



INDUSTRIAL ELECTRICIAN 2016

Based on the Interprovincial Program Guide
(pg. 12 for Program Structure)



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The CCDA Executive Committee recognizes this Interprovincial Program Guide as the national curriculum for the occupation of Industrial Electrician.

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Introduction

Jurisdictions have long recognized the benefit of pooling resources in the development and maintenance of apprenticeship training standards. A successful example of this is the Interprovincial Standards Red Seal Program itself. Essential to the establishment of standards is the development of suitable training systems and programs which enable tradespeople to acquire certification based on these standards. While certification is the responsibility of Apprenticeship administrators throughout Canada, the development and delivery of technical training is the responsibility of jurisdictions.

In 1999, work to develop common training for apprenticeship programs within the Atlantic Provinces began. To date, 22 Curriculum Standards have been developed through the Atlantic Standards Partnership (ASP) project to assist programming staff and instructors in the design and delivery of technical training. Similarly, the Canadian Council of Directors of Apprenticeship (CCDA) embarked on a process for the development of national Interprovincial Program Guides (IPGs) for the Boilermaker, Carpenter and Sprinkler System Installer trades. At its January 2005 strategic planning session, the CCDA identified developing common training standards as one of key activities in moving towards a more cohesive apprenticeship system.

With the support of Human Resources and Skills Development Canada (HRSDC), several provinces and territories have partnered to build on the ASP and the CCDA processes to further develop IPGs to be used across the country. This partnership will create efficiencies in time and resources and promote consistency in training and apprentice mobility.

User Guide

According to the Canadian Apprenticeship Forum, the IPG is: "a list of validated technical training outcomes, based upon those sub-tasks identified as common core in the National Occupational Analysis (NOA), and validated by industry in the provinces and territories as incorporating the essential tasks, knowledge and skills associated with a given trade."

Learning outcomes contained in the IPG represent the minimum common core content for the development of jurisdictional training standards and outlines. IPGs are developed based on the NOAs and extensive industry consultation. The IPG is intended to assist program development staff in the design of jurisdictional plans of training. Each jurisdiction has the flexibility to add additional content.

The IPG was deliberately constructed for ease of use and flexibility of structure in order to adapt to all delivery requirements. It details units of training, unit outcomes and objectives. It does 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 IPG does not dictate study materials, textbooks or learning activities to be used in delivery.

The IPG document includes a recommended leveling structure to facilitate mobility for apprentices moving from one jurisdiction to another. Because of difference in jurisdictional regulations and program durations, levels are offered as suggestions only.

Structure

The IPG is divided into units. The unit codes are used as a means of identification and are not intended to convey the order of delivery. Prerequisites have not been detailed. Each unit consists of *Learning Outcomes* and *Objectives and Content*.

The *Learning Outcomes* are the specific performances that must be evaluated. Wording of the learning outcomes, "Demonstrate knowledge of...", acknowledges the broad spectrum of ways in which knowledge can be shown. It is at the discretion of each jurisdiction to determine the manner in which learning outcomes are evaluated; theoretically, practically or a combination of both.

User Guide *(continued)*

The *Objectives and Content* for the unit details the information to be covered in order to achieve the performances specified in the *Learning Outcomes*. These objectives can be either theoretical or practical in nature, based on the requirements identified through the industry consultation process. The learning activities used to cover the objectives are at the discretion of the jurisdiction; however, practically worded objective statements have been used where industry indicated a need for the apprentices to receive exposure to performing the task or skill outlined while attending technical training. For example, this exposure could be done through instructor demonstration or individual or group performance of the skill or task. This practical training will help to reinforce the theoretical component of the technical training.

Detailed content for each objective has not been developed. Where detail is required for clarity, content has been provided. The content listed within the IPG document is **not** intended to represent an inclusive list; rather, it is included to illustrate the intended direction for the objective. Content may be added or extended in jurisdictional training plans as required.

Jurisdictions are free to deliver the IPG units one at a time or concurrently, provided that all *Learning Outcomes* are met. The IPG does not indicate the amount of time to be spent on a particular unit as the length of time required to deliver the *Learning Outcomes* successfully will depend upon the learning activities and teaching methods used.

IPG Glossary of Terms

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

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 you 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; tell 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.

IPG Glossary of Terms *(continued)*

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 or not it is working correctly.

TROUBLESHOOT

To follow a systematic procedure to identify and locate a problem or malfunction and its cause.

Essential Skills Profiles

Essential Skills are the skills needed for work, learning and life. They provide the foundation for learning all the other skills that enable people to evolve within their jobs and adapt to workplace change.

Over the past several years, the Government of Canada has conducted research examining the skills people use at work. From this research, Essential Skills Profiles have been developed for various occupations.

For more information regarding Essential Skills and to access Essential Skills Profiles for specific occupations, visit Human Resources and Skills Development Canada's Essential Skills website at:

http://www.hrsdc.gc.ca/eng/workplaceskills/essential_skills/general/home.shtml

Profile Chart

OCCUPATIONAL SKILLS			
ELE-100 Safety	ELE-105 Tools and Equipment	ELE-110 Access Equipment	ELE-115 Hoisting, Lifting and Rigging
ELE-120 Introduction to Communication and Trade Documentation	ELE-125 Drawings, Schematics and Specifications	ELE-130 Introduction to the Canadian Electrical Code	ELE-135 Introduction to Computer Use
ELE-150 Conductors and Cables	ELE-160 Conduit, Tubing and Fittings	ELE-165 Raceways, Wireways and Busways	ELE-260 Job Planning
ELE-455 Fiber Optics	ELE-460 Introduction to Commissioning		
WIRING AND LIGHTING SYSTEMS			
ELE-170 Fundamental Wiring	ELE-175 Lighting Systems and Controls	ELE-140 DC Theory	ELE-145 DC Circuits
ELE-220 Voltage Drop and Power Loss	ELE-200 Single-Phase AC Theory	ELE-210 Single-Phase AC Circuits	ELE-225 Single-Phase Service Entrance
ELE-205 Three-Phase Theory	ELE-340 Three-Phase Service Entrance	ELE-240 Exit/Emergency Lighting Systems	ELE-215 Power Supply and Rectifiers
POWER DISTRIBUTION AND GENERATING SYSTEMS			
ELE-415 High Voltage Wiring	ELE-410 High Voltage Breakers and Starters	ELE-350 Transformers	ELE-230 Distribution Equipment
ELE-155 Grounding and Bonding			

Profile Chart *(continued)*

ELECTRICAL EQUIPMENT			
ELE-235 Protective Devices	ELE-315 DC Motors and Controls	ELE-250 Single-Phase Motors	ELE-330 Three-Phase Motors
ELE-245 Motor Starters and Controls I	ELE-325 Motor Starters and Controls II	ELE-425 Drives	ELE-310 Electric Heating Surface Units
ELE-435 Cathodic Protection Systems	IEL-355 Vibration Analysis	IEL-360 Digital Electronics	
EMERGENCY AND STAND-BY SYSTEMS			
ELE-345 Emergency Stand-by Units	ELE-320 DC Generators	ELE-335 AC Generators	ELE-430 Alternative Power Systems
COMMUNICATION SYSTEMS			
ELE-440 Fire Alarm Systems	ELE-445 Security Systems	ELE-450 Communication Systems	
PROCESS CONTROL SYSTEMS			
IEL-465 Analog Devices	ELE-255 Discrete Control Devices	IEL-470 Process Control	ELE-400 Introduction to Programmable Logic Controllers
ELE-405 Introduction to Programmable Logic Controller Programming	IEL-365 Hydraulic Circuits and Control Systems	IEL-370 Pneumatic Control Systems	ELE-420 Distribution System Conditioning
BUILDING AND ENVIRONMENTAL CONTROL SYSTEMS			
ELE-300 Heating, Ventilation and Cooling Systems	ELE-305 Heating, Ventilation and Cooling System Controls	IEL-475 Environmental Control Systems	IEL-480 Building Automation Systems

Program Structure - Nova Scotia Apprenticeship Program

The courses listed below are required technical training in the Nova Scotia Industrial Electrician Apprenticeship Program.

Nova Scotia Course #	Nova Scotia Course Name	Nova Scotia Prerequisites	Interprovincial Program Guide (IPG) Content To Be Covered		
			IPG Units		Pg. #
Level 1 (7 weeks)					
	Integrated Milestone	None	MENT-1801	Workplace Mentoring I <i>(NS Specific)</i>	25
ELEA-0801	Safety Practices / Building Codes	None	ELE-100	Safety	26
			ELE-130	Introduction to the Canadian Electrical Code	27
ELEA-0802	Generic Blueprint	None	ELE-125	Drawings, Schematics and Specifications	28
			ELE-120	Introduction to Communication and Trade Documentation	29
ELEA-1804	Tools & Equipment	ELEA-0801	ELE-105	Tools and Equipment	30
			ELE-110	Access Equipment	31
			ELE-115	Hoisting, Lifting and Rigging	32
			ELE-135	Introduction to Computer Use	34
ELEA-1805	DC Theory / Series & Parallel Circuits	None	ELE-140	DC Theory	35
			ELE-145	DC Circuits	37
ELEA-1806	Conductors, Cables & Voltage Drop	ELEA-0801, 1805	ELE-150	Conductors and Cables	38
			ELE-220	Voltage Drop and Power Loss	40
ELEA-1824	Fundamental Wiring	ELEA-1806	ELE-170	Fundamental Wiring	41
ELEA-1807	Raceway installation	ELEA-1806	ELE-165	Raceways, Wireways and Busways	43
			ELE-160	Conduit, Tubing and Fittings	45
Level 2 (7 weeks)					
ELEA-1834	Single-Phase Theory 1	ELEA-1806 Co-requisite: ELEA-1831	ELE-200	Single-Phase AC Theory	48
ELEA-1831	Single-Phase Theory 2	ELEA-1806 Co-requisite: ELEA-1834	ELE-210	Single-Phase AC Circuits	49
ELEA-1809	Three-Phase Theory / Distribution Systems Conditioning	ELEA-1804, 1831, 1834	ELE-205	Three-Phase Theory	50
			ELE-420	Distribution System Conditioning	51

Nova Scotia Course #	Nova Scotia Course Name	Nova Scotia Prerequisites	Interprovincial Program Guide (IPG) Content To Be Covered		
			IPG Units		Pg. #
ELEA-1810	Distribution Equipment / Protective Devices	ELEA-1804, 1831, 1834	ELE-230	Distribution Equipment	52
			ELE-235	Protective Devices	54
ELEA-1825	Lighting & Controls	ELEA-1804, 1831, 1834	ELE-175	Lighting Systems and Controls	56
			ELE-240	Exit / Emergency Lighting Systems	58
ELEA-1808	Heating Systems	ELEA-1804, 1806	ELE-310	Electric Surface Heating Systems	60
			ELE-305	Heating, Ventilation and Cooling System Controls	62
			ELE-300	Heating, Ventilation and Cooling Systems	64
ELEA-1832	Single-Phase Service Entrance	ELEA-1807, 1810	ELE-225	Single Phase Service Entrance	66
			ELE-155	Grounding and Bonding	68
Level 3 (7 weeks, 6 courses)					
ELEA-1812	Transformers	ELEA-1809	ELE-350	Transformers	70
ELEA-1814	DC Machines & Controls	ELEA-1831, 1834	ELE-315	DC Motors and Controls	72
			ELE-320	DC Generators	74
ELEA-1816	AC Generators / Three-Phase Motors	ELEA-1809	ELE-335	AC Generators	76
			ELE-330	Three-Phase Motors	78
ELEA-1815	Single-Phase Motors	ELEA-1809	ELE-250	Single-Phase Motors	80
ELEA-1817	Motor Starters / Control Devices *(2 week course)	ELEA-0802, 1815, 1816	ELE-245	Motor Starters and Controls I	82
			ELE-325	Motor Starters and Controls II	84
			ELE-255	Discrete Control Devices	86
ELEA-1833	Three-Phase Service Entrance	ELEA-1812, 1832	ELE-340	Three-Phase Service Entrance	88
Level 4 (6 weeks)					
	Integrated Milestone (Construction Electrician only)	MENT-1801	MENT-1802	Workplace Mentoring II (NS Specific)	91
ELEA-1813	High-Voltage Systems	ELEA-1810	ELE-415	High Voltage Wiring	92
			ELE-410	High Voltage Breakers and Starters	94
ELEA-1822	Troubleshooting / Electrical Blueprint	ELEA-0802, 1809	ELEA-1001	Electrical Blueprint (NS Specific)	96
			ELE-260	Job Planning	98
			ELE-460	Introduction to Commissioning	99
			ELEA-1002	Troubleshooting Techniques (NS Specific)	100
ELEA-1838	Power Supply and Rectifiers / Drives	ELEA-1809	ELE-215	Power Supply and Rectifiers	101
			ELE-425	Drives	103

Nova Scotia Course #	Nova Scotia Course Name	Nova Scotia Prerequisites	Interprovincial Program Guide (IPG) Content To Be Covered		
			IPG Units		Pg. #
ELEA-1823	Emergency Stand-by / Communication Systems	ELEA-1804, 1831, 1834	ELE-345	Emergency Stand-by Units	105
			ELE-455	Fiber Optics	107
			ELE-450	Communication Systems	109
			ELE-430	Alternative Power Systems	111
			ELE-435	Cathodic Protection Systems	113
ELEA-1818	Programmable Logic Controllers	ELEA-1816, 1817	ELE-400	Introduction to Programmable Logic Controllers	114
			ELE-405	Introduction to Programmable Logic Controller Programming	116
ELEA-1821	Signaling Systems	ELEA-1804, 1831, 1834	ELE-440	Fire Alarm Systems	117
			ELE-445	Security Systems	119
Level 5 (6 weeks)					
IELA-1826	Hydraulic / Pneumatic Systems	ELEA-1804	IEL-365	Hydraulic Circuits & Control Systems	122
			IEL-370	Pneumatic Control Sys	123
IELA-1828	Process Ctrl / Distrib Ctrl Sys	ELEA-1818	IEL-470	Process Control / Distributed Control Systems	124
IELA-1841	Analog and Digital Devices	ELEA-1817 IELA 1826, 1828	IEL-465	Analog Devices	126
			IEL-480	Building Automat Sys	128
			IEL-360	Digital Electronics	130
IELA-1830	Boiler Control & Air Conditioning	ELEA-1808, 1817	IEL-1130	Boiler Control	132
			IEL-1135	Heat Pumps	133
			IEL-1145	Refrig & AC Controls	134
			IEL-1160	HVAC Electrical Sys	135
IELA-1840	Vibration Analysis / Environmental Control Systems	ELEA-0802, 1816, 1817 IELA-1830	IEL-355	Vibration Analysis	136
			IEL-475	Enviro Control Sys	137
IELA-1836	Program Review	Entire Program	IELA-1836	Program Review (NS Specific)	139
Nova Scotia Industrial Electrician Apprenticeship Program: All courses are required.					

