

PLAN OF TRAINING

Industrial Electrician



**Government of Newfoundland and Labrador
Department of Education
Institutional and Industrial Education Division**

March 2011

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Approved by:

A handwritten signature in cursive script, reading "Paula Hood", written over a horizontal line.

Chairperson, Provincial Apprenticeship and Certification Board

Date:

March 19, 2011

The Joint Planning Committee (JPC) recognizes this Interprovincial Program Guide as the national curriculum for the occupation of Industrial Electrician.

Preface

This Apprenticeship Standard is based on the 2011 edition of the National Occupational Analysis for Industrial Electrician trade.

This document describes the curriculum content for the Industrial Electrician apprenticeship training program and outlines each of the technical training units necessary for the completion of apprenticeship.

Acknowledgements

Advisory committees, industry representatives, instructors and apprenticeship staff provided valuable input to the development of this Apprenticeship Curriculum Standard. Without their dedication to quality apprenticeship training, this document could not have been produced.

We offer you a sincere thank you.

Contact Information

Department of Education
Institutional and Industrial Education Division
Tel: 709-729-2729 / 1-877-771-3737
Email: app@gov.nl.ca
Web: www.gov.nl.ca/app

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A. Conditions Governing Apprenticeship Training

1.0 General

The following general conditions apply to all apprenticeship training programs approved by the Provincial Apprenticeship and Certification Board (PACB) in accordance with the *Apprenticeship Training and Certification Act (1999)*. If an occupation requires additional conditions, these will be noted in the specific Plan of Training for the occupation. In no case should there be a conflict between these conditions and the additional requirements specified in certain Plan of Training.

2.0 Entrance Requirements

2.1 Entry into the occupation as an apprentice requires:

Indenturing into the occupation by an employer who agrees to provide the appropriate training and work experiences as outlined in the Plan of Training.

2.2 Notwithstanding the above, each candidate must have successfully completed a high school program or equivalent, and in addition may be required to have completed certain academic subjects as specified in particular Plan of Training. Mature students, at the discretion of the Director of Institutional and Industrial Education, may be registered. A mature student is defined as one who has reached the age of 19 and who can demonstrate the ability and the interest to complete the requirements for certification.

2.3 At the discretion of the Director of Institutional and Industrial Education, credit toward the apprenticeship program may be awarded to an apprentice for previous work experience and/or training as validated through prior learning assessment.

2.4 An Application for Apprenticeship form must be duly completed.

3.0 Probationary Period

The probationary period for each Memorandum of Understanding will be six months. Within that period the memorandum may be terminated by either party upon giving the other party and the PACB one week notice in writing.

4.0 Termination of a Memorandum of Understanding

After the probationary period referred to in Section 3.0, the Memorandum of Understanding may be terminated by the PACB by mutual consent of the parties involved, or cancelled by the PACB for proper and sufficient cause in the opinion of the PACB.

5.0 Apprenticeship Progression Schedule and Wage Rates

5.1 Progression Schedule

7200 Hour Programs	Requirements for Progression	Progress To
First Year Apprentice	Completion of entry level (Block 1) courses, plus relevant work experience totaling a minimum of 1800 hours *	Second Year
Second Year Apprentice	Completion of advanced level (Block 2) courses, plus relevant work experience totaling a minimum of 3600 hours	Third Year
Third Year Apprentice	Completion of advanced level (Block 3) courses, plus relevant work experience totaling a minimum of 5400 hours	Fourth Year
Fourth Year Apprentice	Completion of advanced level (Block 4) courses and (Blocks 5 & 6) <i>if applicable</i> , plus sign-off of workplace skills required for certification totaling a minimum of 7200 hours**	Write Certification Examination

5400 Hour Programs	Requirements for Progression	Progress To
First Year Apprentice	Completion of entry level (Block 1) courses, plus relevant work experience totaling a minimum of 1800 hours *	Second Year
Second Year Apprentice	Completion of advanced level (Block 2) courses, plus relevant work experience totaling a minimum of 3600 hours	Third Year
Third Year Apprentice	Completion of advanced level (Block 3) courses, plus sign-off of workplace skills required for certification totaling a minimum of 5400 hours	Write Certification Examination

4800 Hour Programs	Requirements for Progression	Progress To
First Year Apprentice	Completion of entry level courses (Block 1) courses, plus relevant work experience totaling a minimum of 1600 hours *	Second Year
Second Year Apprentice	Completion of advanced level (Block 2) courses, plus relevant work experience totaling a minimum of 3200 hours	Third Year
Third Year Apprentice	Completion of advanced level (Block 3) courses, plus sign-off of workplace skills required for certification totaling a minimum of 4800 hours	Write Certification Examination

* All direct entry apprentices must meet the **Requirements for Progression** either through Prior Learning Assessment and Recognition or course completion before advancing to the next year.

** Apprentices in a 7200 hour program which incorporates more than four blocks of training are considered fourth year apprentices pending completion of 100% course credits and workplace skills requirements.

