PROGRAM OUTLINE

Construction Electrician
CONSTRUCTION ELECTRICIAN
HARMONIZED PROGRAM OUTLINE

APPROVED BY INDUSTRY
FEBRUARY 2017

BASED ON
2015 CONSTRUCTION ELECTRICIAN RSOS
AND 2016 INDUSTRIAL ELECTRICIAN RSOS

Developed by
Industry Training Authority
Province of British Columbia
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Section 1

INTRODUCTION

Construction Electrician
This revised 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.

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**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.

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**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](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
- Jesse Carlson  West Coast Reduction
- Greg Gyorfi  IBEW Local 230
- Raymond Keen  IBEW Local 1003
- Robert Kelly  BC Hydro
- Adrien Livingston  Western Joint Electrical Training
- Michelle Neil  IBEW Local 230
- Tom Pennells  Koho Marine Consulting
- Shane Stirling  Epscan
- Stephen Van Rijn  Canfor
- Monty Wood  enCompass Solutions

Subject Matter Experts retained to assist in the development of Program Outline content for Construction Electrician and Industrial Electrician:

- Keith Ankerman  Fortis BC
- Michal Dwojak  Northern Lights College
- Adrien Livingston  Western Joint Electrical Training
- John MacMillan  College of New Caledonia
- Michelle Neil  IBEW Local 230
- Peter Poeschek  Thompson Rivers University
- Daniel Smythe  University of the Fraser Valley
- Kevin Szol  College of the Rockies
- Stephen Van Rijn  Canfor
- Monty Wood  enCompass Solutions

The Industry Training Authority 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.

<table>
<thead>
<tr>
<th>Section</th>
<th>Training Providers</th>
<th>Employers/Sponsors</th>
<th>Apprentices</th>
<th>Challengers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Program Credentialing Model</td>
<td>Communicate program length and structure, and all pathways to completion</td>
<td>Understand the length and structure of the program</td>
<td>Understand the length and structure of the program, and pathway to completion</td>
<td>Understand challenger pathway to Certificate of Qualification</td>
</tr>
<tr>
<td>OAC</td>
<td>Communicate the competencies that industry has defined as representing the scope of the occupation</td>
<td>Understand the competencies that an apprentice is expected to demonstrate in order to achieve certification</td>
<td>View the competencies they will achieve as a result of program completion</td>
<td>Understand the competencies they must demonstrate in order to challenge the program</td>
</tr>
<tr>
<td>Training Topics and Suggested Time Allocation</td>
<td>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.</td>
<td>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.</td>
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</tr>
<tr>
<td>Program Content</td>
<td>Defines the objectives, learning tasks and high level content that must be covered for each competency</td>
<td>Identifies detailed program content; may be used as a checklist prior to signing a recommendation for certification (RFC) for an apprentice</td>
<td>Provides detailed information on program content and performance expectations for demonstrating competency</td>
<td>Allows individual to check program content areas against their own knowledge and performance expectations against their own skill levels</td>
</tr>
<tr>
<td>Achievement Criteria</td>
<td>Defines observable, measureable 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</td>
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<td>Section</td>
<td>Training Providers</td>
<td>Employers/Sponsors</td>
<td>Apprentices</td>
<td>Challengers</td>
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<tr>
<td>Training Provider</td>
<td>Defines the facility requirements, tools and equipment, reference materials (if</td>
<td>Identifies the tools and equipment an apprentice is expected to have access to;</td>
<td>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</td>
<td>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</td>
</tr>
<tr>
<td>Standards</td>
<td>any) and instructor requirements for the program</td>
<td>which are supplied by the training provider and which the student is expected to own</td>
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<tr>
<td>Appendix –</td>
<td>Defines program specific acronyms</td>
<td>Defines program specific acronyms</td>
<td>Defines program specific acronyms</td>
<td>Defines program specific acronyms</td>
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<tr>
<td>Glossary of Acronyms</td>
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<tr>
<td>Assessment Guidelines</td>
<td>Defines the weighting of theory and practical (lab) marks by GAC to be used to</td>
<td>Defines the weighting of theory and practical (lab) marks by GAC to be used to</td>
<td>Defines the weighting of theory and practical (lab) marks by GAC to be used to</td>
<td>Understand the relative weightings of various competencies of the occupation on which assessment is based</td>
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<tr>
<td></td>
<td>calculate an apprentice’s in-school mark for each level. The practical weighting is</td>
<td>calculate an apprentice’s in-school mark for each level. The practical weighting</td>
<td>calculate an apprentice’s in-school mark for each level. The practical weight</td>
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<tr>
<td></td>
<td>a reflection of performance on the achievement criteria for each level. Assessment</td>
<td>is a reflection of performance on the achievement criteria for each level.</td>
<td>ing is a reflection of performance on the achievement criteria for each level.</td>
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<td></td>
<td>Guidelines also define the weighting of the in-school mark to the standard level</td>
<td>Assessment Guidelines also define the weighting of the in-school mark to the</td>
<td>Assessment Guidelines also define the weighting of the in-school mark to the</td>
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<td></td>
<td>exam mark (where applicable) in order to calculate an apprentice’s final mark</td>
<td>standard level exam mark (where applicable) in order to calculate an apprentice’s</td>
<td>standard level exam mark (where applicable) in order to calculate an</td>
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<td></td>
<td>for each level.</td>
<td>final mark for each level.</td>
<td>apprentice’s final mark for each level.</td>
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HARMONIZED PROGRAM OUTLINE
Introduction
Section 2

PROGRAM OVERVIEW

Construction Electrician
Construction Electrician

Program Credentialing Model

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:

- Electrician Common Core Level 3
  - Technical Training: 300 hours
  - Work-Based Training: Accumulate hours
  - ITA Standardized Written Exam

- Electrician Common Core Level 2
  - Technical Training: 300 hours
  - Work-Based Training: Accumulate hours
  - ITA Standardized Written Exam

- Electrician Common Core Level 1
  - Technical Training: 300 hours
  - Work-Based Training: Accumulate hours
  - ITA Standardized Written Exam

- Marine Electrician
  - Technical Training: 180 hours
  - Work-Based Training: 6,000 hours total
  - Interprovincial Red Seal Exam

- Industrial Electrician
  - Technical Training: 300 hours
  - Work-Based Training: 6,000 hours total
  - Interprovincial Red Seal Exam
  - Logbook Signoff

- Construction Electrician Level 4
  - Technical Training: 300 hours
  - Work-Based Training: 6,000 hours total
  - Interprovincial Red Seal Exam

- Industrial Electrician Level 4
  - Technical Training: 300 hours
  - Work-Based Training: 6,000 hours total
  - Interprovincial Red Seal Exam

- Electrician Foundation
  - Technical Training: 720 hours

- C of Q Industrial Electrician
  - Technical Training: Level 1, 2 & 3
  - Work-Based Training: 4,500 hours

- C of A Industrial Electrician
  - (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**

<table>
<thead>
<tr>
<th>A</th>
<th>Use Electrical Circuit Concepts</th>
<th>Analyze DC Circuits</th>
<th>Analyze Principles of Electromagnetism</th>
<th>Analyze Single-Phase AC Circuits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>A1</td>
<td>A2</td>
<td>A3</td>
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<td>1</td>
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</table>

| A4 |                                        |                       |                                       |                                 |

| A5 | Analyze Three-Phase AC Circuits         | A6                     | Anlayze Electronic Circuits             |
|    |                                           |                        |                                        |
|    |                                           |                        |                                        |
| 3  |                                           |                        |                                        |

**PERFORM SAFETY-RELATED FUNCTIONS**

<table>
<thead>
<tr>
<th>B</th>
<th>Use Personal Protection Equipment (PPE) and Safety Equipment</th>
<th>Maintain Safe Work Environment</th>
<th>Perform Lock-out and Tag-out Procedures</th>
</tr>
</thead>
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<td>B1</td>
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</tbody>
</table>

**USE TOOLS AND EQUIPMENT**

<table>
<thead>
<tr>
<th>C</th>
<th>Use Common and Specialty Tools and Equipment</th>
<th>Use Access Equipment</th>
<th>Use Rigging, Hoisting and Lifting Equipment</th>
<th>Use Measuring and Testing Equipment</th>
</tr>
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<tr>
<td></td>
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<td>C1</td>
<td>C2</td>
<td>C3</td>
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<tr>
<td>W</td>
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<tr>
<td>C4</td>
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</tbody>
</table>

**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
## Program Overview

<table>
<thead>
<tr>
<th>ORGANIZE WORK</th>
<th>Interpret Plans, Drawings and Specifications</th>
<th>Use Canadian Electrical Code (CEC)</th>
<th>Organize Materials and Supplies</th>
<th>Plan Project Tasks and Procedures</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>D</td>
<td>D1</td>
<td></td>
<td>D4</td>
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<td>W</td>
<td>D5</td>
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<td></td>
<td>W</td>
<td>D6</td>
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<td></td>
<td>W</td>
<td>D7</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>FABRICATE AND INSTALL SUPPORT COMPONENTS</th>
<th>Fabricate Support Structures</th>
<th>Install Brackets, Hangers and Fasteners</th>
<th>Install Seismic Restraint Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>E</td>
<td>W</td>
<td>E1</td>
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<td></td>
<td>W</td>
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<td>E2</td>
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<td></td>
<td>W</td>
<td></td>
<td>E3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>COMMISSION AND DECOMMISSION ELECTRICAL SYSTEMS</th>
<th>Commission Systems</th>
<th>Perform Startup and Shutdown Procedures</th>
<th>Decommission Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F</td>
<td>W</td>
<td>F1</td>
</tr>
<tr>
<td></td>
<td>W</td>
<td></td>
<td>F2</td>
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<td></td>
<td>W</td>
<td></td>
<td>F3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>USE COMMUNICATION AND MENTORING TECHNIQUES</th>
<th>Use Communication Techniques</th>
<th>Use Mentoring Techniques</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>W</td>
<td>G1</td>
</tr>
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<td>G2</td>
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<td>H1</td>
<td>H2</td>
<td>H3</td>
<td>H4</td>
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<td></td>
<td>W</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INSTALL AND MAINTAIN PROTECTION DEVICES</td>
<td>Install Overcurrent Protection Devices</td>
<td>Install Ground Fault, Arc Fault and Surge Protection Devices</td>
<td>Install Under and Over Voltage Protection Devices</td>
<td>Maintain Protection Devices</td>
</tr>
<tr>
<td></td>
<td>I1</td>
<td>I2</td>
<td>I3</td>
<td>W</td>
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<td></td>
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<td>I4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>INSTALL AND MAINTAIN LOW VOLTAGE DISTRIBUTION SYSTEMS</th>
<th>Install Low Voltage Distribution Equipment</th>
<th>Maintain Low Voltage Distribution Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>J1</td>
<td>J2</td>
</tr>
</tbody>
</table>

