SKILLED TRADES BC

PROGRAM OUTLINE

Construction Electrician

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CONSTRUCTION ELECTRICIAN
HARMONIZED PROGRAM OUTLINE

APPROVED BY INDUSTRY FEBRUARY 2017

REVISED OCTOBER 2020

REVISED SEPTEMBER 2022

BASED ON

2015 CONSTRUCTION ELECTRICIAN RSOS

AND 2016 INDUSTRIAL ELECTRICIAN RSOS

Developed by
SkilledTradesBC
Province of British Columbia

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Section 1

INTRODUCTION

Construction Electrician

Foreword

This Construction Electrician Program Outline is intended as a guide for instructors, apprentices, and employers of apprentices as well as for the use of industry organizations, regulatory bodies, and provincial and federal governments. It reflects updated standards based on the Construction Electrician Red Seal Occupational Standard (RSOS) (2015), Industrial Electrician Red Seal Occupational Standard (RSOS) (2016) and British Columbia industry and instructor subject matter experts.

Practical instruction by demonstration and student participation should be integrated with classroom sessions. Safe working practices, even though not always specified in each operation or topic, are an implied part of the program and should be stressed throughout the apprenticeship.

This Program Outline includes a list of recommended reference textbooks that are available to support the learning objectives and the minimum shop requirements needed to support instruction.

Competencies are to be evaluated through the use of written examinations and practical assessments. The types of questions used on written examinations must reflect the cognitive level indicated by the learning objectives and the learning tasks listed in the related competencies. See the Assessment Guidelines in the Appendix for more details.

Important Program Information:

Industry strongly recommends that apprentices considering attending the Level 1 Construction Electrician program have at least one year of work-based training as an electrical apprentice before beginning their in-school technical training.

Apprentices who attain workplace competencies before attending technical training are in a better position to take advantage of the in-school portions of their apprenticeship.

CANADIAN ELECTRICAL CODE AND THE PROGRAM OUTLINE

The Canadian Electrical Code (CEC) requirements are expected to be applied to all relevant competencies and learning tasks even when a code reference is not given.

SAFETY ADVISORY

Be advised that references to the WorkSafe BC safety regulations contained within these materials do not/may not reflect the most recent Occupational Health and Safety Regulation (the current Standards and Regulation in BC can be obtained on the following website: http://www.worksafebc.com). Please note that it is always the responsibility of any person using these materials to inform him/herself about the Occupational Health and Safety Regulation pertaining to his/her work.

Acknowledgements

Subject Matter Experts retained to assist in the development of the Occupational Analysis Chart for Construction Electrician and Industrial Electrician (2017):

- Keith Ankerman — Fortis BC
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- Keith Ankerman — Fortis BC
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- Kevin Szol — College of the Rockies
- Stephen Van Rhijn — Canfor
- Monty Wood — enCompass Solutions

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- Nathan Chapin — British Columbia Institute of Technology
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SkilledTradesBC would like to acknowledge the dedication and hard work of all the industry representatives appointed to identify the training requirements of the Construction Electrician and Industrial Electrician occupations.

How to Use this Document

This Program Outline has been developed for the use of individuals from several different audiences. The table below describes how each section can be used by each intended audience.

Section	Training Providers	Employers/ Sponsors	Apprentices	Challengers
Program Credentialing Model	Communicate program length and structure, and all pathways to completion	Understand the length and structure of the program	Understand the length and structure of the program, and pathway to completion	Understand challenger pathway to Certificate of Qualification
OAC	Communicate the competencies that industry has defined as representing the scope of the occupation	Understand the competencies that an apprentice is expected to demonstrate in order to achieve certification	View the competencies they will achieve as a result of program completion	Understand the competencies they must demonstrate in order to challenge the program
Training Topics and Suggested Time Allocation	For each level of technical training, this defines the suggested proportion of time spent on each GAC, and the percentage of that time spent on theory versus practical learning. Checkmarks indicate where marks will be allocated. Note that there may be practical time suggested even if there is no defined achievement criteria in a competency.	For each level of technical training, this defines the suggested proportion of time spent on each GAC, and the percentage of that time spent on theory versus practical learning. Checkmarks indicate where marks will be allocated. Note that there may be practical time suggested even if there is no defined achievement criteria in a competency.	For each level of technical training, this defines the suggested proportion of time spent on each GAC, and the percentage of that time spent on theory versus practical learning. Checkmarks indicate where marks will be allocated. Note that there may be practical time suggested even if there is no defined achievement criteria in a competency.	For each level of technical training, this defines the suggested proportion of time spent on each GAC, and the percentage of that time spent on theory versus practical learning. Checkmarks indicate where marks will be allocated. Note that there may be practical time suggested even if there is no defined achievement criteria in a competency.
Program Content	Defines the objectives, learning tasks and high level content that must be covered for each competency	Identifies detailed program content; may be used as a checklist prior to signing a recommendation for certification (RFC) for an apprentice	Provides detailed information on program content and performance expectations for demonstrating competency	Allows individual to check program content areas against their own knowledge and performance expectations against their own skill levels
Achievement Criteria	Defines observable, measurable performance expectations for competencies with a lab component. For this trade, achievement criteria is performed in a lab setting and does not indicate workplace standards	Defines observable, measurable performance expectations for competencies with a lab component. For this trade, achievement criteria is performed in a lab setting and does not indicate workplace standards	Defines observable, measurable performance expectations for competencies with a lab component. For this trade, achievement criteria is performed in a lab setting and does not indicate workplace standards	Defines observable, measurable performance expectations for competencies with a lab component. For this trade, achievement criteria is performed in a lab setting and does not indicate workplace standards

Section	Training Providers	Employers/ Sponsors	Apprentices	Challengers
Training Provider Standards	Defines the facility requirements, tools and equipment, reference materials (if any) and instructor requirements for the program	Identifies the tools and equipment an apprentice is expected to have access to; which are supplied by the training provider and which the student is expected to own	Provides information on the training facility, tools and equipment provided by the school and the student, reference materials they may be expected to acquire, and minimum qualification levels of program instructors	Identifies the tools and equipment a tradesperson is expected to be competent in using or operating; which may be used or provided in a practical assessment
Appendix – Glossary of Acronyms	Defines program specific acronyms	Defines program specific acronyms	Defines program specific acronyms	Defines program specific acronyms
Assessment Guidelines	Defines the weighting of theory and practical (lab) marks by GAC to be used to calculate an apprentice's in-school mark for each level. The practical weighting is a reflection of performance on the achievement criteria for each level. Assessment Guidelines also define the weighting of the in-school mark to the standard level exam mark (where applicable) in order to calculate an apprentice's final mark for each level.	Defines the weighting of theory and practical (lab) marks by GAC to be used to calculate an apprentice's in-school mark for each level. The practical weighting is a reflection of performance on the achievement criteria for each level. Assessment Guidelines also define the weighting of the in-school mark to the standard level exam mark (where applicable) in order to calculate an apprentice's final mark for each level.	Defines the weighting of theory and practical (lab) marks by GAC to be used to calculate an apprentice's in-school mark for each level. The practical weighting is a reflection of performance on the achievement criteria for each level. Assessment Guidelines also define the weighting of the in-school mark to the standard level exam mark (where applicable) in order to calculate an apprentice's final mark for each level.	Understand the relative weightings of various competencies of the occupation on which assessment is based

Section 2

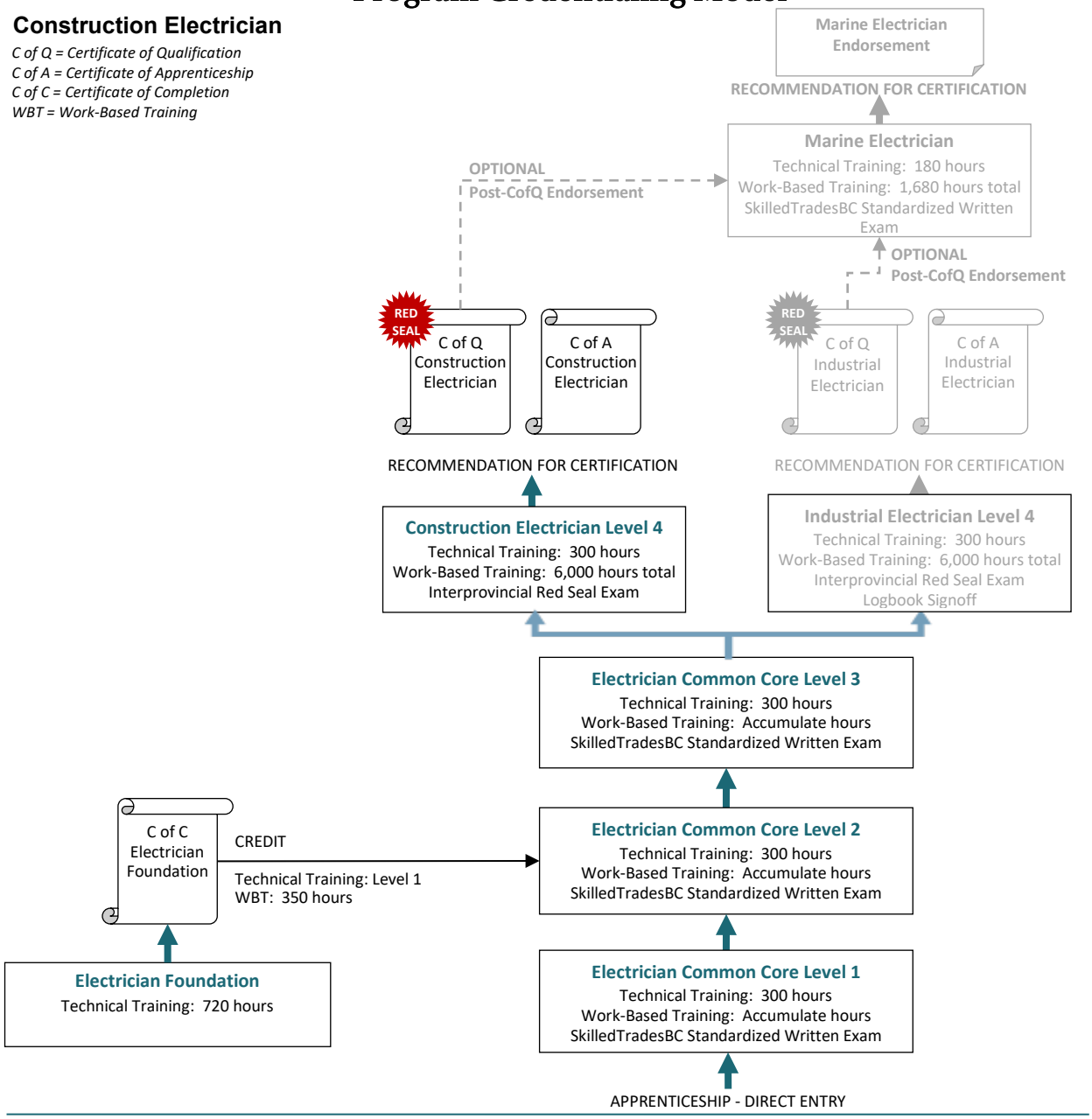
PROGRAM OVERVIEW

Construction Electrician

Program Credentialing Model

Construction Electrician

C of Q = Certificate of Qualification
C of A = Certificate of Apprenticeship
C of C = Certificate of Completion
WBT = Work-Based Training



CROSS-PROGRAM CREDITS

Individuals who hold the credentials listed below are entitled to receive partial credit toward the completion requirements of this program

C of Q Industrial Electrician

Technical Training: Level 1, 2 & 3
Work-Based Training: 4,500 hours

C of A
(Issued in BC prior to February 2006)
Marine Electrician, Industrial Electrician, Neon Electrician or Construction Electrician

Eligible to apply for a Certificate of Qualification without examination (**Note:** Red Seal endorsement granted only with successful challenge of the Interprovincial Red Seal exam)

Occupational Analysis Chart

CONSTRUCTION ELECTRICIAN AND INDUSTRIAL ELECTRICIAN

Occupation Description: Construction Electricians plan, design, assemble, install, alter, repair, inspect, verify, commission, connect, operate, maintain and decommission electrical systems. Electrical systems provide heating, lighting, power, alarm, security, communication and control in residential, commercial, institutional, industrial, transportation, marine and entertainment environments.

Occupation Description: Industrial Electricians inspect, install, test, troubleshoot, repair, and service industrial electrical equipment and associated electrical and electronic controls. Service includes calibration and preventative/predictive maintenance. Industrial electricians are employed by maintenance departments of plants, mines, smelters, oil and gas operations, mills, shipyards, utility companies, manufacturing facilities and other industrial establishments. Some are employed by electrical contractors.

APPLY CIRCUIT CONCEPTS **A**	Use electrical circuit concepts A1	Analyze DC circuits A2	Analyze principles of electromagnetism A3	Analyze single-phase AC circuits A4	
	1 | 2	1	1	2	
	Analyze three-phase AC circuits A5	Analyze electronic circuits A6			
	3	1 | 2 | 3 | 4C			
PERFORM SAFETY-RELATED FUNCTIONS **B**	Use personal protection equipment (PPE) and safety equipment B1	Maintain safe work environment B2	Perform lock-out and tag-out procedures B3		
	1	1	1		
USE TOOLS AND EQUIPMENT **C**	Use common and specialty tools and equipment W C1	Use access equipment W C2	Use rigging, hoisting and lifting equipment W C3	Use measuring and testing equipment C4	
				1 | 3	

W = Competencies for which knowledge or skills are primarily acquired in the workplace

4C = Competency included in Construction Electrician Level 4 Program Outline content

4IE = Competency included in Industrial Electrician Level 4 Program Outline content

Section	Competency	Code	W	1	2	3	4C	4IE
ORGANIZE WORK (D)	Interpret plans, drawings and specifications	D1		1	2	3	4C	4IE
	Use Canadian Electrical Code (CEC)	D2		1				
	Organize materials and supplies	D3	W					
	Plan project tasks and procedures	D4	W					
	Prepare worksite	D5	W					
	Finalize required documentation	D6	W					
	Identify hazardous locations	D7					4C	4IE
FABRICATE AND INSTALL SUPPORT COMPONENTS (E)	Fabricate support structures	E1	W					
	Install brackets, hangers and fasteners	E2	W					
	Install seismic restraint systems	E3	W					
COMMISSION AND DECOMMISSION ELECTRICAL SYSTEMS (F)	Commission systems	F1	W					
	Perform startup and shutdown procedures	F2	W					
	Decommission systems	F3	W					
USE COMMUNICATION AND MENTORING TECHNIQUES (G)	Use communication techniques	G1	W					
	Use mentoring techniques	G2		1				
INSTALL AND MAINTAIN CONSUMER/SUPPLY SERVICES AND METERING EQUIPMENT (H)	Install single-phase consumer/supply services and metering equipment	H1		1	2			
	Install three-phase consumer/supply services and metering equipment	H2				3		
	Maintain single-phase services and metering equipment	H3		1				
	Maintain three-phase services and metering equipment	H4				3		
INSTALL AND MAINTAIN PROTECTION DEVICES (I)	Install overcurrent protection devices	I1			2			
	Install ground fault, arc fault and surge protection devices	I2		1	2			
	Install under and over voltage protection devices	I3						4IE
	Maintain protection devices	I4	W					
INSTALL AND MAINTAIN LOW VOLTAGE DISTRIBUTION SYSTEMS (J)	Install low voltage distribution equipment	J1		1		3		
	Maintain low voltage distribution equipment	J2	W					

W = Competencies for which knowledge or skills are primarily acquired in the workplace

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4IE = Competency included in Industrial Electrician Level 4 Program Outline content

INSTALL AND MAINTAIN POWER CONDITIONING, UNINTERRUPTIBLE POWER SUPPLY (UPS) AND SURGE SUPPRESSION SYSTEMS **K**	Install power conditioning, UPS and surge suppression systems K1			4C	4IE	Maintain power conditioning, UPS and surge suppression systems K2			4C	4IE
INSTALL AND MAINTAIN BONDING, GROUNDING AND GROUND FAULT DETECTION SYSTEMS **L**	Install grounding and bonding systems L1	1	2	3		Maintain grounding and bonding systems L2	W			
	Install ground fault detection systems L3			3		Maintain ground fault detection systems L4	W			
INSTALL AND MAINTAIN POWER GENERATION SYSTEMS **M**	Install AC generating systems M1			3		Maintain AC generating systems M2			3	
	Install DC generating systems M3			3		Maintain DC generating systems M4			3	
INSTALL AND MAINTAIN RENEWABLE ENERGY GENERATING AND STORAGE SYSTEMS **N**	Install renewable energy generating and storage systems N1		2		4C	4IE	Maintain renewable energy generating and storage systems N2	W		
INSTALL AND MAINTAIN HIGH VOLTAGE SYSTEMS **O**	Install high voltage systems O1				4C	4IE	Maintain high voltage systems O2			4C	4IE
INSTALL AND MAINTAIN TRANSFORMERS **P**	Install extra-low and low-voltage single-phase transformers P1		2				Maintain extra-low and low-voltage single-phase transformers P2	W			
	Install low-voltage three-phase transformers P3			3			Maintain low-voltage three-phase transformers P4	W			
	Install high-voltage transformers P5			3			Maintain high-voltage transformers P6	W			
INSTALL AND MAINTAIN RACEWAYS, CABLES AND ENCLOSURES **Q**	Install conductors and cables Q1	1	2				Install raceways, boxes and fittings Q2	1	2		
	Maintain conductors, cables, raceways, boxes and fittings Q3		2								

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4IE = Competency included in Industrial Electrician Level 4 Program Outline content

Competency	Task	Code					
INSTALL AND MAINTAIN BRANCH CIRCUITRY (R)	Install luminaires	R1	1	2			
	Install wiring devices	R2	1	2	3		
	Install lighting controls	R3	1	2			
	Install lighting standards	R4	1				
	Maintain luminaires, wiring devices, lighting controls, lighting standards and branch circuitry	R5		2			
	Install and maintain airport runway lighting systems	R6				4C	
	Install and maintain traffic signal lights and controls	R7				4C	
INSTALL AND MAINTAIN HEATING, VENTILATING AND AIR-CONDITIONING (HVAC) SYSTEMS (S)	Install HVAC systems and controls	S1		2			
	Maintain HVAC systems and controls	S2		2			
INSTALL AND MAINTAIN EXIT AND EMERGENCY LIGHTING SYSTEMS (T)	Install exit and emergency lighting systems	T1		2			
	Maintain exit and emergency lighting systems	T2		2			
INSTALL AND MAINTAIN CATHODIC PROTECTION SYSTEMS (U)	Install cathodic protection systems	U1		2			
	Maintain cathodic protection systems	U2		2			
INSTALL AND MAINTAIN MOTOR STARTERS AND CONTROLS (V)	Install motor starters and controls	V1	1	2	3		
	Maintain motor starters and controls	V2	1	2	3		
INSTALL AND MAINTAIN DRIVES (W)	Install drives	W1			3		
	Maintain drives (W)	W2					
INSTALL AND MAINTAIN NON-ROTATING EQUIPMENT AND ASSOCIATED CONTROLS (X)	Install non-rotating equipment and associated controls	X1				4C	4IE
	Maintain non-rotating equipment and associated controls	X2					4IE

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4C = Competency included in Construction Electrician Level 4 Program Outline content

4IE = Competency included in Industrial Electrician Level 4 Program Outline content

INSTALL AND MAINTAIN MOTORS **Y**	Install AC motors Y1	Maintain AC motors Y2	Install DC motors Y3	Maintain DC motors Y4	
	3	3	3	3	
INSTALL AND MAINTAIN SIGNALING SYSTEMS **Z**	Install fire alarm systems Z1	Maintain fire alarm systems W Z2	Install security and surveillance systems Z3	Maintain security and surveillance systems W Z4	
	4C 4IE		4C 4IE		
INSTALL AND MAINTAIN COMMUNICATION SYSTEMS **AA**	Install voice/data/video (VDV) systems AA1	Install public address (PA) and intercom systems W (CE only) AA2	Install nurse call systems AA3	Maintain communication systems W AA4	
	1 4C 4IE		4C		
INSTALL AND MAINTAIN BUILDING AUTOMATION SYSTEMS **AB**	Install building automation systems AB1	Maintain building automation systems W AB2			
	4C 4IE				
INSTALL, PROGRAM AND MAINTAIN AUTOMATED CONTROL SYSTEMS **AC**	Install automated control systems AC1	Maintain automated control systems W AC2	Program automated control systems AC3	Optimize system performance AC4	
	4C 4IE		4C 4IE	4IE	
INSTALL AND MAINTAIN PNEUMATIC, HYDRAULIC CONTROL AND PUMPING SYSTEMS **AD**	Install pneumatic control systems AD1	Maintain pneumatic control systems W (IE Only) AD2	Install hydraulic control systems AD3	Maintain hydraulic control systems W (IE Only) AD4	
	4IE		4IE		
	Install and maintain pumping systems AD5				
	4IE				

W = Competencies for which knowledge or skills are primarily acquired in the workplace

4C = Competency included in Construction Electrician Level 4 Program Outline content

4IE = Competency included in Industrial Electrician Level 4 Program Outline content