5.2 For the duration of each Apprenticeship Training Period, the apprentice who is not covered by a collective agreement, shall be paid a progressively increased

schedule of wages.

Program Duration	Wage Rates		Comments
7200 Hours	1 st Year	60%	These wage rates are percentages of the prevailing journeyperson's wage rate in the place of employment of the apprentice. No apprentice shall be paid less than the wage rate established by the Labour Standards Act (1988), as now in force or as hereafter amended, or by other Order, as amended from time to time replacing the first mentioned Order.
	2 nd Year	70%	
	3 rd Year	80%	
	4 th Year	90%	
5400 Hours and 4800 Hours	1 st Year	60%	
	2 nd Year	75%	
	3 rd Year	90%	
4000 Hours			(Hairstylist Program) - The apprentice shall be paid no less than the minimum wage for hours worked and a commission agreed upon between the apprentice and the employer.

6.0 Tools

Apprentices shall be required to obtain hand tools as and when specified by the PACB.

7.0 Periodic Examinations and Evaluation

- 7.1 Every apprentice shall submit to such occupational tests and examinations as the PACB shall direct. If after such occupational tests and examinations the apprentice is found to be making unsatisfactory progress, his/her rate of wage shall not be advanced as provided in Section 5 until his/her progress is satisfactory to the Director of Institutional and Industrial Education and his/her date of completion shall be deferred accordingly. Persistent failure to pass required tests shall be a cause for revocation of his/her Memorandum of Understanding.
- 7.2 Upon receipt of reports of accelerated progress of the apprentice, the PACB may shorten the term of apprenticeship and advance the date of completion

accordingly.

- 7.3 For each and every course, a formal assessment is required for which 70% is the pass mark. A mark of 70% must be attained in both the theory examination and the practical project assignment, where applicable.

8.0 Granting of Certificates of Apprenticeship

Upon the successful completion of apprenticeship, the PACB shall issue a Certificate of Apprenticeship

9.0 Hours of Work

Any hours employed in the performance of duties related to the designated occupation will be credited towards the completion of the term of apprenticeship. Appropriate documentation of these hours must be provided.

10.0 Copies of the Registration for Apprenticeship

The Director of Institutional and Industrial Education shall provide copies of the Registration for Apprenticeship form to all signatories to the document.

11.0 Ratio of Apprentices to Journeypersons

The ratio of apprentices to journeypersons shall not exceed two apprentices to every one journeyperson employed, with the condition that one of these be a final year apprentice.

12.0 Relationship to a Collective Bargaining Agreement

Collective agreements take precedence over the conditions outlined in the Plan of Training.

13.0 Amendments to a Plan of Apprenticeship Training

A plan of training may be amended at any time by the PACB.

14.0 Employment, Re-Employment and Training Requirements

- 14.1 The Plan of Training requires apprentices to regularly attend their place of employment.
- 14.2 The Plan of Training requires apprentices to regularly attend training programs for that occupation as prescribed by the PACB.
- 14.3 Failure to comply with Sections 14.1 and/or 14.2 will result in cancellation of the Memorandum of Understanding. Apprentices may have their MOUs reinstated by the PACB but would be subject to a commitment to complete the entire program as outlined in the General Conditions of Apprenticeship. An apprentice will be required to pay a reinstatement fee. Permanent cancellation in the said occupation is the result of non-compliance.
- 14.4 Cancellation of the Memorandum of Understanding to challenge journeyperson examinations, if unsuccessful, would require an apprentice to serve a time penalty of two (2) years before reinstatement as an apprentice or registering as a Trade Qualifier.
- 14.5 Under the Plan of Training the employer is required to keep each apprentice employed as long as work is available, and if the apprentice is laid off due to lack of work, to give first opportunity to be hired before another is hired.
- 14.6 The employer will permit each apprentice to regularly attend training programs as prescribed by the PACB.
- 14.7 Apprentices who cannot acquire all the workplace skills at their place of employment will have to be evaluated in a simulated work environment at a training institution and have sign-off done by instructors to meet the requirements for certification.

15.0 Appeals to Decisions Based on Conditions Governing Apprenticeship Training

Persons wishing to appeal any decisions based on the above conditions must do so in writing to the Minister of Education within 30 days of the decision.

B. Requirements for Red Seal Certification

1. Evidence the required work experiences outlined in this Plan of Training have been obtained. This evidence must be in a format clearly outlining the experiences and must be signed by an appropriate person or persons attesting that these experiences have been obtained to the level required.
2. Successful completion of all required courses in program.
3. A combination of training from an approved training program and suitable work experience totalling 7200 hours.

OR

A total of 9000 hours of suitable work experience

4. Completion of a National Red Seal examination, to be set at a place and time determined by the Institutional and Industrial Education Division.
5. Payment of the appropriate examination fee.

C. Roles and Responsibilities of Stakeholders in the Apprenticeship Process

The apprenticeship process involves a number of stakeholders playing significant roles in the training of apprentices. This section outlines these roles and the responsibilities resulting from them.