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
### INSTALL AND MAINTAIN POWER CONDITIONING, UNINTERRUPTIBLE POWER SUPPLY (UPS) AND SURGE SUPPRESSION SYSTEMS

<table>
<thead>
<tr>
<th>Task</th>
<th>4C</th>
<th>4IE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>K1</strong> Install Power Conditioning, UPS and Surge Suppression Systems</td>
<td>4C</td>
<td>4IE</td>
</tr>
<tr>
<td><strong>K2</strong> Maintain Power Conditioning, UPS and Surge Suppression Systems</td>
<td>4C</td>
<td>4IE</td>
</tr>
</tbody>
</table>

### INSTALL AND MAINTAIN BONDING, GROUNDING AND GROUND FAULT DETECTION SYSTEMS

<table>
<thead>
<tr>
<th>Task</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>L1</strong> Install Grounding and Bonding Systems</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td><strong>L2</strong> Maintain Grounding and Bonding Systems</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td><strong>L3</strong> Install Ground Fault Detection Systems</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td><strong>L4</strong> Maintain Ground Fault Detection Systems</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

### INSTALL AND MAINTAIN POWER GENERATION SYSTEMS

<table>
<thead>
<tr>
<th>Task</th>
<th>M1</th>
<th>M2</th>
<th>M3</th>
<th>M4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>M1</strong> Install AC Generating Systems</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td><strong>M2</strong> Maintain AC Generating Systems</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

### INSTALL AND MAINTAIN RENEWABLE ENERGY GENERATING AND STORAGE SYSTEMS

<table>
<thead>
<tr>
<th>Task</th>
<th>N1</th>
<th>N2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>N1</strong> Install Renewable Energy Generating and Storage Systems</td>
<td>2</td>
<td>4C</td>
</tr>
<tr>
<td><strong>N2</strong> Maintain Renewable Energy Generating and Storage Systems</td>
<td>2</td>
<td>4C</td>
</tr>
</tbody>
</table>

### INSTALL AND MAINTAIN HIGH VOLTAGE SYSTEMS

<table>
<thead>
<tr>
<th>Task</th>
<th>O1</th>
<th>O2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>O1</strong> Install High Voltage Systems</td>
<td>4C</td>
<td>4IE</td>
</tr>
<tr>
<td><strong>O2</strong> Maintain High Voltage Systems</td>
<td>4C</td>
<td>4IE</td>
</tr>
</tbody>
</table>

### INSTALL AND MAINTAIN TRANSFORMERS

<table>
<thead>
<tr>
<th>Task</th>
<th>P1</th>
<th>P2</th>
<th>P3</th>
<th>P4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>P1</strong> Install Extra-Low and Low-Voltage Single-Phase Transformers</td>
<td>2</td>
<td>3</td>
<td>W</td>
<td>P4</td>
</tr>
<tr>
<td><strong>P2</strong> Maintain Extra-Low and Low-Voltage Single-Phase Transformers</td>
<td>2</td>
<td>3</td>
<td>W</td>
<td>P4</td>
</tr>
<tr>
<td><strong>P3</strong> Install Low-Voltage Three-Phase Transformers</td>
<td>2</td>
<td>3</td>
<td>W</td>
<td>P4</td>
</tr>
<tr>
<td><strong>P4</strong> Maintain Low-Voltage Three-Phase Transformers</td>
<td>2</td>
<td>3</td>
<td>W</td>
<td>P4</td>
</tr>
</tbody>
</table>

### INSTALL AND MAINTAIN RACEWAYS, CABLES AND ENCLOSURES

<table>
<thead>
<tr>
<th>Task</th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
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<tbody>
<tr>
<td><strong>Q1</strong> Install Conductors and Cables</td>
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<td>2</td>
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</tr>
<tr>
<td><strong>Q2</strong> Install Raceways, Boxes and Fittings</td>
<td>1</td>
<td>2</td>
<td>W</td>
</tr>
<tr>
<td><strong>Q3</strong> Maintain Conductors, Cables, Raceways, Boxes and Fittings</td>
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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
<table>
<thead>
<tr>
<th>Section</th>
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<tr>
<td><strong>INSTALL AND MAINTAIN BRANCH CIRCUITRY</strong></td>
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<td>R1</td>
<td>Install Luminaires</td>
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<tr>
<td>R2</td>
<td>Install Wiring Devices</td>
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<tr>
<td>R3</td>
<td>Install Lighting Controls</td>
</tr>
<tr>
<td>R4</td>
<td>Install Lighting Standards</td>
</tr>
<tr>
<td>R5</td>
<td>Maintain Luminaires, Wiring Devices, Lighting Controls, Lighting Standards and Branch Circuitry</td>
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<tr>
<td>R6</td>
<td>Install and Maintain Airport Runway Lighting Systems</td>
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<tr>
<td>R7</td>
<td>Install and Maintain Traffic Signal Lights and Controls</td>
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<td><strong>INSTALL AND MAINTAIN HEATING, VENTILATING AND AIR-CONDITIONING (HVAC) SYSTEMS</strong></td>
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<tr>
<td>S1</td>
<td>Install HVAC Systems and Controls</td>
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<td>S2</td>
<td>Maintain HVAC Systems and Controls</td>
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<td><strong>INSTALL AND MAINTAIN EXIT AND EMERGENCY LIGHTING SYSTEMS</strong></td>
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<tr>
<td>T1</td>
<td>Install Exit and Emergency Lighting Systems</td>
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<tr>
<td>T2</td>
<td>Maintain Exit and Emergency Lighting Systems</td>
</tr>
<tr>
<td><strong>INSTALL AND MAINTAIN CATHODIC PROTECTION SYSTEMS</strong></td>
<td></td>
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<tr>
<td>U1</td>
<td>Install Cathodic Protection Systems</td>
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<td>Maintain Cathodic Protection Systems</td>
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<tr>
<td><strong>INSTALL AND MAINTAIN MOTOR STARTERS AND CONTROLS</strong></td>
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<tr>
<td>V1</td>
<td>Install Motor Starters and Controls</td>
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<td><strong>INSTALL AND MAINTAIN DRIVES</strong></td>
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<td>W1</td>
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<td><strong>INSTALL AND MAINTAIN NON-ROTATING EQUIPMENT AND ASSOCIATED CONTROLS</strong></td>
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<td>X1</td>
<td>Install Non-Rotating Equipment and Associated Controls</td>
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<tr>
<td>X2</td>
<td>Maintain Non-Rotating Equipment and Associated Controls</td>
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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
**HARMONIZED PROGRAM OUTLINE**  
**Program Overview**

<table>
<thead>
<tr>
<th>INSTALL AND MAINTAIN MOTORS</th>
<th>Install AC Motors</th>
<th>Maintain AC Motors</th>
<th>Install DC Motors</th>
<th>Maintain DC Motors</th>
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<tr>
<th>INSTALL AND MAINTAIN COMMUNICATION SYSTEMS</th>
<th>Install Voice/Data/Video (VDV) Systems</th>
<th>Install Public Address (PA) and Intercom Systems</th>
<th>Install Nurse Call Systems</th>
<th>Maintain Communication Systems</th>
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<tr>
<td></td>
<td>AA</td>
<td>AA1</td>
<td>AA2</td>
<td>AA3</td>
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<td>4C 4IE</td>
<td>W (CE only)</td>
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<tr>
<th>INSTALL AND MAINTAIN BUILDING AUTOMATION SYSTEMS</th>
<th>Install Building Automation Systems</th>
<th>Maintain Building Automation Systems</th>
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<tr>
<td></td>
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<thead>
<tr>
<th>INSTALL, PROGRAM AND MAINTAIN AUTOMATED CONTROL SYSTEMS</th>
<th>Install Automated Control Systems</th>
<th>Maintain Automated Control Systems</th>
<th>Program Automated Control Systems</th>
<th>Optimize System Performance</th>
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<td>AC2</td>
<td>AC3</td>
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<tr>
<th>INSTALL AND MAINTAIN PNEUMATIC, HYDRAULIC CONTROL AND PUMPING SYSTEMS</th>
<th>Install Pneumatic Control Systems</th>
<th>Maintain Pneumatic Control Systems</th>
<th>Install Hydraulic Control Systems</th>
<th>Maintain Hydraulic Control Systems</th>
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### ELECTRICIAN COMMON CORE– LEVEL 1