Training Topics and Suggested Time Allocation: Level 1

ELECTRICIAN COMMON CORE– LEVEL 1

			% of Time Allocated to:		
		% of Time	Theory	Practical	Total
Line A	**APPLY CIRCUIT CONCEPTS**	**56%**	**90%**	**10%**	**100%**
A1	Use electrical circuit concepts		✓	✓	
A2	Analyze DC circuits		✓	✓	
A3	Analyze principles of electromagnetism		✓		
A6	Analyze electronic circuits		✓	✓	
Line B	**PERFORM SAFETY-RELATED FUNCTIONS**	**3%**	**95%**	**5%**	**100%**
B1	Use personal protection equipment (PPE) and safety equipment		✓		
B2	Maintain safe work environment		✓		
B3	Perform lock-out and tag-out procedures		✓	✓	
Line C	**USE TOOLS AND EQUIPMENT**	**2%**	**90%**	**10%**	**100%**
C4	Use measuring and testing equipment		✓	✓	
Line D	**ORGANIZE WORK**	**8%**	**100%**	**0%**	**100%**
D1	Interpret plans, drawings and specifications		✓		
D2	Use Canadian Electrical Code (CEC)		✓		
Line G	**USE COMMUNICATION AND MENTORING TECHNIQUES**	**1%**	**100%**	**0%**	**100%**
G2	Use mentoring techniques		✓		
Line H	**INSTALL AND MAINTAIN CONSUMER/SUPPLY SERVICES AND METERING EQUIPMENT**	**4%**	**100%**	**0%**	**100%**
H1	Install single-phase consumer/supply services and metering equipment		✓		
H3	Maintain single-phase services and metering equipment		✓		
Line I	**INSTALL AND MAINTAIN PROTECTION DEVICE**	**2%**	**100%**	**0%**	**100%**
I2	Install ground fault, arc fault and surge protection devices		✓		
Line J	**INSTALL AND MAINTAIN LOW VOLTAGE DISTRIBUTION SYSTEMS**	**2%**	**100%**	**0%**	**100%**
J1	Install low voltage distribution equipment		✓		
Line L	**INSTALL AND MAINTAIN BONDING, GROUNDING AND GROUND FAULT DETECTION SYSTEMS**	**2%**	**100%**	**0%**	**100%**
L1	Install grounding and bonding systems		✓		
Line Q	**INSTALL AND MAINTAIN RACEWAYS, CABLES AND ENCLOSURES**	**4%**	**100%**	**0%**	**100%**
Q1	Install conductors and cables		✓		

			% of Time Allocated to:		
		% of Time	Theory	Practical	Total
Q2	Install raceways, boxes and fittings		✓		
Line R	**INSTALL AND MAINTAIN BRANCH CIRCUITRY**	**6%**	**90%**	**10%**	**100%**
R1	Install luminaires		✓		
R2	Install wiring devices		✓		
R3	Install lighting controls		✓	✓	
R4	Install lighting standards		✓		
Line V	**INSTALL AND MAINTAIN MOTOR STARTERS AND CONTROLS**	**8%**	**90%**	**10%**	**100%**
V1	Install motor starters and controls		✓	✓	
V2	Maintain motor starters and controls		✓		
Line AA	**INSTALL AND MAINTAIN COMMUNICATION SYSTEMS**	**2%**	**75%**	**25%**	**100%**
AA1	Install voice/data/video (VDV) systems		✓	✓	
	Total Percentage for Electrician Common Core Level 1	**100%**			

Training Topics and Suggested Time Allocation: Level 2

ELECTRICIAN COMMON CORE – LEVEL 2

			% of Time Allocated to:		
		% of Time	Theory	Practical	Total
Line A	**APPLY CIRCUIT CONCEPTS**	**41%**	**90%**	**10%**	**100%**
A1	Use electrical circuit concepts		✓		
A4	Analyze single-phase AC circuits		✓	✓	
A6	Analyze electronic circuits		✓	✓	
Line D	**ORGANIZE WORK**	**5%**	**100%**	**0%**	**100%**
D1	Interpret plans, drawings and specifications		✓		
Line H	**INSTALL AND MAINTAIN CONSUMER/SUPPLY SERVICES AND METERING EQUIPMENT**	**5%**	**100%**	**0%**	**100%**
H1	Install single-phase consumer/supply services and metering equipment		✓		
Line I	**INSTALL AND MAINTAIN PROTECTION DEVICES**	**4%**	**95%**	**5%**	**100%**
I1	Install overcurrent protection devices		✓		
I2	Install ground fault, arc fault and surge protection devices		✓		
Line L	**INSTALL AND MAINTAIN BONDING, GROUNDING AND GROUND FAULT DETECTION SYSTEMS**	**2%**	**100%**	**0%**	**100%**
L1	Install grounding and bonding systems		✓		
Line N	**INSTALL AND MAINTAIN RENEWABLE ENERGY GENERATING AND STORAGE SYSTEMS**	**2%**	**100%**	**0%**	**100%**
N1	Install renewable energy generating and storage systems		✓		
Line P	**INSTALL AND MAINTAIN TRANSFORMERS**	**13%**	**80%**	**20%**	**100%**
P1	Install extra-low and low-voltage single-phase transformers		✓	✓	
Line Q	**INSTALL AND MAINTAIN RACEWAYS, CABLES AND ENCLOSURES**	**2%**	**100%**	**0%**	**100%**
Q1	Install conductors and cables		✓		
Q2	Install raceways, boxes and fittings		✓		
Q3	Maintain conductors, cables, raceways, boxes and fittings		✓		
Line R	**INSTALL AND MAINTAIN BRANCH CIRCUITRY**	**6%**	**100%**	**0%**	**100%**
R1	Install luminaires		✓		
R2	Install wiring devices		✓		
R3	Install lighting controls		✓		
R5	Maintain luminaires, wiring devices, lighting controls, lighting standards and branch circuitry		✓		
Line S	**INSTALL AND MAINTAIN HEATING, VENTILATING AND AIR-CONDITIONING (HVAC) SYSTEMS**	**6%**	**100%**	**0%**	**100%**
S1	Install HVAC systems and controls		✓		

			% of Time Allocated to:		
		% of Time	Theory	Practical	Total
S2	Maintain HVAC systems and controls		✓		
Line T	**INSTALL AND MAINTAIN EXIT AND EMERGENCY LIGHTING SYSTEMS**	**3%**	**100%**	**0%**	**100%**
T1	Install exit and emergency lighting systems		✓		
T2	Maintain exit and emergency lighting systems		✓		
Line U	**INSTALL AND MAINTAIN CATHODIC PROTECTION SYSTEMS**	**1%**	**100%**	**0%**	**100%**
U1	Install cathodic protection systems		✓		
U2	Maintain cathodic protection systems		✓		
Line V	**INSTALL AND MAINTAIN MOTOR STARTERS AND CONTROLS**	**10%**	**90%**	**10%**	**100%**
V1	Install motor starters and controls		✓	✓	
V2	Maintain motor starters and controls		✓		
	Total Percentage for Electrician Common Core Level 2	**100%**			

Training Topics and Suggested Time Allocation: Level 3

ELECTRICIAN COMMON CORE – LEVEL 3

			% of Time Allocated to:		
		% of Time	Theory	Practical	Total
Line A	**APPLY CIRCUIT CONCEPTS**	**34%**	**90%**	**10%**	**100%**
A5	Analyze three-phase AC circuits		✓	✓	
A6	Analyze electronic circuits		✓	✓	
Line C	**USE TOOLS AND EQUIPMENT**	**2%**	**100%**	**0%**	**100%**
C4	Use measuring and testing equipment		✓		
Line D	**ORGANIZE WORK**	**4%**	**100%**	**0%**	**100%**
D1	Interpret plans, drawings and specifications		✓		
Line H	**INSTALL AND MAINTAIN CONSUMER/SUPPLY SERVICES AND METERING EQUIPMENT**	**4%**	**100%**	**0%**	**100%**
H2	Install three-phase consumer/supply services and metering equipment		✓		
H4	Maintain three-phase services and metering equipment		✓		
Line J	**INSTALL AND MAINTAIN LOW VOLTAGE DISTRIBUTION SYSTEMS**	**2%**	**100%**	**0%**	**100%**
J1	Install low voltage distribution equipment		✓		
Line L	**INSTALL AND MAINTAIN BONDING, GROUNDING AND GROUND FAULT DETECTION SYSTEMS**	**2%**	**100%**	**0%**	**100%**
L1	Install grounding and bonding systems		✓		
L3	Install ground fault detection systems		✓		
Line M	**INSTALL AND MAINTAIN POWER GENERATION SYSTEMS**	**10%**	**90%**	**10%**	**100%**
M1	Install AC generating systems		✓	✓	
M2	Maintain AC generating systems		✓		
M3	Install DC generating systems		✓		
M4	Maintain DC generating systems		✓		
Line P	**INSTALL AND MAINTAIN TRANSFORMERS**	**10%**	**90%**	**10%**	**100%**
P3	Install low-voltage three-phase transformers		✓	✓	
P5	Install high-voltage transformers		✓		
Line R	**INSTALL AND MAINTAIN BRANCH CIRCUITRY**	**2%**	**100%**	**0%**	**100%**
R2	Install wiring devices		✓		
Line V	**INSTALL AND MAINTAIN MOTOR STARTERS AND CONTROLS**	**9%**	**90%**	**10%**	**100%**
V1	Install motor starters and controls		✓	✓	
V2	Maintain motor starters and controls		✓		

			% of Time Allocated to:		
		% of Time	Theory	Practical	Total
Line W	**INSTALL AND MAINTAIN DRIVES**	**4%**	**100%**	**0%**	**100%**
W1	Install drives		✓		
Line Y	**INSTALL AND MAINTAIN MOTORS**	**17%**	**80%**	**20%**	**100%**
Y1	Install AC motors		✓	✓	
Y2	Maintain AC motors		✓		
Y3	Install DC motors		✓	✓	
Y4	Maintain DC motors		✓		
	Total Percentage for Electrician Common Core Level 3	**100%**			

Training Topics and Suggested Time Allocation: Level 4

CONSTRUCTION ELECTRICIAN – LEVEL 4

			% of Time Allocated to:		
		% of Time	Theory	Practical	Total
Line A	**APPLY CIRCUIT CONCEPTS**	**20%**	**100%**	**0%**	**100%**
A6	Analyze electronic circuits		✓		
Line D	**ORGANIZE WORK**	**7%**	**100%**	**0%**	**100%**
D1	Interpret plans, drawings and specifications		✓		
D7	Identify hazardous locations		✓		
Line K	**INSTALL AND MAINTAIN POWER CONDITIONING, UNINTERRUPTIBLE POWER SUPPLY (UPS) AND SURGE SUPPRESSION SYSTEMS**	**4%**	**100%**	**0%**	**100%**
K1	Install power conditioning, UPS and surge suppression systems		✓		
K2	Maintain power conditioning, UPS and surge suppression systems		✓		
Line N	**INSTALL AND MAINTAIN RENEWABLE ENERGY GENERATING AND STORAGE SYSTEMS**	**8%**	**100%**	**0%**	**100%**
N1	Install renewable energy generating and storage systems		✓		
Line O	**INSTALL AND MAINTAIN HIGH VOLTAGE SYSTEMS**	**10%**	**100%**	**0%**	**100%**
O1	Install high voltage systems		✓		
O2	Maintain high voltage systems		✓		
Line R	**INSTALL AND MAINTAIN BRANCH CIRCUITRY**	**4%**	**100%**	**0%**	**100%**
R6	Install and maintain airport runway lighting systems		✓		
R7	Install and maintain traffic signal lights and controls		✓		
Line X	**INSTALL AND MAINTAIN NON-ROTATING EQUIPMENT AND ASSOCIATED CONTROLS**	**2%**	**100%**	**0%**	**100%**
X1	Install non-rotating equipment and associated controls		✓		
Line Z	**INSTALL AND MAINTAIN SIGNALING SYSTEMS**	**8%**	**90%**	**10%**	**100%**
Z1	Install fire alarms systems		✓	✓	
Z3	Install security and surveillance systems		✓		
Line AA	**INSTALL AND MAINTAIN COMMUNICATION SYSTEMS**	**6%**	**100%**	**0%**	**100%**
AA1	Install voice/data/video (VDV) systems		✓		
AA3	Install nurse call systems		✓		
Line AB	**INSTALL AND MAINTAIN BUILDING AUTOMATION SYSTEMS**	**6%**	**100%**	**0%**	**100%**
AB1	Install building automation systems		✓		
Line AC	**INSTALL, PROGRAM AND MAINTAIN AUTOMATED CONTROL SYSTEMS**	**25%**	**100%**	**0%**	**100%**

		% of Time	% of Time Allocated to: Theory	Practical	Total
AC1	Install automated control systems		✓		
AC3	Program automated control systems		✓		
	Total Percentage for Construction Electrician Level 4	**100%**			

Section 3

PROGRAM CONTENT

Construction Electrician

Level 1

Electrician Common Core

Line (GAC): A APPLY CIRCUIT CONCEPTS

Competency: A1 Use electrical circuit concepts

Objectives

To be competent in this area, the individual must be able to:

- Apply electrical circuit concepts.
- Perform electrical circuit calculations.
- Perform meter readings to verify circuit concepts.
- Describe the principles of alternating current.

LEARNING TASKS	CONTENT
1. Describe the structure of matter	• States of matter • Elements and compounds • Molecules and atoms • Conductors, insulators and semiconductors
2. Describe the concepts of electric charge and current flow	• Laws of charges and electrostatic fields • Applications of static charges • Hazards of static charges • Electron flow and polarity • Direct current and alternating current
3. Describe methods of producing electricity	• Triboelectric effect • Electrochemical effect • Piezoelectric effect • Thermoelectric effect • Photovoltaic effect • Magneto electric effect
4. Describe electrical quantities, units and symbols and metric prefixes	• Metric prefixes • Coulomb • Ampere • Volt • Ohm • Watt • Joule
5. Describe the relationship between electrical power and energy	• Power and energy calculations • Percent efficiency • Reasons for different voltage levels
6. Identify common drawings for electric circuits	• Pictorial diagram • Block diagram • One-line diagram • Wiring diagram

LEARNING TASKS	CONTENT
	• Schematic diagram
7. Describe the basic operation of electric circuits	• Circuit terminology • Circuit components • Polarity and current flow
8. Perform calculations by applying electric circuit laws	• Ohm's Law • Watt's Law • Factors affecting resistance • Power dissipation in resistance devices • Voltage drop and power loss in conductors • Efficiency calculations
9. Perform meter readings to verify circuit concepts	• Safety precautions • Voltmeter use • Ammeter use • Ohmmeter use • Multimeter use • Reading scales
10. Describe features of resistors	• Common types and ratings • Resistor colour codes • Potentiometers and rheostats
11. Describe features of switches	• CEC • Terminology • Switch classifications • Circuit applications
12. Describe features of circuit protection devices	• CEC • Terminology • Fuses • Circuit breakers
13. Describe the characteristics of common conducting materials and conductor forms	• CEC • Properties of conducting materials • Solid conductors • Stranded conductors
14. Describe common insulating materials used for conductors	• CEC • Properties of common insulations • Insulation ratings • Applications and conditions of use
15. Describe the application of various types of conductors	• CEC • Categories of use • Single conductors • Cables

LEARNING TASKS	CONTENT
	• Flexible wires and cords • Bus bars • Grounding and bonding
16. Measure and describe sizing of conductors	• CEC • Circular and square mils • American wire gauge sizes • Metric wire sizes
17. Calculate the resistance of conductors	• CEC • Factors affecting resistance • Temperature effects
18. Determine the ampacity of various types of conductors	• CEC • Factors affecting ampacity • Conductor charts
19. Solve problems involving conductor line drop and line loss	• Line voltage drop • Line power loss • Conductor sizing
20. Describe the generation of an alternating voltage	• Factors affecting generated EMF • Features of alternators • Development of a sine wave voltage
21. Describe the features of alternating current	• Advantages of AC • Values of AC • AC terminology • Waveforms and phasor representations
22. Describe the difference between DC ohmic and effective AC resistance	• Skin effect • Hysteresis loss • Eddy current loss • Dielectric loss • Radiation loss

Achievement Criteria

Performance	The learner will be able to: perform meter readings to verify circuit concepts
Conditions	In a lab setting as part of a practical project
Criteria	The learner will be evaluated on: • Safety • Achieving the expected meter reading

Line (GAC): A APPLY CIRCUIT CONCEPTS

Competency: A2 Analyze DC circuits

Objectives

To be competent in this area, the individual must be able to:

- Describe the operating principles of series circuits.
- Analyze series circuits.
- Describe the operating principles of parallel circuits.
- Analyze parallel circuits.
- Describe the operating principles of combination circuits.
- Analyze combination circuits.
- Describe the operating principles of voltage dividers.
- Analyze voltage dividers.
- Describe the operating principles of bridge circuits.
- Analyze bridge circuits.
- Describe the operating principles of three-wire circuits.
- Analyze three-wire circuits.

LEARNING TASKS	CONTENT
1. Describe the characteristics of a series circuit	• Connection of components • Polarity • Resistance, voltage and current • Effects of an open • Circuit applications
2. Solve problems involving series circuits	• Development of schematic diagrams • Kirchhoff's Voltage Law • Resistance, voltage, current and power calculations
3. Describe effects of voltage sources in series	• Series aiding EMFs • Series opposing EMFs
4. Connect and test series circuits	• Component selection • Circuit connections and measurements • Testing and troubleshooting
5. Describe the characteristics of a parallel circuit	• Connection of components • Polarity • Voltage, current and resistance • Effects of an open • Circuit applications
6. Solve problems involving parallel circuits	• Development of schematic diagrams • Kirchhoff's Current Law

LEARNING TASKS	CONTENT
	• Resistance, voltage, current and power calculations • Branch current proportionality
7. Describe effects of voltage sources in parallel	• Polarity and connections • Standby (backup) systems
8. Connect and test parallel circuits	• Component selection • Circuit connections and measurements • Testing and troubleshooting
9. Describe the characteristics of a combination circuit	• Connection of components • Polarity • Voltage, current and resistance • Effects of an open • Circuit applications
10. Solve problems involving combination circuits	• Development of schematic diagrams • Kirchhoff's Voltage and Current laws • Series equivalent circuits • Resistance, voltage, current and power calculations
11. Connect and test combination circuits	• Component selection • Circuit connections and measurements • Testing and troubleshooting
12. Describe the characteristics of a voltage divider circuit	• Connection of components • Polarity • Voltage, current and resistance • Loading effects • Positive and negative voltages • Potentiometer circuits • Applications
13. Solve problems involving voltage divider circuits	• Voltage, current, resistance and power calculations
14. Connect and test voltage divider circuits	• Component selection • Circuit connections and measurements • Testing and troubleshooting
15. Describe the characteristics of a bridge circuit	• Connection of components • Polarity • Voltage, current and resistance • Wheatstone bridge • Applications
16. Solve problems involving bridge circuits	• Balanced bridge conditions • Unbalanced bridge conditions

LEARNING TASKS	CONTENT
17. Connect and test bridge circuits	• Component selection • Circuit connections and measurements • Testing and troubleshooting
18. Describe the features of a three-wire distribution system	• CEC • Connection of components • Neutral grounding and safety • Balanced loading • Unbalanced loading • Effect of open (high resistance) neutral • Effect of open (blown fuse) line
19. Solve problems involving three-wire circuits	• CEC • Balanced load conditions • Unbalanced load conditions • Open neutral and/or open line conditions
20. Connect and test three-wire circuits	• Component selection • Circuit connections and measurements • Testing and troubleshooting

Achievement Criteria

Performance — The learner will be able to: connect and test DC Circuits:

- series circuits
- parallel circuits
- combination circuits
- voltage dividers
- bridge circuits
- three-wire circuits

Conditions — In a lab setting as part of a practical project

Criteria — The learner will be evaluated on:

- Safety
- Achieving the expected meter readings

Line (GAC): A APPLY CIRCUIT CONCEPTS

Competency: A3 Analyze principles of electromagnetism

Objectives

To be competent in this area, the individual must be able to:

- Describe the principles of electromagnetism.
- Solve problems involving magnetic circuits.

LEARNING TASKS	CONTENT
1. Describe the characteristics of magnetic lines of force	• Direction of magnetic fields • Magnetic loops • Magnetic tension • Laws of attraction and repulsion • Magnetic screens • Methods of magnetizing and demagnetizing ferromagnetic materials
2. Describe the effects of current carrying conductors and coils	• Left hand rule for current carrying conductors • Parallel current carrying conductors • Left hand rule for coils • Features of electromagnets
3. Describe terminology and units of measure for magnetic circuits	• Magnetomotive force • Magnetic flux and flux density • Reluctance and permeability • Saturation and hysteresis • Residual magnetism • Magnetic cores and air gaps
4. Describe applications of magnetic devices	• Lifting magnets • Solenoids and relays • Bells and buzzers • Magnetic circuit breaker • Field poles for motors and generators
5. Solve problems involving electromagnetic circuits	• Magnetomotive force • Magnetizing force • Magnetic flux and flux density • Reluctance and permeability • Saturation and hysteresis • Magnetic cores and air gaps

Line (GAC): A APPLY CIRCUIT CONCEPTS

Competency: A6 Analyze electronic circuits

Objectives

To be competent in this area, the individual must be able to:

- Describe operating principles of diodes in DC circuits.
- Connect and test diodes in DC circuits.
- Describe operating principles of BJTs in DC circuits.
- Connect and test BJTs in DC electronic circuits.

LEARNING TASKS	CONTENT
1. Describe characteristics of semiconductor materials	• Semiconductor elements • N-type semiconductor • P-type semiconductor • Temperature coefficient
2. Describe features of the PN junction diode	• Voltage and current characteristics • Leads and polarity • Specifications and ratings • Free wheeling diode
3. Connect and test PN junction diodes	• Component selection • Circuit connections and measurements • Testing and troubleshooting
4. Describe features of the Zener diode	• Voltage and current characteristics • Leads and polarity • Specifications and ratings
5. Solve problems relating to Zener diodes	• Voltage regulation
6. Connect and test voltage regulation circuits	• Component selection • Circuit connections and measurements • Testing and troubleshooting
7. Describe features of photo and light-emitting diodes	• Voltage and current characteristics • Leads and polarity • Specifications and ratings
8. Connect and test photo and light-emitting diodes	• Component selection • Circuit connections and measurements • Testing and troubleshooting
9. Describe features of the bipolar junction transistor	• NPN and PNP types • Symbols and lead identification • Common case styles
10. Solve problems relating to bipolar junction transistors	• Gain calculations (alpha, beta)

LEARNING TASKS	CONTENT
	• Current calculations • Saturation biasing • Cut-off biasing
11. Describe basic applications of the junction transistor in DC circuits	• DC switch circuit • Terms and abbreviations • Ratings and specifications
12. Describe features of specialty transistors	• Darlington transistors • Phototransistors
13. Connect and test bipolar transistors	• Component selection • Circuit connections and measurements • Testing and troubleshooting

Achievement Criteria

Performance	The learner will be able to: connect and test DC Electronic Circuits: • PN Junction diodes • Zener diodes • Light emmiting diodes • Bipolar transistors
Conditions	In a lab setting as part of a practical project
Criteria	The learner will be evaluated on: • Safety • Achieving the expected circuit operation

Line (GAC): B PERFORM SAFETY-RELATED FUNCTIONS

Competency: B1 Use personal protection equipment (PPE) and safety equipment

Objectives

To be competent in this area, the individual must be able to:

- Describe safety equipment and PPE.
- Apply personal safety precautions and procedures.

