify the partners involved in apprenticeship training.
5. Describe the shared responsibilities for workplace learning in apprenticeship.
6. Identify different learning needs and strategies to address challenges or barriers in the workplace.
 - i) learning disabilities
 - ii) language
 - iii) underrepresentation
7. Identify the components that create a positive and inclusive workplace culture.
 - i) workplace characteristics
 - ii) individual behaviours
8. Identify various learning styles and determine one's own learning preferences.
9. Explain how learning preferences impact learning new skills.
10. Identify different learning strategies to meet individual learning needs.

11. Describe the importance of adapting to a variety of teaching and learning methods in the workplace.
12. Identify techniques for effective communication as a learner.
 - i) verbal and non-verbal
 - ii) active listening
13. Identify and describe personal responsibilities and attitudes that contribute to on-the-job success.
 - i) self advocating
 - ii) asking questions
 - iii) accepting constructive feedback
 - iv) working safely
 - v) employing time management techniques and being punctual

Practical Objectives:

N/A

Learning Outcomes:

- Demonstrate knowledge of drawings, schematics and specifications and their applications.
- Demonstrate knowledge of imperial and metric units in trade documentation.
- Demonstrate knowledge of interpreting and extracting information from basic drawings, schematics and specifications.

IEL 2021 Red Seal Occupational Standard Reference:

3.01 Interprets plans, drawings and specifications.

Suggested Hours:

12 Hours

Theoretical Objectives:

1. Define terminology associated with drawings, schematics and specifications.
2. Identify types of drawings, schematics and specifications and describe their applications.
 - i) civil/site
 - ii) architectural
 - iii) mechanical
 - iv) structural
 - v) electrical
 - vi) shop
 - vii) sketches
 - viii) as-builts
3. Interpret imperial and metric units of measure used in trade documentation.
4. Interpret and extract information from basic drawings, schematics and specifications.
 - i) elevations
 - ii) scales
 - iii) legends
 - iv) symbols and abbreviations
 - v) notes and specifications
 - vi) addendums
 - vii) Construction Specifications Canada (CSC)
 - specification divisions 25, 26, 27 and 28

5. Explain how scaling is performed to position devices.
 - i) metric
 - ii) imperial
6. Explain how three-dimensional (3D) modelling and building information modelling (BIM) digital blueprints can facilitate construction methods such as interpreting and updating drawings.
7. Describe how mobile devices can receive specifications and other relevant information to assist in diagnostic procedures.

Practical Objectives:

N/A

Learning Outcomes:

- Demonstrate knowledge of procedures to plan and organize materials and supplies.
- Demonstrate knowledge of procedures to prepare worksite.
- Demonstrate knowledge of procedures to locate elements encased in concrete and soil.

IEL 2021 Red Seal Occupational Standard Reference:

- 3.03 Organizes materials and supplies.
- 3.04 Plans project tasks and procedures.
- 3.05 Prepares specific location in facility.

Suggested Hours:

6 Hours

Theoretical Objectives:

1. Identify sources of information relevant to organize materials and supplies.
 - i) drawings
 - ii) specifications
 - iii) client requirements
2. Describe considerations to organize materials and supplies.
 - i) available space
 - ii) schedule
 - iii) storage location
3. Identify sources of information relevant to prepare the worksite.
 - i) drawings
 - ii) specifications
 - iii) authority having jurisdiction (AHJ)
 - iv) client requirements
4. Identify hazards and describe safe work practices when preparing the worksite.
 - i) confined spaces
 - ii) open trenches
 - iii) overhead hazards
 - iv) uneven ground
 - v) high traffic area
 - vi) elevated work areas
 - vii) underground hazards

viii) leading edges

5. Describe considerations to prepare the worksite.

- i) available space
- ii) schedule/sequence
- iii) permits
- iv) hazards assessment
- v) personnel
- vi) tools and equipment
- vii) materials and supplies
- viii) storage location

6. Identify elements in concrete walls and floors, slab on grade and in soil and the types of surveying equipment used to locate them.

- i) conduits
- ii) heating cables
- iii) pipes
- iv) reinforcement bar
- v) post-tensioned cables

7. Describe safety requirements when using x-ray surveying equipment in occupied buildings.

Practical Objectives:

N/A

Learning Outcomes:

- Demonstrate knowledge of direct current (DC) electricity and associated principles.
- Demonstrate knowledge of basic electric circuits and components.
- Demonstrate knowledge of ohm's law.
- Demonstrate knowledge of units of measure and symbols relating to DC electricity.
- Demonstrate knowledge of the instruments and procedures used to measure electricity.
- Demonstrate knowledge of calculating values of voltage, current, resistance and power in electric circuits.

IEL 2021 Red Seal Occupational Standard Reference:

N/A

Suggested Hours:

30 Hours

Theoretical Objectives:

1. Define terminology associated with DC electricity.
2. Identify hazards and describe safe work practices pertaining to DC electricity.
3. Explain atomic structure of matter and electron theory.
 - i) conductors
 - ii) semi-conductors
 - iii) insulators
4. Identify the forms of energy that produce electricity and describe their associated principles.
 - i) chemical action
 - ii) piezoelectric effect
 - iii) mechanical/magnetism
 - iv) heat
 - v) light and solar
 - vi) friction
5. Describe basic electric circuits.
 - i) electron path (conductors)
 - ii) load
 - iii) source

- iv) control

6. Identify basic components found in DC electric circuits and describe their purpose and operation.
7. Identify units of measure and symbols pertaining to DC electricity.
8. Explain Ohm's Law.
9. Identify basic electrical properties and describe their relationship.
 - i) voltage
 - ii) current
 - iii) resistance
 - iv) power
10. Identify instruments used for measuring electricity and describe their applications and procedures for use.
11. Perform calculations to determine the values of voltage, current, resistance and power in simple electric circuits.

Practical Objectives:

1. Use instruments to troubleshoot DC components.
 - i) closed circuit
 - ii) open circuit

Learning Outcomes:

- Demonstrate knowledge of series, parallel and complex DC circuits, their characteristics and operation.
- Demonstrate knowledge of Kirchhoff's law.
- Demonstrate knowledge of calculations for DC circuit values.
- Demonstrate knowledge of procedures to troubleshoot DC circuits.

IEL 2021 Red Seal Occupational Standard Reference:

N/A

Suggested Hours:

30 Hours

Theoretical Objectives:

1. Define terminology associated with DC circuits.
2. Explain the characteristics and operation of series DC circuits.
3. Explain the characteristics and operation of parallel DC circuits.
4. Identify types of complex DC circuits and describe their characteristics and operation.
 - i) series-parallel
 - ii) parallel-series
5. Explain Kirchoff's Laws.
 - i) current
 - ii) voltage
6. Perform calculations to determine series, parallel and complex DC circuit related values.
7. Describe the procedures used to troubleshoot series, parallel and complex DC circuits.

Practical Objectives:

1. Use instruments to troubleshoot series, parallel and complex DC circuits.

Learning Outcomes:

- Demonstrate knowledge of single-phase electricity, its characteristics, and associated principles.
- Demonstrate knowledge of AC components and their characteristics.
- Demonstrate knowledge of calculations for single-phase circuit values.

IEL 2021 Red Seal Occupational Standard Reference:

N/A

Suggested Hours:

18 Hours

Theoretical Objectives:

1. Define terminology associated with single-phase electricity.
2. Identify hazards and describe safe work practices pertaining to single-phase electricity.
3. Identify units of measure and symbols pertaining to single-phase electricity.
4. Explain the principles of magnetism.
5. Explain the principles of electromagnetism.
6. Explain the principles of electromagnetic induction.
7. Identify types of electromagnetic induction and describe their characteristics and applications.
 - i) self-induction
 - ii) mutual induction
8. Explain alternating current (AC).
 - i) sine wave values and characteristics
 - instantaneous
 - peak
 - peak to peak
 - RMS
 - average (DC level)

9. Identify types of components found in AC circuits and describe their purpose and operation.
 - i) resistors
 - ii) inductors
 - iii) capacitors
10. Perform calculations pertaining to single-phase theory.

Practical Objectives:

N/A

Learning Outcomes:

- Demonstrate knowledge of series and parallel AC circuits and components, their characteristics and operation.
- Demonstrate knowledge of AC circuit calculations for series, parallel and three-wire configurations.
- Demonstrate knowledge of procedures to troubleshoot AC circuits.

IEL 2021 Red Seal Occupational Standard Reference:

N/A

Suggested Hours:

30 Hours

Theoretical Objectives:

1. Define terminology associated with series and parallel AC circuits.
2. Explain the characteristics and operation of series AC circuits.
3. Explain the characteristics and operation of parallel AC circuits.
4. Explain Kirchoff's Laws.
 - i) current
 - ii) voltage
5. Identify types of components found in AC circuits and describe their purpose and operation.
 - i) resistors
 - ii) inductors
 - iii) capacitors
6. Perform calculations to determine series and parallel AC circuit related values.
 - i) resistance in series/parallel
 - ii) inductance in series/parallel
 - iii) capacitance in series/parallel
7. Explain single-phase three-wire systems and describe their characteristics, purpose, and operation.

8. Perform single-phase three-wire system calculations.
 - i) Edison three-wire
 - ii) open neutral circuit values
9. Describe the procedures used to troubleshoot series and parallel AC circuits.

Practical Objectives:

1. Use electrical instruments to troubleshoot series and parallel AC circuits.

ELE-165

Introduction to the Canadian Electrical Code

Learning Outcomes:

- Demonstrate knowledge of the layout of the Canadian Electrical Code (CEC).
- Demonstrate knowledge of procedures to locate and interpret information in the Canadian Electrical Code (CEC).

IEL 2021 Red Seal Occupational Standard Reference:

N/A

Suggested Hours:

6 Hours

Theoretical Objectives:

1. Define terminology associated with the CEC.
2. Explain the layout of the CEC.
 - i) sections
 - ii) appendices
 - iii) tables
 - iv) indexes
3. Identify methods to locate information in the CEC and describe their associated procedures.
 - i) by keyword in index
 - ii) by subject area

Practical Objectives:

1. Locate and interpret information in the CEC.

Learning Outcomes:

- Demonstrate knowledge of grounding and bonding methods and equipment.
- Demonstrate knowledge of procedures to install grounding systems.
- Demonstrate knowledge of procedures to install bonding systems.

IEL 2021 Red Seal Occupational Standard Reference:

11.01 Installs grounding systems.
11.03 Installs bonding systems.

Suggested Hours:

6 Hours

Theoretical Objectives:

1. Define terminology associated with grounding and bonding.
2. Identify hazards and describe safe work practices pertaining to grounding and bonding.
3. Interpret codes, regulations and standards pertaining to grounding and bonding.
4. Interpret information pertaining to grounding and bonding found on drawings and specifications.
5. Identify tools and equipment used to install grounding and bonding systems and describe their applications and procedures for use.
6. Identify grounding methods.
7. Identify bonding methods.
8. Identify grounding conductors, equipment and components and describe their characteristics and applications.
9. Identify bonding conductors, equipment and components and describe their characteristics and applications.
10. Identify considerations and requirements for selecting grounding conductors, methods, equipment and components.

11. Identify considerations and requirements for selecting bonding conductors, methods, equipment and components.
12. Explain purpose and differences between grounding and bonding and identify situations where interconnection of bonding is required.
13. Describe the procedures used to install grounding systems.
14. Describe the procedures used to calculate grounding conductor size.
15. Describe the procedures used to install bonding systems.
16. Describe the procedures used to calculate bonding conductor size.

Practical Objectives:

N/A

Learning Outcomes:

- Demonstrate knowledge of single-phase services and applications.
- Demonstrate knowledge of procedures to install single-phase services.
- Demonstrate knowledge of load calculations for single-phase service.
- Demonstrate knowledge of procedures to service and maintain single-phase services.
- Demonstrate knowledge of procedures to commission, start up, shut down and decommission single-phase services.

IEL 2021 Red Seal Occupational Standard Reference:

- 5.01 Commissions systems.
- 5.02 Performs shutdown and startup procedures.
- 5.03 Decommissions systems.
- 7.01 Installs single-phase utility and non-utility supply services and metering equipment
- 7.02 Maintains single-phase utility and non-utility supply services and metering equipment.
- 8.01 Installs overcurrent protection devices.
- 8.02 Maintains overcurrent protection devices.
- 8.03 Installs ground fault, arc fault and surge protection devices.
- 8.04 Maintains ground fault, arc fault and surge protection devices.

Suggested Hours:

18 Hours

Theoretical Objectives:

1. Define terminology associated with single-phase services.
2. Identify hazards and describe safe work practices pertaining to single-phase services.
3. Interpret codes, regulations and standards pertaining to single-phase services.
4. Interpret information pertaining to single-phase services found on drawings and specifications.
5. Identify types of single-phase services and describe their characteristics and applications.
 - i) temporary service
 - ii) overhead
 - iii) underground
 - iv) single metering

- v) multiple metering

6. Identify service components, service conductors and fasteners and describe their purpose and applications.
7. Identify considerations and requirements for selecting the type of single-phase services, service components and service conductors.
8. Identify sources of information and documentation required for the installation of single-phase services.
 - i) drawings
 - ii) disposal documents
 - iii) work orders
 - iv) permits
 - v) supply authority documentation
 - vi) terminal identification
9. Identify types of tools and equipment used to install and maintain single-phase services and describe their applications and procedures for use.
10. Describe the procedures used to install single-phase services, service components and service conductors.
11. Describe the procedures used to connect service conductors.
12. Describe the procedures used to ground and bond single-phase services.
13. Describe the procedures used to calculate load for single-phase services.
14. Describe the procedures used to service single-phase services and their components.
15. Describe the procedures used to maintain single-phase services and their components.
16. Describe the procedures used to commission, start up, shut down and decommission single-phase services.
17. Identify types of protection devices used with single-phase services and describe their applications.

Practical Objectives:

1. Install a single-phase service.

Learning Outcomes:

- Demonstrate knowledge of single-phase/low-voltage power distribution equipment, their applications and operation.
- Demonstrate knowledge of procedures to install single-phase/low-voltage power distribution equipment.
- Demonstrate knowledge of calculations for single-phase power distribution equipment ratings.
- Demonstrate knowledge of procedures to service and maintain single-phase/low-voltage power distribution equipment.
- Demonstrate knowledge of procedures to commission, start up, shut down and decommission single-phase/low-voltage power distribution equipment.

IEL 2021 Red Seal Occupational Standard Reference:

- 5.01 Commissions systems.
- 5.02 Performs shutdown and startup procedures.
- 5.03 Decommissions systems.
- 8.05 Installs under- and over-voltage protection devices.
- 8.06 Maintains under- and over-voltage protection devices.
- 9.01 Installs low-voltage distribution equipment.
- 9.02 Maintains low-voltage distribution equipment.

Suggested Hours:

18 Hours

Theoretical Objectives:

1. Define terminology associated with single-phase power distribution equipment.
2. Identify hazards and describe work practices pertaining to single-phase power distribution equipment.
3. Interpret codes, regulations and standards pertaining to single-phase power distribution equipment.
4. Interpret information pertaining to single-phase power distribution equipment found on drawings and specifications.
5. Identify types of single-phase power distribution equipment and describe their characteristics, applications and operation.

6. Identify tools and equipment used to install, service and maintain single-phase power distribution equipment and describe their applications and procedures for use.
7. Identify considerations and requirements for selecting single-phase power distribution equipment and enclosures.
 - i) load
 - ii) voltage ratings
 - iii) required circuit capacity/amperage ratings
8. Describe the procedures used to install single-phase power distribution equipment.
9. Describe the procedures used to connect single-phase power distribution equipment.
10. Describe the procedures for transporting and moving single-phase electrical equipment.
11. Perform calculations to determine single-phase distribution equipment ratings.
 - i) panels/sub-panels
 - ii) disconnects
 - iii) overcurrent devices
12. Describe the procedures used to service single-phase power distribution equipment and their components.
13. Describe the procedures used to maintain single-phase power distribution equipment and their components.
14. Describe the procedures to commission, start up, shut down, and decommission single-phase power distribution equipment.
15. Identify types of protection devices used with single-phase power distribution equipment and describe their applications.