#### Training Topics and Suggested Time Allocation: Level 1

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<thead>
<tr>
<th>Line</th>
<th>Topic Description</th>
<th>% of Time Allocated to:</th>
<th>Theory</th>
<th>Practical</th>
<th>Total</th>
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<tr>
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<tr>
<td><strong>Line A</strong></td>
<td>APPLY CIRCUIT CONCEPTS</td>
<td>57%</td>
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<td>A1</td>
<td>Use Electrical Circuit Concepts</td>
<td>✓</td>
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<td>✓</td>
<td>100%</td>
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<tr>
<td>A2</td>
<td>Analyze DC Circuits</td>
<td>✓</td>
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<td>✓</td>
<td>100%</td>
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<tr>
<td>A3</td>
<td>Analyze Principles of Electromagnetism</td>
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<td>✓</td>
<td>100%</td>
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<tr>
<td>A6</td>
<td>Analyze Electronic Circuits</td>
<td>✓</td>
<td></td>
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<tr>
<td><strong>Line B</strong></td>
<td>PERFORM SAFETY-RELATED FUNCTIONS</td>
<td>4%</td>
<td>95%</td>
<td>5%</td>
<td>100%</td>
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<tr>
<td>B1</td>
<td>Use Personal Protection Equipment (PPE) and Safety Equipment</td>
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<td>B2</td>
<td>Maintain Safe Work Environment</td>
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<tr>
<td>B3</td>
<td>Perform Lock-out and Tag-out Procedures</td>
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<td><strong>Line C</strong></td>
<td>USE TOOLS AND EQUIPMENT</td>
<td>2%</td>
<td>90%</td>
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<td>100%</td>
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<tr>
<td>C4</td>
<td>Use Measuring and Testing Equipment</td>
<td>✓</td>
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<td>✓</td>
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<tr>
<td><strong>Line D</strong></td>
<td>ORGANIZE WORK</td>
<td>10%</td>
<td>100%</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td>D1</td>
<td>Interpret Plans, Drawings and Specifications</td>
<td>✓</td>
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<tr>
<td>D2</td>
<td>Use Canadian Electrical Code (CEC)</td>
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<tr>
<td><strong>Line G</strong></td>
<td>USE COMMUNICATION AND MENTORING TECHNIQUES</td>
<td>1%</td>
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<tr>
<td>G2</td>
<td>Use Mentoring Techniques</td>
<td>✓</td>
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<tr>
<td><strong>Line H</strong></td>
<td>INSTALL AND MAINTAIN CONSUMER/SUPPLY SERVICES AND METERING EQUIPMENT</td>
<td>4%</td>
<td>100%</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td>H1</td>
<td>Install Single-phase Consumer/Supply Services and Metering Equipment</td>
<td>✓</td>
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<tr>
<td>H3</td>
<td>Maintain Single-phase Services and Metering Equipment</td>
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<td><strong>Line I</strong></td>
<td>INSTALL AND MAINTAIN PROTECTION DEVICE</td>
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<tr>
<td>I2</td>
<td>Install Ground Fault, Arc Fault and Surge Protection Devices</td>
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<tr>
<td><strong>Line J</strong></td>
<td>INSTALL AND MAINTAIN LOW VOLTAGE DISTRIBUTION SYSTEMS</td>
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<tr>
<td>J1</td>
<td>Install Low Voltage Distribution Equipment</td>
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<tr>
<td><strong>Line L</strong></td>
<td>INSTALL AND MAINTAIN BONDING, GROUNDING AND GROUND FAULT DETECTION SYSTEMS</td>
<td>2%</td>
<td>100%</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td>L1</td>
<td>Install Grounding and Bonding Systems</td>
<td>✓</td>
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</tr>
<tr>
<td>Line</td>
<td>Activity</td>
<td>% of Time</td>
<td>Theory</td>
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<tr>
<td>Q</td>
<td>INSTALL AND MAINTAIN RACEWAYS, CABLES AND ENCLOSURES</td>
<td>4%</td>
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<td>0%</td>
<td>100%</td>
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<tr>
<td>Q1</td>
<td>Install Conductors and Cables</td>
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<tr>
<td>Q2</td>
<td>Install Raceways, Boxes and Fittings</td>
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<td>R</td>
<td>INSTALL AND MAINTAIN BRANCH CIRCUITRY</td>
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<td>10%</td>
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<td>Install Luminaires</td>
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<td>Install Wiring Devices</td>
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<tr>
<td>R3</td>
<td>Install Lighting Controls</td>
<td>✔</td>
<td>✔</td>
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<td>R4</td>
<td>Install Lighting Standards</td>
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<td>AA1</td>
<td>Install Voice/Data/Video (VDV) Systems</td>
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### Training Topics and Suggested Time Allocation: Level 2

#### ELECTRICIAN COMMON CORE – LEVEL 2

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<tr>
<td>Line A</td>
<td>APPLY CIRCUIT CONCEPTS</td>
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<td>Use Electrical Circuit Concepts</td>
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<tr>
<td>A4</td>
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<td>A6</td>
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<tr>
<td>Line D</td>
<td>ORGANIZE WORK</td>
<td>5%</td>
</tr>
<tr>
<td>D1</td>
<td>Interpret Plans, Drawings and Specifications</td>
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<td>Line H</td>
<td>INSTALL AND MAINTAIN CONSUMER/SUPPLY SERVICES AND METERING EQUIPMENT</td>
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<tr>
<td>H1</td>
<td>Install Single-phase Consumer/Supply Services and Metering Equipment</td>
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<td>Line I</td>
<td>INSTALL AND MAINTAIN PROTECTION DEVICES</td>
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<td>I1</td>
<td>Install Overcurrent Protection Devices</td>
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<td>I2</td>
<td>Install Ground Fault, Arc Fault and Surge Protection Devices</td>
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<td>INSTALL AND MAINTAIN BONDING, GROUNDING AND GROUND FAULT DETECTION SYSTEMS</td>
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<td>L1</td>
<td>Install Grounding and Bonding Systems</td>
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<td>Line M</td>
<td>INSTALL AND MAINTAIN POWER GENERATION SYSTEMS</td>
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<td>M3</td>
<td>Install DC Generating Systems</td>
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<td>M4</td>
<td>Maintain DC Generating Systems</td>
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<td>INSTALL AND MAINTAIN TRANSFORMERS</td>
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<td>Install Extra-Low and Low-Voltage Single-Phase Transformers</td>
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<td>INSTALL AND MAINTAIN RACEWAYS, CABLES AND ENCLOSURES</td>
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<tr>
<td>Q1</td>
<td>Install Conductors and Cables</td>
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<tr>
<td>Q2</td>
<td>Install Raceways, Boxes and Fittings</td>
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<td>Maintain Conductors, Cables, Raceways, Boxes and Fittings</td>
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### HARMONIZED PROGRAM OUTLINE
#### Program Overview

**% of Time Allocated to:**

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<th>% of Time</th>
<th>Theory</th>
<th>Practical</th>
<th>Total</th>
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<tr>
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<td>Install Luminaires</td>
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<td>0%</td>
<td>100%</td>
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<tr>
<td>R2</td>
<td>Install Wiring Devices</td>
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</tr>
<tr>
<td>R3</td>
<td>Install Lighting Controls</td>
<td></td>
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<tr>
<td>R5</td>
<td>Maintain Luminaires, Wiring Devices, Lighting Controls, Lighting Standards and Branch Circuitry</td>
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<table>
<thead>
<tr>
<th>Line</th>
<th>INSTALL AND MAINTAIN HEATING, VENTILATING AND AIR-CONDITIONING (HVAC) SYSTEMS</th>
<th>% of Time</th>
<th>Theory</th>
<th>Practical</th>
<th>Total</th>
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<td>100%</td>
</tr>
<tr>
<td>S2</td>
<td>Maintain HVAC Systems and Controls</td>
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<table>
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<th>Line</th>
<th>INSTALL AND MAINTAIN EXIT AND EMERGENCY LIGHTING SYSTEMS</th>
<th>% of Time</th>
<th>Theory</th>
<th>Practical</th>
<th>Total</th>
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<tr>
<td>T2</td>
<td>Maintain Exit and Emergency Lighting Systems</td>
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<th>% of Time</th>
<th>Theory</th>
<th>Practical</th>
<th>Total</th>
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</thead>
<tbody>
<tr>
<td>U1</td>
<td>Install Cathodic Protection Systems</td>
<td>1%</td>
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Total Percentage for Electrician Common Core Level 2: 100%
## Training Topics and Suggested Time Allocation: Level 3

### ELECTRICIAN COMMON CORE – LEVEL 3

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<tr>
<th>Line</th>
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<td><strong>APPLY CIRCUIT CONCEPTS</strong>&lt;br&gt;A5 Analyze Three-Phase AC Circuits&lt;br&gt;A6 Analyze Electronic Circuits</td>
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<td><strong>ORGANIZE WORK</strong>&lt;br&gt;D1 Interpret Plans, Drawings and Specifications&lt;br&gt;D7 Identify Hazardous Locations</td>
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<td>Line H</td>
<td><strong>INSTALL AND MAINTAIN CONSUMER/SUPPLY SERVICES AND METERING EQUIPMENT</strong>&lt;br&gt;H2 Install Three-phase Consumer/Supply Services and Metering Equipment&lt;br&gt;H4 Maintain Three-phase Services and Metering Equipment</td>
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<td>Line L</td>
<td><strong>INSTALL AND MAINTAIN BONDING, GROUNDING AND GROUND FAULT DETECTION SYSTEMS</strong>&lt;br&gt;L1 Install Grounding and Bonding Systems&lt;br&gt;L3 Install Ground Fault Detection Systems</td>
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<td><strong>INSTALL AND MAINTAIN POWER GENERATION SYSTEMS</strong>&lt;br&gt;M1 Install AC Generating Systems&lt;br&gt;M2 Maintain AC Generating Systems</td>
<td>6%</td>
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<td><strong>INSTALL AND MAINTAIN TRANSFORMERS</strong>&lt;br&gt;P3 Install Low-Voltage Three-Phase Transformers&lt;br&gt;P5 Install High-Voltage Transformers</td>
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<td><strong>INSTALL AND MAINTAIN MOTOR STARTERS AND CONTROLS</strong>&lt;br&gt;V1 Install Motor Starters and Controls&lt;br&gt;V2 Maintain Motor Starters and Controls</td>
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## Program Overview

### % of Time Allocated to:

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Total Percentage for Electrician Common Core Level 3: 100%
# Training Topics and Suggested Time Allocation: Level 4