The Apprentice:

- completes all required technical training courses as approved by the PACB.
- finds appropriate employment.
- completes all required work experiences in combination with the required hours.
- ensures work experiences are well documented.
- approaches apprenticeship training with an attitude and commitment that fosters the qualities necessary for a successful career as a qualified journeyman.
- obtains the required hand tools as specified by the PACB for each period of training of the apprenticeship program.

The Employer:

- provides high quality work experiences in an environment conducive to learning.
- remunerates apprentices as set out in the Plan of Training or Collective Agreements.
- provides feedback to training institutions, Institutional and Industrial Education Division and apprentices in an effort to establish a process of continuous quality improvement.
- where appropriate, releases apprentices for the purpose of returning to a training institution to complete the necessary technical courses.

- ensures work experiences of the apprentice are documented.

The Training Institution:

- provides a high quality learning environment.
- provides the necessary student support services that will enhance an apprentice's ability to be successful.
- participates with other stakeholders in the continual updating of programs.

The Institutional and Industrial Education Division:

- establishes and maintains program advisory committees under the direction of the PACB.
- promotes apprenticeship training as a viable career option to prospective apprentices and other appropriate persons involved, such as career guidance counsellors, teachers, parents, etc.
- establishes and maintains a protocol with training institutions, employers and other appropriate stakeholders to ensure the quality of apprenticeship training programs.
- ensures all apprentices are appropriately registered and records are maintained as required.
- schedules all necessary technical training periods for apprentices to complete requirements for certification.
- administers provincial/interprovincial examinations.

The Provincial Apprenticeship and Certification Board:

- sets policies to ensure the provisions of the *Apprenticeship and Certification Act (1999)* are implemented.
- ensures advisory and examination committees are established and maintained.
- accredits institutions to deliver apprenticeship training programs.
- designates occupations for apprenticeship training and/or certification.

D. Program Structure

For each and every course, a formal assessment is required for which 70% is the pass mark. A mark of 70% must be attained in both the theory examination and the practical project assignment, where applicable.

The order of course delivery within each block can be determined by the educational agency, as long as pre-requisite conditions are satisfied.

Entry Level Courses – Block 1			
Course No.	Course Name	Hours	Pre-requisite(s)
TS1520	WHMIS	6	-
TS1530	Standard First Aid	14	-
ER1100	Rigging	30	ER1410
ER1110	Hand Tools	15	ER1410
ER1121	Power Tools	24	ER1410
ER1131	Fasteners	15	ER1121
ER1140	DC Theory	30	ER1410
ER1151	Series and Parallel DC Circuits	45	ER1140
ER1160	Codes	30	-
ER1170	Voltage Drop and Power Loss	30	ER1151, ER1160
ER1180	Single Phase Theory	60	ER1170
ER1190	Three-Phase Theory	30	ER1180
ER1201	Drawings, Schematics and Specifications	30	ER1160
ER1220	Conduit, Tubing and Fittings	30	ER1131

Entry Level Courses – Block 1			
Course No.	Course Name	Hours	Pre-requisite(s)
ER1230	Conductors and Cables	45	ER1220
ER1241	Fundamental Wiring	60	ER1230
ER1250	Protective Devices	30	ER1230
ER1261	Transformers	60	ER1190/1250
ER1270	Single Phase Service Entrance	30	ER1261
ER1280	Three-Phase Service Entrance	30	ER1270
ER1370	Distribution Equipment	20	ER1280
ER1341	Fire Alarms	20	ER1370
ER1360	Electric Heating Systems and Controls	30	ER1370
ER1410	Safety Practices	30	-
ER2000	Raceways, Wireways and Busways	30	ER1220
ER2116	Troubleshooting Techniques	6	ER1410
CM2150	Workplace Communications	45	-
MR1220	Customer Service	30	-
SP2330	Quality Assurance / Quality Control	30	-
MC1050	Introduction to Computers	30	-
SD1700	Workplace Skills	30	-
SD1710	Job Search Techniques	15	-
SD1720	Entrepreneurial Awareness	15	-
OT1230	Workplace Exposure	60	-

Entry Level Courses – Block 1			
Course No.	Course Name	Hours	Pre-requisite(s)
MA1060	Basic Math	60	-
AP1100	Introduction to Apprenticeship	15	-
Total Hours		1110	

Required Work Experience

Block 2			
Course No.	Course Name	Hours	Pre-requisite(s)
ER2010	Lighting and Controls	30	Completion of All Entry Level Programs
ER2030	Three Phase Motors	30	Completion of All Entry Level Programs
ER2041	Control Devices	30	ER2030
ER2050	Motors Starters and Controllers	60	ER2041
ER2021	Single Phase AC Motors	30	ER1270
ER2073	Power Supply and Rectifiers	50	Completion of All Entry Level Programs
ER2133	Signaling and Communication Systems	10	ER1370
Total Hours		240	