Practical Objectives:

N/A

Learning Outcomes:

- Demonstrate knowledge of conductors and cables, their components, applications and operations.
- Demonstrate knowledge of procedures to install conductors and cables.
- Demonstrate knowledge of the procedures to service and maintain cables.

IEL 2021 Red Seal Occupational Standard Reference:

16.01 Installs conductors and cables.
16.02 Maintains conductors and cables.

Suggested Hours:

18 Hours

Theoretical Objectives:

1. Define terminology associated with conductors and cables.
2. Identify hazards and describe safe work practices pertaining to conductors and cables.
3. Interpret codes, regulations and standards pertaining to conductors and cables.
4. Interpret information pertaining to conductors and cables found on drawings and specifications.
5. Identify types of conductors and cables and describe their characteristics and applications.
6. Identify conductor and cable components and describe their characteristics and applications.
 - i) mechanical fittings
 - ii) compression fittings
 - iii) straps
 - iv) connectors
 - v) hangers
 - vi) heat shrink
 - vii) anti-oxidant compound
7. Identify tools and equipment used to install, service and maintain conductors and cables and describe their applications and procedures for use.

8. Identify considerations and requirements for removal of conductors, cables, and their components.
9. Identify considerations and requirements for selecting conductors, cables, and their components.
10. Identify considerations and requirements for installing conductors, cables, and their components and accessories.
 - i) conduit fill
 - ii) methods of pulling conductors/cables
 - iii) de-rating factors
 - iv) routing
 - v) location
11. Describe the procedures used to remove conductors, cables, and their components.
12. Describe the procedures used to prepare and install conductors, cables, and their components.
13. Describe the procedures used to splice conductors and cables.
14. Describe the procedures used to terminate conductors and cables.
15. Describe the procedures used to service cables.
16. Identify considerations when maintaining cables.
 - i) changes from original installation
 - ii) heat points
 - iii) physical damage
 - iv) information from end user
17. Describe the procedures used to maintain cables.

Practical Objectives:

1. Install, splice and terminate conductors and cables.

ELE-190 **Conduit, Tubing and Fittings**

Learning Outcomes:

- Demonstrate knowledge of conduit, tubing and fittings, their components and applications.
- Demonstrate knowledge of procedures to install conduit, tubing and fittings.
- Demonstrate knowledge of procedures to maintain conduit, tubing and fittings.

IEL 2021 Red Seal Occupational Standard Reference:

- 16.03 Installs conduit, tubing and fittings.
- 16.06 Maintains conduit, tubing, fittings, raceways, boxes and enclosures.

Suggested Hours:

12 Hours

Theoretical Objectives:

1. Define terminology associated with conduit, tubing and fittings.
2. Identify hazards and describe safe work practices pertaining to conduit, tubing and fittings.
 - i) environmental conditions
 - ii) situations and inside/outside conditions that can cause damage on specific types of conduit, tubing and fittings
3. Interpret codes, regulations and standards pertaining to conduit, tubing and fittings.
4. Interpret information pertaining to conduit, tubing and fittings found on drawings and specifications.
5. Identify types of conduit, tubing and fittings and describe their characteristics, applications and limitations.
 - i) electrical metallic tubing (EMT)
 - ii) rigid PVC
 - iii) flexible conduit
 - iv) rigid metal
 - v) electrical non-metallic tubing (ENT)
 - vi) direct burial 2 (DB2)
6. Perform calculations to determine conduit size.

7. Identify conduit, tubing and fitting components and describe their characteristics and applications.
8. Identify considerations and requirements for selecting conduit, tubing and fittings, and their components.
 - i) calculate conduit expansion
9. Identify tools and equipment used to install and maintain conductors and cables and describe their applications and procedures for use.
10. Describe the procedures used to remove conduit and tubing.
11. Describe the procedures used to cut, thread (if applicable) and bend conduit and tubing.
12. Describe the procedures used to install and support conduit and tubing systems and components.
13. Identify considerations when maintaining conduit, tubing and fittings.
 - i) corrosion
 - ii) condition of supports
 - iii) tightness and presence of mounting screws
 - iv) tightness of locknuts
 - v) physical damage
 - vi) cleanliness
14. Describe the procedures to repair or replace conduit, tubing and fittings.
15. Describe the procedures used to tighten or adjust conduit, tubing and fittings.
16. Describe the procedures used to clean conduit, tubing and fittings.

Practical Objectives:

1. Cut and bend conduit and tubing.

Learning Outcomes:

- Demonstrate knowledge of raceways, their components and applications.
- Demonstrate knowledge of procedures to install raceways.
- Demonstrate knowledge of procedures to service and maintain raceways.

IEL 2021 Red Seal Occupational Standard Reference:

16.04 Installs raceways.
16.06 Maintains conduit, tubing, fittings, raceways, boxes and enclosures.

Suggested Hours:

6 Hours

Theoretical Objectives:

1. Define terminology associated with raceways.
2. Identify hazards and describe safe work practices pertaining to raceways.
3. Interpret codes, regulations and standards pertaining to raceways.
4. Interpret information pertaining to raceways found on drawings and specifications.
5. Identify types of raceways and describe their characteristics and applications.
 - i) cable tray
 - ii) underfloor raceways
 - iii) busways
 - iv) cellular raceways
 - v) surface raceways
 - vi) wire trays/wireways
 - vii) bus ducts
 - viii) cable bus
6. Identify raceway components and describe their characteristics and applications.
 - i) fittings (couplings and connectors)
 - ii) supports
 - iii) expansion joints
 - iv) floor boxes
 - v) junction boxes

7. Identify tools and equipment used to install and maintain raceways and describe their applications and procedures for use.
8. Identify considerations and requirements for removal of raceways and their components.
9. Identify considerations and requirements for selecting raceways and their components.
10. Describe the procedures used to remove raceways and their components.
11. Describe the procedures used to install and support raceways and their components.
12. Identify considerations when servicing and maintaining raceways.
 - i) changes from original installation
 - ii) heat points
 - iii) physical damage
 - iv) information from end user
13. Describe the procedures used to service and maintain raceways.

Practical Objectives:

N/A

Learning Outcomes:

- Demonstrate knowledge of boxes and enclosures and their applications.
- Demonstrate knowledge of procedures to install boxes and enclosures.
- Demonstrate knowledge of procedures to service and maintain boxes and enclosures.

IEL 2021 Red Seal Occupational Standard Reference:

16.05 Installs boxes and enclosures.

16.06 Maintains conduit, tubing, fittings, raceways, boxes and enclosures.

Suggested Hours:

12 Hours

Theoretical Objectives:

1. Define terminology associated with boxes and enclosures.
2. Identify hazards and describe safe work practices pertaining to boxes and enclosures.
3. Interpret codes, regulations and standards pertaining to boxes and enclosures.
4. Interpret information pertaining to boxes and enclosures found on drawings and specifications.
5. Identify types of boxes and enclosures and describe their characteristics and applications.
 - i) device
 - ii) utility
 - iii) FS/FD
 - iv) masonry
 - v) square
 - vi) octagon
 - vii) pancake
 - viii) power and communication
 - ix) 347 V
 - x) pull
 - xi) splitter

6. Identify tools and equipment used to install, service and maintain support boxes and enclosures and describe their applications and procedures for use.
7. Identify considerations and requirements for removal of boxes and enclosures.
8. Identify considerations and requirements for selecting boxes and enclosures.
 - i) volume
 - ii) environment
 - iii) accessibility
 - iv) size of raceway or cable entering the box or enclosure
 - v) CSA/NEMA classification
9. Describe the procedures used to remove boxes and enclosures.
10. Describe the procedures used to install and support boxes and enclosures.
11. Identify considerations when servicing and maintaining boxes and enclosures.
12. Describe the procedures used to service and maintain boxes and enclosures.

Practical Objectives:

N/A

Learning Outcomes:

- Demonstrate knowledge of wiring devices, their applications and operation.
- Demonstrate knowledge of procedures to install wiring devices.
- Demonstrate knowledge of procedures to service and maintain wiring device components.

IEL 2021 Red Seal Occupational Standard Reference:

17.03 Installs wiring devices.
17.04 Maintains wiring devices.

Suggested Hours:

6 Hours

Theoretical Objectives:

1. Define terminology associated with wiring devices.
2. Identify hazards and describe safe work practices pertaining to wiring devices.
3. Interpret codes, regulations and standards pertaining to wiring devices.
4. Interpret information pertaining to wiring devices found on drawings and specifications.
5. Identify types of wiring devices and describe their applications and operation.
 - i) lampholders
 - ii) indicator lamps
 - iii) switches
 - iv) sensors
 - v) safety switches
 - vi) power outlets
 - vii) receptacles
6. Identify tools and equipment used to install, service and maintain wiring devices and components and describe their applications and procedures for use.
7. Identify considerations and requirements for removal of wiring devices.
8. Identify considerations and requirements for selection of wiring devices.
9. Describe the procedures used to remove wiring devices.

10. Describe the procedures used to install wiring devices.
11. Describe the procedures used to service and maintain wiring device components.

Practical Objectives:

N/A

Learning Outcomes:

- Demonstrate knowledge of luminaires and lamps, their applications and operation.
- Demonstrate knowledge of procedures used to install luminaires and lamps.
- Demonstrate knowledge of lighting control components, their applications and operation.
- Demonstrate knowledge of procedures to install lighting control components.
- Demonstrate knowledge of procedures to service and maintain luminaires, lamps and lighting control components.

IEL 2021 Red Seal Occupational Standard Reference:

17.01 Installs luminaires.
17.02 Maintains luminaires.

Suggested Hours :

24 Hours

Theoretical Objectives:

1. Define terminology associated with luminaires and lighting controls.
2. Identify hazards and describe safe work practices pertaining to luminaires and lighting controls.
3. Interpret codes, regulations and standards pertaining to lighting systems.
 - i) luminaires and lamps
 - ii) lighting controls
4. Interpret information pertaining to lighting systems found on drawings and specifications.
 - i) luminaires and lamps
 - ii) lighting controls
5. Identify types of luminaires and lamps and describe their applications and operations.
 - i) luminaires
 - pole mounted
 - wall mounted
 - ceiling mounted
 - pendant
 - surface

- recessed
- ii) lamps
 - high intensity discharge (HID)
 - light emitting diode (LED)
 - incandescent
 - fluorescent
 - ultraviolet
 - infrared
 - low pressure sodium
 - quartz
 - induction

6. Identify luminaire and lamp components and describe their characteristics and applications.
7. Identify considerations and requirements for removal of luminaires, lamps and their components.
8. Identify considerations and requirements for selecting luminaires, lamps and their components.
9. Describe the procedures used to remove luminaires, lamps and their components.
10. Describe the procedures used to install and support luminaires, lamps and their components.
11. Describe the procedures used to perform tests related to luminaires and lamps.
12. Identify types of lighting control components and describe their characteristics and applications.
 - i) extra low-voltage switching
 - ii) line voltage switching
 - iii) time clocks
 - iv) ambient light sensor
 - v) programmable lighting controller
 - vi) photo cells and motion sensors
 - vii) relays
 - viii) occupancy sensors
13. Identify tools and equipment used to install, service and maintain luminaires and lamps and describe their applications and procedures for use.
14. Identify considerations and requirements for removal and disposal of lighting control components.

15. Identify considerations and requirements for selecting lighting control components.
16. Describe the procedures used to remove lighting control components.
17. Describe the procedures used to install lighting control components.
18. Describe the procedures used to connect lighting control components.
19. Describe the procedures used to test lighting control components.
20. Describe the procedures used to troubleshoot luminaires, lamps and lighting control components.
21. Describe the procedures used to repair/replace luminaires, lamps and lighting control components.
22. Describe the procedures used to install modular wiring systems in luminaires, lamps and lighting controls.
 - i) quick connect/disconnect
 - ii) smart lighting systems
23. Identify electronic components and describe their application as it pertains to luminaires and lightning controls.

Practical Objectives:

1. Install a luminaire and lighting controls with operation from multiple locations.

Learning Outcomes:

- Demonstrate knowledge of communication systems and cabling

IEL 2021 Red Seal Occupational Standard Reference:

27.01 Installs communication systems.

Suggested Hours:

6 Hours

Theoretical Objectives:

1. Define terminology associated with communication systems.
2. Interpret codes, regulations and standards pertaining to communication systems.
 - i) minimum distances and separation requirements
3. Interpret information pertaining to communication systems found on drawings and specifications.
4. Identify types of communication systems and describe their basic characteristics, applications, and operation.
 - i) voice/data/video (VDV)
 - ii) closed-circuit television (CCTV)
 - iii) public address
 - iv) intercom
 - v) nurse call
5. Identify basic communication system components and describe their characteristics and applications.
 - i) cabling
 - ii) termination levels
 - iii) outlet jacks
 - iv) face plates
 - v) cable supports
 - vi) connectors
 - vii) splitters
 - viii) terminators

6. Identify considerations and requirements for selecting basic communication systems and their components.
7. Describe the procedures used to install communication cabling.
8. Explain the purpose and benefits of shielded communication cable.

Practical Objectives:

N/A

Level 2

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Learning Outcomes:

- Demonstrate knowledge of procedures to plan and organize job tasks.

IEL 2021 Red Seal Occupational Standard Reference:

3.04 Plans project tasks and procedures.

Suggested Hours:

6 Hours

Theoretical Objectives:

1. Identify sources of information relevant to planning job tasks and procedures.
 - i) drawings
 - ii) specifications
 - iii) client requirements
2. Describe considerations to plan and organize job tasks and procedures.
 - i) available space
 - ii) schedule/sequence
 - iii) permits
 - iv) hazard assessment
 - assessment form sample
 - v) personnel
 - vi) tools and equipment
 - vii) materials and supplies
 - viii) storage location/laydown area
 - ix) accessible installation awareness
 - x) sustainability and environmentally friendly techniques
3. Describe the function of project schedule charts.

Practical Objectives:

N/A

ELE-225

Voltage Drop and Power Loss

Learning Outcomes:

- Demonstrate knowledge of conductor materials and characteristics.
- Demonstrate knowledge of voltage drop and power loss and its impact on a circuit.
- Demonstrate knowledge of calculations for voltage drop and power loss values.

IEL 2021 Red Seal Occupational Standard Reference:

N/A

Suggested Hours:

30 Hours

Theoretical Objectives:

1. Define terminology associated with voltage drop and power loss.
2. Interpret codes, regulations and standards pertaining to voltage drop and power loss.
3. Identify types of conductor materials and describe their characteristics and applications.
4. Identify the units of measure used to describe conductor size.
5. Explain conductor resistance and its effect on a circuit.
6. Describe the procedures used to determine conductor resistance.
7. Explain line voltage drop and its effect on a circuit.
8. Perform calculations to determine line voltage drop.
9. Explain power loss and its effect on a circuit.
10. Perform calculations to determine power loss.

Practical Objectives:

N/A

Learning Outcomes:

- Demonstrate knowledge of environmental conditions and installation procedures.
- Demonstrate knowledge of procedures to prepare worksite.
- Demonstrate knowledge of hazardous locations.
- Demonstrate knowledge of hazardous locations wiring methods.
- Demonstrate knowledge of procedures to service and maintain equipment and components in hazardous locations.

IEL 2021 Red Seal Occupational Standard Reference:

- 1.01 Maintains safe work environment.
- 1.04 Identifies environmental conditions.
- 3.02 Identifies hazardous installations.
- 3.05 Prepares specific location in facility.
- 16.01 Installs conductors and cables.
- 16.02 Maintains conductors and cables.
- 16.03 Installs conduit, tubing and fittings.
- 16.04 Installs raceways.
- 16.05 Installs boxes and enclosures.
- 16.06 Maintains conduit, tubing, fittings, raceways, boxes and enclosures.