LEARNING TASKS	CONTENT

1. Describe PPE	• Types of protection for:
	  ○ Head
	  ○ Hands
	  ○ Lungs
	  ○ Eyes
	  ○ Ears
	  ○ Feet
	  ○ Skin
	• Procedures for use
	• Storage
	• Limitations
	• Regulatory requirements
	• Environmental considerations

2. Describe safety equipment	• Types • Procedures for use • Storage • Limitations • Regulatory requirements

3. Apply personal safety precautions and procedures	• Personal apparell
	  ○ Clothing
	  ○ Hair and beards
	  ○ Jewelery

4. Locate emergency equipment and means of egress	• CEC • Emergency shutoffs • Fire control systems • Eye wash facilities • Emergency exits • First aid facilities • Emergency contact/phone numbers • Muster area

Line (GAC): B PERFORM SAFETY-RELATED FUNCTIONS

Competency: B2 Maintain safe work environment

Objectives

To be competent in this area, the individual must be able to:

- Apply personal safety measures.
- Identify and control workplace hazards.
- Prevent and identify various classes of fires.

LEARNING TASKS	CONTENT

1. Identify hazards	• Hazards include but are not limited to:
	  ○ Electric shocks
	  ○ Arc flashes
	  ○ Fire
	  ○ Liquid spills
	  ○ Designated substances
	  ○ Open holes
	  ○ Confined spaces
	  ○ Excavations
	  ○ Tripping hazards
	  ○ Overhead work
	  ○ Mobile equipment
	  ○ Hazardous locations
	  ○ Working at heights
	  – Ladders
	  – Scaffolds
	  – Work platforms
	  ○ Dust
	  ○ Fumes
	  ○ Horseplay
	  ○ Environmental
	  – Wet
	  – Dusty
	  – Icy
	  – Corrosive
	  – Hot
	  – Cold
	  – Wind
	  – Toxic gasses

2. Identify controls for hazards	• CEC • PPE (See B1) • Fall protection • Safety meetings • Housekeeping

LEARNING TASKS	CONTENT
	• Equipment and machine lockout • Hazard signage • Safe ladder use • Ventilation systems • Clear head • Limits of approach • Respect for others' safety • Constant awareness of surroundings
3. Interpret regulations relating to personal health and safety	• OH&S • WorkSafeBC • WHMIS (Current version) • Safety Data Sheets (SDS)
4. Describe the conditions necessary to support a fire	• Air • Fuel • Heat
5. Describe the classes of fires according to the materials being burned	• Class A • Class B • Class C • Class D • Symbols and colours

6. Apply preventative fire safety precautions when working near, handling or storing flammable liquids or gases, combustible materials and electrical apparatus	• Fuels
	  ○ Diesel
	  ○ Gasoline
	  ○ Propane
	  ○ Natural Gas
	• Ventilation
	  ○ Purging
	• Lubricants
	• Oily rags
	• Combustible metals
	• Aerosols

7. Describe the considerations and steps to be taken prior to fighting a fire	• Warning others and fire department • Evacuation of others • Fire contained and not spreading • Personal method of egress • Training

8. Describe the procedure for using a fire extinguisher	• P.A.S.S.
	  ○ Pull
	  ○ Aim
	  ○ Squeeze
	  ○ Sweep

Line (GAC): B PERFORM SAFETY-RELATED FUNCTIONS

Competency: B3 Perform lock-out and tag-out procedures

Objectives

To be competent in this area, the individual must be able to:

- Describe lockout requirements.
- Perform lock-out and tag-out procedures for various situations.

LEARNING TASKS	CONTENT

1. Describe lockout requirements for various sources of energy	• Electrical
	• Hazardous energy
	  ○ Mechanical
	  ○ Gravity
	  ○ Pressure
	  ○ Static
	• Hydraulic
	  ○ Steam
	  ○ Pneumatic/vacuum
	• Hazardous gases
	  ○ Toxic
	  ○ Flammable

2. Perform lock-out and tag-out	• Procedures
	  ○ Identify
	  ○ Isolate
	  ○ De-energize
	  ○ Verify
	  – Test for zero energy
	  ○ Documentation
	• Plant requirements
	• Use of locks
	  ○ Scissors
	  ○ Breaker locks
	  ○ Cord locks
	• Lockout board
	• Tags
	• Cables
	• Key-box system
	• Blinding
	• Standby person
	• Isolation of vessels
	• Matching of the lockout to the vessel being worked on

Achievement Criteria

Performance	The learner will be able to perform electrical lockout including verification.
Conditions	The learner will be provided with: • Disconnecting means • Scissor • Lock and key • Tag • Multimeter • PPE
Criteria	The learner will be evaluated on: • Safety • Successful completion of lockout procedures

Line (GAC): C USE TOOLS AND EQUIPMENT

Competency: C4 Use measuring and testing equipment

Objectives

To be competent in this area, the individual must be able to:

- Use digital meters.
- Interpret digital meter readings.

LEARNING TASKS	CONTENT

1. Describe digital multimeter functions	• Digital multimeter (DMM)
	• DMM voltmeter functions
	  ○ AC voltage function
	  ○ DC voltage function
	• DMM ammeter function
	• DMM ohmmeter function
	• DMM diode function
	• DMM continuity function
	• Advanced features
	• Digital clamp-on ammeter
	• Manual and auto-range
	  ○ Hold function
	  ○ MIN MAX mode

2. Describe power measurements	• Digital wattmeter
3. Use a Megohmmeter to measure insulation resistance	• Procedure to test

4. Use digital meters	• Safety
	• Circuit placement
	• Polarity indicator
	• Meter verification
	• DMM voltage measurement
	  ○ AC voltage measurement with DMM
	  ○ DC voltage measurement with DMM
	• DMM current measurement
	  ○ AC current measurement with DMM
	  ○ DC current measurement with DMM
	• Using DMM Ohms function to measure resistance
	• DMM category ratings
	• Meter leads

LEARNING TASKS	CONTENT
5. Maintain digital meters	• Inspection • Storage • Calibration • Service • Battery replacement • DMM fuse replacement
6. Interpret meter readings	• Digital display • Symbols • Bar graph readings • Resolution • Accuracy • Counts • Transient voltages

Achievement Criteria

Performance	The learner will use a megohmmeter to test insulation integrity
Conditions	In a lab setting as part of a practical project
Criteria	The learner will be evaluated on: • Safety • Accurate measurement of insulation integrity

Line (GAC): D ORGANIZE WORK

Competency: D1 Interpret plans, drawings and specifications

Objectives

To be competent in this area, the individual must be able to:

- Use residential prints, drawings, manuals and specifications to locate information.
- Use construction drawings to develop a material takeoff.

LEARNING TASKS	CONTENT
1. Identify symbols	• Components • Line weights • Conventions • Labels
2. Describe conventions for schematic diagrams	• Use of lines • Arrangement of components • Labels and identification
3. Describe conventions for wiring diagrams	• Use of lines • Arrangement of components • Labels and identification
4. Describe the conventions for single-line diagrams	• Use of lines • Arrangement of components • Labels and identification
5. Use diagrams to convey information	• Schematic • Wiring • Single-line
6. Convert between schematic and wiring diagrams	• Diagram layouts • Wiring numbering system
7. Describe the principles of orthographic projection	• Principal views • Planes of projection • Hidden lines • Isometric drawings • Section views
8. Identify lines, lettering and dimensioning used in sketches and drawings	• Conventional lines • Techniques of lettering • Basic rules for dimensions
9. Describe the application of working drawings	• Detail drawings • Assembly drawings

10. Describe common construction drawings and their major divisions	• Divisions
	  ○ Architectural
	  ○ Structural
	  ○ Mechanical

LEARNING TASKS	CONTENT
	○ Plumbing ○ Electrical • Working drawings
11. Describe common drawing conventions	• Index page • Title blocks • Scales • Use of lines • Keys, legends and notes • Schedules • Specifications
12. Describe electrical working drawings	• Electrical site/plot plans • Electrical floor plans • Electrical elevation drawings • Electrical sectional drawings • Electrical detail drawings • "As-built" drawings (record drawings) • Branch circuits
13. Use residential prints, drawings and specifications to locate information	• CEC • Select drawings • Read specifications • Identify schedules • Identify symbols • Branch circuits
14. Identify information found in manuals and instructions	• Safety • Models • Assembly • Installation • Programming • Operation • Maintenance • Troubleshooting • Manufacturers' contact information • Warranty information
15. Locate information in manuals and instructions	• Section layout • Manufacturers' contact information
16. Use construction drawings to develop a material takeoff	• Lengths • Quantity • Devices

Line (GAC): D ORGANIZE WORK

Competency: D2 Use Canadian Electrical Code (CEC)

Objectives

To be competent in this area, the individual must be able to:

- Interpret codes, regulations and standards.

LEARNING TASKS	CONTENT
1. Describe the purpose of the CEC	• CSA requirements • BC requirements • Adoption process
2. Describe the general arrangement of CEC rules and regulations	• Layout of the CEC book • Definitions and interpretations
3. Describe the administration of CEC rules and regulations	• Electrical Safety Act and Regulations • Directives • Information bulletins • Permits and inspections • Equipment certification agencies
4. Describe CEC rules and regulations	• Section 0 • Section 2 • Object • Scope • Definitions • Application of general rules
5. Identify applicable codes and regulations	• British Columbia Building Code • Provincial regulations • Municipal regulations (bylaws) • CSA standards

Line (GAC): G USE COMMUNICATION AND MENTORING TECHNIQUES

Competency: G2 Use mentoring techniques

Objectives

To be competent in this area, the individual must be able to:

- Describe the shared responsibilities for workplace learning.

LEARNING TASKS	CONTENT

1. Describe the shared responsibilities for workplace learning	• Active listening
	• Self advocacy
	• Apprenticeship training
	  ○ Technical training
	  ○ On-the-job learning
	  ○ Journeyperson to apprentice ratio
	• Pursuing a mentor

Line (GAC): H INSTALL AND MAINTAIN CONSUMER/SUPPLY SERVICES AND METERING EQUIPMENT

Competency: H1 Install single-phase consumer/supply services and metering equipment

Objectives

To be competent in this area, the individual must be able to:

- Determine single-phase service equipment requirements when CTs and PTs are not required.

LEARNING TASKS	CONTENT
1. Describe the features of a single-phase, three-wire distribution system	• CEC • Circuit connections and grounding • Metering • Protection and control • Shock hazards and safety
2. Describe service entrance equipment	• CEC • Overhead and underground services • Meter base • Main service panel • Grounding and bonding

3. Determine single-phase service requirements when CTs and PTs are not required.	• CEC
	  ○ Permanent
	  ○ Temporary
	• AHJ
	• Supply authority

Line (GAC): H INSTALL AND MAINTAIN CONSUMER/SUPPLY SERVICES AND METERING EQUIPMENT

Competency: H3 Maintain single-phase services and metering equipment

Objectives

To be competent in this area, the individual must be able to:

- Describe maintenance procedures for single-phase services and metering equipment.

LEARNING TASKS	CONTENT
1. Describe maintenance procedures for single-phase services and metering equipment	• CEC • Thermal imaging • Torque specs • Aluminum conductors

Line (GAC): I INSTALL AND MAINTAIN PROTECTION DEVICES

Competency: I2 Install ground fault, arc fault and surge protection devices

Objectives

To be competent in this area, the individual must be able to:

- Identify protective devices.
- Determine protective device requirements.

LEARNING TASKS	CONTENT

1. Identify protective devices	• CEC
	• Ground Fault Circuit Interrupters (GFCI)
	  ○ Class A ratings
	  ○ Equipment Protective Devices (EPD)
	• Arc Fault Circuit Interrupters (AFCI)

2. Determine protective device requirements	• Safety • Mounting techniques • CEC

Line (GAC): J INSTALL AND MAINTAIN LOW VOLTAGE DISTRIBUTION SYSTEMS

Competency: J1 Install low voltage distribution equipment

Objectives

To be competent in this area, the individual must be able to:

- Determine single-phase distribution centre requirements.

LEARNING TASKS	CONTENT
1. Identify types of distribution centres	• CEC • Load centres • Combination panels • Splitters • Switches
2. Identify components of distribution centres	• Overcurrent protection • Overload protection • Busbars • Enclosure type • Enclosure rating
3. Determine distribution centre requirements	• CEC • Mounting requirements • Clearance requirements • Lug rating • Torque requirements • Means of egress • Ventilation • Environment

Line (GAC): L INSTALL AND MAINTAIN BONDING, GROUNDING AND GROUND FAULT DETECTION SYSTEMS

Competency: L1 Install grounding and bonding systems

Objectives

To be competent in this area, the individual must be able to:

- Differentiate between grounding and bonding.
- Determine grounding and bonding requirements for DC and single-phase systems.
- Determine the requirements for the installation of grounding and bonding systems according to the CEC.

LEARNING TASKS	CONTENT
1. Describe the objectives of grounding	• Limit voltage to ground • Shock hazard • Fire prevention • Overcurrent operation
2. Describe the objectives of bonding	• Shock hazard • Overcurrent operation • Eliminate potential differences • Non-electrical equipment
3. Select appropriate materials for grounding and bonding	• Raceways • Materials • Electrodes • Conductors • Connections • Equipment
4. Determine grounding and bonding requirements	• Sizing • Terminating • Testing

Line (GAC): Q INSTALL AND MAINTAIN RACEWAYS, CABLES AND ENCLOSURES

Competency: Q1 Install conductors and cables

Objectives

To be competent in this area, the individual must be able to:

- Identify conductors and cables for residential circuits.
- Determine conductor and cable requirements in residential circuits.
- Determine the requirements for the installation of conductors and cables according to the CEC.

LEARNING TASKS	CONTENT
1. Identify conductors	• Insulation type • Insulation temperature • Insulation voltage rating • Conductor material • Solid or stranded • AWG • Colour coding • Conditions of use

2. Identify cables	• Cable type
	  ○ Armoured
	  ○ Non-metallic sheath
	  ○ Neutral supported
	  ○ Flexible cord
	• Insulation type
	• Insulation temperature
	• Insulation voltage rating
	• Conductor material
	• Solid or stranded
	• AWG
	• Colour coding
	• Conditions of use
	• FT rating

3 Determine conductor requirements	• Ampacities • Derating • Conditions of use • Conduit fill • Voltage rating • Voltage drop • Splicing and termination • Raceways

LEARNING TASKS	CONTENT
	• Open wiring • Support • Mechanical protection • Clearance • Spacing • Colour coding • Protection • Insulation testing • Fire stopping
4 Determine cable requirements	• Ampacities • Derating • Conditions of use • Voltage rating • Voltage drop • Splicing and termination • Raceways • Open wiring • Support • Mechanical protection • Clearance • Spacing • Colour coding • Conductor identification • Protection • Insulation testing • FT rating • Fire stopping • Strain relief • Bonding • Bend radii

Line (GAC): Q INSTALL AND MAINTAIN RACEWAYS, CABLES AND ENCLOSURES

Competency: Q2 Install raceways, boxes and fittings

Objectives

To be competent in this area, the individual must be able to:

- Determine requirements for common raceways, boxes and fittings.

LEARNING TASKS	CONTENT

1. Identify raceways	• Conduit
	  ○ Rigid
	  ○ Rigid PVC
	  ○ Flexible
	  ○ Liquid-tight
	• Electrical metallic tubing
	• Electrical non-metallic tubing
	• Surface raceways

2. Identify boxes and fittings	• Boxes • Cabinets • Fittings
3. Determine the requirements for raceways, boxes, cabinets and fittings	• CEC • Environmental considerations • Mechanical considerations • Seismic requirements • Fire stopping • Manufacturers' specifications • Bonding • Support • Size • Fill • Pulling considerations • Access • Bending • Spacing • Threading • Underground • Sealing and draining • Barriers • Vapour barriers

Line (GAC): R INSTALL AND MAINTAIN BRANCH CIRCUITRY

Competency: R1 Install luminaires

Objectives

To be competent in this area, the individual must be able to:

- Describe the characteristics of light.
- Describe the operation of LED and incandescent lighting.

LEARNING TASKS	CONTENT
1. Describe basic factors affecting vision	• Seeing characteristics of the eye • Size, luminance, contrast and time
2. Describe light characteristics and measurements	• Electromagnetic spectrum and colour • Illumination measurement • Fundamental lighting equations • Control of light • Efficacies of light sources
3. Describe basic factors in lighting design	• Common lighting terminology • Light quantity • Light quality • Luminaire classifications • General lighting levels • Arrangement of lighting • Choice of equipment • Maintenance aspects

4. Describe the construction and features of incandescent lamps	• Operation
	• Constructional features
	• Operating characteristics
	• Infrared heat lamps
	• New trends
	• Installation
	  ○ New
	  ○ Renovation
	• Maintenance

5. Describe basic LED lighting	• Efficacy • Life • White light LEDs • Advantages • Disadvantages • Applications

Line (GAC): R INSTALL AND MAINTAIN BRANCH CIRCUITRY

Competency: R2 Install wiring devices

Objectives

To be competent in this area, the individual must be able to:

- Describe receptacles and switches and their requirements.
- Describe testing of receptacles and switches.

LEARNING TASKS	CONTENT

1. Identify devices	• Switches
	  ○ Ratings
	  ○ Evidence of approval
	  ○ Poles and throws
	  ○ Styles
	  ○ Activation methods
	  ○ Grades
	  ○ Environment
	• Receptacles
	  ○ Ratings
	  ○ Evidence of approval
	  ○ Configurations
	  ○ Grades
	  ○ Single/Duplex
	  ○ Isolated ground
	  ○ Environment

2. Determine device installation requirements	• CEC • Wiring methods • Environment • Orientation • Polarity • Location • Spacing • Finishes • Bonding • Support • Seismic considerations • Construction specification requirements • Manufacturers' specifications
3. Describe device testing requirements	• Sensor operation • Outlet analyzer • Log records • Commissioning

Line (GAC): R INSTALL AND MAINTAIN BRANCH CIRCUITRY

Competency: R3 Install lighting controls

Objectives

To be competent in this area, the individual must be able to:

- Connect and test lighting controls for LED and incandescent.
- Determine the requirements for the installation of lighting controls according to the CEC.

LEARNING TASKS	CONTENT

1. Describe the control of incandescent and LED lamps	• Switches
	  ○ Single-pole
	  ○ Three-way
	  ○ Four-way
	• Switch ratings
	• Pull-type switches
	• Dimmer switches

2. Connect and test lighting controls for LED and incandescent	• Single-pole • Three-way • Four-way • Dimmer

Achievement Criteria

Performance	The learner will be able to: connect three-way and four-way switches
Conditions	In a lab setting as part of a practical project
Criteria	The learner will be evaluated on: • Safety • Successful operation of switching circuit

Line (GAC): R INSTALL AND MAINTAIN BRANCH CIRCUITRY

Competency: R4 Install lighting standards

Objectives

To be competent in this area, the individual must be able to:

- Describe types of lighting standards.
- Describe the installation of lighting standards.

LEARNING TASKS	CONTENT
1. Describe types of lighting standards	• Traffic signal standards • Roadway lighting standards • Parking lot lighting standards • Driveway lighting standards • Decorative lighting standards • Security lighting standards • Sports field lighting standards
2. Describe installation of lighting standards	• Locations • Bases • Access control/theft prevention

Line (GAC): V INSTALL AND MAINTAIN MOTOR STARTERS AND CONTROLS

Competency: V1 Install motor starters and controls

Objectives

To be competent in this area, the individual must be able to:

- Describe the operating principles of manual motor starters.
- Describe the operating principles of magnetic motor starters.
- Describe the operating principles of magnetic motor control circuits.
- Connect manual motor starters.
- Connect magnetic motor starters.
- Connect magnetic motor control circuits.
- Draw wiring and schematic diagrams for AC motor controls.

LEARNING TASKS	CONTENT
1. Describe the features of manual motor starters	• Toggle switch type • Pushbutton type • Drum switch type • Overload protection • Under-voltage release • Starter ratings
2. Draw diagrams for manual AC motor starters	• Single-pole switch • Double-pole switch • Three-pole switch
3. Describe safe procedures for working around motors and controls	• Mechanical hazards • Electrical hazards
4. Connect manual motor starters	• Equipment selection • Connection of components
5. Describe the features of three-phase, AC magnetic motor starters	• Contactor types • Overload relays • Starter ratings
6. Describe the operation of across-the-line magnetic starters	• Power circuit components • Control circuit components • Two-wire control circuits • Three-wire control circuits
7. Draw schematic and wiring diagrams for magnetic starters	• Comparison of schematic and wiring diagrams • Wire numbering systems • Converting between schematic and wiring diagrams
8. Describe features of control relays	• Control relays

LEARNING TASKS	CONTENT
9. Describe the operation of jogging circuits	• Latching relays • Pushbutton circuits • Selector switch circuits • Control relay circuits
10. Describe the operation of reversing magnetic starters	• Power circuit components • Control circuit components • Electrical and mechanical interlocking

Achievement Criteria

Performance	The learner will connect a control circuit to achieve forward/reverse control from two locations
Conditions	In a lab setting as part of a practical project
Criteria	The learner will be evaluated on: • Safety • Correct operation of the circuit

Line (GAC): V INSTALL AND MAINTAIN MOTOR STARTERS AND CONTROLS

Competency: V2 Maintain motor starters and controls

Objectives

To be competent in this area, the individual must be able to:

- Describe troubleshooting procedures for motor starters and motor controls.
- Describe maintenance procedures for motor starters and motor controls.

LEARNING TASKS	CONTENT
1. Describe troubleshooting procedures for motor starters and motor controls	• Visual inspections • Analyzing diagrams • Meter measurements • Infrared testing • Common faults
2. Describe maintenance procedures for motor starters and motor controls	• Preventative maintenance • Infrared testing

Line (GAC): AA INSTALL AND MAINTAIN COMMUNICATION SYSTEMS

Competency: AA1 Install voice/data/video (VDV) systems

Objectives

To be competent in this area, the individual must be able to:

- Describe procedures to install a structured cable system.
- Perform termination of data cable.