Required Work Experience

Block 3			
Course No.	Course Name	Hours	Pre-requisite(s)
ER1300	DC Motors and Controls	30	Completion of Block II
ER2161	Solid State Drives	20	ER2073
ER2240	DC Generators	30	ER1300
ER2250	AC Generators	30	ER2030
ER2261	Emergency Stand-by Units	20	ER2250
ER2270	Emergency Lighting Systems	15	Completion of Block II
ER2300	Distribution System Conditioning	30	ER2161
ER2350	Electric Surface Heating Units	15	Completion of Block II
ER1380	Distribution Equipment and Installation	20	Completion of Block II
ER1211	Advanced Drawings, Schematics and Specifications	30	Completion of Block II
Total Hours		240	

Required Work Experience

Block 4			
Course No.	Course Name	Hours	Pre-requisite(s)
ER2061	Central Heating Units	20	Completion of Block III
ER2123	Application of Troubleshooting Techniques	20	ER2116
ER2171	PLC Fundamentals	20	ER2050
ER2180	Programming PLCs	30	ER2171
ER2310	Furnace Controls	15	ER2050
ER2421	Heat Pumps and HVAC Electrical Systems	20	Completion of Block III
ER2363	Refrigeration and Air Conditioning Controls	15	Completion of Block III
ER2390	Fibre Optics	15	Completion of Block III
ER2440	High Voltage Wiring	45	Completion of Block III
ER2141	Security Systems	10	ER1230
ER2500	Explosion Proof Equipment	30	Completion of Block III
Total Hours		240	

Block 5			
Course No.	Course Name	Hours	Pre-requisite(s)
ER2520	Emerging Technologies	30	Completion of Block IV
ER2082	Transistors	30	ER2073
ER2092	Digital Electronics	30	ER2101
ER2101	Operational Amplifiers	15	ER2082
ER2152	Analog Devices	90	ER2092
ER2192	Process Control	30	ER2152
ER2202	Distributed Control Systems (DCS)	30	ER2192
ER2210	Pneumatic Control Systems	15	Completion of Block IV
ER2220	Servomechanism	15	ER2230
ER2230	Hydraulic Circuits and Controls	15	ER2210
ER2320	Boiler Control	15	ER2192
ER2342	Energy Management	15	ER2092
ER2372	Precipitators and Dust Collection Systems	15	ER2320
ER2382	Vibration	15	ER2152
Total Hours		360	

Total Course Credit Hours	2190
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***A student who can meet the Mathematics requirement through an ACUPLACER® test may be exempted from Mathematics 1060. Please check with your training institution.**

ENTRY LEVEL – BLOCK 1

TS1520 Workplace Hazardous Materials Information System (WHMIS)

Description:

This course is designed to give participants the knowledge and skills necessary to define WHMIS, examine hazard identification and ingredient disclosure, explain labeling and other forms of warning, and introduce material safety data sheets (MSDS).

Pre-requisites: None

Course Duration: 6 Hours

Course Outcomes:

Upon successful completion of this course, the apprentice will be able to:

- Interpret and apply the Workplace Hazardous Materials Information System (WHMIS) Regulation under the Occupational Health and Safety Act.

Required Knowledge and Skills:

1. Define WHMIS safety.
 - i. rational and key elements
 - ii. history and development of WHMIS
 - iii. WHMIS legislation
 - iv. WHMIS implementation program
 - v. definitions of legal and technical terms
2. Examine hazard identification and ingredient disclosure.
 - i. prohibited, restricted and controlled products
 - ii. classification and the application of WHMIS information requirements

- iii. responsibilities for classification
 - the supplier
 - the employer
 - the worker - Classification: rules and criteria
 - information on classification
 - classes, divisions and subdivision in WHMIS
 - general rules for classification
 - class A - compressed gases
 - class B - flammable and combustible materials
 - class C - oxidizing material
 - class D - poisonous and infectious material
 - class E - corrosive material
 - class F - dangerously reactive material
 - iv. products excluded from the application of WHMIS legislation
 - consumer products
 - explosives
 - cosmetics, drugs, foods and devices
 - pest control products
 - radioactive prescribed substances
 - wood or products made of wood
 - manufactured articles
 - tobacco or products of tobacco
 - hazardous wastes
 - products handled or transported pursuant to the Transportation of Dangerous Goods (TDG) Act
 - v. comparison of classification systems - WHMIS and TDG
 - vi. general comparison of classification categories
 - vii. detailed comparison of classified criteria
3. Explain labeling and other forms of warning.
- i. definition of a WHMIS label
 - supplier label
 - workplace label
 - other means of identification
 - ii. responsibility for labels
 - supplier responsibility
 - employer responsibility
 - worker responsibility
 - iii. introduce label content, design and location

- supplier labels
 - workplace labels
 - other means of identification
- 4. Introduce material safety data sheets (MSDS).
 - i. definition of a material safety data sheet
 - ii. purpose of the data sheet
 - iii. responsibility for the production and availability of data sheets
 - supplier responsibility
 - employer responsibility
 - workers responsibility

Practical:

1. Locate WHMIS label and interpret the information displayed.
2. Locate a MSDS sheet for a product used in the workplace and determine what personal protective equipment and other precautions are required when handling this product.