Suggested Hours:

24 Hours

Theoretical Objectives:

1. Identify types of hazardous locations and describe safe work practices.
 - i) explosive gas
 - ii) explosive and combustible dust
 - iii) combustible fibers and flyings
2. Interpret codes, regulations and standards pertaining to electrical installations in hazardous locations.
3. Interpret information pertaining to electrical installations in hazardous locations found on drawings and specifications.
4. Identify types of environmental conditions and describe safe work procedures.
 - i) wet
 - ii) dusty

- iii) corrosive
- iv) hot
- v) cold

5. Identify equipment designed for installation and operation in areas according to environmental conditions.
6. Identify and describe wiring procedures and methods for areas according to environmental conditions.
7. Describe how hazardous locations are classified using the division system.
8. Identify types of potentially hazardous materials present and the procedures used to designate an area to be a hazardous location.
9. Identify equipment and fittings designed for installation and operation in hazardous locations.
 - i) conductors and cables
 - ii) conduit tubing and fittings
 - iii) raceways
 - iv) boxes and enclosures
 - v) lighting equipment and controls
 - vi) wiring devices
10. Identify and describe wiring methods for use in hazardous locations.
11. Describe the procedures used to install and connect electrical components, devices and equipment in hazardous locations.
12. Describe the procedures used to service electrical components, devices and equipment in hazardous locations.
13. Describe the procedures used to maintain electrical components, devices and equipment in hazardous locations.

Practical Objectives:

N/A

Learning Outcomes:

- Demonstrate knowledge of DC generating and conversion systems and components, their applications and operation.
- Demonstrate knowledge of procedures to install DC generating and conversion systems.
- Demonstrate knowledge of procedures to service and maintain DC generating and conversion systems.

IEL 2021 Red Seal Occupational Standard Reference:

- 11.01 Installs grounding systems.
- 11.03 Installs bonding systems.
- 12.03 Installs direct current (DC) generating and conversion systems.
- 12.04 Maintains DC generating and conversion systems.

Suggested Hours:

15 Hours

Theoretical Objectives:

1. Define terminology associated with DC generating and conversion systems.
2. Identify hazards and describe safe work practices pertaining to DC generating and conversion systems.
3. Interpret codes, regulations and standards pertaining to DC generating and conversion systems.
4. Interpret information pertaining to DC generating and conversion systems found on drawings and specifications.
5. Identify types of DC generating and conversion systems and explain their operating principles.
 - i) portable
 - ii) stationary
 - iii) transfer methods (manual or automatic)
6. Identify types of DC generators and describe their characteristics and applications.
 - i) series
 - ii) shunt
 - iii) compound

- iv) portable
- v) stationary

7. Identify DC generating and conversion system components and describe their characteristics and applications.
 - i) transfer switch
 - ii) prime mover
 - iii) cables
 - iv) conductors
 - v) overcurrent devices
 - vi) overload devices
 - vii) fuel monitoring and storage
 - viii) solid state rectifiers
 - ix) transformers
 - x) SCRs
 - xi) IGBTs
8. Identify considerations and requirements for selecting DC generating and conversion systems and their components.
9. Identify tools and equipment used to install, service and maintain DC generating and conversion systems and describe their applications and procedures for use.
10. Describe the procedures used to install DC generating and conversion systems and their components.
11. Describe the procedures used to connect DC generating and conversion systems and their components.
 - i) floating ground
12. Describe the procedures used to control the output voltage of DC generators.
13. Describe the procedures used to service DC generating and conversion systems and their components.
14. Describe the procedures used to maintain DC generating and conversion systems and their components.
15. Identify electronic components and describe their application as it pertains to DC generating systems.
16. Identify methods of grounding and bonding DC generating and conversion systems.

Practical Objectives:

N/A

Learning Outcomes:

- Demonstrate knowledge of series and parallel AC circuits and components, their characteristics and operation.
- Demonstrate knowledge of calculations for AC circuit-related values.

IEL 2021 Red Seal Occupational Standard Reference:

N/A

Suggested Hours:

27 Hours

Theoretical Objectives:

1. Define terminology associated with series and parallel AC circuits.
2. Explain the effects of electrical components found in series AC circuits.
 - i) resistance
 - ii) reactance
 - inductive
 - capacitive
 - iii) impedance
3. Explain the effects of electrical components found in parallel AC circuits.
 - i) resistance
 - ii) reactance
 - inductive
 - capacitive
 - iii) impedance
4. Perform calculations to determine series and parallel AC circuit-related values.
 - i) inductive reactance
 - ii) capacitive reactance
 - iii) RL
 - iv) RC
 - v) RLC
 - vi) phase angle
 - vii) true power, apparent power, reactive power
 - viii) power factor
 - ix) impedance

Practical Objectives:

N/A

Learning Outcomes:

- Demonstrate knowledge of overcurrent protection devices, their applications and operation.
- Demonstrate knowledge of procedures to install overcurrent protection devices.
- Demonstrate knowledge of ground fault, arc fault and surge protection devices, their applications and operation.
- Demonstrate knowledge of procedures to install ground fault, arc fault and surge protection devices.
- Demonstrate knowledge of under and over-voltage protection devices, their applications and operation.
- Demonstrate knowledge of procedures to install under and over-voltage protection devices.
- Demonstrate knowledge of procedures to service and maintain protection devices.

IEL 2021 Red Seal Occupational Standard Reference:

- 8.01 Installs overcurrent protection devices.
- 8.02 Maintains overcurrent protection devices.
- 8.03 Installs ground fault, arc fault and surge protection devices.
- 8.04 Maintains ground fault, arc fault and surge protection devices.
- 8.05 Installs under- and over-voltage protection devices.
- 8.06 Maintains under- and over-voltage protection devices.
- 11.06 Maintains ground-fault protection and detection systems

Suggested Hours:

24 Hours

Theoretical Objectives:

1. Define terminology associated with protection devices.
2. Identify hazards and describe safe work practices pertaining to protection devices.
3. Interpret codes, regulations and standards pertaining to protection devices.
 - i) overcurrent devices
 - ii) ground fault devices
 - iii) arc fault devices
 - iv) surge protection devices
 - v) under and over-voltage devices

4. Interpret information pertaining to protection devices found on drawings and specifications.
 - i) overcurrent devices
 - ii) ground fault devices
 - iii) arc fault devices
 - iv) surge protection devices
 - v) under and over-voltage devices
5. Explain the purpose of updating required documentation.
 - i) as-builts
 - ii) schematics
 - iii) panel schedules
 - iv) log sheets
 - v) drive drawings
 - vi) shop drawings
6. Identify tools and equipment used to install, service and maintain protection devices and describe their applications and procedures for use.
7. Explain the purpose and operation of overcurrent protection devices.
8. Explain the effects of short-circuit current and describe the associated damage to the circuit.
9. Identify types of overcurrent protection devices and describe their characteristics and applications.
 - i) fuses
 - ii) breakers
 - iii) relay protection
10. Identify considerations and requirements for selecting overcurrent protection devices.
11. Explain the purpose of coordination studies.
12. Describe the procedures used to install overcurrent protection devices.
13. Describe the procedures used to adjust trip settings.
14. Explain the purpose and operation of ground fault, arc fault and surge protection devices.
15. Identify types of ground fault, arc fault and surge protection devices.
 - i) ground fault
 - GFCI receptacle

- breaker
 - ii) arc fault
 - AFCI receptable
 - breaker
 - iii) surge protection
 - MOV
 - zener diodes
 - thyristors
 - surge suppressors
- 16. Identify considerations and requirements for selecting ground fault, arc fault and surge protection devices.
- 17. Describe the procedures used to install ground fault, arc fault, and surge protection devices.
- 18. Explain the purpose and operation of under and over voltage protection devices.
- 19. Identify types of under and over-voltage protection devices.
- 20. Identify considerations and requirements for selecting under and over-voltage protection devices.
- 21. Describe the procedures used to install under and over-voltage protection devices.
- 22. Describe the procedures used to service protection devices.
- 23. Describe the procedures used to maintain protection devices.
- 24. Identify electronic components and describe their application as it pertains to protection devices.

Practical Objectives:

N/A

Learning Outcomes:

- Demonstrate knowledge of extra-low voltage transformers and components, their applications and operation.
- Demonstrate knowledge of procedures to install extra-low voltage transformers.
- Demonstrate knowledge of procedures to service and maintain extra-low voltage transformers.

IEL 2021 Red Seal Occupational Standard Reference:

- 15.01 Installs extra-low voltage transformers.
- 15.02 Maintains extra-low voltage transformers.

Suggested Hours:

6 Hours

Theoretical Objectives:

1. Define terminology associated with extra-low voltage transformers.
2. Identify hazards and describe safe work practices pertaining to extra-low voltage transformers.
3. Interpret information contained on extra-low voltage transformer nameplates.
4. Explain the operating principles of extra-low voltage transformers.
5. Identify types of extra-low voltage transformers and describe their characteristics and applications.
 - i) Class 1 circuits (per CEC)
 - ii) Class 2 circuits (per CEC)
6. Identify extra-low voltage transformer components and describe their characteristics and applications.
 - i) casing
 - ii) core
 - iii) primary windings
 - iv) secondary windings
7. Identify considerations and requirements for selecting extra-low voltage transformers.

8. Identify tools and equipment used to install, service and maintain extra-low voltage transformers and describe their applications and procedures for use.
9. Describe the procedures used to install extra-low voltage transformers and their components.
10. Describe the procedures used to service extra-low voltage transformers and their components.
11. Describe the procedures used to maintain extra-low voltage transformers and their components.

Practical Objectives:

N/A

Learning Outcomes:

- Demonstrate knowledge of low-voltage single-phase transformers and components, their applications and operation.
- Demonstrate knowledge of procedures to install low-voltage single-phase transformers.
- Demonstrate knowledge of procedures to service and maintain low-voltage single-phase transformers.

IEL 2021 Red Seal Occupational Standard Reference:

15.03 Installs low voltage single-phase transformers.
15.04 Maintains low voltage single-phase transformers.

Suggested Hours:

12 Hours

Theoretical Objectives:

1. Define terminology associated with low-voltage single-phase transforms.
2. Identify hazards and describe safe work practices pertaining to low-voltage single-phase transformers.
3. Interpret codes, regulations and standards pertaining to low-voltage single-phase transformers.
4. Interpret information contained on low-voltage single-phase transformer nameplates.
5. Explain the operating principles of low-voltage single-phase transformers.
6. Explain transformer polarity and terminal markings.
7. Identify types of low-voltage single-phase transformers and describe their characteristics and applications.
 - i) dry-type
 - ii) dielectric liquid-filled
 - iii) isolation
 - iv) step-down, step-up
 - v) auto
 - vi) instrument transformer

8. Identify low-voltage single-phase transformer components and describe their characteristics and applications.
 - i) ventilation fans
 - ii) casings and enclosures
 - iii) core
 - iv) primary and secondary windings
 - v) bushings
 - vi) on-line and off-line (on-load and off-load) tap changers
 - vii) insulating oil/dielectric liquid
 - viii) oil pumps
9. Identify considerations and requirements for selecting low-voltage single-phase transformers.
10. Identify tools and equipment used to install, service and maintain low-voltage single-phase transformers and describe their applications and procedures for use.
11. Describe the procedures used to install low-voltage single-phase transformers.
12. Describe the procedures used to install low-voltage single-phase transformers in parallel.
13. Describe the procedures used to ground low-voltage transformers.
14. Describe the procedures used to service low-voltage single-phase transformers and their components.
15. Describe the procedures used to maintain low-voltage single-phase transformers and their components.

Practical Objectives:

N/A

Learning Outcomes:

- Demonstrate knowledge of renewable energy generating systems, their applications and basic operation.
- Demonstrate knowledge of procedures to connect renewable energy generating systems and control system components.

IEL 2021 Red Seal Occupational Standard Reference:

13.01 Installs renewable energy generating and energy storage systems.

Suggested Hours:

9 Hours

Theoretical Objectives:

1. Define terminology associated with renewable energy generating systems.
2. Identify hazards and describe safe work practices pertaining to renewable energy generating systems.
3. Identify standards pertaining to renewable energy.
 - i) Canadian Net-Zero Emissions Accountability Act (CNZEEA)
 - ii) Leadership in Energy and Environmental Design (LEED)
4. Interpret codes, regulations and standards pertaining to renewable energy generating systems.
 - i) Local supply authority having jurisdiction bulletins
5. Identify types of renewable energy generating systems and describe their characteristics, applications and operation.
 - i) wind turbines
 - ii) photovoltaic systems
6. Identify renewable energy generating system components and describe their purpose and operation.
7. Identify tools and equipment used to connect renewable energy generating systems and describe their applications and procedures for use.

8. Describe the procedures used to ground renewable energy generating systems and their components.
9. Describe the procedures used to connect renewable energy generating systems and control system components.
10. Identify electronic components and describe their application as it pertains to renewable energy generating and storage systems.

Practical Objectives:

N/A

Learning Outcomes:

- Demonstrate knowledge of exit and emergency lighting systems, their applications and operation.
- Demonstrate knowledge of procedures to remove and/or install, exit and emergency lighting systems and their components.
- Demonstrate knowledge of procedures to service exit and emergency lighting systems.
- Demonstrate knowledge of procedures to maintain exit and emergency lighting systems.

IEL 2021 Red Seal Occupational Standard Reference:

20.01 Installs exit and emergency lighting systems.
20.02 Maintains exit and emergency lighting systems.

Suggested Hours:

12 Hours

Theoretical Objectives:

1. Define terminology associated with exit and emergency lighting systems.
2. Interpret codes, regulations and standards pertaining to exit and emergency lighting systems.
 - i) Canadian Electrical Code (CEC)
 - ii) National Building Code of Canada (NBC)
3. Interpret information pertaining to exit and emergency lighting systems found on drawings and specifications.
4. Identify types of exit and emergency lighting systems and describe their characteristics, applications and operation.
 - i) unit equipment
 - ii) central-powered
 - iii) remote lighting units
 - iv) automatic emergency power transfer control relays
5. Identify exit and emergency lighting system components and describe their characteristics and applications.

6. Identify considerations and requirements for removal and disposal of exit and emergency lighting systems and their components.
7. Identify considerations and requirements for selecting exit and emergency lighting systems and their components.
8. Identify tools and equipment used to install, service and maintain exit and emergency lighting systems and describe their applications and procedures for use.
9. Describe the procedures used to remove exit and emergency lighting systems and their components.
10. Describe the procedures used to install exit and emergency lighting systems and their components.
11. Describe the procedures used to test exit and emergency lighting systems and their components and complete the required documentation.
12. Describe the procedures used to diagnose exit and emergency lighting systems and their components.
13. Describe the procedures used to repair/replace exit and emergency lighting systems and their components.
14. Describe the procedures used to maintain exit and emergency lighting systems and their components.
15. Identify electronic components and describe their application as it pertains to exit and emergency lighting systems.

Practical Objectives:

N/A

Learning Outcomes:

- Demonstrate knowledge of heating, ventilation and air-conditioning (HVAC) systems, their applications and operation.
- Demonstrate knowledge of procedures to disconnect and connect HVAC systems and associated equipment.
- Demonstrate knowledge of procedures to service and maintain electrical components of HVAC systems and associated equipment.

IEL 2021 Red Seal Occupational Standard Reference:

18.01 Connects power to HVAC systems and associated equipment.
18.03 Maintains HVAC electrical components.

Suggested Hours:

15 Hours

Theoretical Objectives:

1. Define terminology associated with HVAC systems.
2. Identify hazards and describe safe work practices pertaining to HVAC systems.
3. Interpret codes, regulations and standards pertaining to HVAC systems.
4. Interpret information pertaining to HVAC systems found on drawings and specifications.
5. Explain the principles of heat transfer.
 - i) radiation
 - ii) conduction
 - iii) convection
6. Identify types of HVAC systems and describe their characteristics and applications.
 - i) heat pumps
 - ii) boilers
 - iii) furnace
 - iv) compressor unit
 - v) fan motor
 - vi) chiller systems
 - vii) cooling tower heater

7. Identify considerations and requirements for disconnecting electrical components of HVAC systems and associated equipment.
8. Identify considerations and requirements for connecting electrical components of HVAC systems and associated equipment.
9. Identify tools and equipment used to connect, service and maintain electrical components of HVAC systems and describe their applications and procedures for use.
10. Describe the procedures used to connect electrical components of HVAC systems and associated equipment.
11. Describe the procedures used to disconnect electrical components of HVAC systems and associated equipment.
12. Describe the procedures used to diagnose electrical components of HVAC systems and associated equipment.
13. Describe the procedures used to repair electrical components of HVAC systems and associated equipment.
14. Describe the procedures used to maintain electrical components of HVAC systems and associated equipment.
15. Identify electronic components and describe their application as it pertains to HVAC systems.