## CONSTRUCTION ELECTRICIAN – LEVEL 4

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<th>INSTALL AND MAINTAIN POWER CONDITIONING, UNINTERRUPTIBLE POWER SUPPLY (UPS) AND SURGE SUPPRESSION SYSTEMS</th>
<th>% of Time</th>
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<td>Install Power Conditioning, UPS and Surge Suppression Systems</td>
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<td>K2</td>
<td>Maintain Power Conditioning, UPS and Surge Suppression Systems</td>
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<th>INSTALL AND MAINTAIN RENEWABLE ENERGY GENERATING AND STORAGE SYSTEMS</th>
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<th>Line AA</th>
<th>INSTALL AND MAINTAIN COMMUNICATION SYSTEMS</th>
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<td>AA3</td>
<td>Install Nurse Call Systems</td>
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<th>Line AB</th>
<th>INSTALL AND MAINTAIN BUILDING AUTOMATION SYSTEMS</th>
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<td>AA3</td>
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<td>Line AC</td>
<td>INSTALL, PROGRAM AND MAINTAIN AUTOMATED CONTROL SYSTEMS</td>
<td>% of Time</td>
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<td>Program Automated Control Systems</td>
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<td>Total Percentage for Construction Electrician Level 4</td>
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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

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

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<tr>
<td>16.</td>
<td>Measure and describe sizing of conductors</td>
<td>• Circular and square mils&lt;br&gt;• American wire gauge sizes&lt;br&gt;• Metric wire sizes</td>
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<td>17.</td>
<td>Calculate the resistance of conductors</td>
<td>• Factors affecting resistance&lt;br&gt;• Temperature effects</td>
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<td>18.</td>
<td>Determine the ampacity of various types of conductors</td>
<td>• Factors affecting ampacity&lt;br&gt;• Conductor charts&lt;br&gt;• Use of Canadian Electrical Code</td>
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<tr>
<td>19.</td>
<td>Solve problems involving conductor line drop and line loss</td>
<td>• Line voltage drop&lt;br&gt;• Line power loss&lt;br&gt;• Conductor sizing</td>
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<tr>
<td>20.</td>
<td>Describe the generation of an alternating voltage</td>
<td>• Factors affecting generated EMF&lt;br&gt;• Features of alternators&lt;br&gt;• Development of a sine wave voltage</td>
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<tr>
<td>21.</td>
<td>Describe the features of alternating current</td>
<td>• Advantages of AC&lt;br&gt;• Values of AC&lt;br&gt;• AC terminology&lt;br&gt;• Waveforms and phasor representations</td>
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<td>22.</td>
<td>Describe the difference between DC ohmic and effective AC resistance</td>
<td>• Skin effect&lt;br&gt;• Hysteresis loss&lt;br&gt;• Eddy current loss&lt;br&gt;• Dielectric loss&lt;br&gt;• Radiation loss</td>
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### 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
**LEARNING TASKS | CONTENT**

1. **Describe the characteristics of a series circuit**
   - Connection of components
   - Polarity
   - Resistance, voltage and current
   - Effects of an open circuit
   - 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
   - Circuit applications

6. **Solve problems involving parallel circuits**
   - Development of schematic diagrams
LEARNING TASKS

7. Describe effects of voltage sources in parallel
   - Kirchhoff’s Current Law
   - Resistance, voltage, current and power calculations
   - Branch current proportionality
   - 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
### LEARNING TASKS

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<td>Connect and test three-wire circuits</td>
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### 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
HARMONIZED PROGRAM OUTLINE
Program Content
Level 1

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

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
   - Magnetomotive force
   - Magnetic flux and flux density
   - Reluctance and permeability
   - Saturation and hysteresis
   - Residual magnetism
   - Magnetic cores and air gaps

3. Describe terminology and units of measure for magnetic circuits
   - Lifting magnets
   - Solenoids and relays
   - Bells and buzzers
   - Magnetic circuit breaker
   - Field poles for motors and generators

4. Describe applications of magnetic devices
   - Magnetomotive force
   - Magnetizing force
   - Magnetic flux and flux density
   - Reluctance and permeability
   - Saturation and hysteresis
   - Magnetic cores and air gaps

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

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

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
---|---
11. Describe basic applications of the junction transistor in DC circuits | • Current calculations  
• Saturation biasing  
• Cut-off biasing  
• 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 emitting 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

1. Describe PPE

   • Types of protection for:
     o Head
     o Hands
     o Lungs
     o Eyes
     o Ears
     o Feet
     o 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
     o Clothing
     o Hair and beards
     o Jewelry

4. Locate emergency equipment and means of egress

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

2. Identify controls for hazards
   • PPE (See B1)
   • Fall protection
## LEARNING TASKS

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3. Interpret regulations relating to personal health and safety

4. Describe the conditions necessary to support a fire

5. Describe the classes of fires according to the materials being burned

6. Apply preventative fire safety precautions when working near, handling or storing flammable liquids or gases, combustible materials and electrical apparatus

7. Describe the considerations and steps to be taken prior to fighting a fire

8. Describe the procedure for using a fire extinguisher
HARMONIZED PROGRAM OUTLINE
Program Content
Level 1

LEARNING TASKS

CONTENT

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

2. Perform lock-out and tag-out
   • Procedures
     o Identify
     o Isolate
     o De-energize
     o Verify
       - Test for zero energy
     o Documentation
   • Plant requirements
   • Use of locks
     o Scissors
     o Breaker locks
     o Cord locks
   • Lockout board
   • Tags
   • Cables
   • Key-box system
   • Blinding
   • Standby person
   • Isolation of vessels
LEARNING TASKS

CONTENT

• 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
1. Describe digital multimeter functions
   • Digital multimeter (DMM)
   • DMM voltmeter functions
     o AC voltage function
     o 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
     o Hold function
     o MIN MAX mode

2. Describe power measurements
   • Digital wattmeter

3. Use a Megohmmeter to measure insulation resistance
   • Procedure to test
     • Safety
     • Circuit placement
     • Polarity indicator
     • Meter verification
     • DMM voltage measurement
       o AC voltage measurement with DMM
       o DC voltage measurement with DMM
     • DMM current measurement
       o AC current measurement with DMM
       o DC current measurement with DMM
     • Using DMM Ohms function to measure resistance

4. Use digital meters
LEARNING TASKS

5. Maintain digital meters

6. Interpret meter readings

CONTENT

- DMM category ratings
- Meter leads
- Inspection
- Storage
- Calibration
- Service
- Battery replacement
- DMM fuse replacement
- 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**

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## LEARNING TASKS

### CONTENT
- **Structural**
- **Mechanical**
- **Plumbing**
- **Electrical**
  - Working drawings
  - Index page
  - Title blocks
  - Scales
  - Use of lines
  - Keys, legends and notes
  - Schedules
  - Specifications

### 11. Describe common drawing conventions
- Working drawings
- 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
- Select drawings
- Read specifications
- Identify schedules
- Identify symbols
- Determine code requirements
- 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**

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<td>3. Describe the administration of CEC rules and regulations</td>
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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
1. Describe the shared responsibilities for workplace learning

CONTENT
• Active listening
• Self advocacy
• Apprenticeship training
  o Technical training
  o On-the-job learning
  o 80:20 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

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<td>Describe the features of a single-phase, three-wire distribution system</td>
<td>• Circuit connections and grounding</td>
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<td>• Metering</td>
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<td>• Protection and control</td>
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<td>• Shock hazards and safety</td>
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<td>2.</td>
<td>Describe service entrance equipment</td>
<td>• Overhead and underground services</td>
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<td></td>
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<td>• Meter base</td>
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<td>• Main service panel</td>
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<td>• Grounding and bonding</td>
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<td>3.</td>
<td>Determine single-phase service requirements when CTs and PTs are not required.</td>
<td>• CEC</td>
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<td>** o Permanent</td>
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<td>• AHJ</td>
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<td>• Supply authority</td>
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</tbody>
</table>
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
1. Describe maintenance procedures for single-phase services and metering equipment

CONTENT
• Thermal imaging
• Torque specs
• Aluminum conductors
Objectives

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

• Identify protective devices.
• Determine protective device requirements.

LEARNING TASKS

1. Identify protective devices
   • Ground Fault Circuit Interrupters (GFCI)
     o Class A ratings
     o 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

1. Identify types of distribution centres
   - 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
   - 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.

<table>
<thead>
<tr>
<th>LEARNING TASKS</th>
<th>CONTENT</th>
</tr>
</thead>
</table>
| 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.

LEARNING TASKS

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

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<thead>
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<th>CONTENT</th>
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<tbody>
<tr>
<td>Open wiring</td>
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<tr>
<td>Support</td>
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<td>Mechanical protection</td>
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<td>Clearance</td>
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<td>Spacing</td>
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<td>Colour coding</td>
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<td>Protection</td>
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<tr>
<td>Insulation testing</td>
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<tr>
<td>Fire stopping</td>
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<td>Ampacities</td>
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<td>Derating</td>
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<td>Conditions of use</td>
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<td>Voltage rating</td>
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<td>Voltage drop</td>
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<td>Splicing and termination</td>
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<td>Raceways</td>
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<td>Conductor identification</td>
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<td>Protection</td>
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<td>Insulation testing</td>
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<td>FT rating</td>
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<td>Fire stopping</td>
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<tr>
<td>Strain relief</td>
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<tr>
<td>Bonding</td>
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<tr>
<td>Bend radii</td>
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</tbody>
</table>

4. Determine cable requirements
**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**

<table>
<thead>
<tr>
<th>Task</th>
<th>CONTENT</th>
</tr>
</thead>
</table>
| 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 | - 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.