Suggested Resources:

1. WHMIS Regulation
2. Sample MSDS sheets

TS1530 Standard First Aid

Description:

This course is designed to give the apprentice the ability to recognize situations requiring emergency action and to make appropriate decisions concerning first aid.

Complete a **St. John Ambulance or Canadian Red Cross** Standard First Aid Certificate course.

Pre-requisites: None

Course Duration: 14 Hours

ER1100 Rigging

Description:

This course will provide knowledge of lifting and rigging procedures and use of the equipment.

Pre-requisites: ER1410

Duration: 30 Hours

Objectives and Content:

1. Define the terms related to mechanical advantage.
2. Identify and describe wire rope.
 - i. fatigue and abrasion resistance
 - ii. safety factor
3. Identify and describe fibre rope.
 - i. types and characteristics
 - ii. safety factor
 - iii. safe working loads
 - iv. care
 - coiling and uncoiling
 - storage
 - v. inspection
 - vi. knots, bends and hitches
4. Identify and describe chains used in rigging.
5. Identify and describe rigging hardware items and the procedures for installing them.
 - i. drums
 - ii. sheaves
 - iii. hooks
 - iv. rings, links and swivels

- v. shackles
 - vi. eye bolts
 - vii. turnbuckles
 - viii. spreader and equalizer beams
 - ix. blocks
6. Describe the procedures used to select slings.
- i. sling configurations
 - ii. sling angles
 - iii. safe working loads
7. Identify and describe jacks and their uses.
- i. screw jacks
 - ii. ratchet jacks
 - iii. hydraulic jacks
 - with integral pump
 - with separate pump (ram)
8. Describe the procedures used to select and use ladders and scaffolds.
- i. ladder safety
 - ii. tubular steel sectional scaffolding
 - iii. characteristics of steel scaffolding
 - ease of erection
 - common hoists
9. Describe procedures used to move a load.
- i. load weights
 - ii. center of gravity
 - iii. crane signals
 - iv. OSHA requirements

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Tie knots, bends, and hitches used for lifting and moving equipment.
2. Inspect, select and use the appropriate sling to perform a given task.
3. Inspect, select and use various chain blocks and rope falls.
4. Select and use ladders and scaffolds.
5. Secure, lift and move loads vertically and horizontally.

ER1110 Hand Tools

Description:

This course will involve the identification, selection, operation and care for basic hand tools.

Pre-requisites: ER1410

Duration: 15 Hours

Objectives and Content:

1. Identify types of hand tools and describe their applications and procedures for care and use.
 - i. screwdrivers
 - ii. hammers
 - iii. pliers
 - iv. wrenches
 - v. saws and blades
 - vi. files
 - vii. taps and dies
 - viii. layout tools
 - ix. punches and chisels
 - x. knives
 - xi. fuse pullers
 - xii. knockout punches
 - xiii. hand benders
 - xiv. measuring instruments

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Identify, use and maintain screwdrivers.
2. Identify, use and maintain hammers.
3. Identify, use and maintain pliers.
4. Identify, use and maintain wrenches.
5. Select, use and maintain files.
6. Select and use hacksaw to cut various types of metal.
7. Select, use and clean taps and dies.
8. Select and use measuring and layout tools.
9. Select and use punches and chisels.
10. Select and use handsaws.
11. Select and use hand-operated knock-out punches.

ER1121 Power Tools

Description:

This course will involve the identification, selection, operation and maintenance of power tools.

Pre-requisites: ER1410

Duration: 24 Hours

Objectives and Content:

1. Identify types of power tools and describe their applications and procedures for service and use.
 - i. drills
 - drill bits
 - ii. drill presses
 - iii. hammers
 - iv. saws
 - v. grinders
 - vi. hydraulic tools
 - vii. pneumatic tools
2. Describe the operation of power tools.
 - i. components
 - ii. grounding
3. Identify the types of periodic maintenance testing
 - i. preventative
 - ii. predictive
 - iii. reactive

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Select and use a portable drill and bits for a specific task.
2. Use rotary hammer.
3. Operate a drill press.
4. Determine safe working speeds of wheels on portable and pedestal grinders.
5. Select wheels and discs for portable and pedestal grinders.
6. Operate portable and pedestal grinders.
7. Sharpen wood and metal bits.
8. Operate circular, saber and reciprocating saws.

ER1131 Fasteners

Description:

This course will involve the identification, selection, and installation of fasteners.

Pre-requisites: ER1121

Duration: 15 Hours

Objectives and Content:

1. Identify types of nails and describe their applications and procedures for use.
2. Identify types of screws and bolts and describe their applications and procedures for use.
 - i. wood screws
 - ii. sheet metal screws
 - iii. machine screws and bolts
 - iv. nuts and washers
3. Identify types of anchors and shields and describe their applications and procedures for use.
 - i. masonry anchors
 - ii. cavity fasteners
 - iii. screw anchors
 - fiber
 - metal
 - lead
 - plastic
 - screw-in anchor
 - iv. miscellaneous fasteners
 - concrete screws
 - hollow rivets
 - spring-steel fasteners
 - chemical fasteners

- self-tapping masonry screws
4. Explain the operation of explosive actuated tools.