LEARNING TASKS	CONTENT

1. Describe structured cabling systems	• Data
	• Copper
	  ○ STP
	  ○ UTP
	  ○ Coaxial
	• Patch block/panels
	• Typical topography
	• Generic layout of structured cable systems
	• Standards
	• Construction of cable

2. Describe procedures to install a structured cable system	• CEC • Cable layout • Installation techniques • Tools • Colour coding • Support systems and pathways • Placing cable • Terminations of cables • Bonding • Fire stopping

Achievement Criteria

Performance	The learner will terminate both ends of a twisted pair cable with RJ45 connectors. The learner will use a BIX tool or 110 tool to perform the termination. The termination will be verified with a wire map tool. The termination will be performed to the TIA standard.
Conditions	In a lab setting as part of a practical project.
Criteria	The learner will be evaluated on: • Safety • Correct mapping • Meeting TIA standard

Level 2

Electrician Common Core

Line (GAC): A APPLY CIRCUIT CONCEPTS

Competency: A1 Use electrical circuit concepts

Objectives

To be competent in this area, the individual must be able to:

- Describe the principles of inductance and inductive reactance.
- Describe the principles of capacitance and capacitive reactance.
- Solve problems using applied mathematics.
- Solve problems involving resistors, inductors, and capacitors in DC and AC circuits.

LEARNING TASKS	CONTENT
1. Describe terminology associated with triangles	• Angles • Types of triangles • Symbols and labels • Pythagorean theorem
2. Describe the relationship between sides and angles for right triangles	• Ratios of sides and angles • Sine function • Cosine function • Tangent function • Pythagorean theorem
3. Solve problems involving right triangles by applying basic trigonometry	• Lines, angles and triangles • Trig functions • Pythagorean theorem
4. Describe standard conventions related to vectors	• Quadrants and coordinates • Direction and polarity • Rectangular and polar expressions • Vector rotation • Lead and lag relationships
5. Solve problems involving vectors	• In-phase vectors • Out-of-phase vectors • Vector additions
6. Solve problems involving AC values	• Conversion of AC values • Ohm's Law and power calculations • Frequency and period calculations
7. Describe the principles of electromagnetic induction	• Factors affecting induced EMF • Lenz's Law • Self-inductance • Mutual inductance
8. Describe the features of inductors	• Factors affecting inductance • Construction and types of inductors

LEARNING TASKS	CONTENT
	• Units and terminology
9. Describe the action of inductors in DC circuits	• Counter EMF and current flow • Inductive time constants • Energy discharge and arc suppression
10. Solve problems involving inductors in DC circuits	• Inductors in series • Inductors in parallel • Time constant curves
11. Connect and test inductive DC circuits	• Component selection • Circuit connections and measurements • Testing and troubleshooting
12. Describe the principles of electrostatic charges	• Electrostatic fields • Field force and intensity • Dielectric strength
13. Describe the features of capacitors	• Factors affecting capacitance • Construction and types of capacitors • Units and terminology
14. Describe the action of capacitors in DC circuits	• Stored charge and current flow • Capacitive time constants • Stored energy and discharge
15. Solve problems involving inductors in DC circuits	• Capacitors in series • Capacitors in parallel • Time constant curves
16. Connect and test capacitive DC circuits	• Component selection • Circuit connections and measurements • Testing and troubleshooting
17. Describe the behaviour of inductors in AC circuits	• Voltage and current relationships • Inductive reactance (X_L) • Reactive power • Non-inductive coils • Saturable reactors • Safety hazards
18. Solve problems involving inductive reactance	• Inductors in series • Inductors in parallel • Frequency and inductive reactance • Voltage, current and power
19. Connect and test inductive AC circuits	• Component selection • Circuit connections and measurements • Testing and troubleshooting

LEARNING TASKS	CONTENT
20. Describe the behaviour of capacitors in AC circuits	• Voltage and current relationships • Capacitive reactance (X_C) • Reactive power • Safety hazards
21. Solve problems involving capacitive reactance	• Capacitors in series • Capacitors in parallel • Frequency and capacitive reactance • Voltage, current and power
22. Connect and test capacitive AC circuits	• Component selection • Circuit connections and measurements • Testing and troubleshooting
23. Describe the factors affecting impedance	• Effective AC resistance • Inductive reactance • Capacitive reactance • Impedance calculations • Phase angle
24. Describe the factors affecting power factor	• True power • Reactive power • Apparent power • Power triangle calculations • Phase angle
25. Measure and calculate the impedance and power factor in an AC circuit	• Component selection • Circuit connections and measurements • Applied calculations

Line (GAC): A APPLY CIRCUIT CONCEPTS

Competency: A4 Analyze single-phase AC circuits

Objectives

To be competent in this area, the individual must be able to:

- Describe the operating principles of single-phase AC series circuits.
- Analyze single-phase AC series circuits.
- Describe the operating principles of single-phase AC parallel circuits.
- Analyze single-phase AC parallel circuits.
- Describe the principles of power factor correction.
- Solve problems involving power factor correction.
- Insert capacitors for power factor correction.

LEARNING TASKS	CONTENT
1. Describe the effects of a series AC circuit containing resistance and inductance (R-L)	• Current and voltage phase relationships • Impedance and lagging power factor • Vector diagrams
2. Describe the effects of a series AC circuit containing resistance and capacitance (R-C)	• Current and voltage phase relationships • Impedance and leading power factor • Vector diagrams
3. Describe the effects of a series AC circuit containing resistance, inductance and capacitance (R-L-C)	• Current and voltage phase relationships • Impedance and power factor • Vector diagrams • Series resonant circuits
4. Solve problems and describe applications involving series AC circuits	• Voltage, current and power • Impedance and power factor • Vector diagrams • Applications
5. Connect and test series AC circuits	• Component selection • Circuit connections and measurements • Testing and troubleshooting
6. Describe the effects of a parallel AC circuit containing branches of resistance and inductance (R-L)	• Current and voltage phase relationships • Impedance and lagging power factor • Vector diagrams
7. Describe the effects of a parallel AC circuit containing branches of resistance and capacitance (R-C)	• Current and voltage phase relationships • Impedance and leading power factor • Vector diagrams
8. Describe the effects of a parallel AC circuit containing branches of resistance, inductance and capacitance (R-L-C)	• Current and voltage phase relationships • Impedance and power factor • Vector diagrams

LEARNING TASKS	CONTENT
	• Parallel resonant circuits • Practical parallel circuits
9. Solve problems and describe applications involving parallel AC circuits	• Voltage, current and power • Impedance and power factor • Vector diagrams • Applications

10. Connect and test parallel AC circuits	• Component selection
	• Circuit connections and measurements
	• Test equipment
	  ○ Power factor meters
	  ○ VAR meters
	• Testing and troubleshooting

11. Describe reasons for power factor correction	• Reduction of energy costs • Increase in system capacity • Increase in distribution efficiency
12. Describe the application of capacitors for power factor correction	• CEC • Capacitor nameplate data • Individual load correction • Feeder correction • Main service correction • Safety hazards and precautions
13. Solve problems involving power factor correction	• Application of power triangle • Correction to unity power factor • Correction to less than unity power factor • Voltage and frequency affects
14. Insert capacitors for power factor correction	• CEC • Component selection • Applied calculations • Circuit connections and measurements • Testing and troubleshooting

Achievement Criteria

Performance	The learner will be able to: connect and test AC circuits: • Series RL circuits • Parallel RL circuits • Series RC circuits • Parallel RC circuits • Series RLC circuits • Parallel RLC circuits • Perform power factor correction
Conditions	In a lab setting as part of a practical project
Criteria	The learner will be evaluated on: • Safety • Achieving the expected meter readings

Line (GAC): A APPLY CIRCUIT CONCEPTS

Competency: A6 Analyze electronic circuits

Objectives

To be competent in this area, the individual must be able to:

- Describe the application of diodes in rectifiers.
- Analyze single-phase rectifier circuits.
- Analyze AC electronic circuits that utilize bipolar-junction transistors (BJTs).

LEARNING TASKS	CONTENT
1. Describe the operation of single-phase AC rectifier circuits	• Half-wave rectifier circuits • Full-wave (bi-phase) rectifier circuits • Full-wave bridge rectifier circuits
2. Describe the operation of filters for rectifier circuits	• Capacitance filters • Inductance filters • Pi filters
3. Determine values for rectified power supplies	• Diode ratings • Output voltage, current and power values • Filter devices • Zener regulators
4. Describe the basic applications of the junction transistor	• Cascaded transistor circuits • AC/DC amplifier circuit • Terms and abbreviations

Achievement Criteria

Performance — The learner will be able to: connect and test electronic circuits:

- Half wave rectifier
- Full wave rectifier
  - Bridge
  - Bi-phase

Conditions — In a lab setting as part of a practical project

Criteria — The learner will be evaluated on:

- Safety
- Achieving the expected meter readings

Line (GAC): D ORGANIZE WORK

Competency: D1 Interpret plans, drawings and specifications

Objectives

To be competent in this area, the individual must be able to:

- Use commercial prints, drawings, manuals and specifications to locate information.

LEARNING TASKS	CONTENT

1. Describe construction drawings and their major divisions for a commercial setting	• Divisions
	  ○ Architectural
	  ○ Structural
	  ○ Mechanical
	  ○ Plumbing
	  ○ Electrical
	• Working drawings

2. Describe electrical working drawings	• Electrical site/plot plans • Electrical floor plans • Electrical elevation drawings • Electrical sectional drawings • Electrical detail drawings • “As-built” drawings (record drawings) • Single-phase installations
3. Use prints, drawings and specifications to locate information	• CEC • Select drawings • Read specifications • Identify schedules • Identify symbols • Single-phase installations

Line (GAC): H INSTALL AND MAINTAIN CONSUMER/SUPPLY SERVICES AND METERING EQUIPMENT

Competency: H1 Install single-phase consumer/supply services and metering equipment

Objectives

To be competent in this area, the individual must be able to:

- Determine single-phase service equipment requirements when CTs are required.

LEARNING TASKS	CONTENT
1. Describe the features of a single-phase, three-wire distribution system	• Circuit connections and grounding • Metering ○ Meter stacks • Protection and control • Shock hazards and safety
2. Determine service entrance requirements	• CEC • Size • Ampacity • Overhead and underground services • Meter base • Grounding and bonding • Supply authority requirements

Line (GAC): I INSTALL AND MAINTAIN PROTECTION DEVICES

Competency: I1 Install overcurrent protection devices

Objectives

To be competent in this area, the individual must be able to:

- Determine protective device requirements.
- Describe procedures to test protective devices.

LEARNING TASKS	CONTENT

1. Identify protective devices	• Fuses
	  ○ Plug
	  ○ Cartridge
	  ○ Knife blade
	  ○ Time delay
	  ○ Class H (Code)
	  ○ HRC
	• Breakers
	  ○ Magnetic (Instantaneous)
	  ○ Thermal
	• Overloads
	  ○ Thermal
	  ○ Magnetic
	  ○ Solid state
	• Specifications
	  ○ Continuous current
	  ○ Interrupting capacity
	  ○ Voltage rating
	  ○ Time current characteristics
	  ○ Body size
	• Rejection features

2. Determine protective device requirements	• CEC
	• Fault current calculations
	• Load calculations
	• Mounting techniques
	• Specifications
	  ○ Continuous current
	  ○ Interrupting capacity
	  ○ Voltage rating
	  ○ Body size
	  ○ Rejection features
	  ○ Fuse coordination
	  ○ Series rating

LEARNING TASKS	CONTENT

3. Describe procedures to test protective devices	• Fuse pullers
	• Renewable links
	• Fuse troubleshooting
	  ○ Criss-cross method
	  ○ Visual inspection

Line (GAC): I INSTALL AND MAINTAIN PROTECTION DEVICES

Competency: I2 Install ground fault, arc fault and surge protection devices

Objectives

To be competent in this area, the individual must be able to:

- Describe surge protection device ratings and installation practices.

LEARNING TASKS	CONTENT
1. Describe surge protection devices	• CEC • Zener diodes • Thyrite • Metal Oxide Varistor (MOV)
2. Describe surge protection device ratings	• Energy rating • Voltage rating
3. Describe installation of surge protection devices	• Location

Line (GAC): L INSTALL AND MAINTAIN BONDING, GROUNDING AND GROUND FAULT DETECTION SYSTEMS

Competency: L1 Install grounding and bonding systems

Objectives

To be competent in this area, the individual must be able to:

- Determine grounding requirements for single-phase AC systems.
- Determine bonding requirements.
- Determine the requirements for the installation of grounding and bonding systems according to the CEC.

LEARNING TASKS	CONTENT
1. Determine grounding requirements for single-phase AC systems	• Sizing • Terminating • Conductors • Lightning protection • Neutral grounding device • Testing
2. Determine bonding requirements	• Sizing • Terminating • Conductors
3. Describe specialty bonding applications	• Livestock buildings • Resistance grounding • Non-electrical components

Line (GAC): N INSTALL AND MAINTAIN RENEWABLE ENERGY GENERATING AND STORAGE SYSTEMS

Competency: N1 Install renewable energy generating and storage systems

Objectives

To be competent in this area, the individual must be able to:

- Describe renewable energy systems.
- Determine the requirements for the installation of renewable energy generating and storage systems according to the CEC.

LEARNING TASKS	CONTENT

1. Describe renewable energy systems	• Types
	  ○ Wind-generated
	  ○ Biomass
	  ○ Photovoltaic
	  ○ Hydrokinetic
	  ○ Fuel cells
	• Operation
	• Characteristics

Line (GAC): P INSTALL AND MAINTAIN TRANSFORMERS

Competency: P1 Install extra-low and low voltage single-phase transformers

Objectives

To be competent in this area, the individual must be able to:

- Describe connection and operation of transformers in parallel.
- Describe the effects of loads on voltage-regulation.
- Describe tap-changer equipment.
- Connect single-phase transformers.
- Connect auto transformers.
- Connect multi-tap and tap changer transformers.
- Connect instrument transformers.
- Determine the installation requirements for single-phase transformers according to the CEC.

LEARNING TASKS	CONTENT
1. Describe the differences between extra-low and low voltage transformers	• Characteristics • Ratings • Applications
2. Describe transformer types and applications	• Remote control and signal transformers • Power and distribution transformers • Instrument transformers • Autotransformers • Special transformers
3. Describe the operating principles of a single-phase transformer	• Mutual induction • Basic construction • Voltage, current and flux relationships • Turns ratios • Transformer symbols • Terminology
4. Calculate transformer values using ratios	• Voltage, current and turns ratios • Volt-ampere ratings • Impedance matching
5. Describe transformer markings and ratings	• High voltage leads • Low voltage leads • Transformer losses and efficiency • Use of nameplate data
6. Determine the polarity and markings for transformers	• Additive and subtractive polarity • Polarity tests • Terminal identification

LEARNING TASKS	CONTENT
7. Configure transformers for step-down and step-up applications	• Equipment selection • Circuit configuration • Circuit measurements
8. Describe the various connections and applications for multi-coil transformers	• Dual-primary connections • Dual-secondary connections • Distribution transformers • Parallel operation
9. Interpret nameplate information	• Common ratings listed • Determining currents • Installation requirements • "K" ratings
10. Solve problems involving transformer calculations	• Voltage, current and turns ratios • kVA ratings • Percent impedance and fault currents
11. Connect transformers	• Equipment selection • Circuit connections and measurements • Mounting • Seismic • Testing and troubleshooting
12. Describe the effects of load on a transformer	• Percent voltage regulation • Resistive loads • Inductive loads • Capacitive loads
13. Describe the application of multi-tap windings and tap changers	• Primary taps and turns-ratio • Secondary taps and turns-ratio • Tap changers
14. Calculate values involving multi-tap and tap changer transformers	• Voltage, current and turns ratios • Percent voltage regulation
15. Connect multi-tap and tap changer transformers	• Equipment selection • Circuit connections and measurements • Testing and troubleshooting
16. Describe constructional features and applications of autotransformers	• Step-down autotransformers • Step-up autotransformers • Multi-tap autotransformers • Variable autotransformers • Safety hazards
17. Describe how standard two-winding transformers can be connected as autotransformers	• Buck-boost connections • Step-type voltage regulators

LEARNING TASKS	CONTENT
18. Solve problems involving autotransformer calculations	• Voltage, current and turns ratios • kVA ratings • Multi-tap circuits • Buck-boost connections
19. Connect autotransformer circuits	• Equipment selection • Circuit connections • Circuit measurements • Testing and troubleshooting
20. Describe the features and applications of instrument transformers	• Current transformers • Potential transformers • Polarity markings • Safety hazards
21. Illustrate instrument transformer connections	• Potential metering • Current metering • Power and energy metering • Protection circuits
22. Solve problems involving instrument transformer calculations	• Voltage, current and turns ratios • Instrument multipliers
23. Connect instrument transformer circuits	• Equipment selection • Circuit connections • Circuit measurements • Testing and troubleshooting

Achievement Criteria 1

Performance — The learner will :

- Connect a single-phase transformer
  - Perform an open-circuit test
  - Perform a short-circuit test

Conditions — In a lab setting as part of a practical project

Criteria — The learner will be evaluated on:

- Safety
- Identification of correct transformer polarity
- Identification of correct transformer impedence

Achievement Criteria 2

Performance	The learner will perform at least 2 of the following: • Connect single-phase transformers in parallel • Connect single-phase transformers as three-wire circuits • Connect isolated winding transformer in buck-and-boost configurations • Connect CTs
Conditions	In a lab setting as part of a practical project
Criteria	The learner will be evaluated on: • Safety • Correct transformer connection

Line (GAC): Q INSTALL AND MAINTAIN RACEWAYS, CABLES AND ENCLOSURES

Competency: Q1 Install conductors and cables

Objectives

To be competent in this area, the individual must be able to:

- Identify conductors and cables for commercial, institutional and industrial circuits.
- Determine conductor and cable requirements for commercial, institutional and industrial circuits.

LEARNING TASKS	CONTENT
1. Identify conductors	• Insulation types • Insulation temperature • Insulation voltage rating • Conductor material • Solid or stranded • AWG • Colour coding • Conditions of use
2. Identify cables	• Cable types • Insulation types • Insulation temperature • Insulation voltage ratings • Conductor material • Solid or stranded • AWG • Colour coding • Conditions of use • FT ratings
3. Determine conductor requirements	• CEC • Ampacities • Derating factors • Conditions of use • Conduit fill • Voltage rating • Voltage drop • Pulling lubricants • Pulling methods • Parallel runs • Temperature during installation • Splicing and termination • Raceways

LEARNING TASKS	CONTENT
	• Open wiring • Support • Mechanical protection • Clearance • Spacing • Colour coding • Protection • Insulation testing • Fire stopping
4. Determine cable requirements	• CEC • Ampacities • Derating factors • Conditions of use • Voltage ratings • Voltage drop • Pulling lubricants • Pulling methods • Parallel runs • Temperature during installation • Splicing and termination • Raceways • Open wiring • Support • Mechanical protection • Clearance • Spacing • Colour coding • Conductor identification • Protection • Insulation testing • Sheath currents • Strain relief • Bonding • Bend radii

Line (GAC): Q INSTALL AND MAINTAIN RACEWAYS, CABLES AND ENCLOSURES

Competency: Q2 Install raceways, boxes and fittings

Objectives

To be competent in this area, the individual must be able to:

- Determine requirements for specialty raceways, boxes and fittings.

LEARNING TASKS	CONTENT
1. Identify raceways	• Under floor raceways • Cellular floors • Auxiliary gutters • Bus ways and splitters • Wire ways • Manufactured wiring systems
2. Identify boxes and fittings	• Boxes • Cabinets • Outlets • Terminal fittings
3. Determine raceway requirements	• CEC • Environmental considerations • Mechanical considerations • Seismic requirements • Manufacturers' specifications • Bonding • Support • Size • Fill • Pulling considerations • Access • Bending • Spacing • Underground • Sealing and draining • Barriers
4. Determine box and fitting requirements	• CEC • Environmental considerations • Mechanical considerations • Seismic requirements • Manufacturers' specifications • Vapour barrier

LEARNING TASKS	CONTENT
	• Bonding • Support • Size • Fill • Pulling considerations • Access • Knockout layout • Identification • Barriers
5. Describe procedures to create and seal openings	• X-ray coring • Structural considerations • Pressurized areas

Line (GAC): Q INSTALL AND MAINTAIN RACEWAYS, CABLES AND ENCLOSURES

Competency: Q3 Maintain conductors, cables, raceways, boxes and fittings

Objectives

To be competent in this area, the individual must be able to:

- Describe the removal of unused conductors and cables.
- Describe maintenance procedures for conductors and cables.

LEARNING TASKS	CONTENT

1. Describe the removal of unused conductors, cables, raceways, boxes and fittings	• Scope of work
	  ○ Limits of removal
	  ○ Maintaining system integrity
	• Document update
	• Safety
	  ○ Electrical lockout
	  ○ Health hazards
	• Disposal

2. Describe maintenance procedures for conductors and cables	• Thermal imaging • Torque specs

Line (GAC): R INSTALL AND MAINTAIN BRANCH CIRCUITRY

Competency: R1 Install luminaires

Objectives

To be competent in this area, the individual must be able to:

- Describe the operation of discharge lighting.

LEARNING TASKS	CONTENT

1. Describe the operation and construction of discharge lighting	• Types
	  ○ Fluorescent
	  ○ High pressure sodium
	  ○ Metal halide
	• Operation characteristics
	• Constructional features

2. Describe installation requirements for discharge lighting	• Control of discharge lighting • Fixtures used as raceways

3. Describe the construction and features of high-intensity discharge lamps	• Metal-halide lamps
	• High-pressure sodium lamp
	• Interchangeable HID lamps
	  ○ Shapes and sizes
	  ○ ANSI code designations

4. Describe the components of high-intensity discharge luminaires	• Electronic ballast • Autotransformer ballast • Auto-regulator ballast • Regulator ballast • High-pressure sodium ballasts • Polarization of lamp-holder • Ballast location • Controls
5. Describe induction lighting	• Principles of operation • Induced current in the lamp bulb • Efficacy • Life • Advantages • Disadvantages • Applications

Line (GAC): R INSTALL AND MAINTAIN BRANCH CIRCUITRY

Competency: R2 Install wiring devices

Objectives

To be competent in this area, the individual must be able to:

- Describe single-phase wiring devices and their requirements.