2008 NOA Sub-task to IPG Unit Comparison

NOA Sub-task		IPG Unit	
Task 1 - Uses and maintains tools and equipment.			
1.01	Maintains hand tools.	ELE-105	Tools and Equipment
1.02	Maintains portable power tools.	ELE-105	Tools and Equipment
1.03	Maintains stationary power tools.	ELE-105	Tools and Equipment
1.04	Maintains powder-actuated tools.	ELE-105	Tools and Equipment
1.05	Maintains mechanical measuring equipment.	ELE-105	Tools and Equipment
1.06	Maintains electrical testing and diagnostic tools.	ELE-105	Tools and Equipment
1.07	Uses scaffolding and access equipment.	ELE-110	Access Equipment
1.08	Uses rigging, tugging, hoisting and lifting equipment.	ELE-115	Hoisting, Lifting and Rigging
1.09	Uses computer systems.	ELE-135	Introduction to Computer Use
1.10	Uses personal protective equipment (PPE) and safety equipment.	ELE-100	Safety
Task 2 - Organizes work.			
2.01	Interprets codes and regulations.	ELE-100	Safety
2.02	Interprets plans, schematics, drawings and specifications.	ELE-125	Drawings, Schematics and Specifications
2.03	Modifies drawings and schematics.	ELE-125	Drawings, Schematics and Specifications
2.04	Uses documentation and reference materials.	ELE-120	Introduction to Communication and Trade Documentation
2.05	Communicates with others.	ELE-120	Introduction to Communication and Trade Documentation
2.06	Compiles a list of materials and supplies.	ELE-260	Job Planning
2.07	Plans project tasks and procedures.	ELE-260	Job Planning
Task 3 - Performs routine activities.			
3.01	Prepares work site.	ELE-260	Job Planning
3.02	Maintains safe work environment.	ELE-100	Safety
3.03	Conducts operational tests.		Throughout
Task 4 - Performs trade-specific activities.			
4.01	Installs fasteners, fittings and connectors.		Throughout

NOA Sub-task		IPG Unit	
4.02	Performs lock-out and tagging procedures.	ELE-100	Safety
4.03	Installs electrical wiring, cabling and terminations.	ELE-150	Conductors and Cables
4.04	Maintains electrical wiring, cabling and terminations.	ELE-150	Conductors and Cables
4.05	Installs communication and intercommunication wiring, cabling and terminations.	ELE-150	Conductors and Cables
		ELE-455	Fiber Optics
4.06	Maintains communication and intercommunication wiring, cabling and terminations.	ELE-150	Conductors and Cables
		ELE-455	Fiber Optics
4.07	Installs raceways, cable trays, busways and associated components.	ELE-160	Conduit, Tubing and Fittings
		ELE-165	Raceways, Wireways and Busways
4.08	Maintains seismic restraint systems. (NOT COMMON CORE)		
Task 5 - Maintains lighting systems.			
5.01	Installs lighting systems.	ELE-170	Fundamental Wiring
		ELE-175	Lighting Systems and Controls
5.02	Inspects lighting systems.	ELE-170	Fundamental Wiring
		ELE-175	Lighting Systems and Controls
5.03	Troubleshoots lighting systems.	ELE-170	Fundamental Wiring
		ELE-175	Lighting Systems and Controls
5.04	Repairs lighting systems.	ELE-170	Fundamental Wiring
		ELE-175	Lighting Systems and Controls
Task 6 - Maintains alternating current (AC) systems.			
6.01	Installs AC systems.	ELE-225	Single-Phase Service Entrance
		ELE-340	Three-Phase Service Entrance
		ELE-170	Fundamental Wiring
		ELE-230	Distribution Equipment
		ELE-235	Protective Devices
6.02	Inspects AC systems.	ELE-225	Single-Phase Service Entrance
		ELE-340	Three-Phase Service Entrance
		ELE-170	Fundamental Wiring
		ELE-230	Distribution Equipment
		ELE-235	Protective Devices
6.03	Troubleshoots AC systems.	ELE-225	Single-Phase Service Entrance
		ELE-340	Three-Phase Service Entrance
		ELE-170	Fundamental Wiring
		ELE-230	Distribution Equipment

NOA Sub-task		IPG Unit	
6.04	Repairs AC systems.	ELE-235	Protective Devices
		ELE-225	Single-Phase Service Entrance
		ELE-340	Three-Phase Service Entrance
		ELE-170	Fundamental Wiring
		ELE-230	Distribution Equipment
		ELE-235	Protective Devices
6.05	Services AC systems.	ELE-225	Single-Phase Service Entrance
		ELE-340	Three-Phase Service Entrance
		ELE-170	Fundamental Wiring
		ELE-230	Distribution Equipment
		ELE-235	Protective Devices
Task 7 - Maintains direct current (DC) systems.			
7.01	Installs DC systems.	ELE-345	Emergency Stand-by Units
		ELE-240	Exit/Emergency Lighting Systems
7.02	Inspects DC systems.	ELE-345	Emergency Stand-by Units
		ELE-240	Exit/Emergency Lighting Systems
7.03	Troubleshoots DC systems.	ELE-345	Emergency Stand-by Units
		ELE-240	Exit/Emergency Lighting Systems
7.04	Repairs DC systems.	ELE-345	Emergency Stand-by Units
		ELE-240	Exit/Emergency Lighting Systems
7.05	Services DC systems.	ELE-345	Emergency Stand-by Units
		ELE-240	Exit/Emergency Lighting Systems
Task 8 - Maintains high voltage power distribution systems.			
8.01	Installs high voltage power systems.	ELE-415	High Voltage Wiring
		ELE-410	High Voltage Breakers and Starters
		ELE-350	Transformers
8.02	Inspects high voltage power systems.	ELE-415	High Voltage Wiring
		ELE-410	High Voltage Breakers and Starters
		ELE-350	Transformers
8.03	Troubleshoots high voltage power systems.	ELE-415	High Voltage Wiring
		ELE-410	High Voltage Breakers and Starters
		ELE-350	Transformers
8.04	Repairs high voltage power systems.	ELE-415	High Voltage Wiring

NOA Sub-task		IPG Unit	
		ELE-410	High Voltage Breakers and Starters
		ELE-350	Transformers
8.05	Services high voltage power systems.	ELE-415	High Voltage Wiring
		ELE-410	High Voltage Breakers and Starters
		ELE-350	Transformers
Task 9 - Maintains low voltage power distribution systems.			
9.01	Installs low voltage power systems.	ELE-350	Transformers
		ELE-230	Distribution Equipment
9.02	Inspects low voltage power systems.	ELE-350	Transformers
		ELE-230	Distribution Equipment
9.03	Troubleshoots low voltage power systems.	ELE-350	Transformers
		ELE-230	Distribution Equipment
9.04	Repairs low voltage power systems.	ELE-350	Transformers
		ELE-230	Distribution Equipment
9.05	Services low voltage power systems.	ELE-350	Transformers
		ELE-230	Distribution Equipment
Task 10 - Maintains DC power systems.			
10.01	Installs DC power systems.	ELE-345	Emergency Stand-by Units
		ELE-240	Exit/Emergency Lighting Systems
10.02	Inspects DC power systems.	ELE-345	Emergency Stand-by Units
		ELE-240	Exit/Emergency Lighting Systems
10.03	Troubleshoot DC power systems.	ELE-345	Emergency Stand-by Units
		ELE-240	Exit/Emergency Lighting Systems
10.04	Repairs DC power systems.	ELE-345	Emergency Stand-by Units
		ELE-240	Exit/Emergency Lighting Systems
10.05	Services DC power systems.	ELE-345	Emergency Stand-by Units
		ELE-240	Exit/Emergency Lighting Systems
Task 11 - Maintains grounding and bonding systems.			
11.01	Installs grounding and bonding systems.	ELE-155	Grounding and Bonding
11.02	Inspects grounding and bonding systems.	ELE-155	Grounding and Bonding
11.03	Troubleshoots grounding and bonding systems.	ELE-155	Grounding and Bonding

NOA Sub-task		IPG Unit	
11.04	Repairs grounding and bonding systems.	ELE-155	Grounding and Bonding
11.05	Services grounding and bonding systems.	ELE-155	Grounding and Bonding
Task 12 - Maintains protective devices.			
12.01	Installs protection devices.	ELE-235	Protective Devices
12.02	Inspects protection devices.	ELE-235	Protective Devices
12.03	Troubleshoots protection devices.	ELE-235	Protective Devices
12.04	Repairs protection devices.	ELE-235	Protective Devices
12.05	Services protection devices.	ELE-235	Protective Devices
Task 13 - Maintains rotating equipment and associated controls.			
13.01	Installs rotating equipment and associated controls.	ELE-315	DC Motors and Controls
		ELE-250	Single-Phase Motors
		ELE-330	Three-Phase Motors
		ELE-255	Discrete Control Devices
		ELE-245	Motor Starters and Controls I
		ELE-325	Motor Starters and Controls II
		ELE-320	DC Generators
13.02	Inspects rotating equipment and associated controls.	ELE-315	DC Motors and Controls
		ELE-250	Single-Phase Motors
		ELE-330	Three-Phase Motors
		ELE-255	Discrete Control Devices
		ELE-245	Motor Starters and Controls I
		ELE-325	Motor Starters and Controls II
		ELE-320	DC Generators
13.03	Troubleshoots rotating equipment and associated controls.	ELE-315	DC Motors and Controls
		ELE-250	Single-Phase Motors
		ELE-330	Three-Phase Motors
		ELE-255	Discrete Control Devices
		ELE-245	Motor Starters and Controls I
		ELE-325	Motor Starters and Controls II
		ELE-320	DC Generators
13.04	Repairs rotating equipment and associated controls.	ELE-315	DC Motors and Controls
		ELE-250	Single-Phase Motors
		ELE-330	Three-Phase Motors
		ELE-255	Discrete Control Devices
		ELE-245	Motor Starters and Controls I
		ELE-325	Motor Starters and Controls II

NOA Sub-task		IPG Unit	
13.05	Services rotating equipment and associated controls.	ELE-320	DC Generators
		ELE-335	AC Generators
		ELE-315	DC Motors and Controls
		ELE-250	Single-Phase Motors
		ELE-330	Three-Phase Motors
		ELE-255	Discrete Control Devices
		ELE-245	Motor Starters and Controls I
		ELE-325	Motor Starters and Controls II
		ELE-320	DC Generators
		ELE-335	AC Generators
Task 14 - Maintains drives and associated controls.			
14.01	Installs drives and associated controls.	ELE-425	Drives
14.02	Inspects drives and associated controls.	ELE-425	Drives
14.03	Troubleshoots drives and associated controls.	ELE-425	Drives
14.04	Repairs drives and associated controls.	ELE-425	Drives
14.05	Services drives and associated controls.	ELE-425	Drives
Task 15 - Maintains non-rotating equipment and associated controls.			
15.01	Installs non-rotating equipment and associated controls.	ELE-310	Electric Heating Surface Units
		ELE-435	Cathodic Protection Systems
15.02	Inspects non-rotating equipment and associated controls.	ELE-310	Electric Heating Surface Units
		ELE-435	Cathodic Protection Systems
15.03	Troubleshoots non-rotating equipment and associated controls.	ELE-310	Electric Heating Surface Units
		ELE-435	Cathodic Protection Systems
15.04	Repairs non-rotating equipment and associated controls.	ELE-310	Electric Heating Surface Units
		ELE-435	Cathodic Protection Systems
15.05	Services non-rotating equipment and associated controls.	ELE-310	Electric Heating Surface Units
		ELE-435	Cathodic Protection Systems
Task 16 - Maintains uninterruptible power supply systems (UPS).			
16.01	Installs UPS systems.	ELE-345	Emergency Stand-by Units
16.02	Inspects UPS systems.	ELE-345	Emergency Stand-by Units
16.03	Troubleshoots UPS systems.	ELE-345	Emergency Stand-by Units
16.04	Repairs UPS systems.	ELE-345	Emergency Stand-by Units
16.05	Services UPS systems.	ELE-345	Emergency Stand-by Units
Task 17 - Maintains standby power generating systems.			
17.01	Installs standby power generating systems.	ELE-320	DC Generators
		ELE-335	AC Generators
		ELE-430	Alternative Power Systems
17.02	Inspects standby power generating systems.	ELE-320	DC Generators
		ELE-335	AC Generators