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Install fasteners
2. Use powder actuated tools to fasten materials to concrete and steel.
3. Dismantle, inspect, clean and reassemble powder actuated tools.

ER1140 DC Theory

Description:

This course will include knowledge of direct current circuit theory, calculation of DC circuits, and the selection and use of measuring instruments.

Pre-requisites: ER1410

Duration: 30 Hours

Objectives and Content:

1. Identify hazards and describe safe work practices pertaining to DC electricity.
2. Describe the atomic structure of matter.
 - i. electron theory
 - matter
 - atoms
 - electric charge
 - protons, electrons, neutron
 - ii. static electricity and electrostatics
 - positive and negative charge
 - electrostatic field
 - transferring static electricity
 - conduction
 - induction
 - iii. discharging static charges
 - electrons in motion
 - causes of current
 - conductors, semi-conductors, insulators
 - electron current flow
 - conventional current flow

3. Identify electrical units and symbols.
 - i. absolute electrical units
 - current
 - voltage
 - resistance
 - ii. prefixes for absolute units
4. Identify different forms of energy and describe the effects of dynamic electricity.
 - i. different forms of energy to produce electricity
 - chemical action
 - piezoelectric effect
 - magnetism
 - heat
 - light and solar energy
 - friction
 - ii. effects of dynamic electricity
 - heating effects
 - chemical effects
 - magnetic effects
 - psychological and physiological effects
5. Identify and analyze the components necessary for the assembly of an electric circuit.
 - i. the electron path (conductors)
 - ii. the load
 - iii. the source
 - iv. the control
 - v. closed circuit
 - vi. open circuit
 - vii. short circuit
6. Identify and describe the three basic electrical properties.
 - i. voltage
 - ii. current
 - iii. resistance
7. Explain Ohm's Law.

8. Describe the following in relation to electricity.
 - i. work
 - ii. power
 - iii. joules and coulombs
 - iv. electrical power (watt)
 - v. combination of the Power formulas and Ohm's Law
 - vi. watts and horsepower
 - vii. BTU
 - viii. kilowatt hours
 - meter reading and cost
9. Identify measuring instruments and describe their applications and procedures for use.
 - i. ammeter
 - ii. voltmeter
 - iii. ohmmeter
 - iv. multimeter
 - v. circuit tester
 - vi. continuity tester
 - vii. megger

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Compute values of electrical energy and power.
2. Use electrical measuring instruments.
3. Use instruments to troubleshoot DC components
 - i. closed circuit
 - ii. open circuit
 - iii. short circuit
4. Ensure calibration of measuring instruments in accordance with manufacturing specifications.
5. Conduct megger test.

ER1151 Series and Parallel DC Circuits

Description:

This course will involve performing calculations to determine series, parallel and complex DC circuit related values.

Pre-requisites: ER1140

Duration: 45 Hours

Objectives and Content:

1. Describe the characteristics of a series circuit and calculate values.
 - i. resistance
 - ii. current
 - iii. voltage
 - iv. power
 - v. open resistor
 - vi. shorted resistor
2. Describe the characteristics of a parallel circuit and calculate values.
 - i. resistance
 - ii. current
 - iii. voltage
 - iv. power
 - v. open resistor
 - vi. shorted resistor
3. Explain Kirchhoff's Laws.
 - i. current law
 - ii. voltage law
4. Describe the characteristics of a combination circuit and calculate values.
5. Describe the procedures used to troubleshoot series, parallel and complex DC

circuits.

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Analyze and measure amperage and voltage in series DC circuits.
2. Analyze and measure amperage and voltage in parallel DC circuits.
3. Analyze and measure amperage and voltage in combination DC circuits.
4. Analyze and measure resistance and/or continuity in basic DC circuits.
5. Analyze and measure power consumption in basic DC circuits.

ER1160 Codes

Description:

This course will introduce the structure of the Canadian Electrical Code (CEC) and the National Building Code (NBC) and the procedures used to locate and interpret information.

Pre-requisites: None

Duration: 30 Hours

Objectives and Content:

Canadian Electrical Code (CEC)

1. Understand and be able to use the Canadian Electrical Code (CEC).
 - i. knowledge of CEC content
 - sections
 - tables
 - diagrams
 - appendices
 - index
 - division, subdivision, etc.
 - ii. use of the CEC
 - using key words in the index
 - using table of contents
 - using subject area
2. Describe the procedures used to locate, select and gather information from the CEC handbook.
 - i. purpose of the handbook
 - ii. rationale for rules
 - iii. intent for rules
 - iv. diagrams and figures

National Building Code (NBC)

3. Understand and be able to use the National Building Code (NBC) as it relates to the CEC.
 - i. background and purpose of the code
 - ii. preface
 - iii. table of contents
 - iv. numbering system
 - v. index
 - vi. appendix
 - vii. tables
 - viii. scope and definitions
 - ix. general requirements
 - x. use and occupancy

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Locate and select information from the CEC, Part 1.
2. Locate and select information from the CEC Handbook.
3. Locate and select information from the National Building Code (NBC).