LEARNING TASKS	CONTENT
1. Identify devices	• Disconnecting means • Isolation switch • Capacitors • Splitters • Utilization equipment
2. Determine device installation requirements	• CEC • Wiring methods • Environment • Orientation • Polarity • Location • Finishes • Bonding • Support • Construction specification requirements • Manufacturers' specifications
3. Describe procedures to test devices	• Documentation • Commissioning

Line (GAC): R INSTALL AND MAINTAIN BRANCH CIRCUITRY

Competency: R3 Install lighting controls

Objectives

To be competent in this area, the individual must be able to:

- Describe lighting controls for discharge lighting.

LEARNING TASKS	CONTENT
1. Describe the control of discharge lighting	• Relays • Contactors • Time clocks • Photo cells • Hand-off-auto control

Line (GAC): R INSTALL AND MAINTAIN BRANCH CIRCUITRY

Competency: R5 Maintain luminaires, wiring devices, lighting controls, lighting standards and branch circuitry

Objectives

To be competent in this area, the individual must be able to:

- Describe troubleshooting procedures for discharge lighting.
- Describe maintenance for discharge lighting.

LEARNING TASKS	CONTENT

1. Describe basic troubleshooting for high-intensity discharge luminaires	• Checking
	  ○ Ballasts
	  ○ Lamps
	  ○ Supply voltage
	  ○ Defective controls
	  ○ Electrical connections

2. Describe troubleshooting procedures for discharge lighting circuits	• Ballasts • Igniter • Mismatched components

3. Describe maintenance for discharge lighting	• Cleaning
	• Lamp replacement
	• Efficacy
	• Disposal considerations
	  ○ Mercury
	  ○ Sodium

Line (GAC): S INSTALL AND MAINTAIN HEATING, VENTILATING AND AIR-CONDITIONING (HVAC)SYSTEMS

Competency: S1 Install HVAC systems and controls

Objectives

To be competent in this area, the individual must be able to:

- Describe the components of HVAC systems.
- Describe the application of energy management devices.
- Describe controls for heating, ventilating and air conditioning.
- Determine the installation requirements for heating systems according to the CEC.

LEARNING TASKS	CONTENT

1. Describe common heating and cooling systems	• Types of area climate control
	  ○ Electric boilers
	  ○ Baseboard heaters
	  ○ Unit heaters
	  ○ Forced-air furnaces
	  ○ Duct and plenum heaters
	  ○ Series heating cable sets
	  ○ Hot water heating
	  ○ Heat pumps
	  ○ Geothermal
	• Operation
	  ○ Open loop
	  ○ Closed loop
	• Electronic air cleaners
	• Humidifiers
	• System layout
	• Thermostats and controls

2. Describe the components of HVAC systems	• System layout • Power and control circuits • Fans • Pumps • Heat pumps • Dampers • Valves • Heating and cooling equipment
3. Describe the application of energy management devices	• Time clocks • Programmable thermostats • Computer-based systems • Meter alarms • Load shedders

LEARNING TASKS	CONTENT
4. Describe controls for heating, ventilating, and air conditioning	• Selection of components • System layout • Circuit connections

Line (GAC): S INSTALL AND MAINTAIN HEATING, VENTILATING AND AIR-CONDITIONING (HVAC)SYSTEMS

Competency: S2 Maintain HVAC systems and controls

Objectives

To be competent in this area, the individual must be able to:

- Describe maintenance procedures for HVAC systems and controls.

LEARNING TASKS	CONTENT
1. Describe maintenance procedures for HVAC systems and controls	• Testing • Troubleshooting • Filters • Motors • Flame-proving device

Line (GAC): T INSTALL AND MAINTAIN EXIT EMERGENCY LIGHTING SYSTEMS

Competency: T1 Install exit and emergency lighting systems

Objectives

To be competent in this area, the individual must be able to:

- Describe exit and emergency lighting systems.
- Determine the requirements for the installation of exit and emergency lighting systems according to the CEC.

LEARNING TASKS	CONTENT

1. Identify types of exit and emergency lighting systems	• Emergency lighting equipment
	  ○ Unit lighting
	  ○ Exit lighting
	• Battery banks
	  ○ Unit equipment

2. Describe battery requirements for exit and emergency lighting systems	• Types • Charging

Line (GAC): T INSTALL AND MAINTAIN EXIT EMERGENCY LIGHTING SYSTEMS

Competency: T2 Maintain exit and emergency lighting systems

Objectives

To be competent in this area, the individual must be able to:

- Describe procedures to test exit and emergency lighting systems.
- Describe procedures to maintain exit and emergency lighting systems.

LEARNING TASKS	CONTENT
1. Describe procedures to test exit and emergency lighting systems	• CEC • Scheduling • Automatic testing • Commissioning records • Load testing
2. Describe procedures to maintain exit and emergency lighting systems	• Lamp replacement • Cleaning • Efficacy • Battery replacement • Battery disposal considerations

Line (GAC): U INSTALL AND MAINTAIN CATHODIC PROTECTION SYSTEMS

Competency: U1 Install cathodic protection systems

Objectives

To be competent in this area, the individual must be able to:

- Describe cathodic protection systems.
- Determine the requirements for cathodic protection according to the CEC.

LEARNING TASKS	CONTENT
1. Describe cathodic protection systems	• Purpose • Equipment • Functions • Locations • Grounding

Line (GAC): U INSTALL AND MAINTAIN CATHODIC PROTECTION SYSTEMS

Competency: U2 Maintain cathodic protection systems

Objectives

To be competent in this area, the individual must be able to:

- Describe maintenance of cathodic protection systems.

LEARNING TASKS	CONTENT
1. Describe maintenance of cathodic protection systems	• Preventative • Reference points • Sacrificial anode • Cabling • Current flow

Line (GAC): V INSTALL AND MAINTAIN MOTOR STARTERS AND CONTROLS

Competency: V1 Install motor starters and controls

Objectives

To be competent in this area, the individual must be able to:

- Describe the operating principles of common control devices.
- Describe the operating principles of magnetic motor starters.
- Describe the operating principles of magnetic motor control circuits.
- Connect magnetic motor starters.
- Connect magnetic motor control circuits.
- Draw wiring and schematic diagrams for AC motor controls.

LEARNING TASKS	CONTENT
1. Describe features of common control devices	• Pressure switches • Float switches • Flow switches • Temperature switches • Limit switches • Proximity switches Photoelectric switches
2. Describe features and applications of plugging switches	• Zero-speed switches • Lockout relay • Control circuits o Anti-plugging o Plugging
3. Draw circuit diagrams involving automatic and sequence control	• Definite sequence control • Timed sequence control • Anti-plugging and plugging using timing relays • Pump motor control • Reversing starter control • Other applications
4. Describe the features of three-phase, AC magnetic motor starters	• Contactor types • Overload relays • Starter ratings
5. Describe the operation of across-the-line magnetic starters	• CEC • Power circuit components • Control circuit components • Two-wire control circuits • Three-wire control circuits

LEARNING TASKS	CONTENT
6. Draw schematic and wiring diagrams for magnetic starters	• Comparison of schematic and wiring diagrams • Wire numbering systems • Converting between schematic and wiring diagrams
7. Describe features of control relays	• Control relays • Smart relays • Timing relays • Latching relays
8. Describe the operation of jogging circuits	• CEC • Pushbutton circuits • Selector switch circuits • Control relay circuits

Achievement Criteria

Performance	The learner will connect a control circuit to achieve a forward/reverse anti-plugging circuit from two locations using timers.
Conditions	In a lab setting as part of a practical project
Criteria	The learner will be evaluated on: • Safety • Correct operation of the circuit

Line (GAC): V INSTALL AND MAINTAIN MOTOR STARTERS AND CONTROLS

Competency: V2 Maintain motor starters and controls

Objectives

To be competent in this area, the individual must be able to:

- Describe troubleshooting procedures for motor starters and motor controls.
- Describe maintenance procedures for motor starters and motor controls.

LEARNING TASKS	CONTENT
1. Describe troubleshooting procedures for motor starters and motor controls	• Visual inspections • Analyzing diagrams • Meter measurements • Infrared testing • Common faults
2. Describe maintenance procedures for motor starters and motor controls	• Preventative maintenance • Infrared testing

Level 3

Electrician Common Core

Line (GAC): A APPLY CIRCUIT CONCEPTS

Competency: A5 Analyze three-phase AC circuits

Objectives

To be competent in this area, the individual must be able to:

- Describe the characteristics of three-phase AC circuits.
- Calculate voltage, current, impedance, power and power factor in three-phase AC circuits.
- Calculate power factor correction of three-phase AC circuits.

LEARNING TASKS	CONTENT
1. Describe the characteristics of three-phase AC systems	• Generation of three-phase voltage • Phase sequence • Phasor representations • Advantages
2. Describe characteristics of the wye connection	• CEC • Source connections • Voltage and current relationships • Power and power factor • Neutral and grounding
3. Describe characteristics of the delta connection	• CEC • Source connections • Voltage and current relationships • Power and power factor • Three-phase, four-wire delta systems
4. Calculate voltage, current and power for balanced three-phase circuits	• Wye source, wye load • Wye source, delta load • Delta source, delta load • Delta source, wye load
5. Calculate the neutral current in wye-connected circuits	• CEC • Balanced three-phase, four-wire loads • Unbalanced three-phase, four-wire loads • Current phasors • Use of two phases and common
6. Describe the effects of an open in three-phase wye and delta circuits	• Single-phasing • Open line conditions • Open load conditions

LEARNING TASKS	CONTENT

7. Connect and test three-phase circuits	• Selection of components
	• Circuit connections and measurements
	• Test equipment
	  ○ Power factor meters
	  ○ VAR meters
	• Testing and troubleshooting

8. Calculate power and power factor in balanced three-phase systems	• Power in balanced systems • Power factor in balanced systems • Wattmeter connections for power measurements
9. Describe the connection of capacitors for three-phase, power factor correction	• Wye-connected capacitor banks • Delta-connected capacitor banks • Safety hazards
10. Calculate the ratings of capacitors for three-phase, power factor correction	• Capacitor values for PF correction • Resulting line current values

Achievement Criteria

Performance	The learner will be able to: perform meter readings to verify three-phase circuit concepts
Conditions	In a lab setting as part of a practical project
Criteria	The learner will be evaluated on: • Safety • Achieving the expected meter reading

Line (GAC): A APPLY CIRCUIT CONCEPTS

Competency: A6 Analyze electronic circuits

Objectives

To be competent in this area, the individual must be able to:

- Describe operating principles of field effect transistors (FETs) and insulated gate bipolar transistors (IGBTs).
- Analyze electronic circuits that utilize FETs and IGBTs.
- Describe thyristor circuits.
- Describe rectification circuits.
- Describe logic gates.
- Describe number systems.
- Connect and test thyristor circuits.
- Connect and test rectifier circuits.
- Calculate values for rectified power supplies.

LEARNING TASKS	CONTENT
1. Describe the features of field effect transistors and IGBTs	• Amplifier circuit • Terms and abbreviations • Ratings and specifications • Channel types • Advantages/disadvantages • Data sheets • Symbols and lead identification • Common case styles
2. Describe features of the silicon controlled rectifier (SCR)	• Symbol and lead identification • Case styles • Specifications and ratings
3. Describe the function of the SCR	• Voltage and current characteristics • DC circuit action • AC circuit action • Terms and definitions
4. Describe SCR triggering circuits for AC phase control	• Resistance triggering • Resistance-capacitance triggering • Phase control circuits
5. Describe features of the triac	• Symbol and lead identification • Case styles • Voltage and current characteristics • Ratings and specifications
6. Describe features of specialty thyristors	• DIAC • Unijunction transistor

LEARNING TASKS	CONTENT
	• Light-activated SCR • Gate turnoff thyristors (GTOs)
7. Describe the application of thyristors	• Oscillator circuits • Battery charging circuits • Lamp dimmer circuits • Motor control circuits
8. Connect and test thyristor circuits	• Selection of components • Circuit connections and measurements • Testing and troubleshooting
9. Describe the operation of three-phase AC rectifier circuits	• Three-phase, half-wave rectifiers • Three-phase, full-wave rectifiers • Three-phase, SCR converter circuits
10. Calculate values for rectified power supplies	• Diode/SCR ratings • Output voltage, current and power values • Filter devices
11. Connect and test rectifier circuits	• Component selection • Circuit connections and measurements • Testing and troubleshooting
12. Describe the causes of static electricity and the effect of electrostatic discharge (ESD)	• Effects on solid state devices
13. Describe common number systems used in digital electronics	• Decimal system • Octal system • Binary system • Hexadecimal system • Binary-coded-decimal • Number conversions
14. Describe the operation of common logic gates	• Types • Functions

Achievement Criteria

Performance — The learner will: connect three-phase rectifiers
- Three-phase half-wave
- Three-phase full-wave

Conditions — In a lab setting as part of a practical project

Criteria — The learner will be evaluated on:
- Safety
- Achieving the expected circuit operation

Line (GAC): C USE TOOLS AND EQUIPMENT

Competency: C4 Use measuring and testing equipment

Objectives

To be competent in this area, the individual must be able to:

- Identify causes of poor power quality.
- Describe the use of power quality analyzers.

LEARNING TASKS	CONTENT
1. Identify problems with power quality	• Sags (dips) • Swells • Transient over voltages • Harmonics • Flicker • Voltage regulation • Frequency variations • High frequency noise • Extremely fast transients (EFTs) • Unbalance

2. Identify possible causes of poor power quality	• Sags and swells
	  ○ Abrupt load changes
	  ○ Abrupt impedance changes
	  – Poor connections
	• Low frequency transients
	  ○ Capacitor switching
	• High frequency transients
	  ○ Lightning
	  ○ Inductive loads
	• EFTs
	  ○ Arcing faults
	  ○ Bad brushes
	• Harmonics
	  ○ Transformers
	  ○ Switching power supplies

3. Describe the use of power quality analyzers	• Tests
	  ○ Voltage unbalance
	  ○ Total harmonic distortion
	  ○ Increasing phase current
	  ○ Voltage sags/swells
	  ○ Peak demand
	  ○ Power factor and reactive demand
	• Interpretation of test results and graphs

Line (GAC): D ORGANIZE WORK

Competency: D1 Interpret plans, drawings and specifications

Objectives

To be competent in this area, the individual must be able to:

- Use institutional prints, drawings, manuals and specifications to locate information.

LEARNING TASKS	CONTENT

1. Describe construction drawings and their major divisions for an institutional setting	• Divisions
	  ○ Architectural
	  ○ Structural
	  ○ Mechanical
	  ○ Plumbing
	  ○ Electrical
	• Working drawings

2. Describe electrical working drawings	• Electrical site/plot plans • Electrical floor plans • Electrical elevation drawings • Electrical sectional drawings • Electrical detail drawings • “As-built” drawings (record drawings) • Three-phase installations
3. Use prints, drawings and specifications to locate information for institutional settings	• CEC • Select drawings • Read specifications • Identify schedules • Identify symbols • Three-phase installations

Line (GAC): H INSTALL AND MAINTAIN CONSUMER/SUPPLY SERVICES AND METERING EQUIPMENT

Competency: H2 Install three-phase consumer/supply services and metering equipment

Objectives

To be competent in this area, the individual must be able to:

- Determine three-phase service equipment requirements.

LEARNING TASKS	CONTENT
1. Describe the features of a three-phase service and metering systems	• Circuit connections and grounding • Metering • Protection and control • Shock hazards and safety • Three-phase, four-wire systems • Three-phase, three-wire systems
2. Determine service entrance requirements	• CEC • Size • Ampacity • Overhead and underground services • Meter base • Grounding and bonding • Supply authority requirements
3. Determine low-voltage, three-phase service requirements	• CEC • Permanent • Temporary

Line (GAC): H INSTALL AND MAINTAIN CONSUMER/SUPPLY SERVICES AND METERING EQUIPMENT

Competency: H4 Maintain three-phase services and metering equipment

Objectives

To be competent in this area, the individual must be able to:

- Describe maintenance procedures for three-phase services and metering equipment.
- Determine the requirements for the maintenance of three-phase services and metering equipment according to the CEC.

LEARNING TASKS	CONTENT
1. Describe maintenance procedures for three-phase services and metering equipment	• Thermal imaging • Torque specs

Line (GAC): J INSTALL AND MAINTAIN LOW VOLTAGE DISTRIBUTION SYSTEMS

Competency: J1 Install low voltage distribution equipment

Objectives

To be competent in this area, the individual must be able to:

- Determine three-phase distribution centre requirements.

LEARNING TASKS	CONTENT
1. Identify types of distribution centres	• Load centres • Combination panels • Splitters • Switches • Motor control centres (MCC) • Power distribution centres (PDC)
2. Identify components of distribution centres	• Overcurrent protection • Overload protection • Busbars • Enclosure type • Enclosure rating
3. Determine distribution centre requirements	• CEC • Mounting requirements • Clearance requirements • Lug rating • Torque requirements • Means of egress • Ventilation • Environment

Line (GAC): L INSTALL AND MAINTAIN BONDING, GROUNDING AND GROUND FAULT DETECTION SYSTEMS

Competency: L1 Install grounding and bonding systems

Objectives

To be competent in this area, the individual must be able to:

- Determine grounding requirements for three-phase AC systems.
- Determine the requirements for the installation of grounding and bonding systems according to the CEC.

LEARNING TASKS	CONTENT
1. Determine grounding requirements for three-phase AC systems	• Sizing • Terminating • Conductors • Testing
2. Describe system grounding techniques	• Features of grounding • Resistance grounding • Reactance grounding • Zigzag grounding • System grounding components

Line (GAC): L INSTALL AND MAINTAIN BONDING, GROUNDING AND GROUND FAULT DETECTION SYSTEMS

Competency: L3 Install ground fault detection systems

Objectives

To be competent in this area, the individual must be able to:

- Describe ground fault detection systems.
- Determine the requirements for the installation of ground fault detection systems according to the CEC.

LEARNING TASKS	CONTENT
1. Describe ground fault detection systems	• Three-lamp method
2. Describe high impedance ground fault detection	• Resistive • Reactors • Zig zag

Line (GAC): M INSTALL AND MAINTAIN POWER GENERATION SYSTEMS

Competency: M1 Install AC generating systems

Objectives

To be competent in this area, the individual must be able to:

- Describe operating principles of three-phase alternators.
- Connect three-phase alternators.

LEARNING TASKS	CONTENT
1. Describe the constructional features of three-phase alternators	• Revolving armature types • Revolving field types • Field excitation and brushless exciters • Nameplate data
2. Describe operating principles of three-phase alternators	• Frequency control • Voltage control • Voltage regulation characteristics
3. Identify common connections for three-phase alternators	• Terminal marking conventions • Wye-connected alternators • Delta-connected alternators • Exciter field connections
4. Describe the conditions for operating alternators in parallel (synchronizing)	• Conditions for synchronizing • Synchronizing procedure • Load sharing characteristics
5. Connect three-phase alternators	• CEC • Equipment selection • Connections and measurements • Synchronizing and load sharing

Achievement Criteria

Performance	The learner will: connect a three-phase alternator
Conditions	In a lab setting as part of a practical project
Criteria	The learner will be evaluated on: • Safety • Achieving the expected alternator operation

Line (GAC): M INSTALL AND MAINTAIN POWER GENERATION SYSTEMS

Competency: M2 Maintain AC generating systems

Objectives

To be competent in this area, the individual must be able to:

- Describe maintenance and troubleshooting for alternators.

LEARNING TASKS	CONTENT
1. Describe maintenance and troubleshooting for alternators	• Visual inspections • Electrical faults • Mechanical faults • Brushes • Slip-rings • Bearings

Line (GAC): M INSTALL AND MAINTAIN POWER GENERATION SYSTEMS

Competency: M3 Install DC generating systems

Objectives

To be competent in this area, the individual must be able to:

- Describe the characteristics of DC generators.
- Describe the operating principles of DC generators.

LEARNING TASKS	CONTENT
1. Describe the constructional features of DC generators	• Armature and commutator • Field poles and coils • Brushes and rigging • Frames and bearings
2. Describe the operating principles of generators	• Factors affecting induced voltage • Methods of field excitation • Requirements for voltage build-up • Armature reaction and interpoles • Voltage regulation • Motor effect in generators
3. Describe the characteristics of the various types of DC generators	• Series generator • Shunt generator • Compound generators

Line (GAC): M INSTALL AND MAINTAIN POWER GENERATION SYSTEMS

Competency: M4 Maintain DC generating systems

Objectives

To be competent in this area, the individual must be able to:

- Describe the maintenance of DC generators.

LEARNING TASKS	CONTENT
1. Describe basic maintenance and troubleshooting procedures for DC generators	• Mechanical checks • Electrical checks • Visual inspections • Electrical faults • Mechanical faults • Brush selection • Commutator maintenance

Line (GAC): P INSTALL AND MAINTAIN TRANSFORMERS

Competency: P3 Install low-voltage three-phase transformers

Objectives

To be competent in this area, the individual must be able to:

- Describe applications of three-phase auto transformers.
- Describe three-phase applications of instrument transformers.
- Calculate voltage, current and kVA values for three-phase transformer banks.
- Calculate voltage, current and kVA values for three-phase autotransformer circuits.
- Calculate instrument transformer ratings and meter readings in three-phase circuits.
- Connect three single-phase transformers as a three-phase bank.
- Connect three-phase autotransformers.
- Connect instrument transformers in three-phase circuits.
- Determine the requirements for low-voltage three-phase transformers according to the CEC.