NOA Sub-task		IPG Unit	
		ELE-430	Alternative Power Systems
17.03	Troubleshoots standby power generating systems.	ELE-320	DC Generators
		ELE-335	AC Generators
		ELE-430	Alternative Power Systems
17.04	Repairs standby power generating systems.	ELE-320	DC Generators
		ELE-335	AC Generators
		ELE-430	Alternative Power Systems
17.05	Services standby power generating systems.	ELE-320	DC Generators
		ELE-335	AC Generators
		ELE-430	Alternative Power Systems
Task 18 - Maintains alarm systems.			
18.01	Installs alarm systems.	ELE-440	Fire Alarm Systems
		ELE-445	Security Systems
18.02	Inspects alarm systems.	ELE-440	Fire Alarm Systems
		ELE-445	Security Systems
18.03	Troubleshoots alarm systems.	ELE-440	Fire Alarm Systems
		ELE-445	Security Systems
18.04	Repairs alarm systems.	ELE-440	Fire Alarm Systems
		ELE-445	Security Systems
18.05	Services alarm systems.	ELE-440	Fire Alarm Systems
		ELE-445	Security Systems
Task 19 - Maintains paging systems.			
19.01	Installs paging systems.	ELE-450	Communication Systems
19.02	Inspects paging systems.	ELE-450	Communication Systems
19.03	Troubleshoots paging systems.	ELE-450	Communication Systems
19.04	Repairs paging systems.	ELE-450	Communication Systems
19.05	Services paging systems.	ELE-450	Communication Systems
Task 20 - Maintains audiovisual systems.			
20.01	Installs audiovisual systems.	ELE-445	Security Systems
20.02	Inspects audiovisual systems.	ELE-445	Security Systems
20.03	Troubleshoots audiovisual systems.	ELE-445	Security Systems
20.04	Repairs audiovisual systems.	ELE-445	Security Systems
20.05	Services audiovisual systems.	ELE-445	Security Systems
Task 21 - Maintains network systems.			
21.01	Installs network systems.	ELE-450	Communication Systems
21.02	Inspects network systems.	ELE-450	Communication Systems
21.03	Troubleshoots network systems.	ELE-450	Communication Systems
21.04	Repairs network systems.	ELE-450	Communication Systems
21.05	Services network systems.	ELE-450	Communication Systems

NOA Sub-task		IPG Unit	
Task 22 - Maintains input/output field devices.			
22.01	Installs input/output field devices.	IEL-465	Analog Devices
		ELE-255	Discrete Control Devices
22.02	Inspects input/output field devices.	IEL-465	Analog Devices
		ELE-255	Discrete Control Devices
22.03	Troubleshoots input/output field devices.	IEL-465	Analog Devices
		ELE-255	Discrete Control Devices
22.04	Repairs input/output field devices.	IEL-465	Analog Devices
		ELE-255	Discrete Control Devices
22.05	Services input/output field devices.	IEL-465	Analog Devices
		ELE-255	Discrete Control Devices
Task 23 - Maintains process control systems.			
23.01	Installs process control systems.	IEL-470	Process Control
		ELE-400	Introduction to Programmable Logic Controllers
		ELE-405	Introduction to Programmable Logic Controller Programming
23.02	Inspects process control systems.	IEL-470	Process Control
		ELE-400	Introduction to Programmable Logic Controllers
		ELE-405	Introduction to Programmable Logic Controller Programming
23.03	Troubleshoots process control systems.	IEL-470	Process Control
		ELE-400	Introduction to Programmable Logic Controllers
		ELE-405	Introduction to Programmable Logic Controller Programming
23.04	Repairs process control systems.	IEL-470	Process Control
		ELE-400	Introduction to Programmable Logic Controllers
		ELE-405	Introduction to Programmable Logic Controller Programming
23.05	Services process control systems.	IEL-470	Process Control
		ELE-400	Introduction to Programmable Logic Controllers
		ELE-405	Introduction to Programmable Logic Controller Programming
23.06	Optimizes PLCs.	ELE-400	Introduction to Programmable Logic Controllers
		ELE-405	Introduction to Programmable Logic Controller Programming

NOA Sub-task		IPG Unit	
Task 24 - Maintains electrical components of heating and cooling systems.			
24.01	Installs electrical components of heating and cooling systems.	ELE-300	Heating, Ventilation and Cooling Systems
		ELE-305	Heating, Ventilation and Cooling System Controls
24.02	Inspects electrical components of heating and cooling systems.	ELE-300	Heating, Ventilation and Cooling Systems
		ELE-305	Heating, Ventilation and Cooling System Controls
24.03	Troubleshoots electrical components of heating and cooling systems.	ELE-300	Heating, Ventilation and Cooling Systems
		ELE-305	Heating, Ventilation and Cooling System Controls
24.04	Repairs electrical components of heating and cooling systems.	ELE-300	Heating, Ventilation and Cooling Systems
		ELE-305	Heating, Ventilation and Cooling System Controls
24.05	Services electrical components of heating and cooling systems.	ELE-300	Heating, Ventilation and Cooling Systems
		ELE-305	Heating, Ventilation and Cooling System Controls
Task 25 - Maintains building automation systems.			
25.01	Installs building automation systems.	IEL-480	Building Automation Systems
25.02	Inspects building automation systems.	IEL-480	Building Automation Systems
25.03	Troubleshoots building automation systems.	IEL-480	Building Automation Systems
25.04	Repairs building automation systems.	IEL-480	Building Automation Systems
25.05	Services building automation systems.	IEL-480	Building Automation Systems
Task 26 - Maintains environmental control systems.			
26.01	Installs environmental control systems.	IEL-475	Environmental Control Systems
26.02	Inspects environmental control systems.	IEL-475	Environmental Control Systems
26.03	Troubleshoots environmental control systems.	IEL-475	Environmental Control Systems
26.04	Repairs environmental control systems.	IEL-475	Environmental Control Systems
26.05	Services environmental control systems.	IEL-475	Environmental Control Systems

LEVEL 1

MENT-1801

Workplace Mentoring I

(Nova Scotia Unit of Instruction)

Learning Outcomes:

- Identify and explain strategies for learning workplace skills.
- Demonstrate strategies to assist in learning skills in the workplace.

Objectives and Content:

1. Describe the importance of your own experiences.
2. Identify the partners involved in apprenticeship.
3. Describe the shared responsibilities for workplace learning.
4. Determine your own learning preferences and explain how these relate to learning new skills.
5. Describe the importance of different types of skills in the workplace.
6. Describe the importance of essential skills in the trade.
7. Identify different ways of learning.
8. Identify your learning preferences.
9. Identify different learning needs and strategies to meet learning needs.
10. Identify techniques for effective communication.
11. Identify strategies to assist in learning a skill.

Resource:

- Recommended resource to use in the delivery of this unit:
www.apprenticeship.nsc.ca/mentoring/apprentice.htm

ELE-100 Safety

Learning Outcomes:

- Demonstrate knowledge of safety equipment, their applications, maintenance and procedures for use.
- Demonstrate knowledge of safe work practices.
- Demonstrate knowledge of regulatory requirements pertaining to safety.

Objectives and Content:

1. Identify types of personal protective equipment (PPE) and clothing and describe their applications and limitations.
2. Describe the procedures used to care for and maintain PPE.
3. Identify hazards and describe safe work practices.
 - i) personal
 - ii) workplace
 - energy state awareness (electrical & mechanical)
 - arc flash awareness
 - isolation and de-energizing procedures
 - lockout / tag out
 - confined space awareness
 - fire
 - heights (fall arrest)
 - chemical / gas / radiation
 - asbestos
 - iii) environmental
 - discharge/spills
4. Identify and describe workplace safety and health regulations.
 - i) federal
 - Material Safety Data Sheets (MSDS)
 - Workplace Hazardous Material Information System (WHMIS)
 - ii) provincial/territorial
 - iii) municipal

ELE-130

Introduction to the Canadian Electrical Code

Learning Outcomes:

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

Objectives and Content:

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

Learning Outcomes:

- Demonstrate knowledge of drawings, schematics and specifications and their applications.
- Demonstrate knowledge of interpreting and extracting information from drawings, basic schematics and specifications.

Objectives and Content:

1. Define terminology associated with drawings, schematics and specifications.
2. Identify types of drawings and describe their applications.
 - i) civil/site
 - ii) architectural
 - iii) mechanical
 - iv) structural
 - v) electrical
 - vi) shop drawings
 - vii) sketches
 - viii) as-builts
3. Interpret and extract information from drawings.
 - i) alphabet of lines
 - ii) elevations
 - iii) scales
 - iv) legends
 - v) symbols and abbreviations
 - vi) notes and specifications
4. Interpret and extract information from basic schematics and specifications.
5. Describe the function of a CAD system.
6. Identify documentation requirements for modifying drawings and specifications.
7. Describe the procedures used to document changes made to equipment and wiring.

ELE-120

Introduction to Communication and Trade Documentation

Learning Outcomes:

- Demonstrate knowledge of effective communication practices.
- Demonstrate knowledge of trade related documentation and its use.

Objectives and Content:

1. Describe the importance of effective verbal and non-verbal communication.
 - i) other tradespersons
 - ii) colleagues
 - iii) supervisors
 - iv) suppliers/manufacturers

2. Identify types of trade related documentation and describe their purpose, applications and procedures for use.
 - i) manufacturers' specifications
 - ii) codes and standards
 - Canadian Electrical Code
 - National Building Code
 - iii) work orders
 - iv) maintenance schedules
 - v) maintenance records

ELE-105 Tools and Equipment

Learning Outcomes:

- Demonstrate knowledge of tools and equipment, their applications, maintenance and procedures for use.

Objectives and Content:

1. Identify types of hand tools and describe their applications and procedures for use.
2. Describe the procedures used to inspect and maintain hand tools.
3. Identify types of power tools and describe their applications and procedures for use.
 - i) electric
 - ii) hydraulic
 - iii) pneumatic
4. Describe the procedures used to inspect and maintain power tools.
5. Identify types of basic electrical measuring and test equipment and describe their general applications.
6. Describe the procedures used to inspect and maintain electrical measuring and test equipment.
7. Identify types of powder actuated tools and describe their applications.

ELE-110 Access Equipment

Learning Outcomes:

- Demonstrate knowledge of ladders, scaffolding and hydraulic lifts, their applications, limitations and procedures for use.

Objectives and Content:

1. Define terminology associated with ladders, scaffolding and hydraulic lifts.
2. Identify hazards and describe safe work practices pertaining to ladders, scaffolding and hydraulic lifts.
 - i) fall arrest
3. Identify codes and regulations pertaining to ladders, scaffolding and hydraulic lifts.
 - i) training and certification requirements
4. Identify types of ladders, scaffolding and hydraulic lifts and describe their characteristics and applications.
5. Describe the procedures used to erect and dismantle ladders and scaffolding.
6. Describe the procedures used to inspect, maintain and store ladders, scaffolding and hydraulic lifts.

Learning Outcomes:

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

Objectives and Content:

1. Define terminology associated with hoisting, lifting and rigging.
2. Identify hazards and describe safe work practices pertaining to hoisting, lifting and rigging.
3. Identify hazards and describe safe work practices pertaining to mobile and overhead cranes.
4. Identify codes and regulations pertaining to hoisting, lifting and rigging.
 - training and certification requirements
5. Identify types of rigging equipment and accessories and describe their applications and procedures for use.
6. Identify types of hoisting and lifting equipment and accessories and describe their applications and procedures for use.
7. Describe the procedures used to inspect, maintain and store hoisting, lifting and rigging equipment.
8. Identify types of knots, hitches, splices and bends and describe their applications and the procedures used to tie them.
9. Describe the considerations when rigging material/equipment for lifting.
 - i) load characteristics
 - ii) equipment and accessories
 - iii) environmental factors
 - iv) anchor points
 - v) sling angles

10. Describe the procedures used to ensure the work area is safe for lifting.
 - i) supervision of lift
 - ii) securing work area
 - iii) communication

11. Identify and describe procedures used to communicate during hoisting, lifting and rigging operations.
 - i) hand signals (awareness of)
 - ii) electronic communications
 - iii) audible/visual

Learning Outcomes:

- Demonstrate knowledge of trade related computer equipment and accessories and their use.

Objectives and Content:

1. Define terminology associated with trade related computer use.
2. Identify trade related computer equipment and accessories and describe their characteristics and applications.
 - i) hardware
 - ii) software
 - iii) interfacing equipment
3. Identify the requirements and describe the procedures used to backup data and equipment configuration.
4. Describe the procedures used to create, edit and save word processing documents.

Learning Outcomes:

- Demonstrate knowledge of direct current (DC) electricity, its characteristics and associated principles.
- 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.

Objectives and Content:

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 characteristics and purpose.
7. Identify units of measure and symbols pertaining to DC electricity.
8. Explain Ohm's Law.
9. Identify the 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 electricity related values.
12. Use instruments to troubleshoot DC components.
 - i) closed circuit
 - ii) open circuit
 - iii) short circuit

ELE-145 DC Circuits

Learning Outcomes:

- Demonstrate knowledge of series, parallel and complex DC circuits, their characteristics and operation.

Objectives and Content:

1. Define terminology associated with series and parallel 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.
8. Use instruments to troubleshoot series, parallel and complex DC circuits.