<table>
<thead>
<tr>
<th>LEARNING TASKS</th>
<th>CONTENT</th>
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</thead>
</table>
| 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  
- Tungsten-halogen lamps  
- Infrared heat lamps  
- New trends  
- Installation  
  - New  
  - Renovation  
- Maintenance |
| 5. Describe basic LED lighting | - Efficacy  
- Life  
- White light LEDs  
- Advantages  
- Disadvantages  
- Applications |
HARMONIZED PROGRAM OUTLINE
Program Content
Level 1

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

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

2. Determine device installation requirements
   • 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.

LEARNING TASKS
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
HARMONIZED PROGRAM OUTLINE
Program Content
Level 1

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
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. Describes installation of lighting standards
   • Locations
   • Bases
   • Access control/theft prevention
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

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
   - Design of the system

2. Describe procedures to install a structured cable system
   - Manufacturer's installer certification
   - Certification and warranty procedures
   - 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 CAT5 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
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
<table>
<thead>
<tr>
<th>LEARNING TASKS</th>
<th>CONTENT</th>
</tr>
</thead>
</table>
| 9. Describe the action of inductors in DC circuits | • Construction and types of inductors  
• 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 |
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<tr>
<th>LEARNING TASKS</th>
<th>CONTENT</th>
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<tbody>
<tr>
<td>20. Describe the behaviour of capacitors in AC circuits</td>
<td>- Testing and troubleshooting</td>
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<td>- Voltage and current relationships</td>
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<tr>
<td></td>
<td>- Capacitive reactance ($X_C$)</td>
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<td></td>
<td>- Reactive power</td>
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<td>- Safety hazards</td>
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<tr>
<td>21. Solve problems involving capacitive reactance</td>
<td>- Capacitors in series</td>
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<td>- Capacitors in parallel</td>
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<td>- Frequency and capacitive reactance</td>
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<td>- Voltage, current and power</td>
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<tr>
<td>22. Connect and test capacitive AC circuits</td>
<td>- Component selection</td>
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<td>- Circuit connections and measurements</td>
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<td>- Testing and troubleshooting</td>
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<td>23. Describe the factors affecting impedance</td>
<td>- Effective AC resistance</td>
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<td>- Inductive reactance</td>
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<td>- Capacitive reactance</td>
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<td>- Impedance calculations</td>
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<td>- Phase angle</td>
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<td>24. Describe the factors affecting power factor</td>
<td>- True power</td>
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<td>- Reactive power</td>
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<td>- Apparent power</td>
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<td>- Power triangle calculations</td>
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<td>- Phase angle</td>
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<tr>
<td>25. Measure and calculate the impedance and power factor in an AC circuit</td>
<td>- Component selection</td>
</tr>
<tr>
<td></td>
<td>- Circuit connections and measurements</td>
</tr>
<tr>
<td></td>
<td>- Applied calculations</td>
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</tbody>
</table>
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
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
LEARNING TASKS
and capacitance (R-L-C)

9. Solve problems and describe applications involving parallel AC circuits

10. Connect and test parallel AC circuits

11. Describe reasons for power factor correction

12. Describe the application of capacitors for power factor correction

13. Solve problems involving power factor correction

14. Insert capacitors for power factor correction

CONTENT

- Vector diagrams
- Parallel resonant circuits
- Practical parallel circuits
- Voltage, current and power
- Impedance and power factor
- Vector diagrams
- Applications
- Component selection
- Circuit connections and measurements
- Test equipment
  - Power factor meters
  - VAR meters
- Testing and troubleshooting
- Reduction of energy costs
- Increase in system capacity
- Increase in distribution efficiency
- Capacitor nameplate data
- Individual load correction
- Feeder correction
- Main service correction
- Safety hazards and precautions
- Application of power triangle
- Correction to unity power factor
- Correction to less than unity power factor
- Voltage and frequency affects
- 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).

<table>
<thead>
<tr>
<th>LEARNING TASKS</th>
<th>CONTENT</th>
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</thead>
</table>
| 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
    o  Bridge
    o  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
HARMONIZED PROGRAM OUTLINE  
Program Content  
Level 2

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

1. Describe construction drawings and their major divisions for a commercial setting 
   • Divisions 
     o Architectural 
     o Structural 
     o Mechanical 
     o Plumbing 
     o 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 
   • Select drawings 
   • Read specifications 
   • Identify schedules 
   • Identify symbols 
   • Determine code requirements 
   • 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

1. Describe the features of a single-phase, three-wire distribution system
   • Circuit connections and grounding
   • Metering
     o Meter stacks
   • Protection and control
   • Shock hazards and safety
   • Size
   • Ampacity
   • Overhead and underground services
   • Meter base
   • Grounding and bonding
   • Supply authority requirements

2. Determine service entrance 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
1. Identify protective devices
   • Fuses
     o Plug
     o Cartridge
     o Knife blade
     o Time delay
     o Class H (Code)
     o HRC
   • Breakers
     o Magnetic (Instantaneous)
     o Thermal
   • Overloads
     o Thermal
     o Magnetic
     o Solid state
   • Specifications
     o Continuous current
     o Interrupting capacity
     o Voltage rating
     o Time current characteristics
     o Body size
   • Rejection features
   • Fault current calculations
   • Load calculations
   • Mounting techniques
   • Specifications
     o Continuous current
     o Interrupting capacity
     o Voltage rating
     o Body size
     o Rejection features
     o Fuse coordination
     o Series rating

2. Determine protective device requirements
<table>
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<tr>
<th>LEARNING TASKS</th>
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<td>3. Describe procedures to test protective devices</td>
<td>• Fuse pullers</td>
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<td>• Renewable links</td>
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<td>• Fuse troubleshooting</td>
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<td>o Criss-cross method</td>
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<td></td>
<td>o Visual inspection</td>
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</tbody>
</table>
Objectives

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

- Describe surge protection device ratings and installation practices.

LEARNING TASKS

1. Describe surge protection devices

2. Describe surge protection device ratings

3. Describe installation of surge protection devices

CONTENT

- Zener diodes
- Thyrite
- Metal Oxide Varistor (MOV)
- Energy rating
- Voltage rating
- 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.

LEARNING TASKS
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): 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
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

CONTENT
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
1. Describe basic maintenance and troubleshooting procedures for DC generators

CONTENT
- Mechanical checks
- Electrical checks
- Visual inspections
- Electrical faults
- Mechanical faults
- Brush selection
- Commutator maintenance
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.

LEARNING TASKS
1. Describe renewable energy systems

CONTENT
• Types
  o Wind-generated
  o Biomass
  o Photovoltaic
  o Hydrokinetic
  o 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.

LEARNING TASKS
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

7. Configure transformers for step-down and step-
<table>
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</table>
| up applications | • 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 |
| 18. Solve problems involving autotransformer | • Voltage, current and turns ratios |
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LEARNING TASKS

19. Connect autotransformer circuits
   CONTENT
   • kVA ratings
   • Multi-tap circuits
   • Buck-boost connections

20. Describe the features and applications of instrument transformers
   CONTENT
   • Equipment selection
   • Circuit connections
   • Circuit measurements
   • Testing and troubleshooting

21. Illustrate instrument transformer connections
   CONTENT
   • Current transformers
   • Potential transformers
   • Polarity markings
   • Safety hazards

22. Solve problems involving instrument transformer calculations
   CONTENT
   • Voltage, current and turns ratios
   • Instrument multipliers

23. Connect instrument transformer circuits
   CONTENT
   • Equipment selection
   • Circuit connections
   • Circuit measurements
   • Testing and troubleshooting

Achievement Criteria 1
Performance
The learner will:
• Connect a single-phase transformer
  o Perform an open-circuit test
  o 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 impedance

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

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

   • 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

4. Determine cable requirements

CONTENT
- Open wiring
- Support
- Mechanical protection
- Clearance
- Spacing
- Colour coding
- Protection
- Insulation testing
- Fire stopping
- 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.

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<td>• Cellular floors</td>
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<td>• Auxiliary gutters</td>
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<td>• Bus ways and splitters</td>
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<td>2. Identify boxes and fittings</td>
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<td>3. Determine raceway requirements</td>
<td>• Environmental considerations</td>
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<td>• Mechanical considerations</td>
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<td>• Barriers</td>
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<td>4. Determine box and fitting requirements</td>
<td>• Environmental considerations</td>
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<td></td>
<td>• Mechanical considerations</td>
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<td></td>
<td>• Seismic requirements</td>
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<td>• Manufacturers’ specifications</td>
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<td>• Vapour barrier</td>
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<td>5. Describe procedures to create and seal openings</td>
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<td>• Structural considerations</td>
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<td>• Pressurized areas</td>
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</tbody>
</table>
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
1. Describe the removal of unused conductors, cables, raceways, boxes and fittings
   • Scope of work
     o Limits of removal
     o Maintaining system integrity
   • Document update
   • Safety
     o Electrical lockout
     o Health hazards
   • Disposal

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

1. Describe the operation and construction of discharge lighting
   • Types
     o Fluorescent
     o High pressure sodium
     o Low pressure sodium
     o Mercury vapour
     o 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
   • Mercury vapour lamp
   • Metal-halide lamps
   • High-pressure sodium lamp
   • Interchangeable HID lamps
     o Shapes and sizes
     o ANSI code designations

4. Describe the components of high-intensity discharge luminaires
   • Reactor ballast
   • Autotransformer ballast
   • Auto-regulator ballast
   • Regulator ballast
   • Two-lamp ballasts
   • 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
1. Identify devices
   • Disconnecting means
   • Isolation switch
   • Capacitors
   • Splitters
   • Utilization equipment

2. Determine device installation requirements
   • 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
1. Describe the control of discharge lighting

<table>
<thead>
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<th>CONTENT</th>
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</thead>
</table>
| • Relays  
| • Contactors  
| • Time clocks  
| • Photo cells  
| • Hand-off-auto control |
HARMONIZED PROGRAM OUTLINE
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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

1. Describe basic troubleshooting for high-intensity discharge luminaires
   • Checking
     o Ballasts
     o Lamps
     o Supply voltage
     o Defective controls
     o 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
     o Mercury
     o 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.