ER1170 Voltage Drop and Power Loss

Description:

This course will involve performing calculations on voltage drop and power loss and its impact on a circuit.

Pre-requisites: ER1151, ER1160

Duration: 30 Hours

Objectives and Content:

1. Identify the types of conductor materials and describe their characteristics.
 - i. aluminum
 - ii. copper
2. Identify types of insulators and describe their characteristics and applications.
3. Explain conductor resistance and its effects on a circuit.
 - i. resistivity
 - ii. cross-sectional area
 - iii. length
 - iv. temperature coefficient of resistance
4. Describe the procedures used to determine conductor resistance.
5. Explain line voltage drop and its effects on a circuit.
 - i. factor affecting voltage drop
 - ii. calculate voltage drop
 - iii. CEC requirements
 - iv. voltage drop percentage
6. Explain power loss and its effects on a circuit.
 - i. calculate power loss
7. Describe the operation of a three-wire system.

- i. purpose of a three-wire system
- ii. neutral wire

Practical:

1. Use CEC tables to calculate voltage drop.
2. Calculate the absolute values in three-wire circuits.

ER1180 Single Phase Theory

Description:

This course will include knowledge of single-phase electricity, AC components, AC circuits, and their characteristics and associated principles.

Pre-requisites: ER1170

Duration: 60 Hours

Objectives and Content:

1. Describe the principles of magnetism and the action of magnets.
 - i. magnetic and nonmagnetic substances categories
 - magnetic and nonmagnetic substances
 - poles of a magnet and the earth
 - ii. the theory of magnetism
 - magnetized and unmagnetized
 - magnetic field
 - magnetic lines
 - iii. magnetism properties
 - flux density (Weber's theory)
 - forces between magnetic poles
 - induced magnetism
 - permeability
 - reluctance
 - shielding
 - permanent and temporary magnet
 - retentivity
 - residual magnetism
 - demagnetizing
2. Describe the principles of electromagnetism.
 - i. the theory of electromagnetism
 - characteristics of an electromagnetic field

- magnetic field around a current-carrying conductor
 - ii. direction of current flow and magnetic flux
 - direction of current and flux
 - dot-cross method
 - left-hand conductor rule
 - electromagnetic coil
 - left-hand coil rule
 - iii. the electromagnet
 - characteristic of electromagnets (core, turns, strength)
 - magnetic saturation
 - core losses (hysteresis, eddy current, I^2R)
 - uses of electromagnets
- 3. Describe the principles and characteristics of electromagnetic induction.
 - i. principles of electromagnetic induction
 - Faraday's law
 - factors affecting amount of induced voltage
 - ii. self and mutual induction
 - self induction
 - henries
 - CEMF
 - mutual induction
- 4. Identify hazards and describe safe work practices pertaining to single-phase electricity.
- 5. Describe the generation of alternating current.
 - i. direction of induced voltage
 - ii. left-hand generator rule
 - iii. alternation/revolution
 - iv. cycle
 - v. sine wave/plotting
 - vi. electrical and mechanical degrees
- 6. Define different values and terms of alternating current.
 - i. alternating current values
 - instantaneous values
 - maximum (peak) values
 - peak to peak values

- effective (RMS) values
 - average values
 - ii. terminology of alternating current circuits
 - frequency / hertz
 - period
 - phase (in phase, lagging, leading)
- 7. Describe the characteristics of components found in AC circuits.
 - i. resistance in an AC circuit
 - ii. inductance in an AC circuit
 - iii. capacitance in an AC circuit
 - iv. impedance in an AC circuit
 - trigonometric functions
 - impedance vector
 - v. AC power and power factor correction in an AC circuit
 - power factor introduction
 - pure resistive circuit
 - pure inductive circuit
 - pure capacitive circuit
 - resistive-reactive circuit
 - apparent power and reactive power
 - power factor correction
- 8. Solve RL, RC, and RLC AC series and AC parallel circuits.
 - i. circuits with resistance and inductive reactance
 - ii. circuits with resistance capacitive reactance
 - iii. circuits with resistance, inductive reactance and capacitive reactance
 - iv. power factor calculation

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit

Practical Projects include:

1. Determine the properties of an AC circuit.
2. Connect AC series and AC parallel circuits containing RLC components.
3. Determine absolute values in AC series and AC parallel circuits containing RLC components.

4. Calculate power and power factor in AC circuits.
5. Use electrical instruments to troubleshoot series and parallel AC circuits.

ER1190 Three-Phase Theory

Description:

This course will include knowledge of three-phase electricity, its characteristics and associated principles, and will involve performing calculations of three-phase circuits.