Learning Outcomes:

- Demonstrate knowledge of conductors and cables and their associated components.
- Demonstrate knowledge of the procedures used to install conductors and cables.
- Demonstrate knowledge of the procedures used to terminate conductors.

Objectives and Content:

1. Define terminology associated with conductors and cables.
2. Identify hazards and describe safe work practices pertaining to conductors and cables.
3. Identify tools and equipment relating to conductors and cables and describe their applications and procedures for use.
4. Interpret codes and regulations pertaining to conductors and cables.
 - i) Canadian Electrical Code (CEC)
5. Interpret information pertaining to conductors and cables found on drawings and specifications.
6. Identify types of conductors and cables and describe their characteristics and applications.
7. Identify conductor and cable components and accessories and describe their characteristics and applications.
8. Identify methods of conductor protection and describe their characteristics and applications.
 - i) mechanical
 - ii) electrical
9. Identify the considerations and requirements for selecting conductors and cables and their associated components and accessories.

10. Describe the procedures used to install conductors and cables and their associated components and accessories.
11. Describe the procedures used to terminate conductors.

Learning Outcomes:

- Demonstrate knowledge of voltage drop and power loss and its impact on a circuit.

Objectives and Content:

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

ELE-170 Fundamental Wiring

Learning Outcomes:

- Demonstrate knowledge of basic wiring applications and their associated devices and components.
- Demonstrate knowledge of the procedures used to install basic wiring devices and components.

Objectives and Content:

1. Define terminology associated with basic wiring.
2. Identify hazards and describe safe work practices pertaining to basic wiring.
3. Interpret codes and regulations pertaining to basic wiring.
4. Interpret information pertaining to basic wiring found on drawings and specifications.
5. Identify tools and equipment related to basic wiring applications and describe their applications and procedures for use.
6. Identify types of basic wiring applications.
 - i) lights and switches
 - ii) receptacles
 - iii) exhaust fans
 - iv) water pumps and water heaters
 - v) heaters and controls
 - vi) extra low voltage wiring
 - doorbell
 - lighting
7. Identify types of cables used in basic wiring applications and describe their characteristics.
 - i) non-metallic sheathed cables
 - ii) armored cables

8. Describe the procedures used to cut, strip and terminate wires used in basic wiring applications.
9. Describe the procedures used to fish and install cables used in basic wiring applications.
10. Describe the procedures used to provide mechanical protection and support for cables used in basic wiring applications.
11. Identify types of devices used in basic wiring applications and describe their characteristics.
 - i) lampholders
 - ii) switches
 - iii) receptacles
12. Describe the procedures used to install devices used in basic wiring applications.
13. Identify types of boxes used in basic wiring applications and describe their characteristics.
 - i) outlet
 - ii) junction
14. Describe the procedures used to select and install boxes used in basic wiring applications.

ELE-165

Raceways, Wireways and Busways

Learning Outcomes:

- Demonstrate knowledge of raceways, wireways and busways, their components and accessories.
- Demonstrate knowledge of the procedures used to select, install and support raceways, wireways and busways.
- Demonstrate knowledge of the procedures used to install cables and conductors in cable tray.

Objectives and Content:

1. Define terminology associated with raceways, wireways and busways.
2. Identify hazards and describe safe work practices pertaining to raceways, wireways and busways.
3. Interpret codes and regulations pertaining to raceways, wireways and busways.
4. Interpret information pertaining to raceways, wireways and busways found on drawings and specifications.
5. Identify tools and equipment relating to raceways, wireways and busways and describe their applications and procedures for use.
6. Identify types of raceways, wireways and busways and describe their characteristics and applications.
7. Identify raceway, wireway and busway components and accessories and describe their characteristics and applications.
8. Identify considerations and requirements for selecting raceways, wireways and busways and their components and accessories.
9. Describe the procedures used to install raceways, wireways and busways, their components and accessories.
10. Identify types of cable tray and describe their characteristics and applications.

11. Identify cable tray components and accessories and describe their characteristics and applications.
12. Identify the considerations and requirements for selecting cable tray and its components and accessories.
13. Describe the procedures used to install and support cable tray.
14. Describe the procedures used to install and secure cables and conductors in cable tray.

Learning Outcomes:

- Demonstrate knowledge of conduit, tubing and fittings, their components and accessories.
- Demonstrate knowledge of the procedures used to select, cut, bend and install conduit, tubing and fittings.

Objectives and Content:

1. Define terminology associated with conduit, tubing and fittings.
2. Identify hazards and describe safe work practices pertaining to conduit, tubing and fittings.
3. Interpret codes and regulations pertaining to conduit, tubing and fittings.
4. Interpret information pertaining to conduit, tubing and fittings found on drawings and specifications.
5. Identify tools and equipment related to conduit, tubing and fittings and describe their applications and procedures for use.
6. Identify types of conduit and tubing and describe their characteristics, applications and limitations.
7. Identify conduit and tubing components and accessories and describe their characteristics and applications.
 - i) fittings
 - ii) couplings
 - iii) connectors
 - iv) boxes
 - v) supports
8. Identify the considerations and requirements for selecting conduit and tubing and their associated components and accessories.
9. Describe the procedures used to cut and bend conduit and tubing.

10. Describe the procedures used to install and support conduit and tubing systems.
11. Describe the procedures used to select and install conduit and tubing related components.

LEVEL 2

Learning Outcomes:

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

Objectives and Content:

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 the types of electromagnetic induction and describe their characteristics and applications.
 - i) self induction
 - ii) mutual induction
8. Explain alternating current (AC).
9. Identify types of components found in AC circuits and describe their characteristics and applications.
 - i) resistors
 - ii) inductors
 - iii) capacitors
10. Perform calculations pertaining to single-phase circuits.

Learning Outcomes:

- Demonstrate knowledge of series and parallel AC circuits, their characteristics and operation.

Objectives and Content:

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. Perform calculations to determine series and parallel AC circuit related values.
6. Describe the procedures used to troubleshoot series and parallel AC circuits.
7. Explain single-phase three-wire systems and describe their characteristics, purpose, and operation.
8. Perform single-phase three-wire system calculations.
9. Use electrical instruments to troubleshoot series and parallel AC circuits.

Learning Outcomes:

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

Objectives and Content:

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.
7. Describe the procedures used to measure three-phase electricity.
8. Perform calculations for balanced and unbalanced loads.
9. Perform calculations pertaining to three-phase electricity.
 - i) true power
 - ii) apparent power
 - iii) reactive power
 - iv) power factor

Learning Outcomes:

- Demonstrate knowledge of the methods and equipment used for distribution system conditioning.

Objectives and Content:

1. Define terminology associated with distribution system conditioning.
2. Identify hazards and describe safe work practices pertaining to distribution system conditioning.
3. Interpret codes and regulations pertaining to distribution system conditioning.
4. Interpret information pertaining to distribution system conditioning found on drawings and specifications.
5. Identify tools and equipment relating to distribution system conditioning and describe their applications and procedures for use.
6. Explain power quality and its impact on equipment operation.
7. Explain power factor correction and its associated calculations.
8. Identify types of power factor correction equipment and describe their characteristics, applications and operation.
9. Explain harmonics and its impact on power distribution systems.
10. Identify equipment used to reduce harmonics in power distribution systems and describe their characteristics, applications and operation.
11. Explain voltage fluctuations and their impact on power distribution systems.
12. Identify surge suppression equipment used in power distribution system conditioning and describe their characteristics, applications and operation.

ELE-230 Distribution Equipment

Learning Outcomes:

- Demonstrate knowledge of distribution equipment, their applications and operation.
- Demonstrate knowledge of the procedures used to install, connect, troubleshoot, maintain, repair and test distribution equipment.

Objectives and Content:

1. Define terminology associated with distribution equipment.
2. Identify hazards and describe safe work practices pertaining to distribution equipment.
3. Interpret codes and regulations pertaining to distribution equipment.
4. Interpret information pertaining to distribution equipment found on drawings and specifications.
5. Identify tools and equipment relating to distribution equipment and describe their applications and procedures for use.
6. Identify types of distribution equipment and describe their characteristics and applications.
 - i) enclosures
 - ii) disconnect switches and switchgear
 - iii) panel boards
 - iv) low-voltage switchboards
 - v) motor control centers
7. Identify distribution equipment components and accessories and describe their characteristics and applications.
8. Identify the considerations and requirements for selecting distribution equipment, its components and accessories.

9. Describe the procedures used to install and connect distribution equipment, its components and accessories.
10. Describe the procedures used to troubleshoot distribution equipment, its components and accessories.
11. Describe the procedures used to maintain, repair and test distribution equipment, its components and accessories.

Learning Outcomes:

- Demonstrate knowledge of protective devices, their applications and operation.
- Demonstrate knowledge of the procedures used to install, connect, troubleshoot, maintain, repair and test protective devices.

Objectives and Content:

1. Define terminology associated with protective devices.
2. Identify hazards and describe safe work practices pertaining to protective devices.
3. Interpret codes and regulations pertaining to protective devices.
4. Interpret information pertaining to protective devices found on drawings and specifications.
5. Identify tools and equipment relating to protective devices and describe their applications and procedures for use.
6. Explain the purpose and operation of protective devices.
 - i) overcurrent/overload protection
 - ii) short circuit protection
7. Explain the effects of short-circuit current and describe the associated damage to the circuit.
8. Identify types of protective devices and describe their characteristics and applications.
 - i) overcurrent devices
 - ii) overload devices
 - iii) ground fault circuit interrupters
 - iv) arc fault circuit interrupters
9. Identify protective device components and accessories and describe their characteristics and applications.

10. Identify the considerations and requirements for selecting protective devices, their components and accessories.
 - i) ratings
11. Describe the procedures used to install protective devices, their components and accessories.
12. Describe the procedures used to troubleshoot protective devices, their components and accessories.
13. Describe the procedures used to maintain, repair and test protective devices, their components and accessories.

Learning Outcomes:

- Demonstrate knowledge of lighting systems and controls, their applications and operation.
- Demonstrate knowledge of the procedures used to install, connect, troubleshoot, maintain, repair and test lighting systems and controls.
- Demonstrate knowledge of the procedures used to store and dispose of fluorescent lighting ballasts, capacitors and lamps.

Objectives and Content:

1. Define terminology associated with lighting systems and controls.
2. Identify hazards and describe safe work practices pertaining to lighting systems and controls.
3. Interpret codes and regulations pertaining to lighting systems and controls.
4. Interpret information pertaining to lighting systems and controls found on drawings and specifications.
5. Identify tools and equipment relating to lighting systems and controls and describe their applications and procedures for use.
6. Identify types of lighting systems and describe their characteristics and applications.
7. Identify lighting system components and accessories and describe their characteristics and applications.
8. Identify types of lighting system controls and describe their characteristics and applications.
 - i) extra low voltage
 - ii) low voltage
9. Identify lighting system control components and accessories and describe their characteristics and applications.

10. Identify considerations and requirements for selecting lighting systems, their controls, components and accessories.
11. Describe the procedures used to install and connect lighting systems, their controls, components and accessories.
12. Describe the procedures used to troubleshoot lighting systems, their controls, components and accessories.
13. Describe the procedures used to maintain, repair and test lighting systems, their controls, components and accessories.
14. Identify the hazards associated with the storage and disposal of fluorescent lighting system ballasts, capacitors and lamps.
15. Describe the procedures used to store and dispose of fluorescent lighting system ballasts, capacitors and lamps.

Learning Outcomes:

- Demonstrate knowledge of exit/emergency lighting systems, their applications and operation.
- Demonstrate knowledge of the procedures used to install, connect, troubleshoot, maintain, repair and test exit/emergency lighting systems.

Objectives and Content:

1. Define terminology associated with exit/emergency lighting systems.
2. Identify hazards and describe safe work practices pertaining to exit/emergency lighting systems.
3. Interpret codes and regulations pertaining to exit/emergency lighting systems.
 - i) Canadian Electrical Code requirements
 - ii) National Building Code requirements
4. Interpret information pertaining to exit/emergency lighting systems found on drawings and specifications.
5. Identify tools and equipment relating to exit/emergency lighting systems and describe their applications and procedures for use.
6. Identify types of exit/emergency lighting systems and describe their characteristics and applications.
 - i) self-contained
 - ii) central-powered
 - iii) remote lighting units
7. Identify exit/emergency lighting system components and accessories and describe their characteristics and applications.
8. Identify the considerations and requirements for selecting exit/emergency lighting systems, their components and accessories.

9. Describe the procedures used to install and connect exit/emergency lighting systems, their components and accessories.
10. Describe the procedures used to troubleshoot exit/emergency lighting systems, their components and accessories.
11. Describe the procedures used to maintain, repair and test exit/emergency lighting systems, their components and accessories.

ELE-310 Electric Heating Surface Units

Learning Outcomes:

- Demonstrate knowledge of electric heating surface units, their applications and operation.
- Demonstrate knowledge of the procedures used to install, connect, troubleshoot, maintain, repair and test electric heating surface units.

Objectives and Content:

1. Define terminology associated with electric heating surface units.
2. Identify hazards and describe safe work practices pertaining to electric heating surface units.
3. Interpret codes and regulations pertaining to electric heating surface units.
4. Interpret information pertaining to electric heating surface units found on drawings and specifications.
5. Identify tools and equipment relating to electric heating surface units and describe their applications and procedures for use.
6. Identify types of electric heating surface units and describe their characteristics and applications.
 - i) cables
 - ii) panels
 - iii) heat tracing
 - iv) immersion heaters
7. Identify electric heating surface unit controls, components and accessories and describe their characteristics and applications.
8. Identify the considerations and requirements for selecting electric heating surface units, their controls, components and accessories.
9. Describe the procedures used to install and connect electric heating surface units, their controls, components and accessories.