Practical Objectives:

N/A

Learning Outcomes:

- Demonstrate knowledge of heating, ventilation and air-conditioning (HVAC) control components, their applications and operation.
- Demonstrate knowledge of procedures to install HVAC control components.
- Demonstrate knowledge of procedures to service and maintain HVAC control components.

IEL 2021 Red Seal Occupational Standard Reference:

18.02 Installs HVAC controls.
18.03 Maintains HVAC electrical components.

Suggested Hours:

12 Hours

Theoretical Objectives:

1. Define terminology associated with HVAC controls.
2. Identify hazards and describe safe work practices pertaining to HVAC controls.
3. Interpret codes, regulations and standards pertaining to HVAC control components.
4. Interpret information pertaining to HVAC control components found on drawings and specifications.
5. Identify types of HVAC control components and describe their characteristics and applications.
 - i) thermostats
 - ii) switches (pressure, temperature, flow, level)
 - iii) time clocks
 - iv) relays
 - v) sensors
 - vi) actuators
 - vii) electrical interlocks
 - viii) multiple function controllers
 - ix) variable frequency drives (VFDs)
6. Identify tools and equipment used to install, service and maintain HVAC controls and describe their applications and procedures for use.

7. Identify considerations and requirements for removal of HVAC control components.
8. Identify considerations and requirements for selecting HVAC control components.
9. Describe the procedures used to remove HVAC control components.
10. Describe the procedures used to install HVAC control components.
11. Describe the procedures used to connect HVAC control components.
12. Describe the procedures used to test HVAC control components.
13. Describe the procedures used to diagnose HVAC controls and their components.
14. Describe the procedures used to repair HVAC controls and their components.
15. Describe the procedures used to maintain HVAC controls and their components.
16. Identify electronic components and describe their application as it pertains to HVAC system controls.

Practical Objectives:

N/A

Learning Outcomes:

- Demonstrate knowledge of electric heating systems, their applications and operation.
- Demonstrate knowledge of procedures to remove and/or install electric heating systems.
- Demonstrate knowledge of procedures to service electric heating systems.
- Demonstrate knowledge of procedures to maintain electric heating systems.

IEL 2021 Red Seal Occupational Standard Reference:

- 19.01 Installs electric heating systems and controls.
- 19.02 Maintains electric heating systems and controls.

Suggested Hours:

12 Hours

Theoretical Objectives:

1. Define terminology associated with electric heating systems.
2. Identify hazards and describe safe work practices pertaining to electric heating systems.
3. Interpret codes, regulations and standards pertaining to electric heating systems.
4. Interpret information pertaining to electric heating systems found on drawings and specifications.
5. Identify types of electric heating systems and describe their applications and operation.
 - i) electric forced air furnace
 - ii) electric boilers
 - iii) convection heaters
 - iv) radiant heaters
 - v) heat tracing cables
 - vi) duct heaters
 - vii) Induction heating
 - viii) heating cables
6. Identify types of domestic water heating systems and describe their applications and operation.
 - i) electric tank water heaters
 - ii) electric tankless water heaters

7. Identify electric heating system components and describe their characteristics and applications.
8. Identify tools and equipment used to install, service and maintain electric heating systems and describe their applications and procedures for use.
9. Identify considerations and requirements for removal of electric heating systems and their components.
10. Identify considerations and requirements for selecting electric heating systems and their components.
11. Describe factors that contribute to basic heat loss.
12. Perform calculations to determine heating requirements.
13. Describe the procedures used to remove electric heating systems and their components.
14. Describe the procedures used to install electric heating systems and their components.
15. Describe the procedures used to diagnose electric heating systems.
16. Describe the procedures used to repair electric heating systems.
17. Describe the procedures used to maintain electric heating systems.
18. Identify electronic components and describe their application as it pertains to electric heating systems.

Practical Objectives:

N/A

Learning Outcomes:

- Demonstrate knowledge of types of electric heating system control components, their applications and operation.
- Demonstrate knowledge of procedures to remove and/or install electric heating system control components.
- Demonstrate knowledge of procedures to service electric heating system control components.
- Demonstrate knowledge of procedures to maintain electric heating system control components.

IEL 2021 Red Seal Occupational Standard Reference:

- 19.01 Installs electric heating systems and controls.
- 19.02 Maintains electric heating systems and controls.

Suggested Hours:

12 Hours

Theoretical Objectives:

1. Define terminology associated with electric heating system controls.
2. Identify hazards and describe safe work practices pertaining to electric heating system controls.
3. Interpret codes, regulations and standards pertaining to electric heating system control components.
4. Interpret information pertaining to electric heating system control components found on drawings and specifications.
5. Identify types of electric heating system control components and describe their characteristics and applications.
 - i) thermostats
 - ii) heating relays
 - iii) sensors
 - iv) contactors
 - v) electrical interlocks
 - vi) semiconductor controls
 - vii) web-based controls

- viii) automated controls
- ix) smart controls

6. Identify considerations and requirements for removal of electric heating system control components.
7. Identify considerations and requirements for selecting electric heating system control components.
8. Identify tools and equipment used to install, service and maintain electric heating system control components.
9. Describe the procedures used to remove electric heating system control components.
10. Describe the procedures used to install electric heating system control components.
11. Describe the procedures used to connect electric heating system control components.
12. Describe the procedures used to test electric heating system control components.
13. Describe the procedures used to diagnose electric heating system control components.
14. Describe the procedures used to repair electric heating system control components.
15. Describe the procedures used to maintain electric heating system control components.
16. Identify electronic components and describe their application as it pertains to electric heating system controls.

Practical Objectives:

N/A

Learning Outcomes:

- Demonstrate knowledge of cathodic protection systems, their applications and operation.
- Demonstrate knowledge of procedures to install, connect and test cathodic protection systems.
- Demonstrate knowledge of procedures to service and maintain cathodic protection systems.

IEL 2021 Red Seal Occupational Standard Reference:

21.01 Installs cathodic protection systems.
21.02 Maintains cathodic protection systems.

Suggested Hours:

6 Hours

Theoretical Objectives:

1. Define terminology associated with cathodic protection systems.
2. Identify hazards and describe safe work practices pertaining to cathodic protection systems.
3. Interpret codes, regulations and standards pertaining to cathodic protection systems.
4. Interpret information pertaining to cathodic protection systems found on drawings and specifications.
5. Identify types of cathodic protection systems and describe their characteristics, applications and operation.
 - i) active rectifier
 - ii) sacrificial anode
6. Identify cathodic protection system components and describe their characteristics, applications and operation.
 - i) rectifier
 - ii) insulating kits
 - iii) cabling
 - iv) breaker
 - v) anode connection cable

- vi) remote reference points
- vii) tap settings in the rectifier enclosure

7. Identify tools and equipment used to install, service and maintain cathodic protection systems and describe their applications and procedures for use.
8. Describe the procedures used to install and connect cathodic protection systems and their components.
9. Describe the procedures used to test cathodic protection systems and their components.
10. Describe the procedures used to diagnose and repair cathodic protection systems.
11. Describe the procedures used to maintain cathodic protection systems.
12. Identify electronic components and describe their application as it pertains to cathodic protection systems.

Practical Objectives:

N/A

Learning Outcomes:

- Demonstrate knowledge of DC motors, their applications and operation.

IEL 2021 Red Seal Occupational Standard Reference:

25.05 Installs direct current (DC) motors.
25.06 Maintains direct current (DC) motors.

Suggested Hours:

12 Hours

Theoretical Objectives:

1. Interpret information contained on motor nameplates.
2. Explain the operating principles of DC motors.
3. Identify types of DC motors and describe their characteristics, applications and operation.
 - i) self-excited
 - ii) separately excited
 - iii) series
 - iv) shunt
 - v) compound
4. Identify DC motor components and describe their purpose and operation.
 - i) frame
 - ii) armature
 - iii) rotor
 - iv) stator
 - v) commutator
 - vi) end bells
 - vii) yoke
 - viii) fans
 - ix) brushes
 - x) bearings
 - xi) bushings

5. Identify considerations and requirements for selecting DC motors and controls and their components.

Practical Objectives:

N/A

Learning Outcomes:

- Demonstrate knowledge of single-phase motor starters and controllers, their applications and operation.
- Demonstrate knowledge of procedures to install single-phase motor starters and controllers.
- Demonstrate knowledge of procedures to service and maintain single-phase motor starters and controllers.

IEL 2021 Red Seal Occupational Standard Reference:

22.01 Installs motor starters.
22.02 Maintains motor starters.

Suggested Hours:

6 Hours

Theoretical Objectives:

1. Define terminology associated with single-phase motor starters.
2. Identify hazards and describe safe work practices pertaining to single-phase motor starters.
3. Interpret codes, regulations and standards pertaining to single-phase motor starters.
4. Interpret information pertaining to single-phase motor starters found on drawings and specifications.
5. Interpret information contained on motor nameplates.
6. Identify types of single-phase motor starters and describe their characteristics and applications.
 - i) manual
 - ii) magnetic
7. Describe starting methods and their applications.
 - i) full voltage
8. Identify tools and equipment used to install single-phase motor starters and describe their applications and procedures for use.

9. Describe the procedures used to install single-phase motor starters and their components and accessories.
 - i) manual
 - ii) magnetic
10. Describe the procedures used to connect single-phase motor starters and their components and accessories.
11. Identify enclosures and wiring methods based on application.
12. Describe the procedures used to service single-phase motor starters, their components and accessories.
13. Describe the procedures used to maintain single-phase motor starters, their components and accessories.

Practical Objectives:

N/A

Learning Outcomes:

- Demonstrate knowledge of basic motor control devices, their applications and operation.
- Demonstrate knowledge of basic motor control circuits, their characteristics and applications.
- Demonstrate knowledge of procedures to service and maintain motor basic control devices.

IEL 2021 Red Seal Occupational Standard Reference:

22.03 Installs motor control devices.
22.04 Maintains motor control devices.

Suggested Hours:

12 Hours

Theoretical Objectives:

1. Define terminology associated with basic motor control devices.
2. Identify hazards and describe safe work practices pertaining to motor control devices.
3. Interpret codes, regulations and standards pertaining to basic motor control circuits and devices.
4. Interpret information pertaining to basic motor control devices found on drawings and specifications.
5. Describe basic motor control devices, their applications and operation.
 - i) emergency stop stations
 - ii) start/stop stations
6. Identify motor control circuit types and describe their characteristics and applications.
 - i) low voltage release (two wire control)
 - ii) low voltage protection (three wire control)
7. Describe circuit functional features of basic hard wired motor control circuits.
 - i) starting and stopping
 - ii) jogging

8. Identify methods used to determine the number of conductors required between basic controls and controller locations.
9. Identify tools and equipment used to service and maintain motor control devices and describe their applications and procedures for use.
10. Describe the procedures used to service basic motor control devices and their components.
11. Describe the procedures used to maintain basic motor control devices and their components.

Practical Objectives:

N/A

Learning Outcomes:

- Demonstrate knowledge of advanced drawings, schematics and specifications.
- Demonstrate knowledge of interpreting and extracting information from advanced drawings, schematics and specifications.
- Demonstrate knowledge of procedures and requirements to document changes to equipment and wiring.

IEL 2021 National Occupational Analysis Reference:

3.01 Uses plans, schematics, drawings and specifications.

Suggested Hours:

12 Hours

Theoretical Objectives:

1. Identify types of advanced drawings, schematics and specifications and describe their applications.
 - i) single-line distribution system layout drawings
 - ii) riser diagrams
 - iii) equipment schedules
 - iv) project documentation
 - v) interference drawings
2. Interpret and extract information from advanced drawings, schematics and specifications.
3. Interpret and extract information from key diagrams used on drawings.
4. Identify documentation requirements for modifying drawings and specifications.
5. Describe the procedures used to document changes made to equipment and wiring.

Practical Objectives:

N/A

Learning Outcomes:

- Demonstrate knowledge of lightning protection systems, their applications and operation.
- Demonstrate knowledge of procedures to install lightning protection systems.
- Demonstrate knowledge of procedures to service and maintain lightning protection systems.

IEL 2021 Red Seal Occupational Standard Reference:

8.03 Installs ground fault, arc fault and surge protection devices

Suggested Hours:

6 Hours

Theoretical Objectives:

1. Define terminology associated with lightning protection systems.
2. Identify hazards and describe safe work practices pertaining to lightning protection systems.
3. Interpret codes, regulations and standards pertaining to lightning protection systems.
4. Interpret information pertaining to lightning protection systems found on drawings and specifications.
5. Identify types of lightning protection systems and describe their characteristics, applications and operation.
 - i) lightning arrester protection
 - ii) structure protection
6. Identify lightning protection system components and describe their purpose and operation.
 - i) lightning rod (air terminal)
 - ii) intercepting conductors
 - iii) down conductors
 - iv) ground electrodes (ground rods)
 - off-grid
 - grid-tie
 - v) supports

vi) lightning arresters

7. Explain the purpose of lightning protection systems.
8. Identify considerations and requirements for selecting the type of lightning protection systems.
9. Identify tools and equipment used to install, service and maintain lightning protection systems and describe their applications and procedures for use.
10. Describe the procedures used to install lightning protection systems and their components.
11. Describe the procedures used to service lightning protection systems and their components.
12. Describe the procedures used to maintain lightning protection systems and their components.

Practical Objectives:

N/A

Level 3

Unit Code	Unit Title	Suggested Hours	Page Number
ELE-320	Three-Phase Theory	30	108
ELE-325	Ground Fault Protection and Detection Systems I	12	110
ELE-330	Three-Phase Services	12	112
ELE-335	Three-Phase Power Distribution Equipment	18	114
ELE-340	AC Generating Systems	18	116
ELE-345	Low-Voltage Three-Phase Transformers	18	118
ELE-350	High-Voltage Transformers	12	121
ELE-355	Motor Starters II	18	123
ELE-360	Motor Control Devices II	24	126
ELE-365	Single-Phase Motors I	18	128
ELE-370	Three-Phase Motors I	18	130
ELE-375	DC Motors II	12	132
ELE-380	AC Drives	18	133
ELE-385	DC Drives	12	135

Learning Outcomes:

- Demonstrate knowledge of three-phase electricity, its characteristics and associated principles.
- Demonstrate knowledge of three-phase electricity calculations.

IEL 2021 Red Seal Occupational Standard Reference:

N/A

Suggested Hours:

30 Hours

Theoretical Objectives:

1. Define terminology associated with three-phase theory.
2. Identify hazards and describe safe work practices pertaining to three-phase electricity.
3. Identify units of measure and symbols pertaining to three-phase electricity.
4. Explain three-phase power generation.
5. Identify types of three-phase connections and describe their characteristics and applications.
 - i) delta
 - ii) wye
6. Explain voltage and current relations in three-phase connections.
 - i) vector analysis
7. Identify tools and equipment used to measure three-phase electricity and describe their applications and procedures for use.
8. Describe the procedures used to measure three-phase electricity.
9. Perform calculations for balanced and unbalanced loads.
10. Perform calculations pertaining to three-phase electricity.
 - i) true power
 - ii) apparent power
 - iii) reactive power

iv) power factor

Practical Objectives:

N/A

Learning Outcomes:

- Demonstrate knowledge of ground fault protection and detection systems, their applications and operation.
- Demonstrate knowledge of procedures to install ground fault protection and detection systems.