LEARNING TASKS

1. Describe common heating and cooling systems

   • Types of area climate control
     o Electric boilers
     o Baseboard heaters
     o Unit heaters
     o Forced-air furnaces
     o Duct and plenum heaters
     o Series heating cable sets
     o Hot water heating
     o Heat pumps
     o Geothermal

   • Operation
     o Open loop
     o 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
LEARNING TASKS

4. Describe controls for heating, ventilating, and air conditioning

CONTENT

- Load shedders
- 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
1. Describe maintenance procedures for HVAC systems and controls

CONTENT
• 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.

LEARNING TASKS
1. Identify types of exit and emergency lighting systems

CONTENT
• Emergency lighting equipment
  o Unit lighting
  o Exit lighting
• Battery banks
  o Unit equipment

2. Describe battery requirements for exit and emergency lighting systems

CONTENT
• 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

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

LEARNING TASKS
1. Describe cathodic protection systems

CONTENT
• 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.

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<thead>
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<th>LEARNING TASKS</th>
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</thead>
</table>
| 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 manual motor starters.
• Describe the operating principles of magnetic motor starters.
• Describe the operating principles of magnetic motor control circuits.
• Describe the operation of magnetic DC motor controllers.
• Connect manual motor starters.
• Connect magnetic motor starters.
• Connect magnetic motor control circuits.
• Draw diagrams for AC motor controls.

LEARNING TASKS

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
LEARNING TASKS

8. Describe features of control relays

9. Describe the operation of jogging circuits

10. Describe the operation of reversing magnetic starters

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

CONTENT

diagrams

- Control relays
- Smart relays
- Timing relays
- Latching relays

- Pushbutton circuits
- Selector switch circuits
- Control relay circuits

- Power circuit components
- Control circuit components
- Electrical and mechanical interlocking

- Manual starters
- Faceplate starter
- Magnetic starters

- Across-the-line starting
- Current-limit acceleration
- Definite-time acceleration
- Field loss protection
- Reversing
- Speed control

- Electromechanical braking
- Dynamic braking
- Regenerative braking

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.

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<td>1. Describe troubleshooting procedures for motor starters</td>
<td>Visual inspections</td>
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<tr>
<td>and motor controls</td>
<td>Analyzing diagrams</td>
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<tr>
<td>• Visual inspections</td>
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<tr>
<td>• Meter measurements</td>
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<td>2. Describe maintenance procedures for motor starters</td>
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<tr>
<td>and motor controls</td>
<td>Infrared testing</td>
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</tbody>
</table>
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.

LEARNING TASKS
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
1. Describe maintenance and troubleshooting for DC motors

CONTENT
• Visual inspections
• Electrical faults
• Mechanical faults
• Brush and commutator maintenance
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
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
   • Source connections
   • Voltage and current relationships
   • Power and power factor
   • Neutral and grounding

3. Describe characteristics of the delta connection
   • 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
   • 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

7. Connect and test three-phase circuits

8. Calculate power and power factor in balanced three-phase systems

9. Describe the connection of capacitors for three-phase, power factor correction

10. Calculate the ratings of capacitors for three-phase, power factor correction

CONTENT

- Selection of components
- Circuit connections and measurements
- Test equipment
  - Power factor meters
  - VAR meters
- Testing and troubleshooting
- Power in balanced systems
- Power factor in balanced systems
- Wattmeter connections for power measurements
- Wye-connected capacitor banks
- Delta-connected capacitor banks
- Safety hazards
- 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
HARMONIZED PROGRAM OUTLINE
Program Content
Level 3

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

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
LEARNING TASKS

6. Describe features of specialty thyristors
   • DIAC
   • Unijunction transistor
   • 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
<table>
<thead>
<tr>
<th>LEARNING TASKS</th>
<th>CONTENT</th>
</tr>
</thead>
</table>
| 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 |
LEARNING TASKS

CONTENT

- 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
1. Describe construction drawings and their major divisions for an institutional setting
   • Divisions
     o Architectural
     o Structural
     o Mechanical
     o Plumbing
     o 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
   • Select drawings
   • Read specifications
   • Identify schedules
   • Identify symbols
   • Determine code requirements
   • Three-phase 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.

LEARNING TASKS
1. Describe hazardous locations
   • Code definitions
     o Section 18
     o Section 20

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

<table>
<thead>
<tr>
<th>LEARNING TASKS</th>
<th>CONTENT</th>
</tr>
</thead>
</table>
| 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 | - Size  
- Ampacity  
- Overhead and underground services  
- Meter base  
- Grounding and bonding  
- Supply authority requirements |
| 3. Determine low-voltage, three-phase service requirements | - 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.

LEARNING TASKS
<table>
<thead>
<tr>
<th>CONTENT</th>
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</thead>
<tbody>
<tr>
<td>1. Describe maintenance procedures for three-phase services and metering equipment</td>
</tr>
<tr>
<td>• Thermal imaging</td>
</tr>
<tr>
<td>• Torque specs</td>
</tr>
</tbody>
</table>
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.

<table>
<thead>
<tr>
<th>LEARNING TASKS</th>
<th>CONTENT</th>
</tr>
</thead>
</table>
| 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 | • 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.

LEARNING TASKS

1. Determine grounding requirements for three-phase AC systems

2. Describe system grounding techniques

CONTENT

• Sizing
• Terminating
• Conductors
• Testing
• 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.

LEARNING TASKS
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

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
   - 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
1. Describe maintenance and troubleshooting for alternators

CONTENT
- Visual inspections
- Electrical faults
- Mechanical faults
- Brushes
- Slip-rings
- Bearings
HARMONIZED PROGRAM OUTLINE
Program Content
Level 3

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.

LEARNING TASKS

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

6. Calculate voltage, current and kVA values for Wye connected autotransformer
LEARNING TASKS

7. Connect three-phase autotransformers

8. Describe instrument transformer connections in three-phase circuits

9. Calculate instrument transformer ratings and meter readings in three-phase circuits

10. Connect instrument transformers in three-phase circuits

CONTENT

• Open-delta connected autotransformer
• Buck-boost connections
• Equipment selection
• Circuit connections
• Circuit measurements
• Potential transformer connections
• Current transformer connections
• Energy and power metering circuits
• Motor protection circuits
• Ground-fault detection circuits
• Potential transformer ratings and voltmeter multipliers and readings
• Current transformer ratings and ammeter multipliers and readings
• Power and energy meter multipliers and readings
• 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
HARMONIZED PROGRAM OUTLINE
Program Content
Level 3

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.

LEARNING TASKS
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
   - Circuit measurements
5. Describe the installation of high-voltage instrument transformers
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.

LEARNING TASKS
1. Identify devices

CONTENT
• Disconnecting means
• Isolation switch
• Capacitors
• Splitters
• Utilization equipment
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.

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<th>LEARNING TASKS</th>
<th>CONTENT</th>
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<td>• Float switches</td>
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<td></td>
<td>• Flow switches</td>
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<tr>
<td></td>
<td>• Temperature switches</td>
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<td></td>
<td>• Limit switches</td>
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<td></td>
<td>• Proximity switches</td>
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<td>• Photoelectric switches</td>
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<td>2. Describe features and applications of plugging</td>
<td>• Zero-speed switches</td>
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<tr>
<td>switches</td>
<td>• Lockout relay</td>
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<td></td>
<td>• Control circuits</td>
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<td></td>
<td>• Anti-plugging</td>
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<td></td>
<td>• Plugging</td>
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<tr>
<td>3. Draw circuit diagrams involving automatic and</td>
<td>• Definite sequence control</td>
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<tr>
<td>sequence control</td>
<td>• Timed sequence control</td>
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<td></td>
<td>• Anti-plugging and plugging using timing relays</td>
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<td>• Pump motor control</td>
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<td></td>
<td>• Reversing starter control</td>
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<td></td>
<td>• Other applications</td>
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<td>4. Connect and test circuits utilizing auxiliary</td>
<td>• Equipment selection</td>
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<tr>
<td>control devices</td>
<td>• Connection of components</td>
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<td>5. Select AC motor starting equipment</td>
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<td></td>
<td>• Reduced-voltage starting</td>
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<td></td>
<td>• Motor current and torque</td>
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<td>• Load requirements</td>
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<td></td>
<td>• Duty cycles and supply requirements</td>
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<tr>
<td>6. Describe primary impedance type starters</td>
<td>• Resistor starting</td>
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</tbody>
</table>
# LEARNING TASKS

<table>
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<th>CONTENT</th>
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<tr>
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<td>• Wye-connection</td>
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<tr>
<td>• Open-delta connection</td>
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<tr>
<td>• Open and closed transition types</td>
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<td>• Current-torque characteristics</td>
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<tr>
<td>• Schematic and wiring diagrams</td>
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<tr>
<td>8. <strong>Describe the operation of wye-delta type starters</strong></td>
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<tr>
<td>• Open and closed transition types</td>
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<td>• Current-torque characteristics</td>
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<td>• Schematic and wiring diagrams</td>
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<tr>
<td>9. <strong>Connect reduced voltage starters</strong></td>
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<tr>
<td>• Equipment selection</td>
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<tr>
<td>• Connection of components</td>
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<td>10. <strong>Describe automatic acceleration of wound-rotor motors</strong></td>
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<tr>
<td>• Definite-time acceleration</td>
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<td>• Speed-sensing acceleration</td>
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<td>• Reversing</td>
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<td>• Speed regulators</td>
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<td>• Regeneration</td>
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<td>• Schematic and wiring diagrams</td>
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<tr>
<td>11. <strong>Connect wound-rotor motor controllers</strong></td>
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<td>• Equipment selection</td>
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<tr>
<td>• Connection of components</td>
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<tr>
<td>12. <strong>Describe the special control features for synchronous motor starters</strong></td>
</tr>
<tr>
<td>• Old and new methods</td>
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<tr>
<td>• Starting methods</td>
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<tr>
<td>• Auto synchronization (PFR)</td>
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<tr>
<td>• Speed detection</td>
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<tr>
<td>• Field application</td>
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<td>• Timing of field application</td>
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<tr>
<td>• Field protection</td>
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<td>• Field rheostat</td>
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<tr>
<td>13. <strong>Describe the operation of synchronous motor starters</strong></td>
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<tr>
<td>• Power circuit</td>
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<tr>
<td>• Control circuit</td>
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<tr>
<td>• Schematic and wiring diagrams</td>
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<tr>
<td>14. <strong>Connect synchronous motor starters</strong></td>
</tr>
<tr>
<td>• Equipment selection</td>
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<tr>
<td>• Connection of components</td>
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<td>15. <strong>Describe braking methods</strong></td>
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<td>• Friction braking</td>
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<td>• Plugging</td>
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<tr>
<td>• Dynamic braking</td>
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<tr>
<td>• Regenerative braking</td>
</tr>
<tr>
<td>• Eddy-current braking</td>
</tr>
<tr>
<td>• Schematic and wiring diagrams</td>
</tr>
</tbody>
</table>
LEARNING TASKS