10. Describe the procedures used to troubleshoot electric heating surface units, their controls, components and accessories.
11. Describe the procedures used to maintain, repair and test electric heating surface units, their controls, components and accessories.

Learning Outcomes:

- Demonstrate knowledge of heating, ventilation and cooling system controls, their applications and operation.
- Demonstrate knowledge of the procedures used to install, connect, program, troubleshoot, maintain, repair and test heating, ventilation and cooling system controls.

Objectives and Content:

1. Define terminology associated with heating, ventilation and cooling system controls.
2. Identify hazards and describe safe work practices pertaining to heating, ventilation and cooling system controls.
3. Interpret codes and regulations pertaining to heating, ventilation and cooling system controls.
4. Interpret information pertaining to heating, ventilation and cooling system controls found on drawings and specifications.
5. Identify tools and equipment relating to heating, ventilation and cooling system controls and describe their applications and procedures for use.
6. Identify types of heating, ventilation and cooling system control devices and describe their characteristics and applications.
 - i) electrical
 - ii) mechanical
7. Identify considerations and requirements for selecting heating, ventilation and cooling system control devices.
 - i) residential
 - ii) commercial
 - iii) industrial

8. Describe the procedures used to install and connect heating, ventilation and cooling system control devices.
9. Describe the procedures used to program heating, ventilation and cooling system control devices.
10. Describe the procedures used to troubleshoot heating, ventilation and cooling system control devices.
11. Describe the procedures used to maintain, repair and test heating, ventilation and cooling system control devices.

Learning Outcomes:

- Demonstrate knowledge of heating, ventilation and cooling systems, their applications and operation.
- Demonstrate knowledge of the procedures used to install, connect, troubleshoot, maintain, repair and test electrical components of heating, ventilation and cooling systems.

Objectives and Content:

1. Define terminology associated with heating, ventilation and cooling systems.
2. Identify hazards and describe safe work practices pertaining to heating, ventilation and cooling systems.
3. Interpret codes and regulations pertaining to heating, ventilation and cooling systems.
4. Interpret information pertaining to heating, ventilation and cooling systems found on drawings and specifications.
5. Identify tools and equipment relating to the electrical installation of heating, ventilation and cooling systems and describe their applications and procedures for use.
6. Explain the principles of heat transfer.
 - i) radiation
 - ii) conduction
 - iii) convection
7. Identify types of heating, ventilation and cooling systems and describe their characteristics and applications.
 - i) heating systems
 - radiant heating
 - convection heating
 - central heating
 - ii) ventilation/air exchange

- iii) cooling
 - refrigeration
 - air conditioning

- 8. Identify heating, ventilation and cooling system components and accessories and describe their characteristics and applications.

- 9. Identify the considerations and requirements for selecting heating, ventilation and cooling systems, their components and accessories.
 - i) residential
 - ii) commercial
 - iii) industrial

- 10. Perform calculations to determine heat loss.

- 11. Perform calculations to determine heating requirements.

- 12. Describe the procedures used to install and connect electrical components of heating, ventilation and cooling systems.

- 13. Describe the procedures used to troubleshoot electrical components of heating, ventilation and cooling systems.

- 14. Describe the procedures used to maintain, repair and test electrical components of heating, ventilation and cooling systems.

Learning Outcomes:

- Demonstrate knowledge of single-phase service entrances, their applications and operation.
- Demonstrate knowledge of the procedures used to install, connect, troubleshoot, maintain, repair and test single-phase service entrances.
- Demonstrate knowledge of demand factor calculations.

Objectives and Content:

1. Define terminology associated with single-phase service entrances.
2. Identify hazards and describe safe work practices pertaining to single-phase service entrances.
3. Interpret codes and regulations pertaining to single-phase service entrances.
4. Interpret information pertaining to single-phase service entrances found on drawings and specifications.
5. Identify sources of information and documentation required for the installation of single-phase service entrances.
6. Identify tools and equipment relating to single-phase service entrances and describe their applications and procedures for use.
7. Identify types of single-phase service entrances and describe their characteristics and applications.
 - i) temporary service
 - ii) overhead
 - iii) underground
 - iv) multiple metering
8. Identify single-phase service entrance components and accessories and describe their characteristics and applications.

9. Identify the considerations and requirements for selecting the type of single-phase service entrances, their components and accessories.
10. Describe the procedures used to calculate demand factor.
11. Describe the procedures used to install and connect single-phase service entrances, their components and accessories.
12. Identify the methods of grounding and bonding single-phase service entrances and describe their associated procedures.
13. Describe the procedures to troubleshoot single-phase service entrances, their components and accessories.
14. Describe the procedures used to maintain, repair and test single-phase service entrances, their components and accessories.

ELE-155

Grounding and Bonding

Learning Outcomes:

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

Objectives and Content:

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

LEVEL 3

ELE-350 Transformers

Learning Outcomes:

- Demonstrate knowledge of transformers, their applications and operation.
- Demonstrate knowledge of the procedures used to install, connect, troubleshoot and maintain transformers.

Objectives and Content:

1. Define terminology associated with transformers.
2. Identify hazards and describe safe work practices pertaining to transformers.
3. Interpret codes and regulations pertaining to transformers.
4. Interpret information pertaining to transformers found on drawings and specifications.
5. Identify tools and equipment relating to transformers and describe their applications and procedures for use.
6. Explain the operating principles of transformers.
7. Interpret information contained on transformer nameplates.
8. Identify types and classes of transformers and describe their characteristics, applications.
 - i) high-voltage
 - ii) low-voltage
 - iii) special
9. Identify applications for special transformers.
 - i) instrument
 - ii) auto transformer
 - iii) ignition
 - iv) isolation
 - v) buck and boost
 - vi) multi-tap

- vii) zig zag
 - viii) scott/tee
10. Identify transformer components and accessories and describe their characteristics and applications.
 11. Explain transformer polarity and terminal markings.
 12. Explain the operation of primary and secondary connections for single-phase transformers.
 13. Explain the operation of primary and secondary connections for three-phase transformers.
 - i) wye to wye
 - ii) wye to delta
 - iii) delta to wye
 - iv) delta to delta
 - v) three-phase four-wire delta
 - vi) open delta
 14. Identify the considerations and requirements for selecting transformers, their components and accessories.
 15. Describe the procedures used to install and connect transformers, their components and accessories.
 16. Describe the procedures used to install transformers in parallel.
 17. Describe the procedures used to troubleshoot transformers, their components and accessories.
 18. Describe the procedures used to maintain and test transformers, their connections, components and accessories.
 19. Perform transformer related calculations.
 - i) turns/voltage/current ratios
 - ii) voltage, current and kVA
 - iii) fault current
 20. Use schematic diagrams to illustrate transformer connections.

ELE-315 DC Motors and Controls

Learning Outcomes:

- Demonstrate knowledge of DC motors and controls, their applications and operation.
- Demonstrate knowledge of the procedures used to install, connect, troubleshoot, maintain, repair and test DC motors and controls.

Objectives and Content:

1. Define terminology associated with DC motors and controls.
2. Identify hazards and describe safe work practices pertaining to DC motors and controls.
3. Interpret codes and regulations pertaining to DC motors and controls.
4. Interpret information pertaining to DC motors and controls found on drawings and specifications.
5. Identify tools and equipment relating to DC motors and controls and describe their applications and procedures for use.
6. Explain the construction and operating principles of DC motors.
7. Interpret information contained on motor nameplates.
8. Identify types of DC motors and describe their characteristics and applications.
9. Identify DC motor components and accessories and describe their characteristics and applications.
10. Identify types of DC motor controls and describe their characteristics and applications.
11. Identify DC motor control components and accessories and describe their characteristics and applications.

12. Identify the considerations and requirements for selecting DC motors and controls, their components and accessories.
13. Describe the procedures used to install and connect DC motors and controls, their components and accessories.
14. Describe the procedures used to troubleshoot DC motors and controls, their components and accessories.
15. Describe the procedures used to maintain, repair and test DC motors and controls, their components and accessories.

Learning Outcomes:

- Demonstrate knowledge of DC generators, their applications and operation.
- Demonstrate knowledge of the procedures used to install, connect, troubleshoot, maintain, repair and test DC generators.

Objectives and Content:

1. Define terminology associated with DC generators.
2. Identify hazards and describe safe work practices pertaining to DC generators.
3. Interpret codes and regulations pertaining to DC generators.
4. Interpret information pertaining to DC generators found on drawings and specifications.
5. Identify tools and equipment relating to DC generators and describe their applications and procedures for use.
6. Explain the generation of DC voltage.
7. Describe the construction of DC generators and explain their operating principles.
8. Identify types of DC generators and describe their characteristics and applications.
 - i) series
 - ii) shunt
 - iii) compound
9. Identify DC generator components and accessories and describe their characteristics and applications.
10. Describe the load/voltage characteristics of separately and static excited generators.

11. Identify the considerations and requirements for selecting DC generators, their components and accessories.
12. Describe the procedures used to install and connect DC generators, their components and accessories.
13. Describe the procedures used to troubleshoot DC generators, their components and accessories.
14. Describe the procedures used to maintain, repair and test DC generators, their components and accessories.

Learning Outcomes:

- Demonstrate knowledge of AC generators, their applications and operation.
- Demonstrate knowledge of the procedures used to install, connect, troubleshoot, maintain, repair and test AC generators.

Objectives and Content:

1. Define terminology associated with AC generators.
2. Identify hazards and describe safe work practices pertaining to AC generators.
3. Interpret codes and regulations pertaining to AC generators.
4. Interpret information pertaining to AC generators found on drawings and specifications.
5. Identify tools and equipment relating to AC generators and describe their applications and procedures for use.
6. Describe the construction of AC generators and explain their operating principles.
7. Identify types of AC generators and describe their characteristics and applications.
 - i) single-phase
 - ii) three-phase
8. Identify AC generator components and accessories and describe their characteristics and applications.
9. Identify the considerations and requirements for selecting AC generators, their components and accessories.

10. Describe the procedures used to install and connect AC generators, their components and accessories.
 - i) stand alone
 - ii) in parallel
11. Describe the procedures used to control the output voltage and frequency of AC generators.
12. Describe the procedures used to troubleshoot AC generators, their components and accessories.
13. Describe the procedures used to maintain, repair and test AC generators, their components and accessories.

ELE-330

Three-Phase Motors

Learning Outcomes:

- Demonstrate knowledge of three-phase motors, their applications and procedures for use.
- Demonstrate knowledge of the procedures used to install, connect, troubleshoot, maintain, repair and test three-phase motors.

Objectives and Content:

1. Define terminology associated with three-phase motors.
2. Identify hazards and describe safe work practices pertaining to three-phase motors.
3. Interpret codes and regulations pertaining to three-phase motors.
4. Interpret information pertaining to three-phase motors found on drawings and specifications.
5. Identify tools and equipment relating to three-phase motors and describe their applications and procedures for use.
6. Describe the construction of three-phase motors and explain their operating principles.
7. Interpret information contained on motor nameplates.
8. Identify types of three-phase motors and describe their characteristics and applications.
 - i) squirrel cage induction
 - ii) wound rotor induction
 - iii) synchronous
9. Identify three-phase motor components and accessories and describe their characteristics and applications.

10. Identify coupling methods for three-phase motors and describe their characteristics and applications.
11. Identify the considerations and requirements for selecting three-phase motors, their components and accessories.
12. Describe the procedures used to install and connect three-phase motors, their components and accessories.
13. Describe the procedures used to troubleshoot three-phase motors, their components and accessories.
14. Describe the procedures used to maintain, repair and test three-phase motors, their components and accessories.

Learning Outcomes:

- Demonstrate knowledge of single-phase motors, their applications and operation.
- Demonstrate knowledge of the procedures used to install, connect, troubleshoot, maintain, repair and test single-phase motors.

Objectives and Content:

1. Define terminology associated with single-phase motors.
2. Identify hazards and describe safe work practices pertaining to single-phase motors.
3. Interpret codes and regulations pertaining to single-phase motors.
4. Interpret information pertaining to single-phase motors found on drawings and specifications.
5. Identify tools and equipment relating to single-phase motors and describe their applications and procedures for use.
6. Explain the construction and operating principles of single-phase motors.
7. Interpret information contained on motor nameplates.
8. Identify types of single-phase motors and describe their characteristics and applications.
9. Identify single-phase motor components and accessories and describe their characteristics and applications.
10. Identify coupling methods for single-phase motors and describe their characteristics and applications.
11. Identify the considerations and requirements for selecting single-phase motors, their components and accessories.

12. Describe the procedures used to install and connect single-phase motors, their components and accessories.
13. Describe the procedures used to troubleshoot single-phase motors, their components and accessories.
14. Describe the procedures used to maintain, repair and test single-phase motors, their components and accessories.

Learning Outcomes:

- Demonstrate knowledge of motor control circuits, their characteristics and applications.
- Demonstrate knowledge of motor starters, their applications and operation.
- Demonstrate knowledge of the procedures used to install, connect, troubleshoot, maintain, repair and test motor starters.