IEL 2021 Red Seal Occupational Standard Reference:

11.05 Installs ground-fault protection and detection systems.

Suggested Hours:

12 Hours

Theoretical Objectives:

1. Define terminology associated with ground fault systems.
2. Interpret codes, regulations and standards pertaining to ground fault systems.
3. Interpret information pertaining to ground fault systems found on drawings and specifications.
4. Identify types of ground fault systems and describe their characteristics and applications.
 - i) ground fault protection (solidly grounded systems)
 - ii) ground fault detection (ungrounded systems, impedance grounded, mobile equipment)
5. Explain the purpose of ground fault systems.
6. Identify considerations and requirements for selecting ground fault system components.
 - i) CTs
 - ii) VTs
 - iii) resistors
 - iv) relays
 - v) annunciations (horns, panels)
 - vi) indicators (pilot lights)
 - vii) reset buttons
 - viii) breakers
 - ix) interconnecting wiring

- x) ground fault sensors (direct, residual or zero sequence)
- xi) meters

7. Identify tools and equipment used to install ground fault protection and detection systems and describe their applications and procedures for use.
8. Describe the procedures used to install ground fault protection and detection systems and their components.
9. Identify electronic components and describe their application as it pertains to ground fault protection and detection systems.

Practical Objectives:

N/A

Learning Outcomes:

- Demonstrate knowledge of three-phase services and their applications.
- Demonstrate knowledge of procedures to install three-phase services.
- Demonstrate knowledge of procedures to service and maintain three-phase services.
- Demonstrate knowledge of load calculations for three-phase services.

IEL 2021 Red Seal Occupational Standard Reference:

7.03 Installs three-phase utility and non-utility supply services and metering equipment.
7.04 Maintains three-phase utility and non-utility supply services and metering equipment.

Suggested Hours:

12 Hours

Theoretical Objectives:

1. Define terminology associated with three-phase services.
2. Identify hazards and describe safe work practices pertaining to three-phase services.
3. Interpret codes, regulations and standards pertaining to three-phase services.
4. Interpret information pertaining to three-phase services found on drawings and specifications.
5. Identify sources of information and documentation required for the installation of three-phase services.
6. Identify types of three-phase services and describe their characteristics and applications.
 - i) temporary service
 - ii) overhead
 - iii) underground
 - iv) single and multiple metering
7. Identify three-phase service components, service conductors and fasteners and describe their purpose and applications.
8. Identify considerations and requirements for selecting three-phase services, service components, service conductors and metering equipment.

9. Identify tools and equipment used to install, service and maintain three-phase services and describe their applications and procedures for use.
10. Describe the procedures used to install three-phase services, service components and service conductors.
11. Describe the procedures used to connect service conductors.
12. Describe the procedures used to ground and bond three-phase services.
13. Perform load calculations.
 - i) balanced
 - ii) un-balanced
14. Describe the procedures used to service three-phase services and their components.
15. Describe the procedures used to maintain three-phase services and their components.

Practical Objectives:

N/A

Learning Outcomes:

- Demonstrate knowledge of three-phase power distribution equipment, their applications and operation.
- Demonstrate knowledge of procedures to install three-phase power distribution equipment.
- Demonstrate knowledge of calculations for three-phase power distribution equipment ratings.
- Demonstrate knowledge of procedures to service and maintain three-phase power distribution equipment.
- Demonstrate knowledge of procedures to commission, start up, shut down, and decommission three-phase power distribution equipment.

IEL 2021 Red Seal Occupational Standard Reference:

9.01 Installs low-voltage distribution equipment.
9.02 Maintains low-voltage distribution equipment.

Suggested Hours:

18 Hours

Theoretical Objectives:

1. Define terminology associated with three-phase power distribution equipment.
2. Identify hazards and describe safe work practices pertaining to three-phase power distribution equipment.
3. Interpret codes, regulations and standards pertaining to three-phase power distribution equipment.
4. Interpret information pertaining to three-phase power distribution equipment found on drawings and specifications.
5. Identify types of three-phase power distribution equipment and describe their characteristics, applications and operation.
 - i) panels
 - ii) sub-panels
 - iii) power distribution centres (PDC)
 - iv) switchboards
 - v) breakers

- vi) fuses
- vii) disconnects
- viii) racking equipment
- ix) CTs
- x) VTs
- xi) busbars
- xii) splitters
- xiii) motor control centres (MCC)

6. Identify considerations and requirements for selecting three-phase power distribution equipment and enclosures.
 - i) load
 - ii) voltage ratings
 - iii) required circuit capacity/amperage ratings
7. Identify tools and equipment used to install, service and maintain three-phase power distribution equipment and describe their applications and procedures for use.
8. Describe the procedures used to install three-phase power distribution equipment.
9. Describe the procedures used to connect three-phase power distribution equipment.
10. Describe the procedures used to transport and move three-phase power distribution equipment.
11. Perform calculations to determine three-phase distribution equipment ratings.
 - i) panels/sub-panels
 - ii) disconnects
 - iii) overcurrent devices
12. Describe the procedures used to service three-phase power distribution equipment and their components.
13. Describe the procedures used to maintain three-phase power distribution equipment and their components.
14. Identify electronic components and describe their application as it pertains to three-phase power distribution equipment.

Practical Objectives:

N/A

Learning Outcomes:

- Demonstrate knowledge of AC generating systems, their applications and operation.
- Demonstrate knowledge of procedures to install and connect AC generating systems.
- Demonstrate knowledge of procedures to service and maintain AC generating systems.

IEL 2021 Red Seal Occupational Standard Reference:

- 11.01 Installs grounding systems.
- 11.03 Installs bonding systems.
- 12.01 Installs alternating current (AC) generating systems.
- 12.02 Maintains AC generating systems.

Suggested Hours:

18 Hours

Theoretical Objectives:

1. Define terminology associated with AC generating systems.
2. Identify hazards and describe safe work practices pertaining to AC generating systems.
3. Interpret codes, standards and regulations pertaining to AC generating systems.
4. Interpret information pertaining to AC generating systems found on drawings and specifications.
5. Identify types of AC generating systems and describe their characteristics, applications and operation.
 - i) single-phase
 - ii) three-phase
 - iii) portable
 - iv) stationary
 - v) manually operated
 - vi) automatically operated
6. Identify AC generating system components and describe their purpose and operation.
7. Identify considerations and requirements for selecting AC generating systems and their components.

8. Identify tools and equipment used to install, service and maintain AC generating systems and describe their applications and procedures for use.
9. Describe the procedures used to install AC generating systems and their components.
10. Describe the procedures used to connect AC generating systems and AC generating system components.
 - i) floating ground
11. Describe the procedures used to interconnect and synchronize AC generating systems with stand-alone or parallel operations.
12. Describe the procedures used to control the output voltage, phase sequencing and frequency of AC generators.
13. Describe the procedures used to service AC generating systems and their components.
14. Describe the procedures used to maintain AC generating systems and their components.
15. Identify electronic components and describe their application as it pertains to AC generating systems.
16. Identify methods of grounding and bonding AC generating systems.

Practical Objectives:

N/A

Learning Outcomes:

- Demonstrate knowledge of low-voltage three-phase transformers, their applications and operation.
- Demonstrate knowledge of procedures to install low-voltage three-phase transformers.
- Demonstrate knowledge of procedures to service and maintain low-voltage three-phase transformers.

IEL 2021 Red Seal Occupational Standard Reference:

15.05 Installs low voltage three-phase transformers.
15.06 Maintains low voltage three-phase transformers.

Suggested Hours:

18 Hours

Theoretical Objectives:

1. Define terminology associated with low-voltage three-phase transformers.
2. Identify hazards and describe safe work practices pertaining to low-voltage three-phase transformers.
3. Interpret codes, regulations and standards pertaining to low-voltage three-phase transformers.
4. Interpret information contained on low-voltage three-phase transformer nameplates.
5. Explain the operating principles of low-voltage three-phase transformers.
6. Explain transformer polarity and terminal markings.
7. Identify the characteristics of low-voltage three-phase transformers.
 - i) wye
 - ii) delta
 - iii) impedance
 - iv) core type
 - v) isolation
 - vi) step-down
 - vii) step-up
 - viii) auto

- ix) toroidal

8. Identify types of low-voltage three-phase transformers and describe their applications.
 - i) dry-type
 - ii) dielectric liquid-filled
9. Identify low-voltage three-phase transformer components and describe their characteristics and applications.
 - i) ventilation fans
 - ii) casings and enclosures
 - iii) core
 - iv) primary and secondary windings
 - v) oil pumps
 - vi) bushings
 - vii) on-line/off-line (on-load/off-load) manual and automatic tap changers
10. Identify winding configurations for low-voltage three-phase transformers.
 - i) wye-wye
 - ii) open-wye
 - iii) wye-delta
 - iv) delta-wye
 - v) open-delta
 - vi) delta-delta
 - vii) zig-zag
 - viii) Scott connection
11. Identify considerations and requirements for selecting low-voltage three-phase transformers.
12. Identify tools and equipment used to install, service and maintain low-voltage three-phase transformers and describe their applications and procedures for use.
13. Describe the procedures used to install low-voltage three-phase transformers.
14. Describe the procedures used to install low-voltage three-phase transformers in parallel.
15. Describe the procedures used to ground low-voltage three-phase transformers.
16. Describe the procedures used to test low-voltage three-phase transformers.
17. Describe the procedures used to service low-voltage three-phase transformers and their components.
18. Describe the procedures used to maintain low-voltage three-phase transformers and their components.

Practical Objectives:

1. Install, connect, and test a low-voltage three-phase transformer.

Learning Outcomes:

- Demonstrate knowledge of high-voltage transformers, their applications and operation.
- Demonstrate knowledge of procedures to install high-voltage transformers.
- Demonstrate knowledge of procedures to service and maintain high-voltage transformers.

IEL 2021 Red Seal Occupational Standard Reference:

15.07 Installs high-voltage transformers.
15.08 Maintains high-voltage transformers.

Suggested Hours:

12 Hours

Theoretical Objectives:

1. Define terminology associated with high-voltage transformers.
2. Identify hazards and describe safe work practices pertaining to high-voltage transformers.
3. Interpret information contained on high-voltage transformer nameplates.
4. Interpret codes, regulations and standards pertaining to high-voltage transformers.
5. Explain the operating principles of high-voltage transformers.
6. Explain transformer polarity and terminal markings.
7. Identify types of high-voltage transformers and describe their characteristics and applications.
 - i) dry-type
 - ii) dielectric liquid-filled
8. Identify high-voltage transformer components and describe their characteristics and applications.
 - i) oil pumps
 - ii) ventilation fans
 - iii) casing
 - iv) core

- v) primary windings
- vi) secondary windings
- vii) desiccant breather
- viii) gas detection (buchholz) relay
- ix) bushings
- x) on-line (on-load) tap changers
- xi) off-line (off-load) tap changers
- xii) oil
- xiii) monitoring devices

9. Identify winding configurations for high-voltage transformers.

- i) wye-wye
- ii) open-wye
- iii) wye-delta
- iv) delta-wye
- v) open-delta
- vi) delta-delta
- vii) zig-zag

10. Identify considerations and requirements for selecting high-voltage transformers.

11. Identify tools and equipment used to install, service and maintain high-voltage transformers and describe their applications and procedures for use.

12. Describe the procedures used to install high-voltage transformers.

13. Describe the procedures used to ground high-voltage transformers.

14. Describe the procedures used to install high-voltage transformers in parallel.

15. Describe the procedures used to test high-voltage transformers.

16. Describe the procedures used to service high-voltage transformers and their components.

17. Describe the procedures used to maintain high-voltage transformers and their components.

Practical Objectives:

N/A

Learning Outcomes:

- Demonstrate knowledge of motor starters and controllers, their applications and operation.
- Demonstrate knowledge of procedures to install motor starters and controllers.
- Demonstrate knowledge of procedures to service and maintain motor starters and controllers.

IEL 2021 Red Seal Occupational Standard Reference:

- 22.01 Installs motor starters.
- 22.02 Maintains motor starters.

Suggested Hours:

18 Hours

Theoretical Objectives:

1. Define terminology associated with motor starters and controllers.
2. Identify hazards and describe safe work practices pertaining to motor starters and controllers.
3. Interpret codes, regulations and standards pertaining to motor starters and controllers.
4. Interpret information pertaining to motor starters found on manufacturers' nameplate data, drawings and specifications.
5. Identify types of motor starters and describe their characteristics and applications.
 - i) starters for AC/DC motors
 - ii) single-phase
 - iii) three-phase AC
 - iv) line voltage starters
 - v) dual speed starter
 - vi) forward/reverse starter
 - vii) soft starters
 - viii) reduced-voltage starters
 - ix) self-protected combination motor controller
6. Describe starting methods and their applications.
 - i) full voltage

- ii) reduced voltage
 - primary resistor
 - autotransformer
 - wye-delta
 - solid state/soft starting
- iii) alternative methods
 - part winding
 - wound rotor starting

7. Identify types of motor control devices and components and describe their characteristics and applications.

- i) wound rotor motor controller
- ii) multi-speed controller
- iii) frequency drives

8. Identify types of motor control centres (MCC) and components and describe their characteristics and applications.

9. Identify tools and equipment used to install, service and maintain motor starters and controllers and describe their applications and procedures for use.

10. Describe the procedures used to install motor starters and controllers and their components and accessories.

11. Describe the procedures used to connect motor starters and controllers and their components and accessories.

12. Describe the procedures used to service motor starters and controllers and their components and accessories.

13. Describe the procedures used to maintain motor starters and controllers and their components and accessories.

14. Identify electronic components and describe their application as it pertains to motor starters.

Practical Objectives:

N/A

Learning Outcomes:

- Demonstrate knowledge of motor control devices, their applications and operation.
- Demonstrate knowledge of motor control circuits, their characteristics and applications.
- Demonstrate knowledge of procedures to service and maintain motor control devices.

IEL 2021 Red Seal Occupational Standard Reference:

22.04 Maintains motor control devices.

Suggested Hours:

24 Hours

Theoretical Objectives:

1. Define terminology associated with motor control devices and circuits.
2. Identify hazards and describe safe work practices pertaining to motor control devices.
3. Interpret codes, regulations and standards pertaining to motor control circuits and devices.
4. Interpret information pertaining to motor control devices found on drawings and specifications.
5. Describe motor control devices, their applications and operation.
 - i) flow switches
 - ii) push buttons
 - iii) relays
 - iv) limit switches
 - v) proximity switches
 - vi) pressure switches
 - vii) level switches
 - viii) temperature switches
 - ix) counters
 - x) timers
 - on-delay
 - off-delay
6. Identify types of motor control devices and describe their characteristics and applications.

- i) PLCs
- ii) pilot devices (limit switches, proximity switches, float switches, sail switches, photo detectors)

7. Describe circuit functional features of hard-wired motor control circuits.

- i) starting and stopping
- ii) forward/reverse
- iii) sequencing
- iv) jogging
- v) quick stop (plugging/anti-plugging)
- vi) multiple location control
- vii) time functions

8. Identify methods to determine the number of conductors required between controls and controller locations.

9. Identify protection devices for motor control circuits and describe their characteristics and applications.

- i) overcurrent
- ii) overload
- iii) overheating
- iv) phase loss
- v) phase reversal

10. Identify tools and equipment used to service and maintain motor control devices and describe their applications and procedures for use.

11. Describe the procedures used to service motor control devices and their components.

12. Describe the procedures used to maintain motor control devices and their components.

13. Identify electronic components and describe their applications as it pertains to motor control devices.

Practical Objectives:

1. Connect and operate control circuits.

Learning Outcomes:

- Demonstrate knowledge of single-phase motors, their applications and operation.
- Demonstrate knowledge of procedures to install and connect single-phase motors.