LEARNING TASKS	CONTENT
1. Describe the construction and features of three-phase transformers	• Core and coil assemblies • Insulation and cooling • Advantages and disadvantages
2. Describe the connections of three-phase transformer banks	• Wye-wye connection • Delta-delta connection • Wye-delta connection • Delta-wye connection • Special four-wire delta connection • Open-wye and open-delta connections
3. Calculate voltage, current and kVA values for three-phase transformer banks	• Step-down and step-up applications • Wye and delta configurations • Phase and line values • Percent impedance and short circuit currents
4. Connect three single-phase transformers as a three-phase bank	• Equipment selection • Circuit connections • Circuit measurements • Mounting
5. Describe common connections for autotransformers in three-phase circuits	• Wye connection • Delta connection • Open-delta connection • Extended-delta connection • Zigzag connection

LEARNING TASKS	CONTENT
6. Calculate voltage, current and kVA values for three-phase autotransformer circuits	• Wye connected autotransformer • Open-delta connected autotransformer • Buck-boost connections
7. Connect three-phase autotransformers	• Equipment selection • Circuit connections • Circuit measurements
8. Describe instrument transformer connections in three-phase circuits	• Potential transformer connections • Current transformer connections • Energy and power metering circuits • Motor protection circuits • Ground-fault detection circuits
9. Calculate instrument transformer ratings and meter readings in three-phase circuits	• Potential transformer ratings and voltmeter multipliers and readings • Current transformer ratings and ammeter multipliers and readings • Power and energy meter multipliers and readings
10. Connect instrument transformers in three-phase circuits	• Equipment selection • Circuit connections • Circuit measurements • Mounting • Safety

Achievement Criteria

Performance	The learner will connect three single-phase transformers as a three-phase bank in a delta-wye configuration
Conditions	In a lab setting as part of a practical project
Criteria	The learner will be evaluated on: • Safety • Phase displacement • Phase configuration

Line (GAC): P INSTALL AND MAINTAIN TRANSFORMERS

Competency: P5 Install high-voltage transformers

Objectives

To be competent in this area, the individual must be able to:

- Describe high-voltage transformer circuits.
- Calculate voltage, current and kVA values for high-voltage transformer banks.
- Calculate instrument transformer ratings and meter readings in high-voltage circuits.
- Describe the installation of high-voltage instrument transformers.
- Determine the requirements for high-voltage three-phase transformers according to the CEC.

LEARNING TASKS	CONTENT
1. Describe the construction and features of high-voltage transformers	• Core and coil assemblies • Insulation and cooling • Terminations
2. Describe the connections of high-voltage transformer banks	• Step-down and step-up applications • Wye and delta configurations
3. Calculate voltage, current and kVA values for high-voltage transformer banks	• Voltage transformer ratings • Current transformer ratings
4. Calculate instrument transformer ratings and meter readings in high-voltage circuits	• Voltage transformer connections • Current transformer connections
5. Describe the installation of high-voltage instrument transformers	• Circuit measurements

Line (GAC): R INSTALL AND MAINTAIN BRANCH CIRCUITRY

Competency: R2 Install wiring devices

Objectives

To be competent in this area, the individual must be able to:

- Describe three-phase wiring devices.
- Determine the requirements for three-phase capacitors according to the CEC.

LEARNING TASKS	CONTENT
1. Identify devices	• Disconnecting means • Isolation switch • Capacitors • Splitters • Utilization equipment

Line (GAC): V INSTALL AND MAINTAIN MOTOR STARTERS AND CONTROLS

Competency: V1 Install motor starters and controls

Objectives

To be competent in this area, the individual must be able to:

- Describe three-phase motor starters and controls.
- Connect reduced voltage starters.
- Connect wound-rotor motor controllers.
- Connect synchronous motor starters.
- Connect motor braking and deceleration controls.
- Describe the operation of magnetic DC motor controllers.
- Determine the requirements for reduce voltage starters according to the CEC.

LEARNING TASKS	CONTENT
1. Select AC motor starting equipment	• Full-voltage starting • Reduced-voltage starting • Motor current and torque • Load requirements • Duty cycles and supply requirements
2. Describe primary impedance type starters	• Resistor starting • Reactor starting
3. Describe the operation of autotransformer type starters	• Wye-connection • Open-delta connection • Open and closed transition types • Current-torque characteristics • Schematic and wiring diagrams
4. Describe the operation of wye-delta type starters	• Open and closed transition types • Current-torque characteristics • Schematic and wiring diagrams
5. Connect reduced voltage starters	• Equipment selection • Connection of components
6. Describe automatic acceleration of wound-rotor motors	• Definite-time acceleration • Speed-sensing acceleration • Reversing • Speed regulators • Regeneration • Schematic and wiring diagrams
7. Connect wound-rotor motor controllers	• Equipment selection • Connection of components
8. Describe the special control features for synchronous motor starters	• Old and new methods • Starting methods

LEARNING TASKS	CONTENT
	○ Auto synchronization (PFR) • Speed detection • Field application • Timing of field application • Field protection • Field rheostat
9. Describe the operation of synchronous motor starters	• Power circuit • Control circuit • Schematic and wiring diagrams
10. Connect synchronous motor starters	• Equipment selection • Connection of components
11. Describe braking methods	• Friction braking • Plugging • Dynamic braking • Regenerative braking • Eddy-current braking • Schematic and wiring diagrams
12. Connect motor braking and deceleration controls	• Equipment selection • Connection of components
13. Describe the features of DC motor controllers	• Manual starters • Faceplate starter • Magnetic starters
14. Describe the operation of magnetic DC motor controllers	• Across-the-line starting • Current-limit acceleration • Definite-time acceleration • Field loss protection • Reversing • Speed control
15. Describe methods of deceleration for DC motors	• Electromechanical braking • Dynamic braking • Regenerative braking

Achievement Criteria

Performance	The learner will connect a wye-to-delta reduce voltage starter for a three-phase squirrel-cage induction motor with an automatic braking method.
Conditions	In a lab setting as part of a practical project
Criteria	The learner will be evaluated on: • Safety • Circuit drawing • Successful operation of the circuit

Line (GAC): V INSTALL AND MAINTAIN MOTOR STARTERS AND CONTROLS

Competency: V2 Maintain motor starters and controls

Objectives

To be competent in this area, the individual must be able to:

- Describe maintenance of three-phase motor starters.

LEARNING TASKS	CONTENT
1. Describe basic maintenance and troubleshooting for three-phase motor starters	• Visual inspections • Electrical faults • Mechanical faults
2. Describe basic maintenance and troubleshooting for three-phase motor controls	• Visual inspections • Troubleshooting equipment • Maintenance procedures

Line (GAC): W INSTALL AND MAINTAIN DRIVES

Competency: W1 Install drives

Objectives

To be competent in this area, the individual must be able to:

- Describe the operation of electronic motor controls.
- Connect AC drives.
- Connect DC drives.
- Configure AC drives.
- Configure DC drives.

LEARNING TASKS	CONTENT
1. Describe the features of DC drives	• Control panel features • Speed and current regulators • Sizes and ratings • Start-up and adjustments • Braking and reversing • Protection
2. Describe the operation of power converters	• Single-phase converters • Three-phase converters • Voltage control
3. Connect adjustable speed DC drives	• Selection of components • Circuit connections
4. Describe the features of AC soft start controllers	• Sizes and ratings • Advantages • Start-up and adjustment
5. Describe the operation of AC soft start controllers	• Phase control • Adjustable parameters
6. Connect AC soft start controllers	• Start-up and adjustment
7. Describe the features of variable frequency AC drives	• Control panel features • Sizes and ratings • Start-up and adjustments
8. Describe the operation of inverters	• Single-phase inverters • Three-phase inverters • Single-phase to three-phase • Variable voltage inverters • Current source inverters • Flux vector • Sensorless flux vector • Pulse width modulation inverters

LEARNING TASKS	CONTENT
9. Describe the operation of AC motors used with variable frequency drives	• Motor types and connections • Rating • Applications • Torque-speed characteristics • Braking and reversing • Ventilation • Protection
10. Connect variable frequency AC drives	• Selection of components • Circuit connections • Start-up and adjustment • Harmonics • Cabling • Inductors

Line (GAC): Y INSTALL AND MAINTAIN MOTORS

Competency: Y1 Install AC motors

Objectives

To be competent in this area, the individual must be able to:

- Describe the operating principles of AC motors.
- Connect AC machines.
- Determine the requirements for the installation of AC motors according to the CEC.

LEARNING TASKS	CONTENT
1. Describe the constructional features of three-phase induction motors	• Stator • Squirrel-cage rotor • End bells and bearings • Enclosure types • Nameplate data
2. Describe the operating principles of three-phase induction motors	• Development of rotating magnetic field • Synchronous speed • Rotor speed and slip • Speed regulation and control • Reversing rotation • Rotor design and torque • Speed-torque-current characteristics • Efficiency • Linear-induction motors
3. Identify common connections for squirrel-cage induction motors	• Terminal marking conventions • Six-lead motors • Nine-lead motors • Twelve-lead motors

4. Connect three-phase, squirrel-cage induction motors	• Equipment selection
	• Connections and measurements
	• Test equipment
	  ○ Phase sequence indicators
	  ○ Motor rotation testers
	  ○ Tachometers

5. Describe the constructional features of the wound-rotor induction motor	• Stator • Wound rotor • Slip rings and brushes • Terminal marking conventions • Nameplate data
6. Describe the operating characteristics of the wound rotor induction motor	• Rotating magnetic field development • Rotor slip and resistance

LEARNING TASKS	CONTENT
	• Speed regulation and control • Reversing rotation • Speed-torque-current characteristics • Efficiency • Secondary resistance classification • Applications
7. Connect three-phase, wound rotor induction motors	• Equipment selection • Connections and measurements
8. Describe the constructional features of three-phase synchronous motors	• Stator • Salient-pole rotor • Slip rings and brushes • Brushless exciters • Nameplate data
9. Describe the operating principles of three-phase synchronous motors	• Amortisseur winding • Field discharge hazards • Reversing • Effects of mechanical load • Effects of rotor field excitation • Power factor correction
10. Identify common connections for three-phase synchronous motors	• Terminal marking conventions • Wye-connected motors • Delta-connected motors
11. Connect three-phase, synchronous motors	• Equipment selection • Connections and measurements
12. Describe the constructional features of split-phase induction motors	• Stator windings • Squirrel-cage rotor • Centrifugal switch • End bells and bearings • Nameplate data
13. Describe the operating principles of split-phase induction motors	• Rotating field development • Rotor torque • Reversing rotation • Capacitor type motors
14. Identify common connections for split-phase types of motors	• Terminal marking conventions • Dual-voltage motor connections
15. Describe the features of other types of single-phase motors	• AC series (universal) motor • Shaded-pole motor • Synchronous (hysteresis) motor
16. Connect single-phase motors	• Equipment selection

LEARNING TASKS

CONTENT

- Connections and measurements

Achievement Criteria

Performance	The learner will: Connect AC motors • Single-phase induction motor • Three-phase induction motor
Conditions	In a lab setting as part of a practical project
Criteria	The learner will be evaluated on: • Safety • Achieving the expected motor operation

Line (GAC): Y INSTALL AND MAINTAIN MOTORS

Competency: Y2 Maintain AC motors

Objectives

To be competent in this area, the individual must be able to:

- Describe basic maintenance and troubleshooting for AC motors.

LEARNING TASKS	CONTENT
1. Describe basic maintenance and troubleshooting for AC motors	• Visual inspections • Electrical faults • Mechanical faults • Brushes and slip-rings • Bearings

Line (GAC): Y INSTALL AND MAINTAIN MOTORS

Competency: Y3 Install DC motors

Objectives

To be competent in this area, the individual must be able to:

- Describe the operating principles of DC motors.
- Connect DC motors.
- Determine the requirements for the installation of DC motors according to the CEC.

LEARNING TASKS	CONTENT
1. Describe the operating principles of DC motors	• Right-hand motor rule • Commutator action and neutral plane • Torque development • Counter EMF and armature current • Mechanical loading effects • Speed regulation • Speed control • Reversing rotation
2. Describe the features and operating characteristics of the shunt motor	• Lead identification and connections • Torque-speed-current characteristics • Speed control and reversing • Applications
3. Describe the features and operating characteristics of the series motor	• Lead identification and connections • Torque-speed-current characteristics • Speed control and reversing • Applications
4. Describe the features and operating characteristics of the compound motor	• Lead identification and connections • Cumulative and differential compounding • Torque-speed-current characteristics • Speed control and reversing • Applications
5. Connect DC motors	• Equipment selection • Connections and measurements

Achievement Criteria

Performance	The learner will: Connect DC motors • Shunt • Series • Compound
Conditions	In a lab setting as part of a practical project
Criteria	The learner will be evaluated on: • Safety • Achieving the expected motor operation

Line (GAC): Y INSTALL AND MAINTAIN MOTORS

Competency: Y4 Maintain DC motors

Objectives

To be competent in this area, the individual must be able to:

- Describe maintenance and troubleshooting for DC motors.

LEARNING TASKS	CONTENT
1. Describe maintenance and troubleshooting for DC motors	• Visual inspections • Electrical faults • Mechanical faults • Brush and commutator maintenance

Level 4

Construction Electrician

Line (GAC): A APPLY CIRCUIT CONCEPTS

Competency: A6 Analyze electronic circuits

Objectives

To be competent in this area, the individual must be able to:

- Describe operating principles of logic gates.
- Analyze electronic circuits that use logic gates.
- Describe common circuit applications for the operational amplifier.

LEARNING TASKS	CONTENT
1. Describe the operation of logic gates	• Truth tables • Boolean expressions • DeMorgan's Theorems • Development of combination circuits
2. Describe the operation of special combination logic circuits	• Flip-flop circuits • Multivibrator circuits • Counters and shift registers
3. Describe the features of integrated circuits (IC)	• Classifications of ICs • Pin configuration • Use of data sheets • Connections and handling
4. Connect and test digital logic circuits	• Selection of components • Circuit connections • Testing and troubleshooting
5. Describe the features of operational amplifiers	• Symbols • Case packages and lead identification • Amplifier action
6. Describe common circuit applications for the operational amplifier	• Voltage-follower circuit • Inverting amplifier circuit • Non-inverting amplifier circuit • Summing amplifier circuit

Line (GAC): D ORGANIZE WORK

Competency: D1 Interpret plans, drawings and specifications

Objectives

To be competent in this area, the individual must be able to:

- Use industrial prints, drawings, manuals and specifications to locate information.

LEARNING TASKS	CONTENT

1. Describe construction drawings and their major divisions for an industrial setting	• Divisions
	  ○ Architectural
	  ○ Structural
	  ○ Mechanical
	  ○ Plumbing
	  ○ Electrical
	• Working drawings

2. Describe electrical working drawings	• Electrical site/plot plans • Electrical floor plans • Electrical elevation drawings • Electrical sectional drawings • Electrical detail drawings • “As-built” drawings (record drawings) • Three-phase installations
3. Use industrial prints, drawings and specifications to locate information	• CEC • Select drawings • Read specifications • Identify schedules • Identify symbols • Three-phase installations • High voltage installations

Line (GAC): D ORGANIZE WORK

Competency: D7 Identify hazardous locations

Objectives

To be competent in this area, the individual must be able to:

- Describe hazardous locations.
- Describe wiring methods for hazardous locations.
- Determine the requirements for hazardous locations according to the CEC.

LEARNING TASKS	CONTENT

1. Describe hazardous locations	• Code definitions
	  ○ Section 18
	  ○ Section 20

2. Describe wiring methods for hazardous locations	• Materials • Cables • Seals • Equipment ratings

Line (GAC): K INSTALL AND MAINTAIN POWER CONDITIONING, UNINTERRUPTIBLE POWER SUPPLY (UPS) AND SURGE SUPPRESSION SYSTEMS

Competency: K1 Install power conditioning, UPS and surge suppression systems

Objectives

To be competent in this area, the individual must be able to:

- Identify types of emergency power systems.
- Determine emergency power system requirements.
- Determine the requirements for the installation of emergency power systems according to the CEC.

LEARNING TASKS	CONTENT

1. Identify types of emergency power systems	• Emergency lighting equipment
	  ○ Unit lighting
	  ○ Exit lighting
	• Battery banks
	  ○ Primary
	  ○ Secondary
	• Standby generators
	• Uninterruptible power supplies (UPS)

2. Describe battery requirements for emergency lighting systems	• Types • Charging • Testing • Safety • Disposal

3. Describe standby generators	• Features of engine-driven generators
	  ○ Critical loads
	  ○ Non-critical loads
	• Alternator wiring
	• Control panel functions
	• Transfer switches

4. Describe uninterruptible power supplies (UPS)	• Offline • Online ○ Line interactive type • Rectifiers • Invertors • Batteries • Filters • Specifications
5. Determine emergency power system requirements	• Matching load requirements • Placement

LEARNING TASKS

CONTENT

- Polarity
- Rotation/Phase sequence
- By-pass switches
- Transfer switches
- Grounding
- Voltage drop calculations
    - Wire size
- Seismic requirements
- Ventilation
- Fuel supply
- Conductor requirements
- Barriers

Line (GAC): K INSTALL AND MAINTAIN POWER CONDITIONING, UNINTERRUPTIBLE POWER SUPPLY (UPS) AND SURGE SUPPRESSION SYSTEMS

Competency: K2 Maintain power conditioning, UPS and surge suppression systems

Objectives

To be competent in this area, the individual must be able to:

- Describe maintenance procedures for emergency power system batteries.
- Describe procedures to test emergency power systems.

LEARNING TASKS	CONTENT
1. Describe maintenance procedures for emergency power system batteries	• Maintenance • Testing
2. Describe procedures to test emergency power systems	• Scheduling • Automatic testing • Commissioning records • Load testing

Line (GAC): N INSTALL AND MAINTAIN RENEWABLE ENERGY GENERATING AND STORAGE SYSTEMS

Competency: N1 Install renewable energy generating and storage systems

Objectives

To be competent in this area, the individual must be able to:

- Describe alternative power systems.
- Install alternative power systems.
- Test alternative power systems.
- Determine the requirements for the installation of renewable energy generating and storage systems according to the CEC.

LEARNING TASKS	CONTENT

1. Describe alternative power systems	• Types
	  ○ Wind-generated
	  ○ Thermal
	  ○ Photovoltaic
	  ○ Hydrokinetic
	  ○ Fuel cells
	• Operation
	• Characteristics

2. Install alternative power systems	• Safety for inter-connected systems
	• Selection
	• Location for maximum efficiency
	• Code requirements and other related standards
	  ○ Signage
	  ○ Supply authority
	  ○ Other associated authorities
	• Mounting components
	• Power conditioning unit (PCU)
	  ○ Utility interactive inverter
	• Connection
	  ○ Grid-tie and stand-alone

3. Test alternative power systems	• Safety for inter-connected systems • Commissioning • Maintenance • Troubleshooting • Recording

Line (GAC): O INSTALL AND MAINTAIN HIGH VOLTAGE SYSTEMS

Competency: O1 Install high voltage systems

Objectives

To be competent in this area, the individual must be able to:

- Describe the purpose of high voltage safety equipment.
- Describe high voltage safety procedures.
- Describe the construction and operating principles of high voltage cables.
- Describe procedures to install and terminate high voltage cable.
- Describe the operating principles of high voltage switch gear and protective devices.
- Describe procedures to install high voltage switch gear and protective devices.

LEARNING TASKS	CONTENT
1. Describe common terms and concepts associated with high voltage systems	• Voltage classifications • Effects of electrostatic fields • Strike and creepage distances • Tracking and flashovers • Impulse voltage ratings
2. Describe features of distribution systems and substation equipment	• Radial, ring and network systems • Unit substations and vaults • Switch yards • Protection and metering

3. Describe hazards and safety precautions for high voltage installations	• Arc blast hazards
	  ○ Z460 and Z462 (CSA standard)
	  ○ Shock and arc flash protection
	• Safe switching and key interlocking
	• Limits of approach
	• Step voltage and touch voltage
	• Ground mats
	• Isolation mats
	• Clearance requirements
	• Grounding of structures and equipment
	• Station ground electrode
	• Lightning arrestors
	• Pole bands

4. Interpret CEC rules and supply authority regulations concerning high voltage installations	• Supply authority regulations • Use of CEC sections 10, 26 and 36 • Applicable tables in CEC
5. Describe features of high voltage cables	• Types of dielectrics • Methods of shielding • Insulation levels

LEARNING TASKS	CONTENT
6. Describe the construction of common medium-voltage cables	• Cable armour • Concentric neutral cable (URD) • Shielded cable • TECK cable • Voltage ratings • AWG size and ampacity
7. Describe practical considerations for high voltage cable installations	• Cable pulling techniques • Types of stress relief • Termination classifications • Termination techniques • Cable splicing techniques
8. Interpret CEC rules and regulations concerning wiring methods for high voltage installations	• Conductors, cables and raceways • Radii of bends • Spacing and supports • Joints, terminations and shielding • Clearance requirements
9. Describe procedures to install a high voltage, single conductor, solid-dielectric cable	• Cable preparation • Stress cone installation • Grounding and shielding
10. Describe the features of high voltage switch gear	• Metal-clad and metal-enclosed switch gear • Ratings of switches • Types of operating mechanisms • Types of switches

11. Describe the features of high voltage fuses	• Ratings of fuses
	• Types of high voltage fuses
	  ○ Expulsion
	  ○ Non-expulsion
	  ○ Current limiting

12. Describe the features of high voltage AC circuit breakers	• Ratings of circuit breakers • Arc suppression • Types of operating mechanisms • Types of circuit breakers and re-closers

13. Describe safety procedures for operating high voltage switches and circuit breakers	• Safety lockout procedures and grounding
	• Arc blast hazards
	  ○ Z460 and Z462 (CSA standard)
	  ○ Shock and arc flash protection
	• Safety inspections
	• Approved live-line tools
	• Voltage testing

LEARNING TASKS	CONTENT
14. Interpret CEC rules and regulations concerning high voltage control and protective equipment	• Service equipment and disconnect means • Overcurrent protection • Potential and current transformers • Indoor installations • Outdoor installations
15. Describe common types of protective relays used in high voltage systems	• Constructional features of relays • Time-current classifications • Overcurrent relays • Differential relays • Voltage relays • Solid state relays • Microprocessor based digital protective relays • Device numbering on schematics • Circuit breaker tripping and closing circuits
16. Describe safety precautions when working with protective relay circuits	• Visual inspections • Relay testing • Secondary shunting

17. Describe procedures to install high voltage switch gear and protective devices	• Safety
	  ○ Shutdown
	  ○ Cleaning
	• Layout
	• Clearances
	• Torque specifications
	• Mounting
	• Seismic requirements
	• Commissioning

18. Describe characteristics of cable insulation	• Capacitance and dielectric absorption
	• Cable deterioration
	  ○ Treeing
	  – Water tree
	  – Electrical tree
	  ○ Partial discharge
	  ○ Manufacturing defects

Line (GAC): O INSTALL AND MAINTAIN HIGH VOLTAGE SYSTEMS

Competency: O2 Maintain high voltage systems

Objectives

To be competent in this area, the individual must be able to:

- Describe the use of test equipment for high voltage circuits.
- Describe field testing methods for high voltage cables.