16. Connect motor braking and deceleration controls

CONTENT

• Equipment selection
• Connection of components

Achievement Criteria

Performance  The learner will connect a forward/reverse magnetic motor control circuit with anti-plugging including all safeties

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
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
HARMONIZED PROGRAM OUTLINE
Program Content
Level 3

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

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
LEARNING TASKS

9. Describe the operation of AC motors used with variable frequency drives

10. Connect variable frequency AC drives

CONTENT
- Pulse width modulation inverters
- Motor types and connections
- Rating
- Applications
- Torque-speed characteristics
- Braking and reversing
- Ventilation
- Protection
- Selection of components
- Circuit connections
- Start-up and adjustment
- Harmonics
- Cabling
- Inductors
### Objectives

To be competent in this area, the individual must be able to:
- Describe the operating principles of AC motors.
- Connect AC machines.

### LEARNING TASKS

| Line (GAC): | INSTALL AND MAINTAIN MOTORS | Competency: | Y1 Install AC Motors |

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| 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  
  o Phase sequence indicators  
  o Motor rotation testers  
  o Tachometers  

| 5. Describe the constructional features of the wound-rotor induction motor | • Stator  
  • Wound rotor  
  • Slip rings and brushes  
  • Terminal marking conventions  
  • Nameplate data  

<p>| 6. Describe the operating characteristics of the wound rotor induction motor | • Rotating magnetic field development |</p>
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<td>• Nameplate data</td>
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<td>14. Identify common connections for split-phase types of motors</td>
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<td>• Rotor torque</td>
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<td></td>
<td>• Reversing rotation</td>
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<td>• Capacitor type motors</td>
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<td>15. Describe the features of other types of single-phase motors</td>
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<td>• Shaded-pole motor</td>
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<td>• Synchronous (hysteresis) motor</td>
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</tbody>
</table>
### LEARNING TASKS
16. Connect single-phase motors

### CONTENT
- Equipment selection
- 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
HARMONIZED PROGRAM OUTLINE
Program Content
Level 3

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
1. Describe basic maintenance and troubleshooting for AC motors

CONTENT
• Visual inspections
• Electrical faults
• Mechanical faults
• Brushes and slip-rings
• Bearings
Level 4

Construction Electrician
HARMONIZED PROGRAM OUTLINE
Program Content
Level 4

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

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
1. Describe construction drawings and their major divisions for an industrial setting
   • Divisions
     o Architectural
     o Structural
     o Mechanical
     o Plumbing
     o 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
   • Select drawings
   • Read specifications
   • Identify schedules
   • Identify symbols
   • Determine code requirements
   • Three-phase installations
   • High voltage installations
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.

LEARNING TASKS

1. Identify types of emergency power systems

2. Describe battery requirements for emergency lighting systems

3. Describe standby generators

4. Describe uninterruptible power supplies (UPS)
LEARNING TASKS

5. Determine emergency power system requirements

CONTENT

- Code requirements
- Matching load requirements
- Placement
- 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

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
HARMONIZED PROGRAM OUTLINE
Program Content
Level 4

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.

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<thead>
<tr>
<th>LEARNING TASKS</th>
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</table>
| 1. Describe alternative power systems | • Types  
  o Wind-generated  
  o Thermal  
  o Photovoltaic  
  o Hydrokinetic  
  o 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  
    o Signage  
    o Supply authority  
    o Other associated authorities  
  • Mounting components  
  • Power conditioning unit (PCU)  
    o Utility interactive inverter  
  • Connection  
    o 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

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
   - 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
LEARNING TASKS

6. Describe the construction of common medium-voltage cables
   - Insulation levels
   - 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
LEARNING TASKS

14. Interpret CEC rules and regulations concerning high voltage control and protective equipment

15. Describe common types of protective relays used in high voltage systems

16. Describe safety precautions when working with protective relay circuits

17. Describe procedures to install high voltage switch gear and protective devices

18. Describe characteristics of cable insulation

CONTENT

- Voltage testing
- Service equipment and disconnect means
- Overcurrent protection
- Potential and current transformers
- Indoor installations
- Outdoor installations
- 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
- Visual inspections
- Relay testing
- Secondary shunting
- Safety
  - Shutdown
  - Cleaning
- Layout
- Clearances
- Torque specifications
- Mounting
- Seismic requirements
- Commissioning
- 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

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
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<td>• Test probes</td>
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<td>• Personal Protective Equipment (PPE)</td>
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<td>• Grounding leads</td>
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<td>• High pot testers</td>
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</table>
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

1. Describe installation requirements for airport runway lighting systems
   - Code requirements
   - Controls
   - Wiring methods
   - Lighting system components
   - Conductors and cables
   - Engineered specifications

2. Test and maintain airport runway 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.

LEARNING TASKS
1. Describe installation requirements for traffic signal lights and controls

CONTENT
• 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).

LEARNING TASKS

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
   - CEC 62-300, 62-400
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.

LEARNING TASKS
1. Describe the features of fire alarm systems
   • Types of fire alarm systems
     o Addressable
     o 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 1
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.

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<th>LEARNING TASKS</th>
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</table>
| 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.

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<tbody>
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<td>1. Describe the basic features of fibre optic installations</td>
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<td>• Features of fibre optic cables</td>
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<td>- Multi-mode</td>
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<td>2. Describe the installation of fibre optic cable</td>
<td>• Installation procedures</td>
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<td>• Wiring requirements</td>
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<td>3. Describe procedures and documentation for testing</td>
<td>• Testing of cables and terminations</td>
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<td>• Troubleshoot failures</td>
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<td>• Test data reports</td>
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</table>
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.

LEARNING TASKS
1. Describe the operating principles of nurse call systems
   • Types
   • Components
   • Applications

2. Describe procedures to install nurse call systems
   • Installation procedures
   • 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
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

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
   - 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

6. Connect PLC systems
   - Use I/O indicator lights to check wiring
   - Use I/O image tables for bit status
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<th>LEARNING TASKS</th>
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</thead>
</table>
| 7. Describe the components of an automated control system | - Monitor/test program on-line  
- Perform safety checks  
- Update documentation  
- Print out working program  
- 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  
- Solenoids, clutches and brakes  
- DC servo motors  
- AC servo motors  
- Encoders and resolvers  
- Stepper motor controls  |
| 10. Describe common types of electrical actuators | - Troubleshooting sensors  
- Adjust set-points  
- Program  |
| 11. Connect automated control systems | |
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

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
<table>
<thead>
<tr>
<th>LEARNING TASKS</th>
<th>CONTENT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Test mode</td>
</tr>
<tr>
<td></td>
<td>• Single scan mode</td>
</tr>
<tr>
<td></td>
<td>• PLC status indicators</td>
</tr>
</tbody>
</table>
Section 4

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 work stations
- 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 lunch room 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**

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

**Level 2**

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<td>Power supply stations (with fixed and variable AC and DC outputs and metering)</td>
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</tr>
<tr>
<td>Sets of resistors, capacitors and inductors for circuit analysis labs</td>
<td>8</td>
</tr>
<tr>
<td>Misc. magnetic devices such as relays, solenoids, bells, buzzers, chimes, etc.</td>
<td>8</td>
</tr>
<tr>
<td>Motor Control Stations (with manual and magnetic starters, reversing starters, assorted switches, TD relays and pilot devices as necessary)</td>
<td>8</td>
</tr>
<tr>
<td>Reversing drum switches</td>
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</tr>
<tr>
<td>Small 3-phase motors</td>
<td>4</td>
</tr>
<tr>
<td>Single-phase, split-phase, dual-voltage motors</td>
<td>4</td>
</tr>
<tr>
<td>DC Machines for DC motor and DC Generator labs</td>
<td>8</td>
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<tr>
<td>Digital scopes, dual-trace, (Analog optional for demo purposes)</td>
<td>8</td>
</tr>
<tr>
<td>Scope meters</td>
<td>8</td>
</tr>
<tr>
<td>Digital multi-meters</td>
<td>8</td>
</tr>
<tr>
<td>Wattmeters</td>
<td>8</td>
</tr>
</tbody>
</table>
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 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
HARMONIZED PROGRAM OUTLINE
Program Content
Section 4

- 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.
Required Reference Materials

- Contact Training Facility for Required Reference Material

Recommended Resources

- Industry Training Authority (ITA) www.itabc.ca
- 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
- Canadian National Building Code

Suggested Texts

- AC FUNDAMENTALS
  by Duff and Herman

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

- CABLES AND WIRING
  AVO Multi-Amp Institute

- DC FUNDAMENTALS
  by Loper and Tedson
  Delmar Publishers……………………………………………………………………..ISBN 0-8273-6572-1
• DELMAR'S STANDARD GUIDE TO TRANSFORMERS
  by Herman and Singleton
  Delmar Publishers........................................................................... ISBN 0-8273-7209-4