IEL 2021 Red Seal Occupational Standard Reference:

25.01 Installs single-phase motors.

Suggested Hours:

18 Hours

Theoretical Objectives:

1. Define terminology associated with single-phase motors.
2. Identify hazards and describe safe work practices pertaining to single-phase motors.
3. Interpret codes, regulations and standards pertaining to single-phase motors.
4. Interpret information pertaining to single-phase motors found on drawings and specifications.
5. Interpret information pertaining to single-phase motors found on motor nameplates.
6. Identify types of single-phase motors and describe their characteristics, applications and operation.
 - i) hermetically sealed
 - ii) dual capacitor
 - iii) capacitor start/induction run
 - iv) split phase
 - v) universal
 - vi) resistance split phase
 - vii) permanent split capacitor
 - viii) shaded pole
7. Identify single-phase motor components and accessories and describe their applications.
 - i) frame
 - ii) centrifugal switch
 - iii) armature

- iv) rotor
- v) stator
- vi) end bells
- vii) yoke
- viii) fans
- ix) brushes
- x) bearings
- xi) bushings

8. Explain the construction and operating principles of single-phase motors.
9. Identify coupling methods for single-phase motors and describe their characteristics and applications.
 - i) flexible couplings
 - ii) fixed couplings
 - iii) magnetic couplings
 - iv) belts and chains
10. Identify considerations and requirements for selecting single-phase motors and their components.
11. Identify tools and equipment used to install and connect single-phase motors and describe their applications and procedures for use.
12. Describe the procedures used to install single-phase motors.
13. Describe the procedures used to connect single-phase motors.
14. Perform single-phase motor calculations.
 - i) overcurrent
 - ii) overload
 - iii) conductors

Practical Objectives:

1. Connect and operate single-phase motors.

Learning Outcomes:

- Demonstrate knowledge of three-phase motors, their applications operation.
- Demonstrate knowledge of procedures to install and connect three-phase motors.

IEL 2021 Red Seal Occupational Standard Reference:

25.03 Installs three-phase motors.

Suggested Hours:

18 Hours

Theoretical Objectives:

1. Define terminology associated with three-phase motors.
2. Identify hazards and describe safe work practices pertaining to three-phase motors.
3. Interpret codes, regulations and standards pertaining to three-phase motors.
4. Interpret information pertaining to three-phase motors found on drawings and specifications.
5. Interpret information contained on three-phase motor nameplates.
6. Explain the construction and operating principles of three-phase motors.
7. Identify types of three-phase motors and describe their characteristics.
 - i) squirrel cage induction
 - ii) wound rotor induction
 - iii) synchronous
8. Identify three-phase motor components and describe their applications.
9. Identify coupling methods for three-phase motors and describe their characteristics and applications.
 - i) flexible couplings
 - ii) fixed couplings
 - iii) magnetic couplings
 - iv) belts and chains

10. Identify considerations and requirements for selecting three-phase motors and their components.
11. Identify tools and equipment used to install and connect three-phase motors and describe their applications and procedures for use.
12. Describe the procedures used to install three-phase motors.
13. Describe the procedures used to connect three-phase motors.
14. Perform three phase motor calculations.
 - i) overcurrent
 - ii) overload
 - iii) conductors

Practical Objectives:

1. Connect and operate three-phase motors.

Learning Outcomes:

- Demonstrate knowledge of DC motors, their applications and procedures for use.
- Demonstrate knowledge of procedures to install and connect DC motors.

IEL 2021 Red Seal Occupational Standard Reference:

25.05 Installs direct current (DC) motors.

Suggested Hours:

12 Hours

Theoretical Objectives:

1. Define terminology associated with DC motors.
2. Identify hazards and describe safe work practices pertaining to DC motors.
3. Interpret codes, regulations and standards pertaining to DC motors.
4. Interpret information pertaining to DC motors found on drawings and specifications.
5. Interpret information contained on motor nameplates.
6. Identify tools and equipment used to install DC motors and controls and their components and describe their applications and procedures for use.
7. Describe the procedures used to install DC motors and their components.
8. Describe the procedures used to connect DC motors and their components.
9. Perform DC motor calculations.
 - i) overcurrent
 - ii) overload
 - iii) conductors

Practical Objectives:

1. Connect and operate DC motors.

Learning Outcomes:

- Demonstrate knowledge of AC drives, their applications and operation.
- Demonstrate knowledge of procedures to install and connect AC drives.
- Demonstrate knowledge of procedures to service and maintain AC drives.

IEL 2021 Red Seal Occupational Standard Reference:

23.01 Installs alternating current (AC) drives.
23.02 Maintains alternating current (AC) drives.

Suggested Hours:

18 Hours

Theoretical Objectives:

1. Interpret codes, regulations and standards pertaining to AC drives.
2. Interpret information pertaining to AC drives found on drawings and specifications.
3. Identify types of AC drives and describe their characteristics, applications and operation.
4. Identify AC drive components and accessories and describe their characteristics, applications and operation.
 - i) rectifiers
 - ii) electro-magnetic compatibility (EMC) filters
 - iii) DC circuits
 - iv) shielded cables
 - v) inverters
 - vi) reactors
 - vii) field components (encoders, tachometers)
5. Explain the operating principles of AC drives and their impact on motor performance.
6. Identify considerations and requirements for selecting AC drives, their components and accessories.
7. Identify tools and equipment used to install, service and maintain AC drives and describe their applications and procedures for use.
8. Describe the procedures used to install AC drives, their components and accessories.

9. Describe the procedures used to connect AC drives, their components and accessories.
10. Describe the procedures used to adjust AC drives, their components and accessories.
11. Describe the procedures used to service and maintain AC drives, their components and accessories.
12. Identify electronic components and describe their application as it pertains to AC drives.

Practical Objectives:

1. Connect, adjust, and operate AC drives.

Learning Outcomes:

- Demonstrate knowledge of DC drives, their applications and operation.
- Demonstrate knowledge of procedures to install and connect DC drives.
- Demonstrate knowledge of procedures to service and maintain DC drives.

IEL 2021 Red Seal Occupational Standard Reference:

23.03 Installs direct current (DC) drives.
23.04 Maintains direct current (DC) drives.

Suggested Hours:

12 Hours

Theoretical Objectives:

1. Define terminology associated with DC drives.
2. Identify hazards and describe safe work practices pertaining to DC drives.
3. Interpret codes, regulations and standards pertaining to DC drives.
4. Interpret information pertaining to DC drives found on drawings and specifications.
5. Identify types of DC drives and describe their characteristics, applications and operation.
6. Identify DC drive components and accessories and describe their characteristics, applications and operation.
 - i) converters
 - ii) regulators
7. Explain the operating principles of DC drives and their impact on motor performance.
8. Identify considerations and requirements for selecting DC drives, their components and accessories.
9. Identify tools and equipment used to install, service and maintain DC drives and describe their applications and procedures for use.
10. Describe the procedures used to install DC drives, their components and accessories.

11. Describe the procedures used to connect DC drives, their components and accessories.
12. Describe the procedures used to configure DC drives, their components and accessories.
13. Describe the procedures used to service and maintain DC drives, their components and accessories.
14. Identify electronic components and describe their application as it pertains to DC drives.

Practical Objectives:

N/A

Level 4

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Learning Outcomes:

- Demonstrate knowledge of effective communication practices as a mentor.
- Demonstrate knowledge of strategies for teaching workplace skills.

IEL 2021 Red Seal Occupational Standard Reference:

6.01 Uses communication techniques.

6.02 Uses mentoring techniques.

Suggested Hours:

6 Hours

Theoretical Objectives:

1. Identify the different roles played by a workplace mentor.
2. Identify strategies to create a supportive learning environment.
3. Identify techniques for effective communication as a mentor.
 - i) constructive feedback
 - ii) active listening
 - iii) leading meetings and one-on-one sessions
4. Describe the steps in teaching a skill.
 - i) identifying the point of lesson
 - ii) linking the lesson
 - iii) demonstrating the skill
 - iv) providing practice
 - v) giving feedback
 - vi) assessing skill and progress
5. Identify strategies to assist in teaching a skill while meeting individual learning needs.
 - i) principles of instruction
 - ii) coaching skills
6. Explain how to adjust a lesson for various situations.

Practical Objectives:

N/A

IEL-405

Ground Fault Protection and Detection Systems II

Learning Outcomes:

- Demonstrate knowledge of procedures to maintain ground fault protection and detection systems.

IEL 2021 Red Seal Occupational Standard Reference:

11.06 Maintains ground-fault protection and detection systems.

Suggested Hours:

3 Hours

Theoretical Objectives:

1. Identify hazards and describe safe work practices pertaining to the maintenance of ground fault protection and detection device systems.
2. Interpret codes, regulations and standards pertaining to ground fault protection and detection systems.
3. Interpret information pertaining to ground fault protection and detection systems found on drawings and specifications.
4. Identify tools and equipment used to maintain ground fault protection and detection systems and describe their application and procedures for use.
5. Describe the procedures used to maintain ground fault protection and detection systems and their components.

Practical Objectives:

N/A

IEL-410

Power Conditioning, Uninterruptible Power Supply (UPS) and Surge Suppression Systems

Learning Outcomes:

- Demonstrate knowledge of power conditioning, UPS and surge suppression systems and their applications.
- Demonstrate knowledge of procedures to install power conditioning, UPS and surge suppression systems.
- Demonstrate knowledge of procedures to maintain power conditioning, ~~uninterruptible power supply~~ UPS and surge suppression systems.

IEL 2021 Red Seal Occupational Standard Reference:

- 10.01 Installs power conditioning systems.
- 10.02 Maintains power conditioning systems.

Suggested Hours:

18 Hours

Theoretical Objectives:

1. Define terminology associated with power conditioning, UPS and surge suppression systems.
2. Identify hazards and describe safe work practices with UPS systems when working with batteries, multiple energy sources and capacitors.
3. Interpret codes, regulations and standards pertaining to power conditioning, UPS and surge suppression systems.
4. Interpret information pertaining to power conditioning, UPS and surge suppression systems found on drawings and specifications.
5. Explain power quality and its impact on equipment operation.
6. Explain single-phase and three-phase power factor correction and its associated calculations.
7. Identify types of power factor correction equipment and describe their characteristics, applications and operation.
 - i) synchronous condensers (motors)

- ii) reactors
- iii) capacitors
- iv) inverters (renewable energy)

8. Identify equipment used to reduce harmonics in power distribution systems and describe their characteristics, applications and operation.

- i) zero sequence/passive and active filters
- ii) K-rated or zig zag transformers and capacitors

9. Identify types of UPS equipment used in power distribution system conditioning and describe their characteristics, applications and operation.

- i) online
- ii) offline
- iii) online interactive
- iv) maintenance bypass and static bypass
- v) batteries and battery charging systems

10. Identify surge suppression equipment used in power distribution system conditioning and describe their characteristics, applications and operation.

- i) capacitors
- ii) shunt coils and diodes

11. Identify tools and equipment used to install and maintain power conditioning, UPS and surge suppression systems and describe their applications and procedures for use.

12. Describe the procedures used to install power conditioning, UPS and surge suppression systems.

13. Describe the procedures used to maintain power conditioning, UPS and surge suppression systems.

14. Identify electronic components and describe their application as it pertains to power conditioning, UPS and surge suppression systems.

Practical Objectives:

N/A

IEL-415 High-Voltage Equipment

Learning Outcomes:

- Demonstrate knowledge of high-voltage equipment, their applications and operation.
- Demonstrate knowledge of procedures to install high-voltage equipment.
- Demonstrate knowledge of testing procedures.
- Demonstrate knowledge of procedures to maintain high-voltage equipment.

IEL 2021 Red Seal Occupational Standard Reference:

- 14.01 Installs high-voltage systems.
- 14.02 Maintains high-voltage systems.

Suggested Hours:

18 Hours

Theoretical Objectives:

1. Define terminology associated with high-voltage equipment.
2. Identify hazards and describe safe work practices pertaining to high-voltage breakers and starters.
 - i) corona discharge
 - ii) ozone gas
 - iii) proximity to energized exposed equipment
3. Interpret codes, regulations and standards pertaining to high-voltage equipment.
4. Interpret information pertaining to high-voltage equipment found on drawings and specifications.
 - i) as-builts
 - ii) schematics (AC, DC)
 - iii) shop drawings
 - iv) single-line drawings
 - v) drive drawings
5. Identify grounding conductors, equipment and components and describe their characteristics and applications.
6. Identify bonding conductors, equipment and components and describe their characteristics and applications.

7. Explain the purpose of grounding grids in relation to step and touch voltages.
8. Explain the function of high-voltage equipment.
9. Identify types of high-voltage equipment and describe their characteristics and applications.
 - i) distribution equipment
 - ii) contactors
 - iii) motor starters
 - iv) transformers
 - v) MCCs
 - vi) capacitors
 - vii) reactors
 - viii) switches
 - ix) disconnects
 - x) rectifiers
 - xi) reclosers
 - xii) VTs
 - xiii) CTs
 - xiv) isolating and load breaking switches
 - xv) transmission
 - xvi) breakers
 - xvii) protection devices
 - xviii) worker protective grounds
 - xix) hot sticks
10. Identify tools and equipment used to install and maintain high-voltage equipment and describe their applications and procedures for use.
11. Describe the procedures used to install high-voltage equipment.
12. Describe the procedures used to size and install ground grid and grounding conductors.
13. Describe the procedures used to isolate faults by de-energizing source of energy.
14. Identify types of commissioning tests and describe their applications.
 - i) polarity
 - ii) ground grid resistance
 - iii) hi-pot
 - iv) phasing
 - v) functionality
 - vi) timing
 - vii) current injection
 - viii) interlocking

- ix) ultrasonic detectors
- x) thermographic imaging device

15. Describe the procedures used to perform ground resistance testing and commissioning testing of high-voltage equipment.
16. Describe the procedures used to maintain high-voltage equipment.
17. Describe the procedures used to install and remove temporary protective ground equipment.

Practical Objectives:

N/A

Learning Outcomes:

- Demonstrate knowledge of high-voltage cables, their applications and operation.
- Demonstrate knowledge of procedures to install, splice and terminate high-voltage cables.
- Demonstrate knowledge of testing procedures.
- Demonstrate knowledge of procedures to maintain high-voltage cables.
- Demonstrate knowledge of procedures to install and remove temporary protective ground equipment.

IEL 2021 Red Seal Occupational Standard Reference:

- 14.01 Installs high-voltage systems.
- 14.02 Maintains high-voltage systems.

Suggested Hours:

12 Hours

Theoretical Objectives:

1. Define terminology associated with high-voltage cables.
2. Identify hazards and describe safe work practices pertaining to high-voltage cables.
3. Interpret codes, regulations and standards pertaining to high-voltage cables.
4. Interpret information pertaining to high-voltage cables found on drawings and specifications.
5. Identify types of high-voltage cables and describe their characteristics and applications.
 - i) armoured cables (with or without shielded conductor)
 - ii) TC cable
 - iii) trailing cables
 - iv) shielded cables
 - v) bus ducts
 - vi) cable bus
6. Identify high-voltage cable components and describe their characteristics and applications.
 - i) potheads
 - ii) stress relief terminations

- iii) strapping
- iv) bracing
- v) splice kits

7. Identify considerations and requirements for selecting high-voltage cables and components.
8. Identify tools and equipment used to install and maintain high-voltage cables and describe their applications and procedures for use.
9. Describe the procedures used to install high-voltage cables.
10. Describe the procedures used to terminate and splice high-voltage cables.
11. Identify and describe testing procedures for high-voltage cables.
12. Describe the procedures used to ground and bond high-voltage cables and their components.
13. Describe the procedures used to maintain high-voltage cables and their components.
14. Describe the procedures used to install and remove temporary protective ground equipment.

Practical Objectives:

N/A

Learning Outcomes:

- Demonstrate knowledge of renewable energy generating systems, their applications and operation.
- Demonstrate knowledge of renewable energy storage systems, their applications and operation.
- Demonstrate knowledge of procedures to install renewable energy generating and storage systems.
- Demonstrate knowledge of procedures to maintain renewable energy generating and storage systems.

IEL 2021 Red Seal Occupational Standard Reference:

- 13.01 Installs renewable energy generating and energy storage systems.
- 13.02 Maintains renewable energy generating and energy storage systems.