LEARNING TASKS	CONTENT

1. Describe the use of a testing equipment for insulation testing of high voltage circuits	• Types and ratings
	  ○ high potential testers
	  ○ megohmmeters
	• Hazards and safety precautions
	  ○ Testing procedures
	• Insulation resistance
	• Insulation currents
	• Insulation test types
	  ○ Proof test
	  ○ Short time test
	  ○ Polarization index
	  ○ Step
	  ○ Step voltage test
	  ○ Dielectric absorption test

2. Describe field testing methods for high voltage cables	• Cable failure causes
	• IEEE standards 400
	• Type 1 tests
	• Type 2 tests
	• AC high potential testing
	  ○ Power frequency
	  ○ Very low frequency (VLF dissipation factor)
	• DC high potential testing
	• Partial discharge testing
	  ○ Online
	  ○ Offline
	• Applications of high potential testing
	• Documentation

3. Describe the care of high voltage test equipment	• Hot sticks • Test probes • Personal Protective Equipment (PPE) • Grounding leads
4. Describe the use of high voltage test equipment	• Hot sticks • Test probes • Personal Protective Equipment (PPE) • Grounding leads • High pot testers

Line (GAC): R INSTALL AND MAINTAIN BRANCH CIRCUITRY

Competency: R6 Install and maintain airport runway lighting systems

Objectives

To be competent in this area, the individual must be able to:

- Describe installation requirements for airport runway lighting systems.

LEARNING TASKS	CONTENT
1. Describe installation requirements for airport runway lighting systems	• CEC and other code requirements • Controls • Wiring methods • Lighting system components • Conductors and cables • Engineered specifications
2. Test, inspect, and maintain airport lighting systems	• See competency O2

Line (GAC): R INSTALL AND MAINTAIN BRANCH CIRCUITRY

Competency: R7 Install and maintain traffic signal lights and controls

Objectives

To be competent in this area, the individual must be able to:

- Describe installation requirements for traffic signal lights and controls.
- Determine the requirements for the installation of traffic signal lights and controls according to the CEC.

LEARNING TASKS	CONTENT
1. Describe installation requirements for traffic signal lights and controls	• Control systems • Control components • Wiring methods • Traffic signal system components

Line (GAC): X INSTALL AND MAINTAIN NON-ROTATING EQUIPMENT AND ASSOCIATED CONTROLS

Competency: X1 Install non-rotating equipment and associated controls

Objectives

To be competent in this area, the individual must be able to:

- Describe the installation of welding equipment.
- Describe the installation of heating systems (non-HVAC).
- Determine the requirements for installing non-rotating equipment and associated controls according to the CEC.

LEARNING TASKS	CONTENT

1. Describe the installation of welding equipment	• Welding equipment
	  ○ Conductor size
	  ○ Overcurrent protection
	  ○ Welder bank calculation

2. Describe the installation of heating systems (non-HVAC)	• Operating principles
	• Types
	  ○ Surface
	  ○ Induction
	  ○ Bare element
	• Controls
	• Installation

Line (GAC): Z INSTALL AND MAINTAIN SIGNALING SYSTEMS

Competency: Z1 Install fire alarm systems

Objectives

To be competent in this area, the individual must be able to:

- Describe the operation of fire alarm and suppression systems.
- Describe procedures to install fire alarm and suppression systems.
- Describe procedures to test fire alarm and suppression systems.
- Connect an initiating and signaling circuit.
- Determine the requirements for the installation of fire alarm systems according to the CEC.

LEARNING TASKS	CONTENT

1. Describe the features of fire alarm systems	• Types of fire alarm systems
	  ○ Addressable
	  ○ Non-addressable
	• Fire alarm system operation
	• Common initiation and signal devices
	• Control panel functions
	• Suppression systems
	• Pre-action systems
	• Ancillary system tie-in
	• Supervision
	• Paging systems
	• Monitoring
	• Annunciator
	• Fire pumps

2. Determine installation requirements for fire alarm systems	• Selection of components • Circuit connections • Device placement • Routing • Installation and wiring requirements • Standards, specifications and codes
3. Describe procedures to test fire alarm and suppression systems.	• Inspection • Verification • Testing and troubleshooting • Standards, specifications and codes

Achievement Criteria

Performance	The learner will: • Connect an initiating circuit • Connect a signaling circuit
Conditions	In a lab setting as part of a practical project
Criteria	The learner will be evaluated on: • Safety • Correct connection of initiating circuit and signaling circuit

Line (GAC): Z INSTALL AND MAINTAIN SIGNALING SYSTEMS

Competency: Z3 Install security and surveillance systems

Objectives

To be competent in this area, the individual must be able to:

- Describe the operating principles of security alarm systems.
- Describe procedures to install security alarm systems.
- Determine the requirements for the installation of security and surveillance systems according to the CEC.

LEARNING TASKS	CONTENT

1. Describe the operating principles of security alarm systems	• Regulatory authorities
	• Types of security systems
	  ○ Silent/Audible
	  ○ Addressable
	• Security alarm system operation
	• Common detection and alarm devices
	• Control panel functions
	• Monitoring and recording
	• Layout
	• Surveillance

2. Describe the components of security alarm systems	• Panels • Programming devices • Initiation and signal • Surveillance • Cable types • Access control
3. Describe procedures to install security alarm systems	• Mounting • Cable routing • Interfacing • Verification • Troubleshooting

Line (GAC): AA INSTALL AND MAINTAIN COMMUNICATION SYSTEMS

Competency: AA1 Install voice/data/video (VDV) systems

Objectives

To be competent in this area, the individual must be able to:

- Describe the installation of fibre optic cable.
- Describe methods of certification for a structured cable system.
- Determine the requirements for the installation of fibre optic cable according to the CEC.

LEARNING TASKS	CONTENT

1. Describe the basic features of fibre optic installations	• Composition of fibre optic cables
	• Features of fibre optic cables
	  ○ Single-mode
	  ○ Multi-mode

2. Describe the installation of fibre optic cable	• Installation procedures • Wiring requirements
3. Describe procedures and documentation for testing	• Testing of cables and terminations • Troubleshoot failures • Test data reports
4. Describe procedures to install a structured cable system	• Design of the system • Manufacturer's installer certification • Certification and warranty procedures

Line (GAC): AA INSTALL AND MAINTAIN COMMUNICATION SYSTEMS

Competency: AA3 Install nurse call systems

Objectives

To be competent in this area, the individual must be able to:

- Describe the operating principles of nurse call systems.
- Describe procedures to install nurse call systems.
- Determine the requirements for the installation of nurse call systems according to the CEC.

LEARNING TASKS	CONTENT
1. Describe the operating principles of nurse call systems	• Types • Components • Applications
2. Describe procedures to install nurse call systems	• Installation procedures • Standards, specifications, and codes • Mounting system components • Connecting systems components • Verification of system

Line (GAC): AB INSTALL AND MAINTAIN BUILDING AUTOMATION SYSTEMS

Competency: AB1 Install building automation systems

Objectives

To be competent in this area, the individual must be able to:

- Describe the operating principles of building automation systems.
- Describe procedures to install building automation systems.

LEARNING TASKS	CONTENT
1. Describe the operating principles of building automation systems	• Lighting • Fire systems • Security systems • HVAC • Irrigation • Sound • Load shedding • Window coverings • DCS • Computer interface • Communication protocols
2. Describe procedures to install building automation systems	• Standards and manufacturers' specifications • Maintenance • Testing and verification

Line (GAC): AC INSTALL, PROGRAM AND MAINTAIN AUTOMATED CONTROL SYSTEMS

Competency: AC1 Install automated control systems

Objectives

To be competent in this area, the individual must be able to:

- Describe the operating principles of programmable logic controllers (PLCs).
- Describe the installation procedures of PLCs.
- Connect PLCs.
- Describe the operating principles of automated control systems.
- Connect automated control systems.

LEARNING TASKS	CONTENT
1. Describe the features of programmable logic controllers (PLCs)	• Input section • Central processing unit • Output section • Programming devices • Common peripherals • Advantages of PLCs
2. Describe the memory system of the processor	• Executive memory • User memory • Input/Output (I/O) addressing • Other addressing
3. Describe input and output (I/O) types	• Discrete AC output types • Discrete DC output types • Discrete AC input types • Discrete DC input types • Burdening resistor • Preferred voltage levels • Analog input types • Analog output types
4. Describe basic installation procedures	• CEC • Environmental considerations • Wiring, grounding and shielding • Power connections and sources
5. Describe the operating cycle of the PLC processor	• Program scan • I/O update • Scan time consideration

LEARNING TASKS	CONTENT
6. Connect PLC systems	• Use I/O indicator lights to check wiring • Use I/O image tables for bit status • Monitor/test program on-line • Perform safety checks • Update documentation • Print out working program
7. Describe the components of an automated control system	• Open loop control systems • Closed loop control systems • Process variables • Control system elements
8. Describe common types of sensors and transducers	• Motion sensors • Force sensors • Fluid sensors • Temperature sensors • Light sensors • Hall effect sensors • Level sensors
9. Describe the action of the controller in automated control systems	• Basic comparator circuits • Application of feedback signals • Modes of control
10. Describe common types of electrical actuators	• Solenoids, clutches and brakes • DC servo motors • AC servo motors • Encoders and resolvers • Stepper motor controls
11. Connect automated control systems	• Troubleshooting sensors • Adjust set-points • Program

Line (GAC): AC INSTALL, PROGRAM AND MAINTAIN AUTOMATED CONTROL SYSTEMS

Competency: AC3 Program automated control systems

Objectives

To be competent in this area, the individual must be able to:

- Write basic PLC programs.
- Use a programming terminal to upload and download PLC programs.

LEARNING TASKS	CONTENT
1. Describe basic programming instructions	• Types of programming languages • Relay ladder logic instructions • Output energize instruction • Examine if on instruction (XIC) • Examine if off instruction (XIO) • Latching and unlatching instructions • Internal relay instructions • Timer and counter instructions
2. Describe the interaction of hardware and software	• Effects of input status on input image tables • Program logic scanning sequence • True-false instruction status • Control of program over output image tables • Effects of output image tables on output devices • Fail-safe wiring practices
3. Write basic PLC programs	• Single motor control • Multi-motor sequences • Reversing motor control • Three-way switch controls • Toggle operation • Pumping systems • Up and down counters • Latching circuits
4. Use a programming terminal	• Application software and PLC logic • Saving PLC documentation • Downloading/uploading programs • On-line monitoring • Editing/modifying programs
5. Describe PLC operating modes	• Run mode • Program mode • Test mode • Single scan mode • PLC status indicators

Section 4

ASSESSMENT GUIDELINES

Assessment Guidelines – Common Core Level 1

Common Core Level 1 Grading Sheet – Subject Competency and Weightings

PROGRAM: IN-SCHOOL TRAINING:	ELECTRICIAN COMMON CORE LEVEL 1		
LINE	**SUBJECT COMPETENCIES**	**THEORY WEIGHTING**	**PRACTICAL WEIGHTING**
A	APPLY CIRCUIT CONCEPTS	50%	40%
B	PERFORM SAFETY-RELATED FUNCTIONS	3%	10%
C	USE TOOLS AND EQUIPMENT	2%	10%
D	ORGANIZE WORK	3%	0%
G	USE COMMUNICATION AND MENTORING TECHNIQUES	0%	0%
H	INSTALL AND MAINTAIN CONSUMER/SUPPLY SERVICES AND METERING EQUIPMENT	5%	0%
I	INSTALL AND MAINTAIN PROTECTION DEVICES	4%	0%
J	INSTALL AND MAINTAIN LOW VOLTAGE DISTRIBUTION SYSTEMS	5%	0%
L	INSTALL AND MAINTAIN BONDING, GROUNDING AND GROUND FAULT DETECTION SYSTEMS	4%	0%
Q	INSTALL AND MAINTAIN RACEWAYS, CABLES AND ENCLOSURES	8%	0%
R	INSTALL AND MAINTAIN BRANCH CIRCUITRY	6%	15%
V	INSTALL AND MAINTAIN MOTOR STARTERS AND CONTROLS	8%	10%
AA	INSTALL AND MAINTAIN COMMUNICATION SYSTEMS	2%	15%
	Total	100%	100%
In-school theory / practical subject competency weighting		90%	10%
Final in-school percentage score		**IN-SCHOOL %**	

Common Core Level 1 Grading Sheet – Subject Competency and Weightings

In-school Percentage Score Combined theory and practical subject competency multiplied by	80%
Standardized Level Exam Percentage Score The exam score is multiplied by	20%
Final Percentage Score	**FINAL%**

Assessment Guidelines – Common Core Level 2

Common Core Level 2 Grading Sheet – Subject Competency and Weightings

PROGRAM: IN-SCHOOL TRAINING:	ELECTRICIAN COMMON CORE LEVEL 2		
LINE	**SUBJECT COMPETENCIES**	**THEORY WEIGHTING**	**PRACTICAL WEIGHTING**
A	APPLY CIRCUIT CONCEPTS	41%	25%
D	ORGANIZE WORK	5%	0%
H	INSTALL AND MAINTAIN CONSUMER/SUPPLY SERVICES AND METERING EQUIPMENT	5%	0%
I	INSTALL AND MAINTAIN PROTECTION DEVICES	2%	0%
L	INSTALL AND MAINTAIN BONDING, GROUNDING AND GROUND FAULT DETECTION SYSTEMS	2%	0%
N	INSTALL AND MAINTAIN RENEWABLE ENERGY GENERATING AND STORAGE SYSTEMS	2%	0%
P	INSTALL AND MAINTAIN TRANSFORMERS	15%	50%
Q	INSTALL AND MAINTAIN RACEWAYS, CABLES AND ENCLOSURES	2%	0%
R	INSTALL AND MAINTAIN BRANCH CIRCUITRY	4%	0%
S	INSTALL AND MAINTAIN HEATING, VENTILATING AND AIR-CONDITIONING (HVAC) SYSTEMS	6%	0%
T	INSTALL AND MAINTAIN EXIT AND EMERGENCY LIGHTING SYSTEMS	1%	0%
U	INSTALL AND MAINTAIN CATHODIC PROTECTION SYSTEMS	1%	0%
V	INSTALL AND MAINTAIN MOTOR STARTERS AND CONTROLS	14%	25%
	Total	100%	100%
In-school theory / practical subject competency weighting		90%	10%
Final in-school percentage score		**IN-SCHOOL %**	

Common Core Level 2 Grading Sheet – Subject Competency and Weightings

In-school Percentage Score Combined theory and practical subject competency multiplied by	80%
Standardized Level Exam Percentage Score The exam score is multiplied by	20%
Final Percentage Score	**FINAL%**

Assessment Guidelines – Common Core Level 3

Level 3 Grading Sheets: Subject Competency and Weightings

PROGRAM: IN-SCHOOL TRAINING:	ELECTRICIAN COMMON CORE LEVEL 3

LINE	SUBJECT COMPETENCIES	THEORY WEIGHTING	PRACTICAL WEIGHTING
A	APPLY CIRCUIT CONCEPTS	33%	20%
C	USE TOOLS AND EQUIPMENT	2%	0%
D	ORGANIZE WORK	4%	0%
H	INSTALL AND MAINTAIN CONSUMER/SUPPLY SERVICES AND METERING EQUIPMENT	4%	0%
J	INSTALL AND MAINTAIN LOW VOLTAGE DISTRIBUTION SYSTEMS	4%	0%
L	INSTALL AND MAINTAIN BONDING, GROUNDING AND GROUND FAULT DETECTION SYSTEMS	2%	0%
M	INSTALL AND MAINTAIN POWER GENERATION SYSTEMS	10%	10%
P	INSTALL AND MAINTAIN TRANSFORMERS	11%	25%
R	INSTALL AND MAINTAIN BRANCH CIRCUITRY	1%	0%
V	INSTALL AND MAINTAIN MOTOR STARTERS AND CONTROLS	7%	20%
W	INSTALL AND MAINTAIN DRIVES	5%	0%
Y	INSTALL AND MAINTAIN MOTORS	17%	25%
	Total	100%	100%
In-school theory / practical subject competency weighting		90%	10%
Final in-school percentage score		**IN-SCHOOL %**	

In-school Percentage Score Combined theory and practical subject competency multiplied by	80%
Standardized Level Exam Percentage Score The exam score is multiplied by	20%
Final Percentage Score	**FINAL%**

Assessment Guidelines – Level 4

Level 4 Grading Sheets: Subject Competency and Weightings

PROGRAM: IN-SCHOOL TRAINING:	CONSTRUCTION ELECTRICIAN LEVEL 4		
LINE	**SUBJECT COMPETENCIES**	**THEORY WEIGHTING**	**PRACTICAL WEIGHTING**
A	APPLY CIRCUIT CONCEPTS	10%	0%
D	ORGANIZE WORK	7%	0%
K	INSTALL AND MAINTAIN POWER CONDITIONING, UNINTERRUPTIBLE POWER SUPPLY (UPS) AND SURGE SUPPRESSION SYSTEMS	7%	0%
N	INSTALL AND MAINTAIN RENEWABLE ENERGY GENERATING AND STORAGE SYSTEMS	10%	0%
O	INSTALL AND MAINTAIN HIGH VOLTAGE SYSTEMS	10%	0%
R	INSTALL AND MAINTAIN BRANCH CIRCUITRY	13%	0%
X	INSTALL AND MAINTAIN NON-ROTATING EQUIPMENT AND ASSOCIATED CONTROLS	2%	0%
Z	INSTALL AND MAINTAIN SIGNALING SYSTEMS	12%	100%
AA	INSTALL AND MAINTAIN COMMUNICATION SYSTEMS	7%	0%
AB	INSTALL AND MAINTAIN BUILDING AUTOMATION SYSTEMS	7%	0%
AC	INSTALL, PROGRAM AND MAINTAIN AUTOMATED CONTROL SYSTEMS	15%	0%
	Total	100%	100%
In-school theory / practical subject competency weighting		97%	3%
Final in-school percentage score		**IN-SCHOOL %**	

Level 4 Grading Sheets: Subject Competency and Weightings

In-school Percentage Score Combined theory and practical subject competency multiplied by	70%
Proprietary Level 4 Exam Percentage Score The exam score is multiplied by	30%
Final in-school percentage score **Apprentices must achieve a minimum 70% as the final in-school percentage score to be eligible to write the Interprovincial Red Seal exam.**	**FINAL%**

All apprentices who complete Level 4 of the Construction Electrician program with a FINAL level percentage score of 70% or greater will write the Interprovincial Red Seal examination as their final assessment.

SkilledTradesBC will enter the apprentices' Construction Electrician Red Seal Interprovincial examination mark in SkilledTradesBC Portal.

A minimum mark of 70% on the examination is required for a pass.

Section 5

TRAINING PROVIDER STANDARDS

Facility Requirements

Classroom Area

- 1,000 sq. ft. for a class size of 16 students
- Comfortable seating (moveable tables and chairs) suitable for training, teaching, lecturing and drafting
- Instructional media to include multimedia projector, projection screen, DVD player, and whiteboard (optional: flip chart)
- In-room temperature regulation and ventilation
- Lighting controls (for lights and shades or blinds)
- Compliance with all local and national fire code and occupational safety requirements

Shop Area

- Minimum 3,000 square feet of shop area including a tool crib and workstations
- Well heated and ventilated
- 10 ft. high ceilings
- Lighting appropriate to detailed work

Lab Requirements

- Fully operational, representative equipment
  (refer to *Shop and Laboratory Equipment* for requirements by level – next page)

Student Facilities

- Adequate lunchroom as per WorkSafeBC requirements
- Adequate washroom facilities as per WorkSafeBC requirements
- Personal storage lockers

Instructor's Office Space

- 150 sq. ft. per instructor, with a desk, chairs and materials storage / filing system

Storage

- 100 sq. ft. per student for storage of materials (may be outdoors)
- 25 sq. ft. per student for tools storage
- 15 sq. ft. per student for individual project and materials storage

Tools and Equipment

Shop Equipment

Required

Equipment List is based on the standard class size of 16 apprentices. The facilities must be suitable for instructional use.