Objectives and Content:

1. Define terminology associated with motor starters.
2. Identify hazards and describe safe work practices pertaining to motor starters.
3. Interpret codes and regulations pertaining to motor starters.
4. Interpret information pertaining to motor starters found on drawings and specifications.
5. Identify tools and equipment relating to motor starters and describe their applications and procedures for use.
6. Identify types of starters and controllers and describe their characteristics and applications.
 - i) manual
 - ii) magnetic
7. Identify circuit types and describe their characteristics and applications.
 - i) low voltage release (two wire control)
 - ii) low voltage protection (three wire control)
8. Describe circuit functional features of common hard wired motor control circuits.
 - i) starting and stopping
 - ii) forward/reverse
 - iii) sequencing
 - iv) jogging
 - v) quick stop

- vi) multiple location control
 - vii) timed functions
9. Identify types of control accessories and describe their characteristics and applications.
 10. Identify considerations and requirements for selecting motor starters, their components and accessories.
 11. Identify the methods used to determine the number of conductors required between controls and controller locations.
 12. Describe the procedures used to install and connect motor starters, their components and accessories.
 13. Describe the procedures used to troubleshoot motor starters, their components and accessories.
 14. Describe the procedures used to maintain, repair and test motor starters, their components and accessories.
 15. Identify protection devices for motor control circuits and describe their characteristics and applications.
 - i) overcurrent
 - ii) overload/overheating
 - iii) phase loss
 - iv) phase reversal

Learning Outcomes:

- Demonstrate knowledge of motor starting and control methods and their applications.
- Demonstrate knowledge of the procedures used to install, connect, troubleshoot, maintain, repair and test motor starters and controls.

Objectives and Content:

1. Identify hazards and describe safe work practices pertaining to motor starters and controls.
2. Interpret codes and regulations pertaining to motor starters and controls.
3. Interpret information pertaining to motor starters and controls found on drawings and specifications.
4. 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
5. Identify types of motor controllers and describe their characteristics and applications.
 - i) wound rotor motor controller
 - ii) multi-speed controller
 - iii) frequency drives
6. Identify motor controller components and accessories and describe their characteristics and applications.

7. Identify types of motor control centers and describe their characteristics and applications.
8. Identify motor control centre components and accessories and describe their characteristics and applications.
9. Describe the procedures used to install and connect motor starters and motor controllers, their components and accessories.
10. Describe the procedures used to troubleshoot motor starters and motor controllers, their components and accessories.
11. Describe the procedures used to maintain, repair and test motor starters and motor controllers, their components and accessories.

Learning Outcomes:

- Demonstrate knowledge of discrete control devices, their applications and operation.
- Demonstrate knowledge of the procedures used to install, connect, troubleshoot, maintain, repair and test discrete control devices.

Objectives and Content:

1. Define terminology associated with discrete control devices.
2. Identify hazards and describe safe work practices pertaining to discrete control devices.
3. Interpret codes and regulations pertaining to discrete control devices.
4. Interpret information pertaining to discrete control devices found on drawings and specifications.
5. Identify tools and equipment relating to discrete control devices and describe their applications and procedures for use.
6. Identify types of discrete control devices and describe their characteristics and applications.
 - i) on-off control
 - ii) counters and totalizers
 - iii) timers
 - iv) relays
 - v) pressure
 - vi) temperature
 - vii) level
 - viii) flow
7. Identify discrete control device components and accessories and describe their characteristics and applications.

8. Identify the considerations and requirements for selecting discrete control devices, their components and accessories.
9. Describe the procedures used to install and connect discrete control devices, their components and accessories.
10. Describe the procedures used to troubleshoot discrete control devices, their components and accessories.
11. Describe the procedures used to maintain, repair and test discrete control devices, their components and accessories.

ELE-340

Three-Phase Service Entrance

Learning Outcomes:

- Demonstrate knowledge of three-phase service entrances, their applications and operation.
- Demonstrate knowledge of the procedures used to install, connect, troubleshoot, maintain, repair and test three-phase service entrances.
- Demonstrate knowledge of three-phase service entrance related calculations.

Objectives and Content:

1. Define terminology associated with three-phase service entrances.
2. Identify hazards and describe safe work practices pertaining to three-phase service entrances.
3. Interpret codes and regulations pertaining to three-phase service entrances.
4. Interpret information pertaining to three-phase service entrances found on drawings and specifications.
5. Identify sources of information and documentation required for the installation of three-phase service entrances.
6. Identify tools and equipment relating to three-phase service entrances and describe their applications and procedures for use.
7. Identify types of three-phase service entrances and describe their characteristics and applications.
8. Identify three-phase service entrance components and accessories and describe their characteristics and applications.
 - i) distribution panel
 - ii) splitters and splitter troughs
 - iii) metering equipment
 - iv) conductors
 - v) grounding and bonding

9. Identify the considerations and requirements for selecting three-phase service entrances, their components and accessories.
10. Describe the procedures used to install and connect three-phase underground service entrances, their components and accessories.
11. Identify the requirements and describe the procedures for conductor installation and termination.
12. Describe the procedures used to troubleshoot three-phase service entrances, their components and accessories.
13. Describe the procedures used to maintain, repair and test three-phase service entrances, their components and accessories.
14. Perform calculations relating to three-phase service entrances.

LEVEL 4

MENT-1802

Workplace Mentoring II (Nova Scotia Unit of Instruction)

Learning Outcomes:

- Identify and explain strategies for teaching workplace skills.
- Demonstrate strategies to assist in teaching skills in the workplace

Objectives and Content:

1. Describe the impact of your own experiences in teaching skills.
2. Identify the different roles played by a workplace mentor.
3. Describe the six-step approach to teaching skills.
4. Explain the importance of identifying the point of the lesson.
5. Identify how to choose a good time to present a lesson.
6. Explain the importance of linking the lessons.
7. Identify the components of the skill (the context).
8. Describe considerations for demonstrating a skill.
9. Identify types of skill practice.
10. Describe considerations in setting up opportunities for skill practice.
11. Explain the importance of providing feedback.
12. Identify techniques for giving effective feedback.
13. Describe a skill assessment.
14. Identify methods of assessing progress.
15. Explain how to adjust a lesson to different situations.

Resource:

- Recommended resource to use in the delivery of this unit:
www.apprenticeship.nsc.ca/mentoring/apprentice.htm

ELE-415

High Voltage Wiring

Learning Outcomes:

- Demonstrate knowledge of high voltage cables, their applications and operation.
- Demonstrate knowledge of the procedures used to install, splice and terminate high voltage wiring.

Objectives and Content:

1. Define terminology associated with high voltage wiring.
2. Identify hazards and describe safe work practices pertaining to high voltage wiring.
3. Identify grounding and bonding requirements relating to high voltage wiring.
4. Interpret codes and regulations pertaining to high voltage wiring.
5. Interpret information pertaining to high voltage wiring found on drawings and specifications.
6. Identify tools and equipment relating to high voltage wiring and describe their applications and procedures for use.
7. Identify types of high voltage cables and describe their characteristics and applications.
 - i) concentric neutral
 - ii) non-shielded
 - iii) shielded
8. Identify high voltage cable components and accessories and describe their characteristics and applications.
9. Identify the considerations and requirements for selecting high voltage cables, their components and accessories.
10. Describe the procedures used to install high voltage cables, their components and accessories.

11. Describe the procedures used to terminate, splice and test high voltage cables.
12. Describe the procedures used for temporary grounding of high voltage equipment.

Learning Outcomes:

- Demonstrate knowledge of high voltage breakers and starters, their applications and operation.
- Demonstrate knowledge of the procedures used to install, connect, troubleshoot, maintain, repair and test high voltage breakers and starters.

Objectives and Content:

1. Define terminology associated with high voltage breakers and starters.
2. Identify hazards and describe safe work practices pertaining to high voltage breakers and starters.
 - i) achieve zero energy state
 - mechanical
 - electrical
3. Interpret codes and regulations pertaining to high voltage breakers and starters.
4. Interpret information pertaining to high voltage breakers and starters found on drawings and specifications.
5. Identify tools and equipment relating to high voltage breakers and starters and describe their applications and procedures for use.
6. Identify types of high voltage breakers and describe their characteristics and applications.
 - i) air
 - ii) oil
 - iii) air blast
 - iv) vacuum
 - v) gas
7. Identify high voltage breaker components and accessories and describe their characteristics and applications.

8. Identify types of high voltage starters and describe their characteristics and applications.
9. Identify high voltage starter components and accessories and describe their characteristics and applications.
10. Identify the considerations and requirements for selecting high voltage breakers and starters, their components and accessories.
11. Describe the procedures used to install and connect high voltage breakers and starters, their components and accessories.
12. Describe the procedures used to isolate and troubleshoot high voltage breakers and starters, their components and accessories.
13. Describe the procedures used for temporary grounding of high voltage equipment.
14. Describe the procedures used to maintain, repair and test high voltage breakers and starters, their components and accessories.

ELEA-1001 Electrical Blueprint

Learning Outcomes:

- Demonstrate knowledge of interpreting , extracting and compiling information from electrical drawings, schematics, site plans, blueprints and specifications.

Objectives and Content:

1. Interpret, extract and compile information from site plans.
 - i) Protected areas
 - ii) Original contours/grades
 - iii) Underground pipe lines
 - iv) Bench marks/datum points
 - v) Grounding grid
 - vi) Area lighting
 - vii) Trench details
 - viii) Service/utility location
 - ix) Symbols

2. Interpret, extract and compile information from elevations, floor plans and reflected ceiling plans.
 - i) General building design
 - ii) Interior finishes
 - iii) Control joints
 - iv) Exterior finishes
 - v) Location of door/windows, air intake/exhaust
 - vi) Number of floors c/w elevations

3. Interpret reference/key diagrams used on blueprints.
 - i) Structural reference grids
 - ii) Key diagrams
 - iii) Reference bubbles
 - iv) Section reference bubbles

4. Interpret, extract and compile information from distribution system layout drawings.
 - i) Switchboards/substations

- ii) Metering centres
 - iii) Component tables
5. Interpret, extract and compile information from single-line drawings.
- i) Feeder size/risers
 - ii) Transformers
 - voltage ratings
 - capacity
 - connections
 - iii) Panel board designations
 - iv) Distribution boards
 - v) Connected apparatus
 - vi) Equipment layout elevations
 - vii) Fire alarm systems
 - viii) Communication systems
 - ix) Energy management systems
6. Interpret, extract and compile information from equipment schedules.
7. Interpret, extract and compile information from motor control center diagrams.
- i) Starter/controller locations
 - ii) Wiring diagrams (generic)
 - iii) Overload/overcurrent
 - iv) Conductor sizes
 - v) Interconnections/interlocking

ELE-260 Job Planning

Learning Outcomes:

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

Objectives and Content:

1. Identify sources of information relevant to planning job tasks.
 - i) documentation
 - ii) drawings
 - iii) related professionals
 - iv) clients

2. Describe the considerations to plan and organize job tasks.
 - i) permits
 - ii) hazard assessment
 - iii) personnel
 - iv) tools and equipment
 - v) materials and supplies
 - vi) scheduling/sequencing

ELE-460 Introduction to Commissioning

Learning Outcomes:

- Demonstrate knowledge of commissioning and its purpose.

Objectives and Content:

1. Define terminology associated with commissioning.
2. Identify hazards and describe safe work practices pertaining to commissioning systems or components.
3. Identify the purpose of commissioning and the types of systems and components requiring it.
4. Identify and interpret information sources and documentation pertaining to the commissioning of systems or components.

ELEA-1002 Troubleshooting Techniques
(Nova Scotia Unit of Instruction)

Learning Outcomes:

- Demonstrate knowledge of troubleshooting techniques and related test instruments.
- Demonstrate knowledge of the procedures used to troubleshoot.

Objectives and Content:

1. Define terminology associated with troubleshooting.
2. Identify hazards and describe safe work practices pertaining to troubleshooting.
 - i) personal
 - ii) equipment
3. Identify conventional troubleshooting techniques.
4. Identify test instruments used to troubleshoot faults and describe their applications and operation.
 - i) meters
 - ii) high-voltage probe adapters
 - iii) indicators
5. Describe the requirements for re-calibration of meters.
6. Describe the procedures used to interpret readings taken from test instruments.

Learning Outcomes:

- Demonstrate knowledge of power supplies and rectifiers, their applications and operation.

Objectives and Content:

1. Define terminology associated with power supply and rectifiers.
2. Identify hazards and describe safe work practices pertaining to power supply and rectifiers.
3. Interpret codes and regulations pertaining to power supply and rectifiers.
4. Interpret information pertaining to power supply and rectifiers found on drawings and specifications.
5. Identify tools and equipment relating to power supply and rectifiers and describe their applications and procedures for use.
6. Identify semiconductor materials and describe their characteristics and applications.
7. Identify power supply and rectifier components and describe their characteristics, applications and operation.
 - i) resistors
 - ii) capacitors
 - iii) inductors
 - iv) diodes
 - PN junction
 - Zener
 - v) rectifiers
 - single-phase rectifier
 - silicon-controlled rectifier (SCR)
 - TRIAC
 - half-wave three-phase rectifier
 - full-wave three-phase rectifier

- vi) thyristors
 - vii) transistors
 - bi-polar
 - field effect transistors (FET)
 - uni-junction
 - insulated gate bi-polar junction (IGBT)
8. Explain the effects of power supply and rectifier components on power in an electronic circuit.
9. Identify the methods used to achieve phase control using triggering circuits.
- i) SCR
 - ii) TRIAC
10. Perform calculations relating to the measurement of power, current and voltage values in rectifier circuits.