• ELECTRIC MOTOR REPAIR, 3rd EDITION
  by Robert Rosenburg and August Hand

• ELECTRICAL CONTROL FOR MACHINES
  by Rexford

• ELECTRICAL MOTOR CONTROLS AUTOMATED INDUSTRIAL SYSTEMS
  by Rockis and Mazur

• ELECTRICAL RACEWAYS AND OTHER WIRING METHODS
  by Loyd

• ELECTRICAL WIRING
  by Seale

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

• ELECTRICAL WIRING - INDUSTRIAL
  by Smith and Herman

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

• ELECTRICITY FOR REFRIGERATION, HEATING AND AIR CONDITIONING
  by Smith

• ELECTRONIC DRIVES
  by Carrow

• ELECTRONIC VARIABLE SPEED DRIVES
  by Brumbach

• ELECTRONICS FOR ELECTRICIANS
  By Stephen Herman

• EMERGENCY, STANDBY AND OTHER AUXILIARY POWER SYSTEMS
  by Editor, EC&M Magazine
  Intertec Publishing Corp................................................................... ISBN 0-87288-603-4
HARMONIZED PROGRAM OUTLINE
Program Content
Section 4

- FIBER OPTIC CABLE SYSTEM INSTALLATION
  by Pearson

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

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

- HEATING, VENTILATING AND AIR CONDITIONING
  by Swenson

- IES LIGHTING HANDBOOK - APPLICATION VOLUME
  by Illuminating Engineering

- IES LIGHTING HANDBOOK - REFERENCE VOLUME
  by Illuminating Engineering

- INTRODUCTION TO DIGITAL SYSTEMS
  by Palmer and Perlman

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

- MODERN CONTROL TECHNOLOGY - COMPONENTS AND SYSTEMS
  by Kilian

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

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

- SOLID STATE FUNDAMENTALS FOR ELECTRICIANS
  by Rockis

- TECHNICIAN’S GUIDE TO PROGRAMMABLE CONTROLLERS
  by Cox

- TROUBLESHOOTING ELECTRIC MOTORS
  by Mazur and Proctor
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

Assessment Guidelines
### Level 1 Grading Sheets: Subject Competency and Weightings

<table>
<thead>
<tr>
<th>PROGRAM: IN-SCHOOL TRAINING:</th>
<th>ELECTRICIAN COMMON CORE LEVEL 1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LINE</strong></td>
<td><strong>SUBJECT COMPETENCIES</strong></td>
</tr>
<tr>
<td>A</td>
<td>APPLY CIRCUIT CONCEPTS</td>
</tr>
<tr>
<td>B</td>
<td>PERFORM SAFETY-RELATED FUNCTIONS</td>
</tr>
<tr>
<td>C</td>
<td>USE TOOLS AND EQUIPMENT</td>
</tr>
<tr>
<td>D</td>
<td>ORGANIZE WORK</td>
</tr>
<tr>
<td>G</td>
<td>USE COMMUNICATION AND MENTORING TECHNIQUES</td>
</tr>
<tr>
<td>H</td>
<td>INSTALL AND MAINTAIN CONSUMER/SUPPLY SERVICES AND METERING EQUIPMENT</td>
</tr>
<tr>
<td>I</td>
<td>INSTALL AND MAINTAIN PROTECTION DEVICES</td>
</tr>
<tr>
<td>J</td>
<td>INSTALL AND MAINTAIN LOW VOLTAGE DISTRIBUTION SYSTEMS</td>
</tr>
<tr>
<td>L</td>
<td>INSTALL AND MAINTAIN BONDING, GROUNDING AND GROUND FAULT DETECTION SYSTEMS</td>
</tr>
<tr>
<td>Q</td>
<td>INSTALL AND MAINTAIN RACEWAYS, CABLES AND ENCLOSURES</td>
</tr>
<tr>
<td>R</td>
<td>INSTALL AND MAINTAIN BRANCH CIRCUITRY</td>
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<tr>
<td>AA</td>
<td>INSTALL AND MAINTAIN COMMUNICATION SYSTEMS</td>
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<td><strong>Total</strong></td>
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**In-school theory / practical subject competency weighting**

<table>
<thead>
<tr>
<th><strong>In-school percentage score</strong></th>
<th><strong>IN-SCHOOL %</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Final in-school percentage score</strong></td>
<td><strong>IN-SCHOOL %</strong></td>
</tr>
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## Level 1 Grading Sheets: Subject Competency and Weightings

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<tr>
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<tbody>
<tr>
<td><strong>In-school Percentage Score</strong></td>
<td>80%</td>
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<tr>
<td>Combined theory and practical subject competency multiplied by</td>
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<tr>
<td><strong>Standardized Level Exam Percentage Score</strong></td>
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<tr>
<td>The exam score is multiplied by</td>
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<tr>
<td><strong>Final Percentage Score</strong></td>
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# Level 2 Grading Sheets: Subject Competency and Weightings

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<tbody>
<tr>
<td>A</td>
<td>APPLY CIRCUIT CONCEPTS</td>
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<td>ORGANIZE WORK</td>
<td>5%</td>
<td>0%</td>
</tr>
<tr>
<td>H</td>
<td>INSTALL AND MAINTAIN CONSUMER/SUPPLY SERVICES AND METERING EQUIPMENT</td>
<td>5%</td>
<td>0%</td>
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<tr>
<td>I</td>
<td>INSTALL AND MAINTAIN PROTECTION DEVICES</td>
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<tr>
<td>L</td>
<td>INSTALL AND MAINTAIN BONDING, GROUNDING AND GROUND FAULT DETECTION SYSTEMS</td>
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<tr>
<td>M</td>
<td>INSTALL AND MAINTAIN POWER GENERATION SYSTEMS</td>
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<td>N</td>
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<td>P</td>
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<td>R</td>
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In-school theory / practical subject competency weighting  
90% | 10%

Final in-school percentage score  
IN-SCHOOL %
## Level 2 Grading Sheets: Subject Competency and Weightings

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<td>The exam score is multiplied by</td>
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Level 3 Grading Sheets: Subject Competency and Weightings

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<td>APPLY CIRCUIT CONCEPTS</td>
</tr>
<tr>
<td>C</td>
<td>USE TOOLS AND EQUIPMENT</td>
</tr>
<tr>
<td>D</td>
<td>ORGANIZE WORK</td>
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<tr>
<td>H</td>
<td>INSTALL AND MAINTAIN CONSUMER/SUPPLY SERVICES AND METERING EQUIPMENT</td>
</tr>
<tr>
<td>J</td>
<td>INSTALL AND MAINTAIN LOW VOLTAGE DISTRIBUTION SYSTEMS</td>
</tr>
<tr>
<td>L</td>
<td>INSTALL AND MAINTAIN BONDING, GROUNDING AND GROUND FAULT DETECTION SYSTEMS</td>
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<tr>
<td>M</td>
<td>INSTALL AND MAINTAIN POWER GENERATION SYSTEMS</td>
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<tr>
<td>P</td>
<td>INSTALL AND MAINTAIN TRANSFORMERS</td>
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<tr>
<td>R</td>
<td>INSTALL AND MAINTAIN BRANCH CIRCUITRY</td>
</tr>
<tr>
<td>V</td>
<td>INSTALL AND MAINTAIN MOTOR STARTERS AND CONTROLS</td>
</tr>
<tr>
<td>W</td>
<td>INSTALL AND MAINTAIN DRIVES</td>
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<td>Y</td>
<td>INSTALL AND MAINTAIN MOTORS</td>
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<td><strong>Total</strong></td>
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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%
## Level 4 Grading Sheets: Subject Competency and Weightings

<table>
<thead>
<tr>
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<th>PRACTICAL WEIGHTING</th>
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</thead>
<tbody>
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<td>APPLY CIRCUIT CONCEPTS</td>
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<tr>
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<td>0</td>
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<tr>
<td>K</td>
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<td>INSTALL AND MAINTAIN NON-ROTATING EQUIPMENT AND ASSOCIATED CONTROLS</td>
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<td>INSTALL AND MAINTAIN SIGNALING SYSTEMS</td>
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<td>AA</td>
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<td>INSTALL AND MAINTAIN BUILDING AUTOMATION SYSTEMS</td>
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<td>AC</td>
<td>INSTALL, PROGRAM AND MAINTAIN AUTOMATED CONTROL SYSTEMS</td>
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<td><strong>Total</strong></td>
<td><strong>100%</strong></td>
<td><strong>100%</strong></td>
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**In-school theory / practical subject competency weighting**

97%  

**Final in-school percentage score**

IN-SCHOOL %
Level 4 Grading Sheets: Subject Competency and Weightings

<table>
<thead>
<tr>
<th>In-school Percentage Score</th>
<th>70%</th>
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<td>Combined theory and practical subject competency multiplied by</td>
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<th>Proprietary Level 4 Exam Percentage Score</th>
<th>30%</th>
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<td>The exam score is multiplied by</td>
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<th>Final Percentage Score</th>
<th>FINAL%</th>
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All apprentices who complete Level 4 of the Construction Electrician program with a FINAL level mark of 70% or greater will write the Interprovincial Red Seal examination as their final assessment.

ITA will enter the apprentices’ Construction Electrician Red Seal Interprovincial examination mark in ITADA. A minimum mark of 70% on the examination is required for a pass.
Appendix B
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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- Mario Baptista, Canem West Services
- Brent Baptiste, Western Pacific Enterprises
- Mike Baxter, Mott Electric Ltd.
- Stuart Blundell, Canfor
- Nick Bourassa, Lakewood Electric
- Dan Campbell, Keldon Electric and Data Ltd.
- Bill Card, Ross Morrison Electric
- Larry Carriere, Keldon Electric and Data Ltd.
- Dallas Crompton, Status Electrical Corp.
- Dave Fettback, Western Pacific Enterprises
- Jim Reaugh, Bridge Electric Corp.
- Al Stewart, Duke Energy Gas Transmission West
- Graham Trafford, Mott Electric Ltd.

Instructor Articulation Representatives
- Jim Gamble – Okanagan College
- Ken Holland – Camosun College
- Alain Lavoie – College of New Caledonia
- Peter Poeschek – Thompson Rivers University
- Ted Simmons – British Columbia Institute of Technology
- John Todrick – University of the Fraser Valley

The Industry Training Authority 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.