*- As Required

Level 1

8	Power supply stations (with fixed and variable AC and DC outputs and metering)
8	Sets of resistors for circuit analysis labs
*	Misc. magnetic devices such as relays, solenoids, bells, buzzers, chimes, etc.
8	Analogue multi-meters
8	Digital multi-meters
8	Digital scopes, dual-trace, (Analog optional for demo purposes)
8	Wattmeters
8	Clamp-on ammeters
1	Solenoid-plunger (wiggy) testers
1	Megger
1	Wheatstone bridge
1	Outlet analyzer
1	Watt-hour meter
4	Wire gauges, micrometers
*	Misc. conductors, cables, raceways, boxes, fittings and receptacles for demo purposes
*	Misc. low voltage single-phase distribution equipment for demo purposes
*	Misc. dimmer, snap switches, etc. for lighting control
*	Misc. Incandescent and LED lights for demo purposes
*	Variety of circuit protective devices
8	Electronic Stations (trainers)
16	Computer workstations with associated software programs and 1 printer
16	Locks, Tags and Scissors
8	Bix tools or 110 tools
4	Wire map tools
8	Residential blueprints

Level 2

8	Power supply stations (with fixed and variable AC and DC outputs and metering)
8	Sets of resistors, capacitors and inductors for circuit analysis labs
*	Misc. magnetic devices such as relays, solenoids, bells, buzzers, chimes, etc.
8	Motor Control Stations (with manual and magnetic starters, reversing starters, assorted switches, TD relays and pilot devices as necessary)
4	Reversing drum switches
8	Small 3-phase motors
4	Single-phase, split-phase, dual-voltage motors
8	Digital scopes, dual-trace, (Analog optional for demo purposes)
8	Scope meters
8	Digital multi-meters
8	Wattmeters
8	Clamp-on ammeters
4	Light (photo) meters
8	Isolation Transformers, dual-winding type (.3 kVA typical)
4	Autotransformers, multi-tap type (.25 kVA typical)
4	Current metering transformers
4	Potential metering transformers

*	Misc. conductors, cables and raceways for demo purposes
*	Misc. light fixtures, Fluorescent lights (rapid start) (instant start), Mercury vapour, Metal halide lights, H.P. Sodium lights, L.P. Sodium lights, Exit Lights, Unit Lighting for demo purposes.
*	Variety of circuit protective devices
1	Single-phase Power factor correction unit (capacitor) for demo purposes
1	Gas fired furnace trainer
1	Electric furnace trainer
1	HVAC roof top trainer
1	Geothermal trainer
1	Heat pump trainer
8	Electronic stations (trainers)
8	Function (signal) generators
16	Computer workstations with associated software programs and 1 printer
8	Commercial blueprints

Level 3

8	Power supply stations, 3 phase (with fixed and variable AC and DC outputs and metering)
8	Sets of resistors, capacitors and inductors for 3-phase circuit analysis labs
8	Three-phase isolation transformers or 24 single-phase transformers to create a 3 phase bank
8	Motor Control Stations (with manual and magnetic starters, reversing starters, control and time-delay relays, electronic relays, assorted switches, plugging and anti-plugging devices, programmable relays and pilot devices, as necessary)
8	DC Machines for DC motor and DC Generator labs
8	Small 3-phase motors
*	Various three-phase reduced-voltage starters, electronic soft start controller for demo purposes (controls, assorted pilot devices, etc. as necessary)
8	Adjustable speed DC drive c/w motors
8	Variable frequency AC (VFD) drive c/w motors
4	Reversing drum switches
8	Three-phase squirrel-cage motors (assorted 6-lead, 9-lead and 12-lead)
4	Three-phase wound-rotor motors and controllers
4	Three-phase synchronous motors and controllers
8	Single-phase, capacitor-start, dual-voltage motors
1	Single-phase, shaded-pole motor
1	Single-phase, universal motor
2	Three-phase alternator synchronizing panel with metering and controls
2	Three-phase alternators with prime movers
8	Digital scopes, dual-trace, (Analog optional for demo purposes)
4	Power quality analyzers
8	Digital multi-meters
8	Wattmeters
8	Clamp-on ammeters
1	Phase-sequence indicator
1	Megger
4	Hand-held tachometers
1	Motor rotation indicator
1	Three-phase Power factor correction unit for demo purposes
*	Misc. conductors, raceways and various hazardous location fittings for demo purposes
8	Three-phase rectifier boards
8	Electronic trainers for discrete components
8	Function (signal) generators
16	Computer workstations with associated software programs and 1 printer
8	Institutional blueprint sets

Level 4 Construction Electrician

8	Power supply stations 3 phase (with fixed and variable AC and DC outputs and metering)
8	Sets of resistors, capacitors and inductors for 3-phase circuit analysis labs
8	Three-phase isolation transformers or 24 single-phase transformers to create a 3 phase bank
8	Three-phase motor control stations (with assorted reduced-voltage/current magnetic starters, reversing starters, electronic starters, control and time-delay relays, assorted pilot devices as necessary)
8	Three-phase squirrel-cage motors (assorted 6-lead, 9-lead and 12-lead)
4	Three-phase wound-rotor motors and controllers
4	Three-phase synchronous motors and controllers
1	Three-phase Power factor correction unit for demo purposes
8	Digital scopes, dual-trace, (Analog optional for demo purposes)
8	Digital multi-meters
8	Wattmeters
8	Clamp-on ammeters
4	Hand-held tachometers
8	Electronic (semiconductor devices) trainers
8	Digital Logic trainers
8	Function (signal) generators
16	Computer workstations with associated software programs and 1 printer
8	PLC workstations, with associated software
8	PLC simulator display boards
1	Transducer fundamentals trainer for demo of automated controls
4	Conventional non-addressable fire alarm systems c/w initiating, signal and alarm devices
4	Addressable fire alarm systems c/w initiating, signal and alarm devices
1	Standby power system transfer switch for demo purposes
1	Data cabling installation and test equipment demo
1	Fibre optic tool kit for data cabling demo
1	Nurse call system trainer for demo purposes
1	Security system trainer for demo purposes
1	UPS System for demo purposes
1	Photovoltaic trainer for demo purposes
1	Voice/Data/Video (VDV) system trainer for demo purposes
8	Industrial blueprints
*	Various High voltage demo's protective relaying and metering
*	Various High voltage test equipment demo's including approved gloves, hot stick, voltage tester, mats, and personal protective equipment for demo purposes
*-	Various HV cable stress cone termination kits for demo purposes

Student Tools (supplied by student)

Required

Contact Training Facility for recommended tools and equipment that students need to supply.

Reference Materials

Required Reference Materials

- Contact Training Facility for Required Reference Material

Recommended Resources

- SkilledTradesBC www.skilledtradesbc.ca
- Workplace Hazardous Materials Information System (WHMIS) and First Aid http://www.hc-sc.gc.ca/ewh-semt/occup-travail/whmis-simdut/index-eng.php
- WorkSafeBC (WCB) www.worksafebc.com

Codes

- National Fire Code of Canada
- BC Ministry of Housing
- Queen's Printer for BC Code books
  - BC Building Code
  - BC Fire Code
  - BC Electrical Code
- National Fire Protection Association
  - NFPA 80 – Standards for Fire Doors and Fire Windows
  - NFPA 101 – Life Safety Code
- Canadian National Building Code

Suggested Texts

1. AC FUNDAMENTALS
   by Duff and Herman
   Delmar Publishers.....ISBN 0-8273-6527-6

2. BRITISH COLUMBIA BUILDING CODE
   Building Standards Branch
   Ministry of Municipal Affairs.....ISBN 0-7726-1574-8

3. CABLES AND WIRING
   AVO Multi-Amp Institute
   Delmar Publishers.....ISBN 0-8273-5460-6

4. DC FUNDAMENTALS
   by Loper and Tedson
   Delmar Publishers.....ISBN 0-8273-6572-1

5. DELMAR'S STANDARD GUIDE TO TRANSFORMERS
   by Herman and Singleton
   Delmar Publishers.....ISBN 0-8273-7209-4

6. ELECTRIC MOTOR REPAIR, 3rd EDITION
   by Robert Rosenburg and August Hand
   Delmar Publishers.....ISBN 0-0305-9584-3

7. ELECTRICAL CONTROL FOR MACHINES
   by Rexford
   Delmar Publishers.....ISBN 0-8273-2792-7

8. ELECTRICAL MOTOR CONTROLS AUTOMATED INDUSTRIAL SYSTEMS
   by Rockis and Mazur
   American Technical Publishers Inc.....ISBN 0-8269-1666-X

9. ELECTRICAL RACEWAYS AND OTHER WIRING METHODS
   by Loyd
   Delmar Publishers.....ISBN 0-8273-5460-6

10. ELECTRICAL WIRING
    by Seale
    Howard W. Sams and Company.....ISBN 0-672-22695-2

11. ELECTRICAL WIRING - COMMERCIAL
    by Mullin, Smith, Fraser and Jackson
    Nelson Canada.....ISBN 0-17-604839-1

12. ELECTRICAL WIRING - INDUSTRIAL
    by Smith and Herman
    Delmar Publishers.....ISBN 0-8273-6653-1

13. ELECTRICAL WIRING - RESIDENTIAL
    by Mullin and Fraser
    Nelson Canada.....ISBN 0-17-604839-7

14. ELECTRICITY FOR REFRIGERATION, HEATING AND AIR CONDITIONING
    by Smith
    Delmar Publishers.....ISBN 0-8273-2772-2

15. ELECTRONIC DRIVES
    by Carrow
    TAB Books - McGraw-Hill.....ISBN 0-07-011611-3

16. ELECTRONIC VARIABLE SPEED DRIVES
    by Brumbach
    Delmar Publishers.....ISBN 0-8273-6937-9

17. ELECTRONICS FOR ELECTRICIANS
    By Stephen Herman
    Delmar Publishers.....ISBN 0-7668-2863-8

18. EMERGENCY, STANDBY AND OTHER AUXILIARY POWER SYSTEMS
    by Editor, EC&M Magazine
    Intertec Publishing Corp. .....ISBN 0-87288-603-4

19. FIBER OPTIC CABLE SYSTEM INSTALLATION
    by Pearson
    Delmar Publishers.....ISBN 0-8273-7318-X

20. FIRE ALARM SYSTEMS - A REFERENCE MANUAL
    by Canadian Fire Alarm Association
    Prosafe Publications Ltd. .....ISBN 0-9692433-2-4

21. HAZARDOUS CLASSIFIED LOCATIONS
    by Loyd
    Delmar Publishers.....ISBN 0-8273-6982-4

22. HEATING, VENTILATING AND AIR CONDITIONING
    by Swenson
    American Technical Publishers Inc. .....ISBN 0-8269-0675-3

23. IES LIGHTING HANDBOOK - APPLICATION VOLUME
    by Illuminating Engineering
    Society of North America.....ISBN 0-87995-024-2

24. IES LIGHTING HANDBOOK - REFERENCE VOLUME
    by Illuminating Engineering
    Society of North America.....ISBN 0-87995-015-3

25. INTRODUCTION TO DIGITAL SYSTEMS
    by Palmer and Perlman
    Schaum's Outline SeriesI.....ISBN 0-07-048439-2

26. INTRODUCTION TO THE FIRE DETECTION AND ALARM INDUSTRY
    by Canadian Fire Alarm Association
    Prosafe Publications Ltd.....ISBN 0-9692433-2-4

27. MODERN CONTROL TECHNOLOGY - COMPONENTS AND SYSTEMS
    by Kilian
    West Publishing Company.....ISBN 0-314-06631-4

28. PROGRAMMABLE CONTROLLER CIRCUITS
    by Bertrand
    Delmar Publishers.....ISBN 0-8273-7066-0

29. SMART HOUSE WIRING
    Delmar Publishers.....ISBN 0-8273-5489-4

30. SOLID STATE FUNDAMENTALS FOR ELECTRICIANS
    by Rockis
    American Technical Publishers Inc.....ISBN 0-8269-1631-7

31. TECHNICIAN'S GUIDE TO PROGRAMMABLE CONTROLLERS
    by Cox
    Delmar Publishers.....ISBN 0-8273-6238-2

32. TROUBLESHOOTING ELECTRIC MOTORS
    by Mazur and Proctor
    American Technical Publishers Inc. .....ISBN 0-8269-1765-8

33. TROUBLESHOOTING ELECTRICAL/ELECTRONIC SYSTEMS
by Mazur and Proctor
American Technical Publishers Inc.....ISBN 0-8269-1775-5

NOTE:

This list of Reference Materials is for training providers. Apprentices should contact their preferred training provider for a list of recommended or required texts for this program.

Instructor Requirements

Occupation Qualification

The instructor must possess:

- For Levels 1, 2 & 3:
  - A Construction Electrician or Industrial Electrician BC Certificate of Qualification preferably with Red Seal Endorsement
  - A Construction Electrician or Industrial Electrician Certificate of Qualification from another Canadian jurisdiction with Red Seal Endorsement only
- For Level 4:
  - A Construction Electrician BC Certificate of Qualification preferably with Red Seal Endorsement
  - A Construction Electrician Certificate of Qualification from another Canadian jurisdiction with Red Seal Endorsement only

Work Experience

A minimum of 5 years' experience working in the industry as a journeyperson.

Instructional Experience and Education

It is preferred that the instructor also possesses one of the following:

- An Instructor's Diploma or equivalent
- A Bachelor's Degree in Education
- A Master's Degree in Education

Appendices

Appendix A

Previous Contributors

Acknowledgements (2013)

The Program Outline was prepared with the advice and direction of an industry steering committee convened initially by the BC Construction Industry Training Organization (CITO). Members include:

Industry Subject Matter Experts retained to assist in the development of Program Outline content (2013):

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Stuart Blundell, Canfor
Nick Bourassa, Lakewood Electric
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Ted Simmons – British Columbia Institute of Technology
John Todrick – University of the Fraser Valley

SkilledTradesBC would like to acknowledge the dedication and hard work of all the industry representatives appointed to identify the training requirements of the Construction Electrician occupation.

Appendix B

Summary of 2020 Revisions

Summary of 2020 Revisions

SUMMARY OF REVISIONS TO 2020 CONSTRUCTION ELECTRICIAN AND INDUSTRIAL ELECTRICIAN PROGRAM OUTLINES			
2016 HARMONIZED PO	**MOVED TO**	**COMPETENCIES**	**DETAILS**
HL2	HL3	M3 Install DC generating systems	Entire competency moved to HL3
HL2	HL3	M4 Maintain DC generating systems	Entire competency moved to HL3
HL2	HL3	V1 Install motor starters and controls Objective: Describe the operation of magnetic DC motor controllers. Learning tasks 11, 12, 13: 11. Describe the features of DC motor controllers 12. Describe the operation of magnetic DC motor controllers 13. Describe methods of deceleration for DC motors	1 learning objective and 3 learning tasks that apply to DC motors have been moved to V1 HL3
HL2	HL3	Y3 Install DC motors • Includes Achievement Criteria: Connect DC Motors	Entire competency moved to HL3, including achievement criteria
HL2	HL3	Y4 Maintain DC motors	Entire competency moved to HL3
HL3	CE HL4 IE HL4	D7 Identify hazardous locations	Entire competency moved to CE HL4 and IE HL4
In addition to moved content, the following components were adjusted to reflect the changes: Occupational Analysis Chart, Suggested time allocation for CC Level 2, CC Level 3, CE Level 4 and IE Level 4, Assessment Guidelines for CC Level 2, CC Level 3, CE Level 4 and IE Level 4, and the tools and equipment list.			

Appendix C

Summary of 2022 Revisions

Summary of 2022 Revisions

SUMMARY OF REVISIONS TO 2022 CONSTRUCTION ELECTRICIAN AND INDUSTRIAL ELECTRICIAN PROGRAM OUTLINES		
ELECTRICIAN COMMON CORE LEVEL 1		
SECTION	**CHANGE**	
Occupational Analysis Chart	• Level 1 added to Line V	
Time Allocation Chart	• Line V (V1 and V2) added • Changes to % of time for Line A, B, D, R, V, AA	
Program Content	**Canadian Electrical Code (CEC) added for the following Learning Tasks (LTs) and Objectives (Obj):**	
	Competency	**Learning Task or Objective**
	A1	LTs 11-18
	A2	LTs 18-19
	B1	LT 4
	B2	LT 2
	D1	LTs 13
	H1	LTs 1-2
	H3	LT 1
	I2	LT 1
	J1	LTs 1 and 3
	L1	Obj
	Q1	Obj
	Q2	LT 3
	R2	LT 2
	R3	Obj
	AA1	LT 2
	Additional content changes:	
	Competency	**Change**
	A6	LT 2: Added *Free wheeling diode* to content points
	R1	LT 4: Removed *Tungsten halogen lamps* from content points
	V1	Competency added to Level 1
	V2	Competency added to Level 1
	AA1	LT 1: Removed *Design of the system* from content points LT 2: Removed *Manufacturer's installer certification* and *Certification and warranty procedures* from content points Achievement Criteria: Changed *CAT5 cable* to *twisted pair* cable
Assessment Guidelines	• Changed Theory Weighting for Lines B, C, D, Q, R, V, AA. (Added Line V) • Changed Practical Weighting for Lines R, V, AA. (Added Line V)	

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<tr><th colspan="3">SUMMARY OF REVISIONS TO 2022 CONSTRUCTION ELECTRICIAN AND INDUSTRIAL ELECTRICIAN PROGRAM OUTLINES</th></tr>
<tr><th colspan="3">ELECTRICIAN COMMON CORE LEVEL 2</th></tr>
<tr><th>SECTION</th><th colspan="2">CHANGE</th></tr>
<tr><td>Time Allocation Chart</td><td colspan="2">• Changes to % of time for Line N, V</td></tr>
<tr><td rowspan="30">Program Content</td><td colspan="2">Canadian Electrical Code (CEC) added for the following Learning Tasks (LTs) and Objectives (Obj):</td></tr>
<tr><td>Competency</td><td>Learning Task or Objective</td></tr>
<tr><td>A4</td><td>LTs 12 and 14</td></tr>
<tr><td>D1</td><td>LT 3</td></tr>
<tr><td>H1</td><td>LT 2</td></tr>
<tr><td>I1</td><td>LT 2</td></tr>
<tr><td>I2</td><td>LT 1</td></tr>
<tr><td>L1</td><td>Obj</td></tr>
<tr><td>N1</td><td>Obj</td></tr>
<tr><td>P1</td><td>Obj</td></tr>
<tr><td>Q1</td><td>LTs 3-4</td></tr>
<tr><td>Q2</td><td>LTs 3-4</td></tr>
<tr><td>R2</td><td>LT 2</td></tr>
<tr><td>S1</td><td>Obj</td></tr>
<tr><td>T1</td><td>Obj</td></tr>
<tr><td>T2</td><td>LT 1</td></tr>
<tr><td>U1</td><td>Obj</td></tr>
<tr><td>V1</td><td>LTs 5 and 8 (previously numbered 6 and 9)</td></tr>
<tr><td colspan="2">Additional content changes:</td></tr>
<tr><td>Competency</td><td>Change</td></tr>
<tr><td>R1</td><td>LT 1: Removed Low pressure sodium and Mercury vapour from content points
LT 3: Removed Mercury vapour lamp from content points
LT 4: Removed Two lamp ballasts from content points
LT 4: Changed Ballast to Electronic ballast in the content points</td></tr>
<tr><td>V1</td><td>Obj: Removed Describe the operating principles of manual motor starters and Connect manual motor starters
Obj: Added Describe the operating principles of common control devices
Obj: Changed Draw diagrams for AC motor controls to Draw wiring and schematic diagrams for AC motor controls
LT 1-4 and 10: Removed. (LT 1-4 and 10 moved to Level 1 Competency V1)
New LT 1-3: Describe features of common control devices; Describe features and applications of plugging switches; Draw circuit diagrams involving automatic and sequence control (Previous LTs 5-9 are now LTs 4-8)</td></tr>
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<tr><td>Competency</td><td>Learning Task or Objective</td></tr>
<tr><td>A5</td><td>LTs 2, 3, and 5</td></tr>
<tr><td>D1</td><td>LT 3</td></tr>
<tr><td>H2</td><td>LTs 2-3</td></tr>
<tr><td>H4</td><td>Obj</td></tr>
<tr><td>J1</td><td>LT 3</td></tr>
<tr><td>L1</td><td>Obj</td></tr>
<tr><td>L3</td><td>Obj</td></tr>
<tr><td>M1</td><td>LT 5</td></tr>
<tr><td>P3</td><td>Obj</td></tr>
<tr><td>P5</td><td>Obj</td></tr>
<tr><td>R2</td><td>Obj</td></tr>
<tr><td>V1</td><td>Obj</td></tr>
<tr><td>Y1</td><td>Obj</td></tr>
<tr><td>Y3</td><td>Obj</td></tr>
<tr><td colspan="2">Additional content changes:</td></tr>
<tr><td>Competency</td><td>Change</td></tr>
<tr><td>V1</td><td>LT 1-4: Removed. (LT 1-3 moved to Level 2 Competency V1)
Achievement Criteria: Changed the Performance Criteria</td></tr>
<tr><td>Assessment Guidelines</td><td colspan="2">• Changed Theory Weighting for Lines P, V</td></tr>
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<tr><td>Competency</td><td>Learning Task or Objective</td></tr>
<tr><td>D1</td><td>LT 3</td></tr>
<tr><td>D7</td><td>Obj</td></tr>
<tr><td>K1</td><td>Obj</td></tr>
<tr><td>N1</td><td>Obj</td></tr>
<tr><td>R6</td><td>LT 1</td></tr>
<tr><td>R7</td><td>Obj</td></tr>
<tr><td>X1</td><td>Obj</td></tr>
<tr><td>Z1</td><td>Obj</td></tr>
<tr><td>Z3</td><td>Obj</td></tr>
<tr><td>AA1</td><td>Obj</td></tr>
<tr><td>AA3</td><td>Obj</td></tr>
<tr><td>AC1</td><td>LT 4</td></tr>
<tr><td colspan="2">Additional content changes:</td></tr>
<tr><td>Competency</td><td>Change</td></tr>
<tr><td>R6</td><td>LT 2: Changed from Test and maintain airport runway lighting systems to Test, inspect, and maintain airport lighting systems</td></tr>
<tr><td>AA1</td><td>New LT added: Describe procedures to install a structured cable system. Content points in new LT: Design of the system, Manufacturer's installer certification, Certification and warranty procedures
New Obj added: Describe methods of certification for a structured cable system</td></tr>
<tr><td>AA3</td><td>LT 2: Added Standards, specifications, and codes to content points</td></tr>
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<tr><th colspan="3">SUMMARY OF REVISIONS TO 2022 CONSTRUCTION ELECTRICIAN AND INDUSTRIAL ELECTRICIAN PROGRAM OUTLINES</th></tr>
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<tr><td>D1</td><td>LT 3</td></tr>
<tr><td>D7</td><td>Obj</td></tr>
<tr><td>K1</td><td>Obj</td></tr>
<tr><td>N1</td><td>Obj</td></tr>
<tr><td>X1</td><td>Obj</td></tr>
<tr><td>Z1</td><td>Obj</td></tr>
<tr><td>Z3</td><td>Obj</td></tr>
<tr><td>AA1</td><td>Obj</td></tr>
<tr><td>AC1</td><td>LT 10</td></tr>
<tr><td>AD5</td><td>LT 2</td></tr>
<tr><td colspan="2">Additional content changes:</td></tr>
<tr><td>Competency</td><td>Change</td></tr>
<tr><td>AA1</td><td>Obj: Added Describe methods of certification for a structured cable system
New LT added: Describe procedures to install a structured cable system. Content points in new LT: Design of the system; Manufacturer’s installer certification; Certification and warranty procedures. (Note: New LT is LT 1. Previous LT 1-7 are now LT 2-8)</td></tr>
<tr><td>AC1</td><td>LT 19: Expanded to include in accordance with manufacturer’s specifications</td></tr>
</table>