ELE-425 Drives

Learning Outcomes:

- Demonstrate knowledge of solid state DC and variable frequency drives (VFDs), their applications and operation.
- Demonstrate knowledge of the procedures used to install, connect, troubleshoot, adjust, repair and test solid state DC drives and VFDs.

Objectives and Content:

1. Define terminology associated with solid state DC drives and VFDs.
2. Identify hazards and describe safe work practices pertaining to solid state DC drives and VFDs.
3. Interpret codes and regulations pertaining to solid state DC drives and VFDs.
4. Interpret information pertaining to solid state DC drives and VFDs found on drawings and specifications.
5. Identify tools and equipment relating to solid state DC drives and VFDs and describe their applications and procedures for use.
6. Identify types of solid state DC motor controllers and describe their characteristics, applications and operation.
7. Identify solid state DC motor controller components and accessories and describe their characteristics, applications and operation.
8. Identify the considerations and requirements for selecting solid state DC motor controllers, their components and accessories.
9. Describe the procedures used to install and connect solid state DC motor controllers, their components and accessories.
10. Describe the procedures used to adjust solid state DC motor controllers, their components and accessories.

11. Describe the procedures used to troubleshoot solid state DC motor controllers, their components and accessories.
12. Describe the procedures used to repair and test solid state DC motor controllers, their components and accessories.
13. Explain the operating principles of VFDs and their impact on motor performance.
14. Identify types of VFDs and describe their characteristics, applications and operation.
15. Identify VFD components and accessories and describe their characteristics, applications and operation.
16. Identify the considerations and requirements for selecting VFDs, their components and accessories.
17. Describe the procedures used to install and connect VFDs, their components and accessories.
18. Describe the procedures used to adjust VFDs, their components and accessories.
19. Describe the procedures used to troubleshoot VFDs, their components and accessories.

ELE-345 Emergency Stand-by Units

Learning Outcomes:

- Demonstrate knowledge of emergency stand-by units, their applications and operation.
- Demonstrate knowledge of the procedures used to install, connect, troubleshoot, maintain, repair and test emergency stand-by units.

Objectives and Content:

1. Define terminology associated with emergency stand-by units.
2. Identify hazards and describe safe work practices pertaining to emergency stand-by units.
3. Interpret codes and regulations pertaining to emergency stand-by units.
 - i) Canadian Electrical Code requirements
 - ii) National Building Code requirements
 - iii) Canadian Standards Association requirements
4. Interpret information pertaining to emergency stand-by units found on drawings and specifications.
5. Identify types of emergency stand-by units and describe their characteristics and applications.
 - i) generator systems
 - ii) uninterruptable power supplies
6. Identify types of batteries and describe their characteristics, applications and maintenance.
7. Identify emergency stand-by unit components and accessories and describe their characteristics and applications.
8. Identify types of transfer switches and describe their characteristics and applications.
 - i) manual
 - ii) automatic

9. Identify transfer switch components and accessories and describe their characteristics and applications.
10. Identify the considerations and requirements for selecting emergency stand-by units and transfer switches, their components and accessories.
11. Describe the procedures used to install and connect emergency stand-by units and transfer switches, their components and accessories.
12. Describe the procedures used to troubleshoot emergency stand-by units and transfer switches, their components and accessories.
13. Describe the procedures used to maintain, repair and test emergency stand-by units and transfer switches, their components and accessories.

Learning Outcomes:

- Demonstrate knowledge of fiber optics, their applications and operation.
- Demonstrate knowledge of the procedures used to install, and connect, troubleshoot, maintain, repair and test fiber optic cables.

Objectives and Content:

1. Define terminology associated with fiber optics.
2. Identify hazards and describe safe work practices pertaining to fiber optics.
3. Interpret codes and regulations pertaining to fiber optics.
4. Interpret information pertaining to fiber optics found on drawings and specifications.
5. Identify tools and equipment relating to fiber optics and describe their applications and procedures for use.
6. Explain the propagation of light through the optical fiber.
7. Identify types of fiber optics systems and describe their characteristics and applications.
8. Identify fiber optic system components and describe their characteristics and applications.
 - i) sources
 - ii) detectors
 - iii) transmitters and receivers
9. Identify types of fiber optic cables and describe their characteristics and applications.
 - i) indoor
 - ii) outdoor
 - iii) hybrid

10. Identify fiber optic cable components and accessories and describe their characteristics and applications.
11. Identify the considerations and requirements for selecting fiber optic systems and cables, their components and accessories.
12. Describe the procedures used to install and connect fiber optic systems and cables, their components and accessories.
 - i) bending radius
 - ii) pulling tension
 - iii) lubrication
 - iv) terminating and splicing
13. Describe the procedures used to troubleshoot fiber optic systems and cables, their components and accessories.
14. Describe the procedures used to maintain, repair and test fiber optic systems and cables, their components and accessories.

Learning Outcomes:

- Demonstrate knowledge of communication systems, their applications and operation.
- Demonstrate knowledge of the procedures used to install, connect, troubleshoot, maintain, repair and test communication systems.

Objectives and Content:

1. Define terminology associated with communication systems.
2. Identify hazards and describe safe work practices pertaining to communication systems.
3. Interpret codes and regulations pertaining to communication systems.
4. Interpret information pertaining to communication systems found on drawings and specifications.
5. Identify tools and equipment relating to communication systems and describe their applications and procedures for use.
6. Identify types of communication systems and describe their characteristics and applications.
 - i) voice/data
 - ii) public address
 - iii) nurse call
 - iv) building automation
7. Identify communication system components and accessories and describe their characteristics and applications.
8. Identify methods of data transfer and describe their applications.
 - i) copper
 - ii) fiber optic
 - iii) wireless

9. Identify the considerations and requirements for selecting communication systems, their components and accessories.
10. Describe the procedures used to install and connect communication systems, their components and accessories.
11. Describe the procedures used to troubleshoot communication systems, their components and accessories.
12. Describe the procedures used to maintain, repair and test communication systems, their components and accessories.

Learning Outcomes:

- Demonstrate knowledge of alternative power systems, their applications and operation.
- Demonstrate knowledge of the procedure to install, connect, troubleshoot, repair and test alternative power systems.

Objectives and Content:

1. Define terminology associated with alternative power systems.
2. Identify hazards and describe safe work practices pertaining to alternative power systems.
3. Interpret codes and regulations pertaining to alternative power systems.
4. Interpret information pertaining to alternative power systems found on drawings and specifications.
5. Identify tools and equipment relating to alternative power systems and describe their applications and procedures for use.
6. Identify types of alternative power systems and describe their characteristics, applications and operation.
 - i) solar (photovoltaic)
 - ii) tidal
 - iii) wind
7. Identify alternative power system components and accessories and describe their characteristics, applications and operation.
8. Describe the procedures used to install and connect alternative power systems, their components and accessories.
9. Describe the procedures used to troubleshoot alternative power systems, their components and accessories.

10. Describe the procedures used to repair and test alternative power systems, their components and accessories.

Learning Outcomes:

- Demonstrate knowledge of cathodic protection systems, their applications and operation.
- Demonstrate knowledge of the procedures used to install, connect, troubleshoot, maintain, repair and test cathodic protection systems.

Objectives and Content:

1. Define terminology associated with cathodic protection systems.
2. Identify hazards and describe safe work practices pertaining to cathodic protection.
3. Interpret codes and regulations pertaining to cathodic protection systems.
4. Interpret information pertaining to cathodic protection systems found on drawings and specifications.
5. Identify tools and equipment relating to cathodic protection systems and describe their applications and procedures for use.
6. Identify types of cathodic protection systems and describe their characteristics, applications and operation.
7. Identify cathodic protection system components and describe their characteristics, applications and operation.
8. Describe the procedures used to install and connect cathodic protection systems and their components.
9. Describe the procedures used to troubleshoot cathodic protection systems and their components.
10. Describe the procedures used to maintain, repair and test cathodic protection systems and their components.

Learning Outcomes:

- Demonstrate knowledge of programmable logic controllers (PLCs), their applications and operation.
- Demonstrate knowledge of PLC data highway systems.

Objectives and Content:

1. Define terminology associated with PLCs.
2. Identify hazards and describe safe work practices pertaining to PLCs.
 - i) online vs. offline applications
3. Interpret codes and regulations pertaining to PLCs.
4. Interpret information pertaining to PLCs found on drawings and specifications.
5. Identify sources of information pertaining to PLCs maintenance, configuration and programming.
6. Identify number and code systems and describe their applications.
 - i) number
 - binary
 - decimal
 - hexadecimal
 - octal
 - ii) code
 - BCD (binary coded decimal)
 - ASCII
7. Perform conversions between number systems.
8. Explain and interpret control circuit logic.
 - i) relay logic
 - ii) AND, OR, NOT, NOR and MEMORY

9. Identify PLC components and describe their purpose and operation.
 - i) hardware
 - power supply
 - CPU
 - I/O system
 - programming terminals
 - ii) software
10. Describe the procedures used to install and connect PLCs and their components.
11. Describe the procedures used to maintain and replace PLCs and their components.
12. Identify types of PLC data highway systems and describe their characteristics, applications and operation.
13. Identify PLC data highway system components and describe their characteristics, applications and operation.
14. Identify methods used to communicate with PLCs.
 - i) handheld
 - ii) computer
 - iii) human machine interfacing
15. Identify basic instruction sets for ladder logic and describe their applications.
 - i) XIO (examine if opened)
 - ii) XIC (examine if closed)
 - iii) OTE (output energized)
16. Identify programming languages used to program PLCs.
 - i) ladder diagram (LD)
 - ii) function block diagram (FBD)
 - iii) structured text (ST)
 - iv) instruction list (IL)
 - v) sequential function chart (SFC)
17. Explain the difference between PLC and Distributed Control Systems (DCS).

Learning Outcomes:

- Demonstrate knowledge of programming programmable logic controllers (PLCs).

Objectives and Content:

1. Define terminology associated with PLC programming.
2. Identify hazards and describe safe work practices pertaining to PLCs.
 - i) online vs offline applications
3. Interpret programming languages and describe their applications.
 - i) ladder diagram (LD)
 - ii) function block diagram (FBD)
 - iii) sequential function chart (SFC)
4. Describe the procedures used to configure and program PLCs and their components.
 - i) I/O configuration
 - ii) data table
 - iii) user program
 - iv) communication interface
5. Identify basic instruction set functions in PLC programming.
6. Describe the procedures used to perform basic programming and editing in PLCs.
 - i) online
 - ii) offline

ELE-440 Fire Alarm Systems

Learning Outcomes:

- Demonstrate knowledge of fire alarm systems, their applications and operation.
- Demonstrate knowledge of the procedures used to install, connect, troubleshoot, maintain, repair and test fire alarm systems.

Objectives and Content:

1. Define terminology associated with fire alarm systems.
2. Identify hazards and describe safe work practices pertaining to fire alarm systems.
3. Interpret codes and regulations pertaining to fire alarm systems.
 - i) Canadian Electrical Code requirements
 - ii) National Building Code requirements
 - iii) Fire Code requirements
4. Interpret information pertaining to fire alarm systems found on drawings and specifications.
5. Identify tools and equipment relating to fire alarm systems and describe their applications and procedures for use.
6. Identify types of fire alarm systems and describe their characteristics and applications.
 - i) single stage/single zone
 - ii) multi-zone
 - iii) two stage
 - iv) addressable
7. Identify fire alarm system components and accessories and describe their characteristics and applications.
 - i) initiating devices
 - ii) signaling devices
 - iii) control panel
 - iv) ancillary devices

8. Identify the considerations and requirements for selecting fire alarm systems, their components and accessories.
9. Describe the procedures used to install and connect fire alarm systems, their components and accessories.
10. Describe the procedures used to troubleshoot fire alarm systems, their components and accessories.
11. Describe the procedures used to maintain, repair and test fire alarm systems, their components and accessories.

ELE-445 Security Systems

Learning Outcomes:

- Demonstrate knowledge of security systems, their applications and operation.
- Demonstrate knowledge of the procedures used to install, connect, troubleshoot, maintain, repair and test security systems.

Objectives and Content:

1. Define terminology associated with security systems.
2. Identify hazards and describe safe work practices pertaining to security systems.
3. Interpret codes and regulations pertaining to security systems.
4. Interpret information pertaining to security systems found on drawings and specifications.
5. Identify tools and equipment relating to security systems and describe their applications and procedures for use.
6. Identify types of security and surveillance systems and describe their characteristics and applications.
 - i) perimeter
 - ii) space
 - iii) spot
7. Identify security and surveillance system components and accessories and describe their characteristics and applications.
 - i) devices
 - detection/monitoring
 - alarm/signaling
 - access
 - ii) control panels
8. Identify the considerations and requirements for selecting security and surveillance systems, their components and accessories.

9. Describe the procedures used to install and connect security and surveillance systems, their components and accessories.
10. Describe the procedures used to troubleshoot security and surveillance systems, their components and accessories.
11. Describe the procedures used to maintain, repair and test security and surveillance systems, their components and accessories.

LEVEL 5

Learning Outcomes:

- Demonstrate knowledge of hydraulic circuits and control systems, their applications and operation.

Objectives and Content:

1. Define terminology associated with hydraulic circuits and controls.
2. Identify hazards and describe safe work practices pertaining to hydraulic circuits and control systems.
3. Describe schematics and their applications.
4. Interpret schematics to determine the operation of a hydraulic control system.
5. Identify tools and equipment related to hydraulic control systems and describe their applications and procedures for use.
6. Identify hydraulic control system components and describe their purpose and operation.
 - i) pumps
 - ii) motors
 - iii) actuators
 - iv) valves
 - v) accumulators
7. Describe the procedures used to perform basic inspection and maintenance of hydraulic control systems and components.
8. Describe the procedures used to troubleshoot, repair and test hydraulic systems and components.