Suggested Hours:

12 Hours

Theoretical Objectives:

1. Define terminology associated with renewable energy systems.
2. Identify hazards and describe safe work practices pertaining to renewable energy systems.
3. Interpret codes, regulations and standards pertaining to renewable energy systems.
4. Interpret information pertaining to renewable energy systems found on drawings and specifications.
5. Identify types of renewable energy generating systems and describe their characteristics, applications and operation.
 - i) wind turbines
 - ii) photovoltaic modules/solar panels
 - iii) hydrokinetic
 - iv) geothermal
 - v) fuel cells
 - vi) hydraulic turbines
 - vii) tidal

6. Identify renewable energy generating system components and describe their characteristics, applications and operation.
 - i) transfer switches
 - ii) sun-tracking systems
 - iii) batteries
 - iv) charge controller
 - v) load bank
 - vi) inverters with anti-islanding capability
 - vii) isolation disconnects
 - viii) protection devices
7. Identify types of renewable energy generating system and component connections.
 - i) grid dependent
 - ii) grid independent (stand-alone)
8. Identify types of energy storage systems and components and describe their characteristics, applications and operation.
 - i) pumped hydro
 - ii) compressed air energy storage
 - iii) batteries (various technologies)
9. Identify types of energy storage system and component connections.
10. Identify tools and equipment used to install and maintain renewable energy systems and describe their applications and procedures for use.
11. Describe the procedures used to install renewable energy generating and storage systems and components.
12. Describe the procedures used to ground renewable energy generating and storage systems and their components.
13. Describe the procedures used to connect renewable energy generating and storage systems and components.
14. Describe the procedures used to maintain renewable energy generating and storage systems and their components.
15. Identify electronic components and describe their application as it pertains to renewable energy and storage systems.
16. Describe the procedures used to commission, startup, shutdown, and decommission renewable energy and storage systems.

Practical Objectives:

N/A

IEL-430

Single-Phase Motors II

Learning Outcomes:

- Demonstrate knowledge of procedures to maintain single-phase motors.

IEL 2021 Red Seal Occupational Standard Reference:

25.02 Maintains single-phase motors.

Suggested Hours:

6 Hours

Theoretical Objectives:

1. Identify hazards and describe safe work practices pertaining to single-phase motors.
2. Interpret codes, regulations and standards pertaining to single-phase motors.
3. Interpret information pertaining to single-phase motors found on drawings and specifications.
4. Identify tools and equipment used to maintain single-phase motors and describe their application and procedures for use.
5. Describe the procedures used to diagnose and test single-phase motors and their components.
6. Describe the procedures used to maintain single-phase motors and their components.

Practical Objectives:

N/A

Learning Outcomes:

- Demonstrate knowledge of procedures to maintain DC motors.

IEL 2021 Red Seal Occupational Standard Reference:

25.06 Maintains direct current (DC) motors.

Suggested Hours:

6 Hours

Theoretical Objectives:

1. Identify hazards and describe safe work practices pertaining to DC motors.
2. Interpret codes, regulations and standards pertaining to DC motors.
3. Interpret information pertaining to DC motors found on drawings and specifications.
4. Identify tools and equipment used to maintain DC motors and describe their application and procedures for use.
5. Describe the procedures used to diagnose and test DC motors and their components.
6. Describe the procedures used to maintain DC motors and their components.

Practical Objectives:

N/A

IEL-440

Three-Phase Motors II

Learning Outcomes:

- Demonstrate knowledge of procedures to maintain three-phase motors.

IEL 2021 Red Seal Occupational Standard Reference:

25.04 Maintains three-phase motors.

Suggested Hours:

9 Hours

Theoretical Objectives:

1. Identify hazards and describe safe work practices pertaining to three-phase motors.
2. Interpret codes, regulations and standards pertaining to three-phase motors.
3. Interpret information pertaining to three-phase motors found on drawings and specifications.
4. Identify tools and equipment used to maintain three-phase motors and describe their application and procedures for use.
5. Describe the procedures used to diagnose and test three-phase motors and their components.
6. Describe the procedures used to maintain three-phase motors and their components.

Practical Objectives:

N/A

Learning Outcomes:

- Demonstrate knowledge of startup and shutdown procedures.
- Demonstrate knowledge of commissioning and decommissioning procedures.

IEL 2015 Red Seal Occupational Standard Reference:

- 5.01 Commissions systems.
- 5.02 Performs shutdown and startup procedures.
- 5.03 Decommissions systems.

Suggested Hours:

18 Hours

Theoretical Objectives:

1. Define terminology associated with commissioning and decommissioning.
2. Identify hazards and describe safe work practices pertaining to starting up, shutting down, commissioning and decommissioning systems or equipment.
 - i) hazards
 - arc flash/blast
 - moving and rotating equipment
 - electric shocks
 - stored potential energy
 - mobile equipment
 - relocating power feed
 - ii) safe work practices
 - arc flash/blast analysis
 - lock-out and tag-out
 - verification of proper operation
3. Describe the purpose of starting up, shutting down, commissioning and decommissioning and the types of systems and equipment requiring it.
4. Identify and interpret information sources and documentation pertaining to the starting up, shutting down, commissioning and decommissioning of systems or equipment.
 - i) OEM manuals
 - ii) single line diagrams
 - iii) schematics
 - iv) panel schedules

- v) CEC
- vi) CSA standards
- vii) manufacturers' specifications
- viii) site policies and procedures

5. Describe startup and shutdown procedures and the types of systems and equipment requiring it.

6. Identify diagnostic and testing equipment and procedures for commissioning and decommissioning systems.

- i) multimeters
- ii) voltage testers
- iii) ammeters
- iv) oscilloscopes
- v) power quality analyzers
- vi) high-pot testers
- vii) thermographic imaging devices
- viii) phase/motor rotation meters
- ix) insulation resistance testers
- x) ground loop testers
- xi) acoustic level sensor
- xii) protective relay testers
- xiii) high-voltage equipment testers
- xiv) vibration analysis devices
- xv) very low frequency (VLF) testers
- xvi) partial discharge tester

Practical Objectives:

N/A

Learning Outcomes:

- Demonstrate knowledge of fire alarm systems, their applications and operation.
- Demonstrate knowledge of procedures to install, upgrade and connect fire alarm systems.
- Demonstrate knowledge of procedures to maintain fire alarm systems.

IEL 2021 Red Seal Occupational Standard Reference:

26.01 Installs fire alarm systems.
26.02 Maintains fire alarm systems.

Suggested Hours:

12 Hours

Theoretical Objectives:

1. Define terminology associated with fire alarm systems.
2. Identify hazards and describe safe work practices pertaining to fire alarm systems.
3. Interpret codes, regulations and standards pertaining to fire alarm systems.
 - i) Canadian Electrical Code
 - ii) Underwriters Laboratories of Canada
 - iii) National Building Code
 - iv) National Fire Code
 - v) Regulations specific to AHJ
4. Interpret information pertaining to fire alarm systems found on drawings and specifications.
5. Identify types of fire alarm systems and describe their characteristics, applications and operation.
 - i) non-addressable (Class A, Class B)
 - single stage/single zone
 - multi-zone
 - two-stage
 - ii) addressable (Class A, Class B, DCLA, DCLB, DCLC)
 - single stage/single zone
 - multi-zone
 - two-stage

6. Identify fire alarm system components and describe their characteristics and applications.
 - i) end of line devices
 - resistors
 - diodes
 - ii) initiating devices
 - heat sensors
 - pull stations
 - fire/flame detectors
 - flow switches
 - gate valve switch
 - monitoring modules
 - smoke detectors
 - tamper switches
 - iii) signalling devices
 - horns
 - strobes
 - bells
 - iv) panels
 - fire alarm panels (stand-by batteries)
 - annunciator panels
 - v) relays
7. Describe types of associated systems that interconnect with fire alarm systems.
 - i) fire suppression systems
 - ii) emergency power supplies fan shutdown/startup
 - iii) PA systems
 - iv) local fire department
 - v) magnetic door holders
 - vi) elevator homing contactors
 - vii) egress door securing and releasing devices
 - viii) building automation systems
 - ancillary devices (suppression system contactors and fans)
8. Identify considerations and requirements for selecting fire alarm systems and their components.
9. Identify tools and equipment relating to fire alarm systems and describe their applications and procedures for use.
10. Describe the procedures used to install and connect fire alarm systems and their components.

11. Describe the procedures used to maintain fire alarm systems and their components.
12. Describe the procedures used to test fire alarm systems and their components.
13. Describe the procedures to commission and verify fire alarm systems.

Practical Objectives:

N/A

Learning Outcomes:

- Demonstrate knowledge of security and surveillance systems, their applications and operation.
- Demonstrate knowledge of procedures to install and connect security and surveillance systems.
- Demonstrate knowledge of procedures to maintain security and surveillance systems.

IEL 2021 Red Seal Occupational Standard Reference:

26.03 Installs security and surveillance systems.
26.04 Maintains security and surveillance systems.

Suggested Hours:

6 Hours

Theoretical Objectives:

1. Define terminology associated with security and surveillance systems.
2. Identify hazards and describe safe work practices pertaining to security and surveillance systems.
3. Interpret codes, regulations and standards pertaining to security and systems.
4. Interpret information pertaining to security and surveillance systems found on drawings and specifications.
5. Identify types of security and surveillance systems and describe their characteristics, applications and operation.
 - i) perimeter
 - ii) space
 - iii) spot
6. Identify security and surveillance system components and describe their characteristics and applications.
 - i) devices
 - detection/monitoring
 - alarm/signaling
 - access
 - ii) control panels

7. Describe types of associated systems that interconnect with security and surveillance systems.
 - i) central alarm monitoring
 - ii) automatic doors
 - iii) LAN
 - iv) building automation systems
 - v) lighting
8. Identify tools and equipment relating to security and surveillance systems and describe their applications and procedures for use.
9. Identify considerations and requirements for selecting security and surveillance systems and their components.
10. Describe the procedures used to install and connect security and surveillance systems and their components.
11. Describe the procedures used to maintain security and surveillance systems and components.
12. Describe the procedures used to test security and surveillance systems and their components.
13. Describe the procedures used to commission and verify security and surveillance systems.

Practical Objectives:

N/A

IEL-460

Communication Systems (Voice/Data/Video and Closed-Circuit TV)

Learning Outcomes:

- Demonstrate knowledge of VDV and CCTV systems, their applications and operation.
- Demonstrate knowledge of procedures to install and connect VDV and CCTV systems
- Demonstrate knowledge of procedures to maintain VDV and CCTV systems.

IEL 2021 Red Seal Occupational Standard Reference:

27.01 Installs communication systems.
27.02 Maintains communication systems.

Suggested Hours:

6 Hours

Theoretical Objectives:

1. Define terminology associated with VDV and CCTV systems.
2. Identify hazards and describe safe work practices pertaining to VDV and CCTV systems.
3. Interpret codes, regulations and standards pertaining to VDV and CCTV systems.
4. Interpret information pertaining to VDV and CCTV systems found on drawings and specifications.
5. Identify types of VDV and CCTV systems and describe their characteristics, applications and operation.
6. Identify VDV and CCTV system components and accessories and describe their characteristics and applications.
7. Identify methods of data transfer and describe their applications.
 - i) structured cabling
 - ii) fiber optic
 - iii) wireless
8. Describe types of associated systems that interconnect with VDV and CCTV systems.

9. Identify tools and equipment relating to VDV and CCTV systems and describe their applications and procedures for use.
10. Identify considerations and requirements for selecting VDV and CCTV systems and their components.
11. Describe the procedures used to install and connect VDV and CCTV systems and their components.
12. Describe the procedures used to maintain VDV and CCTV systems and their components.
13. Describe the procedures used to test VDV and CCTV systems and their components.

Practical Objectives:

N/A

IEL-465

Communication Systems (Public Address and Intercom Systems)

Learning Outcomes:

- Demonstrate knowledge of public address (PA) and intercom systems, their applications and operation.
- Demonstrate knowledge of procedures to install and connect PA and intercom systems.
- Demonstrate knowledge of procedures to maintain PA and intercom systems.

IEL 2021 Red Seal Occupational Standard Reference:

- 27.01 Installs communication systems.
- 27.02 Maintains communication systems.

Suggested Hours:

6 Hours

Theoretical Objectives:

1. Define terminology associated with PA and intercom systems.
2. Identify hazards and describe safe work practices pertaining to PA and intercom systems.
3. Interpret codes, regulations and standards pertaining to PA and intercom systems.
4. Interpret information pertaining to PA and intercom systems found on drawings and specifications.
5. Identify types of PA and intercom systems and describe their characteristics, applications and operation.
6. Identify PA and intercom system components and accessories and describe their characteristics and applications.
7. Identify methods of data transfer and describe their applications.
 - i) structured cabling
 - ii) fiber optic
 - iii) wireless
8. Describe types of associated systems that interconnect with PA and intercom systems.

9. Identify tools and equipment relating to PA and intercom systems and describe their applications and procedures for use.
10. Identify considerations and requirements for selecting PA and intercom systems and their components.
11. Describe the procedures used to install and connect PA and intercom systems and their components.
12. Describe the procedures used to maintain PA and intercom systems and their components.
13. Describe the procedures used to test PA and intercom systems and their components.

Practical Objectives:

N/A

Learning Outcomes:

- Demonstrate knowledge of nurse call systems, their applications and operation.
- Demonstrate knowledge of procedure to install and connect nurse call systems.
- Demonstrate knowledge of procedures to maintain nurse call systems.

IEL 2021 Red Seal Occupational Standard Reference:

27.01 Installs communication systems.
27.02 Maintains communication systems.

Suggested Hours:

6 Hours

Theoretical Objectives:

1. Define terminology associated with nurse call systems.
2. Identify hazards and describe safe work practices pertaining to nurse call systems.
3. Interpret codes, regulations and standards pertaining to nurse call systems.
4. Interpret information pertaining to nurse call systems found on drawings and specifications.
5. Identify types of nurse call systems and describe their characteristics, applications and operation.
6. Identify nurse call system components and accessories and describe their characteristics and applications.
7. Identify methods of data transfer and describe their applications.
 - i) structured cabling
 - ii) fiber optic
 - iii) wireless
8. Describe types of associated systems that interconnect with nurse call systems.
9. Identify considerations and requirements for selecting nurse call systems and their components.

10. Describe the procedures used to install and connect nurse call systems and their components.
11. Describe the procedures used to maintain nurse call systems and their components.
12. Describe the procedures used to test nurse call systems and their components.

Practical Objectives:

N/A

Learning Outcomes:

- Demonstrate knowledge of building automation and control systems, their applications and operation.
- Demonstrate knowledge of procedures to install building automation and control systems
- Demonstrate knowledge of procedures to maintain building automation and control systems
- Demonstrate knowledge of emerging technologies and sustainable construction practices in smart buildings.

IEL 2021 Red Seal Occupational Standard Reference:

28.01 Installs building automation systems.
28.02 Maintains building automation systems.

Suggested Hours:

12 Hours

Theoretical Objectives:

1. Define terminology associated with building automation and control systems.
 - i) smart buildings
 - ii) energy efficiency
 - iii) smart grids
2. Identify hazards and describe safe work practices pertaining to building automation and control systems.
3. Interpret codes, regulations and standards pertaining to building automation and control systems.
4. Interpret information pertaining to building automation and control systems found on drawings and specifications.
5. Identify types of building automation and control systems and describe their characteristics, applications and operation
 - i) energy management
 - ii) security and surveillance

6. Identify building automation and control systems and describe their characteristics, applications, and operation.
 - i) network cabling
 - ii) sensors and devices (temperature, occupancy, light levels)
 - iii) servers
 - iv) power over ethernet (PoE) switches
 - v) graphical user interfaces (GUIs)
7. Identify types of building control systems and describe their characteristics and applications.
 - i) pneumatic
 - ii) analog electrical
 - III) direct digital
 - iv) computer control
8. Identify building control systems components and describe their characteristics and applications.
 - i) damper motors
 - ii) valves
 - iii) contactors
 - iv) contacts
 - v) annunciators
 - vi) thermostats
 - vii) solenoids
 - viii) flow and sail switches
 - ix) sensors
9. Describe types of associated systems that interconnect with building automation and control systems.
 - i) local area network (LAN)
 - ii) elevator systems
 - iii) fire alarm and suppression systems
 - iv) security and surveillance systems
 - v) heating, ventilation and air conditioning (HVAC)
 - vi) lighting
 - vii) renewable energy systems
10. Identify tools and equipment used to install and maintain building automation and control systems and describe their applications and procedures for use.
11. Identify considerations and requirements for selecting building automation and control systems and their components.