Learning Outcomes:

- Demonstrate knowledge of pneumatic control systems, their applications and operation.

Objectives and Content:

1. Define terminology associated with pneumatic control systems.
2. Identify hazards and describe safe work practices pertaining to pneumatic control systems.
3. Describe schematics and their applications.
4. Interpret schematics to determine the operation of a pneumatic control system.
5. Identify tools and equipment related to pneumatic control systems and describe their applications and procedures for use.
6. Identify pneumatic control system components and describe their purpose and operation.
7. Describe the procedures used to perform basic inspection and maintenance of pneumatic control systems and components.
8. Describe the procedures used to troubleshoot, repair and test pneumatic control systems and components.

Learning Outcomes:

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

Objectives and Content:

1. Define terminology associated with process control.
2. Identify hazards and describe safe work practices pertaining to process control.
3. Interpret information pertaining to process control found on drawings and specifications.
4. Identify tools and equipment relating to process controllers and describe their applications and procedures for use.
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 the 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.

Learning Outcomes:

- Demonstrate knowledge of analog devices, their applications and operation.
- Demonstrate knowledge of the procedures used to install, connect, calibrate, troubleshoot, repair and test analog devices.

Objectives and Content:

1. Define terminology associated with analog devices.
2. Identify hazards and describe safe work practices pertaining to analog devices.
3. Interpret information pertaining to analog devices found on drawings and specifications.
4. Identify tools and equipment relating to analog devices and describe their applications and procedures for use.
5. Explain the use of analog versus digital devices.
6. Identify types of analog devices and describe their characteristics, applications and operation.
7. Identify analog device components and accessories and describe their characteristics and applications.
8. Identify types of signals used with analog devices and describe their characteristics, applications and operation.
 - i) air
 - ii) current
 - iii) voltage
9. Explain the use of analog devices for measurement.
 - i) pressure
 - ii) temperature
 - iii) flow

- iv) level
 - v) mass and density
10. Identify the considerations and requirements for selecting analog devices, their components and accessories.
 11. Describe the procedures used to install, connect and set analog devices, their components and accessories.
 12. Describe the procedures used to calibrate analog devices.
 13. Describe the procedures used to troubleshoot analog devices, their components and accessories.
 14. Describe the procedures used to repair and test analog devices, their components and accessories.

Learning Outcomes:

- Demonstrate knowledge of building automation systems, their applications and operation.
- Demonstrate knowledge of the procedures used to install, connect, calibrate, troubleshoot, maintain, repair and test building automation systems.

Objectives and Content:

1. Define terminology associated with building automation systems.
2. Identify hazards and describe safe work practices pertaining to building automation systems.
3. Interpret codes and regulations pertaining to building automation systems.
4. Interpret information pertaining to building automation systems found on drawings and specifications.
5. Identify tools and equipment relating to building automation systems and describe their applications and procedures for use.
6. Identify types of building automation systems and describe their characteristics and operation.
 - i) energy
 - ii) security
 - iii) heating, ventilation and cooling (HVAC)
7. Identify building automation system components and describe their characteristics, applications and operation.
8. Identify the considerations and requirements for selecting building automation systems and their components.
9. Describe the procedures used to install and connect building automation systems and their components.

10. Describe the procedures used to calibrate building automation systems and their components.
11. Describe the procedures used to troubleshoot building automation systems and their components.
12. Describe the procedures used to maintain, repair and test building automation systems and their components.

Learning Outcomes:

- Demonstrate knowledge of digital electronics, their applications and operation.

Objectives and Content:

1. Define terminology associated with digital electronics.
2. Interpret information pertaining to digital electronics found on drawings and specifications.
3. Identify types of logic gates and describe their applications.
 - i) AND gate
 - ii) OR gate
 - iii) NOT gate
 - iv) NAND gate
 - v) NOR gate
 - vi) exclusive-OR circuit
4. Identify types of circuits and describe their characteristics, features and applications.
 - i) integrated
 - ii) flip-flop
 - RS type
 - T type
 - D type
 - JK type
5. Identify types of devices related to flip-flop circuits and describe their characteristics, applications and operation.
 - i) multivibrators
 - ii) counters
 - iii) shift registers
 - iv) truth tables
6. Identify types of basic optoelectronic components and describe their characteristics, applications and operation.

7. Identify conversion devices and describe their characteristics, applications and operation.
 - i) analog to digital
 - ii) digital to analog

Learning Outcomes:

- Demonstrate knowledge of boiler controls.
- Demonstrate knowledge of the procedures to install and maintain boiler controls.

Objectives and Content:

1. Locate and interpret information related to boiler controls.
 - i) Drawings and symbols
 - ii) Schematics
 - iii) Manufacturers specifications
2. Describe the operation of boilers and their components.
 - i) Safety considerations
 - ii) Motors
 - iii) Control devices
 - iv) Sensing devices
 - v) Igniters
 - vi) Flame detectors and sensors
 - vii) Boiler startup sequence
3. Describe the procedures used to install boiler controls.
 - i) Protective devices
 - ii) Wiring
4. Describe the procedures used to maintain boilers controls.
 - i) Inspect
 - ii) Repair components
 - iii) Replace components
 - iv) Lubricate components
5. Describe the procedures used to troubleshoot safety interlocks.
6. Identify regulatory requirements related to boiler controls.
 - i) Boiler and Pressure Vessel Act

Learning Outcomes:

- Demonstrate knowledge of heat pumps and their associated devices and controls.
- Demonstrate knowledge of the procedures to install and maintain heat pumps and their associated devices and controls.

Objectives and Content:

1. Locate and interpret information related to heat pumps and their installations.
 - i) Drawings and symbols
 - ii) Schematics
 - iii) Manufacturer's specifications
2. Describe the operating principles of heat pumps.
3. Describe the procedures used to install heat pumps and their associated equipment.
4. Describe the procedures used to maintain heat pumps.
 - i) Control circuitry
 - ii) Field devices
 - iii) Use of test equipment to verify proper operation
5. Identify regulatory requirements related to heat pumps.

Learning Outcomes:

- Demonstrate knowledge of electrical components and controls for refrigeration and air conditioning systems.
- Demonstrate knowledge of the procedures to maintain and troubleshoot electrical components and controls for refrigeration and air conditioning systems.

Objectives and Content:

1. Locate and interpret information related to refrigeration and air conditioning controls.
 - i) Drawings and symbols
 - ii) Schematics
 - iii) Manufacturer's specifications
2. Describe the operating principles of refrigeration and air conditioning units.
3. Identify and describe system components and controls.
4. Describe the procedures used to troubleshoot and maintain electrical components and controls for refrigeration and air conditioning systems.
5. Identify regulatory requirements relating to refrigeration and air conditioning units.
6. Describe safety considerations.
 - i) CFC's
 - ii) WHMIS
 - iii) Ammonia

IEL-1160 HVAC Electrical Systems

Learning Outcomes:

- Demonstrate knowledge of HVAC electrical systems.
- Demonstrate knowledge of the procedures to install and maintain and HVAC electrical systems.

Objectives and Content:

1. Locate and interpret information related to HVAC electrical systems.
 - i) Drawings and symbols
 - ii) Schematics
 - iii) Manufacturer's specifications
2. Describe the operating principles of HVAC electrical systems.
3. Describe the procedures used to install and maintain HVAC electrical systems.
 - i) Clean
 - ii) Inspect
 - iii) Lubricate
 - iv) Replace components
 - v) Calibrate
 - vi) Test
4. Identify regulatory requirements relating to HVAC systems.

Learning Outcomes:

- Demonstrate knowledge of the procedures used to perform vibration analysis.

Objectives and Content:

1. Define terminology associated with vibration analysis.
2. Identify hazards and describe safe work practices pertaining to vibration analysis.
3. Identify tools and equipment used for vibration analysis and describe their applications and procedures for use.
4. Identify and interpret sources of information pertaining to vibration analysis.
 - i) manufacturers' specifications
 - ii) vibration standards and charts
 - iii) Canadian Machinery Vibration Association (CMVA) interpretations and guidelines
5. Identify causes of vibration.
6. Identify vibration analysis methods and describe their applications.
7. Describe the procedures used to perform vibration analysis.
8. Record and interpret data collected using vibration analysis.

Learning Outcomes:

- Demonstrate knowledge of environmental control systems, their applications and operation.
- Demonstrate knowledge of the procedures used to install, connect, calibrate, troubleshoot, maintain, repair and test environmental control systems.
- Demonstrate knowledge of the procedures used to store, handle and dispose of hazardous materials.

Objectives and Content:

1. Define terminology associated with environmental control systems.
2. Identify hazards and describe safe work practices pertaining to environmental control systems.
3. Interpret codes and regulations pertaining to environmental control systems.
4. Interpret information pertaining to environmental control systems found on drawings and specifications.
5. Identify tools and equipment relating to environmental control systems and describe their applications and procedures for use.
6. Explain the purpose and operation of environmental control systems.
7. Identify types of environmental control systems and describe their characteristics and applications.
 - i) waste management
 - ii) noise reduction
 - iii) water treatment
 - iv) dust suppression
 - v) emissions
8. Identify environmental control system components and describe their characteristics and applications.
 - i) samplers

- ii) analyzers
 - iii) scrubbers
 - iv) skimmers
9. Identify the considerations and requirements for selecting environmental control systems and their components.
 10. Describe the procedures used to install and connect environmental control systems and their components.
 11. Describe the procedures used to calibrate environmental control systems and their components.
 12. Describe the procedures used to troubleshoot environmental control systems and their components.
 13. Describe the procedures used to maintain, repair and test environmental control systems and their components.
 14. Describe the procedures used to store, handle and dispose of hazardous materials.

IELA-1836

Program Review

(Nova Scotia Unit of Instruction)

Learning Outcomes:

- Upon successful completion of this unit, the apprentice will complete a study plan based on the National Occupational Analysis.

Objectives and Content:

1. Identify areas of the program where knowledge of theory is weakest.
2. Identify areas where workplace experience is lacking or weak.
3. Identify resources necessary to address areas of shortfall.
4. Identify timelines to address areas of weakness.

Suggested Learning Activities:

1. Conduct a mock certification exam to be used for diagnostic purposes.
2. Review the National Occupational Analysis.
3. Review the Apprentice Logbook.
4. Review the Exam Preparation information found at www.nsapprenticeship.ca under Exam Preparation.
5. Conduct a final mock certification exam.

Resources:

These are the recommended resources to use in the delivery of this unit:

- Exam Preparation information, including videos, occupational analyses, exam counseling sheets, practice exams and sample questions, and other study materials and resources, can be found at www.nsapprenticeship.ca under Exam Preparation.
- Apprentice's personal logbook
- Applicable codes and regulations
- Program texts

Evaluation: pass/fail

Formulas

1. $kVA = V \times A / 1000$
2. $RPM = 120F / P$
3. $V_S / V_P = N_S / N_P$
4. $N_S / N_P = I_P / I_S$
5. $P = I^2 R$
6. $I = E/R$
7. $P = E \times I$
8. True 3 Φ Power = $E_L \times I_L \times PF \times 1.732$
9. P (Watts) = $hp \times 746$
10. $E_P \times N_S = E_S \times N_P$
11. $PF = W/VA$
12. Wye $E_P = E_L / 1.732$
13. (Series Inductors) $L_T = L_1 + L_2 + L_3$
14. (Parallel Inductors) $1 / L_T = 1 / L_1 + 1/L_2 + 1 / L_3$
15. (Parallel Capacitors) $C_T = C_1 + C_2 + C_3$
16. Series Capacitors) $1 / C_T = 1 / C_1 + 1/C_2 + 1 / C_3$
17. $X_L = 2\pi f l$
18. $X_C = 1 / 2\pi f C$
19. $C^2 = A^2 + B^2$
20. $Z = \sqrt{R^2 + (X_L^2 - X_C^2)}$
21. Fault Current = Secondary current/ Impedance
22. 1 W = 3.41 BTU / H
23. $N = 120F/P$
24. Power (HP) = Torque (lb.in) x speed/63,025
25. Motor Efficiency % = (Power out / Power in) x 100
26. $T_K = T_C + 273.15$
27. % Slip = (Stator speed – Rotor speed / Stator speed) x 100
28. % Voltage regulation (Transformers or Alternators) = (Voltage no-load – Voltage full-load / Voltage full-load) x 100
29. 3 Φ Amps = VA / Volts x 1.732
30. Motor Torque (N·m) = W x 9.549 / Speed
31. 1 ft.lb = 1.356 N·m
32. Torque (ft.lb) = $P_{HP} \times 5252 / \text{Speed}$
33. 3 Φ Apparent Power (VA) = $E_L \times I_L \times 1.732$
34. $T_F = T_C \times 9/5 + 32$
35. 1 gallon = .0036047 in³

Nova Scotia Document Evaluation Form

Thank you for your interest in the development and revision of this document. Upon review of the document, please record your feedback in relation to the following items:

- course division and organization
- relevancy of the content
- errors or omissions
- other suggestions for improvement and consideration

Overall comments are to be entered on this evaluation form and specific changes are to be entered directly on the document in the relevant area(s). When making proposed corrections(s) in the document, please use red ink. When all feedback has been recorded, return this evaluation form along with the document to the Apprenticeship Office noted at the bottom of the page.

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