12. Describe the procedures used to install building automation and control systems and their components.
13. Describe the procedures used to maintain building automation and control systems and their components.
13. Describe the procedures used to test building automation and control systems and their components.
14. Describe the procedures used to commission and verify building automation and control systems.
16. Describe emerging technologies and sustainable practices.
 - i) monitoring and diagnostics
 - ii) energy-efficient materials
 - iii) innovations in smart buildings
 - (Internet of Things (IoT))
 - cloud-based systems

Practical Objectives:

N/A

Learning Outcomes:

- Demonstrate knowledge of procedures to perform predictive/preventative maintenance.

IEL 2021 Red Seal Occupational Standard Reference:

Integrated throughout

Suggested Hours:

12 Hours

Theoretical Objectives:

1. Define terminology associated with predictive/preventative maintenance.
2. Identify hazards and describe safe work practices pertaining to predictive/preventative maintenance.
3. Identify tools and equipment used for predictive/preventative maintenance and describe their applications and procedures for use.
4. Identify and interpret sources of information pertaining to predictive/preventative maintenance.
 - i) manufacturers' specifications
 - ii) OEM manuals
 - iii) standards and charts
 - iv) data/historical records
5. Identify types of maintenance programs and describe their purpose.
 - i) preventative
 - ii) predictive
 - iii) proactive
6. Identify methods of predictive maintenance and describe their associated procedures.
 - i) non-destructive testing
 - megohm meter
 - thermal
 - ultra sonic
 - micrometer
 - ii) vibration analysis

iii) oil analysis

7. Record and interpret data collected during predictive/preventative maintenance.

Practical Objectives:

N/A

Learning Outcomes:

- Demonstrate knowledge of automated control systems, their components, applications and operation.
- Demonstrate knowledge of data communication systems for automated control systems.
- Demonstrate knowledge of procedures to install and connect automated control systems and their components.
- Demonstrate knowledge of procedures to maintain automated control systems.
- Demonstrate knowledge of procedures to program, configure and optimize automated control systems.

IEL 2021 Red Seal Occupational Standard Reference:

- 30.01 Installs automated control systems.
- 30.02 Maintains automated control systems.
- 30.03 Programs automated control systems.
- 30.04 Optimizes system performance.

Suggested Hours:

60 Hours

Theoretical Objectives:

1. Define terminology associated with automated control systems.
2. Interpret codes, regulations and standards pertaining to automated control systems.
3. Interpret information pertaining to automated control systems found on drawings and specifications.
4. Identify sources of information pertaining to automated control system service, maintenance, configuration and programming.
5. Identify number and code systems and describe their applications.
 - i) number systems
 - binary
 - decimal
 - hexadecimal
 - octal
 - ii) code systems

- binary coded decimal (BCD)
- American Standard Code for Information Interchange (ASCII)
- gray code

6. Explain and interpret control circuit logic.

- i) relay logic
- ii) ladder logic
- iii) function block
- iv) text based

7. Identify types of automated control systems and describe their characteristics.

- i) PLC
- ii) SCADA
- iii) DCS
- iv) DNP

8. Identify automated control system components and describe their purpose and operation.

- i) hardware
 - power supply
 - central processing unit (CPU)
 - input/output (I/O) system
 - programming terminals
- ii) software

9. Identify types of automated control system data communication systems and describe their characteristics.

- i) Ethernet
- ii) Modbus
- iii) Profibus
- iv) BACnet
- v) Fieldbus
- vi) DeviceNet

10. Identify automated control system data communication system components and describe their characteristics.

11. Identify devices used to communicate with interconnected automated control systems.

- i) handheld mobile devices
- ii) computer
- iii) human machine interface (HMI)

12. Identify basic instruction sets for ladder logic and describe their applications.

- i) examine-on (normally open contact)

- ii) examine-off (normally closed contact)
- iii) output energized (OTE)

13. Identify tools and equipment relating to automated control systems and describe their applications and procedures for use.

14. Describe the procedures used to install and connect automated control systems and their components.

15. Describe the procedures used to maintain automated control systems and their components.

16. Identify automated control system programming languages and describe their applications.

- i) ladder diagram (LD)
- ii) function block diagram (BD)
- iii) structured text (ST)
- iv) instruction list (IL)
- v) sequential function chart (SFC)

17. Describe the procedures used to program, edit and configure automated control systems.

- i) online
- ii) offline

18. Perform conversions between number systems.

Practical Objectives:

1. Design, program, and execute a program for a PLC.

Learning Outcomes:

- Demonstrate knowledge of pneumatic control systems, their components and operation.
- Demonstrate knowledge of pneumatic related calculations.
- Demonstrate knowledge of procedures to install pneumatic control system equipment and components.
- Demonstrate knowledge of procedures to maintain pneumatic control system equipment and components.

IEL 2021 Red Seal Occupational Standard Reference:

31.01 Installs pneumatic control systems.
31.02 Maintains pneumatic control systems.

Suggested Hours:

18 Hours

Theoretical Objectives:

1. Define terminology associated with pneumatic control systems.
2. Identify hazards and describe safe work practices pertaining to pneumatic control systems.
3. Interpret codes, regulations and standards pertaining to pneumatic control systems.
4. Interpret information pertaining to pneumatic control systems devices found on drawings and specifications.
5. Interpret schematics to determine the operation of a pneumatic control system.
6. Identify types of pneumatic control systems and describe their applications and operation.
 - i) instrument air
 - ii) instrument gas
7. Identify types of pneumatic control system components and describe their purpose and operation.

8. Identify tools and equipment used to install and maintain pneumatic control systems and describe their applications and procedures for use.
9. Describe the procedures used to install pneumatic control systems and their components.
10. Describe the procedures used to maintain pneumatic control systems and their components.
11. Perform pneumatic related calculations.
 - i) signal conversion
 - ii) unit conversion
12. Describe the procedures to commission, startup, shutdown and decommission pneumatic control systems.

Practical Objectives:

N/A

Learning Outcomes:

- Demonstrate knowledge of hydraulic systems and control devices, their applications and operation.
- Demonstrate knowledge of hydraulic control systems, their components and operation.
- Demonstrate knowledge of procedures to install hydraulic control system equipment and components.
- Demonstrate knowledge of procedures to maintain hydraulic control system equipment and components.

IEL 2021 Red Seal Occupational Standard Reference:

31.03 Installs hydraulic control systems.
31.04 Maintains hydraulic control systems.

Suggested Hours:

12 Hours

Theoretical Objectives:

1. Define terminology associated with hydraulic systems and controls.
2. Identify hazards and describe safe work practices pertaining to hydraulic systems and controls.
3. Interpret codes, regulations and standards pertaining to hydraulic systems and controls.
4. Interpret information pertaining to hydraulic systems and controls found on drawings and specifications.
5. Identify schematics to determine the operation of hydraulic control systems.
6. Identify hydraulic control system components and describe their purpose and operation.
 - i) pumps
 - ii) motors
 - iii) actuators
 - iv) valves
 - v) accumulators

7. Identify tools and equipment used to install and maintain hydraulic control systems and components and describe their applications and procedures for use.
8. Describe the procedures used to install hydraulic control systems and their components.
9. Describe the procedures used to maintain hydraulic control systems and their components.
10. Describe the procedures to commission, startup, shutdown and decommission hydraulic control systems.

Practical Objectives:

N/A

Learning Outcomes:

- Demonstrate knowledge of analog devices, their applications and operation.
- Demonstrate knowledge of procedures to install discrete and analogue devices.
- Demonstrate knowledge of procedures to maintain discrete and analog devices.

IEL 2021 Red Seal Occupational Standard Reference:

- 29.01 Installs discrete input/output (I/O) devices.
- 29.02 Maintains discrete input/output (I/O) devices.
- 29.03 Installs analog input/output (I/O) devices.
- 29.04 Maintains analog input/output (I/O) devices.

Suggested Hours:

30 Hours

Theoretical Objectives:

1. Define terminology associated with discrete and analog devices.
2. Identify hazards and describe safe work practices pertaining to discrete and analog devices.
3. Interpret codes, regulations and standards pertaining to discrete and analog control devices.
4. Interpret information pertaining to discrete and analog control devices found on drawings and specifications.
5. Explain the use of discrete versus analog devices.
6. Identify types of discrete control devices and describe their characteristics and applications.
 - i) input
 - pressure
 - proximity
 - level
 - motion
 - flow
 - temperature

- vibration
- stop/start stations

ii) output

- solenoid valves
- relays
- indicator lights

7. Identify types of analog control devices and describe their characteristics and applications.

i) input

- pressure
- proximity
- level
- motion
- flow
- temperature and vibration transmitters
- proportional valves
- encoders
- tachometers

ii) output

- proportional valves
- linear actuators
- transducers

8. Explain the use of discrete and analog control devices for measurement.

- i) pressure
- ii) temperature
- iii) flow
- iv) level
- v) mass
- vi) density
- viii) position

9. Identify discrete control device components and accessories and describe their characteristics and applications.

10. Identify types of signals used with discrete and analog devices and describe their characteristics, applications and operation.

- i) resistance
- ii) current
- iii) voltage (sinking or sourcing)

11. Identify considerations and requirements for selecting discrete and analog control devices, their components and accessories.
12. Identify tools and equipment used to install and maintain discrete and analog control devices and describe their applications and procedures for use.
13. Describe the procedures used to install and connect discrete and analog control devices, their components and accessories.
14. Describe the procedures used to calibrate discrete and analog control devices.
15. Describe the procedures used to maintain discrete and analog control devices, their components and accessories.
16. Describe the procedures used to test discrete and analog control devices, their components and accessories.

Practical Objectives:

1. Install and calibrate an analog device.

Learning Outcomes:

- Demonstrate knowledge of process control and its purpose.
- Demonstrate knowledge of process controllers, their components and operation.
- Demonstrate knowledge of procedures to install, calibrate, troubleshoot and test process controllers.
- Demonstrate knowledge of procedures to tune process controllers.

IEL 2021 Red Seal Occupational Standard Reference:

30.02 Maintains automated control systems.

30.04 Optimizes system performance.

Suggested Hours:

30 Hours

Theoretical Objectives:

1. Define terminology associated with process control.
2. Identify hazards and describe safe work practices pertaining to process control.
3. Identify tools and equipment relating to process controllers and describe their applications and procedures for use.
4. Interpret information pertaining to process control found on drawings and specifications.
5. Explain process control and its purpose.
6. Identify methods of process control and describe their applications.
7. Identify modes of process control and describe their characteristics, operation and combinations.
 - i) on-off
 - ii) proportional (P)
 - iii) integral (I)
 - iv) derivative (D)
 - v) P, I, PI, PD, PID
8. Explain process dynamics and their impact on process control.

9. Identify considerations and requirements for selecting process controllers.
10. Describe the procedures used to install, connect, and set-up process controllers.
11. Describe the procedures used to tune process controllers.
12. Identify types of control loops and describe their operation.
 - i) closed loop
 - ii) open loop
13. Describe the procedures used to troubleshoot process controllers.
14. Describe the procedures to commission, startup, shutdown and decommission process controllers.

Practical Objectives:

1. Set up a control loop.

Learning Outcomes:

- Demonstrate knowledge of other fixed equipment and controls, their applications, maintenance, and procedures for use.
- Demonstrate knowledge of limitations and ratings of other fixed equipment and controls.
- Demonstrate knowledge of procedures to install other fixed equipment and controls.
- Demonstrate knowledge of procedures to maintain other fixed equipment and controls.

IEL 2021 Red Seal Occupational Standard Reference:

24.01 Installs other fixed equipment and associated controls.
24.02 Maintains other fixed equipment and associated controls.

Suggested Hours:

12 Hours

Theoretical Objectives:

1. Define terminology associated with other fixed equipment and controls.
2. Identify hazards and describe safe work practices pertaining to other fixed equipment and controls.
3. Identify types of other fixed equipment and controls
 - i) welding equipment
 - ii) electro-magnets
 - iii) electrostatic precipitators
 - iv) industrial equipment
 - v) x-ray equipment
 - vi) conveyors
 - vii) charging equipment
4. Interpret information pertaining to connecting other fixed equipment and controls.
5. Describe the procedures used to identify and replace malfunctioning components of other fixed equipment and controls.
6. Describe the procedures used to operate other fixed equipment and controls.

7. Describe the procedures used to troubleshoot and maintain other fixed equipment and controls.

Practical Objectives:

N/A

Learning Outcomes:

- Demonstrate knowledge of the Red Seal Occupational Standard and its relationship to the Red Seal Exam.
- Demonstrate knowledge of overall comprehension of the trade in preparation for the Red Seal Exam.

CEL 2021 Red Seal Occupational Standard Reference:

Entire Red Seal Occupational Standard (RSOS)

Suggested Hours:

30 Hours

Theoretical Objectives:

1. Define terminology associated with an RSOS.
 - i) major work activity
 - ii) levels
 - iii) tasks
 - iv) sub-tasks
2. Explain how an RSOS is developed and the link it has with the Red Seal exam.
 - i) development
 - ii) validation
 - iii) level and task weighting
 - iv) examination breakdown (pie-chart)
3. Identify Red Seal products and describe their use for preparing for the Red Seal exam.
 - i) red seal website
 - ii) examination preparation guide
 - iii) sample question
 - iv) examination breakdown
 - v) self-assessment
4. Explain the relationship between the RSOS and the AACs.
5. Review Common Occupational Skills for the Industrial Electrician trade as identified in the RSOS.
 - i) safety-related functions
 - ii) tools and equipment

- iii) organizes work
- iv) fabricates and installs support components
- v) commissions and decommission systems
- vi) communication and mentoring techniques

6. Review Process to Install and Maintain Generating, Transmission, Distribution and Service Systems for the Industrial Electrician trade as identified in the RSOS.

- i) utility and non-utility supply services and metering equipment
- ii) protection devices
- iii) low-voltage distribution systems
- iv) power conditioning systems
- v) grounding, bonding and ground-fault protection and detection systems
- vi) power generating and conversion systems
- vii) renewable energy generating and energy storage systems
- viii) high-voltage systems
- ix) transformers

7. Review process to Install and Maintain Wiring Systems for the Industrial Electrician trade as identified in the RSOS.

- i) raceways, cables, conductors and enclosures
- ii) branch circuitry and devices
- iii) heating, ventilation and air-conditioning electrical components
- iv) electric heating system and controls
- v) exit and emergency lighting systems
- vi) cathodic protection systems

8. Review process to Install and Maintain Rotating and Other Fixed Equipment for the Industrial Electrician trade as identified in the RSOS.

- i) motor starters and control devices
- ii) drives
- iii) other fixed equipment and associated controls
- iv) motors
- v) communication systems
- vi) integrated control systems

9. Review process to Install and Maintain Signalling and Communication Systems for the Industrial Electrician trade as identified in the RSOS.

- i) signalling systems
- ii) communication systems
- iii) building automation systems

10. Review process to Install and Maintain Process Control Systems for the Industrial Electrician trade as identified in the RSOS.

- i) input/output devices

- ii) automated control systems
- iii) pneumatic and hydraulic control systems

11. Review Canadian Electrical Code.

Practical Objectives:

N/A

Feedback and Revisions

This AACs will be amended periodically; comments or suggestions for improvements should be directed to:

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470 York St. PO Box 6000
Fredericton, NB E3B 5H1
Tel: 506-453-2260
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Newfoundland and Labrador:

Apprenticeship and Trades Certification
Immigration, Population Growth and Skills
Confederation Building, West Block
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www.nsapprenticeship.ca

Any comments or suggestions received will be reviewed and considered to determine the course of action required. If the changes are deemed to be minor, they will be held for implementation during the next review cycle. If immediate change is deemed appropriate and approved by the Atlantic Trade Advisory Committee, it will result in a revision to this version of the AACs and will be detailed in the following section.

Version Changes

Revision Date	Section	Description of Change
2024	All Sections	Updated to RSOS