Pre-requisites: ER1180

Duration: 30 Hours

Objectives and Content:

1. Identify hazards and describe safe work practices pertaining to three-phase electricity.
2. Describe the generation of three-phase voltages.
 - i. characteristics of three-phase
 - ii. phase sequence
3. Describe the voltage and current values in three-phase wye connections.
 - i. voltage and current relationships in a wye connection
 - ii. current relationships in a wye connection
 - iii. ground connections
 - iv. 3-wire wye connections
 - v. 4-wire wye connections
 - vi. phase loss calculations
4. Describe the voltage and current values in three-phase delta connections.
 - i. cautions regarding improper delta connections
 - ii. voltage relationships in a delta connection
 - iii. current relationships in a delta connection
 - iv. open delta connections
 - v. 3-wire delta connections
 - vi. 4-wire delta connections
 - vii. comparing wye and delta systems

5. Perform calculations for balanced and unbalanced loads.
6. Describe the procedures used to calculate three-phase power, volt-amperes, reactive power and power factor.
 - i. three-phase apparent power
 - ii. three-phase power
 - iii. power factor
 - iv. measurements for three-phase power
7. Describe the procedures used to measure three-phase power using watt meters.
 - i. two watt meter method
 - ii. three watt meter method
 - iii. polyphase watt meter

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Calculate three-phase power, volt-amperes, reactive power, and power factor.
2. Connect three-phase circuits and measure three-phase power using watt-meters.

ER1201 Drawings, Schematics and Specifications

Description:

This course will include knowledge of drawings, schematics and specifications and their applications.

Pre-requisites: ER1160

Duration: 30 Hours

Objectives and Content:

1. Identify types of drawings and describe their applications.
 - i. civil / site
 - ii. architectural
 - iii. mechanical
 - iv. structural
 - v. electrical
 - vi. shop drawings
 - vii. sketches
 - viii. as-builts
 - ix. piping and instrument drawings (P and ID's)
 - x. installation drawings
 - xi. loop drawings
 - xii. location drawings
 - xiii. logic drawings
2. Review and interpret information from drawings.
 - i. alphabet of lines
 - ii. elevations
 - iii. scales
 - iv. legends
 - v. symbols and abbreviations
 - vi. notes and specifications

3. Review and interpret information from basic drawings, schematics, wiring diagrams and documents.
4. Describe procedures used to obtain material lists.

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Gather and interpret information from various drawings.
2. Determine measurements from scaled drawings.
3. Use information to obtain a materials list for installation.
4. Sketch basic drawing views.

ER1220 Conduit, Tubing and Fittings

Description:

This course will include knowledge of installing various types of conduit, tubing, fittings, components and accessories.

Pre-requisites: ER1131

Duration: 30 Hours

Objectives and Content:

1. Describe the various types of conduits and tubing, their characteristics and applications.
 - i. metallic rigid and EMT
 - ii. non-metallic rigid (PVC)
 - iii. flexible
2. Describe the various fittings, couplings, and device boxes used with conduits and tubing.
 - i. fittings
 - ii. couplings
 - iii. connectors
 - iv. boxes and enclosures
 - v. supporting methods
3. Describe the terms associated with the bending of conduit and tubing.
 - i. back-to-back
 - ii. 90 degree bend
 - iii. concentric bends
 - iv. “dog leg” or “kick”
 - v. gain
 - vi. leg length
 - vii. offsets

- viii. rise on stub-up
 - ix. saddles
 - x. developed length
- 4. Identify hazards and describe safe work practices pertaining to conduit, tubing and fittings.
- 5. Identify the CEC requirements used to prepare, bend and install rigid metal conduit.
 - i. preparation
 - ii. cutting conduit by hand
 - iii. cutting conduit using power devices
 - iv. bending
 - v. reaming rigid conduit
 - vi. threading rigid conduit by hand
 - vii. machine threading
 - viii. portable power units
 - ix. hazardous locations
- 6. Identify the CEC requirements used to properly prepare, bend and install EMT.
 - i. preparation
 - cutting EMT
 - reaming EMT
 - ii. bending
 - hand benders
 - mechanical benders
 - hydraulic benders
 - the little “kicker”
 - iii. installation
 - types of couplings and connectors
 - fittings
 - boxes
- 7. Identify the CEC requirements used to prepare, bend and install PVC conduits.
 - i. preparation
 - ii. cutting
 - iii. fittings
 - iv. joining
 - v. bending

- preparing for bending
 - hand held heaters
 - floor model heaters
 - liquid PVC heaters
 - precautions when bending
 - prefabricated bends
 - expansion and contraction
8. Describe ENT, its applications and limitations.
- i. general information
 - ii. couplings and connectors
 - iii. CEC requirements
9. Describe EB1, DB2/ES2, their applications, limitations and installation.
- i. restrictions
 - ii. methods of installation
 - iii. CEC requirements
10. Describe flexible conduit, its applications, limitations and installation.
- i. cutting
 - ii. connectors
 - iii. CEC requirements
11. Identify the size requirements of pull boxes and junction boxes according to CEC requirements.
- i. straight pulls
 - ii. angle pulls
 - iii. U-pulls

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Apply proper cutting, coupling and termination methods used with conduit.
2. Install rigid metal conduit.
3. Prepare and bend EMT.
4. Install EMT.
5. Prepare and install PVC conduit.

6. Determine the size requirements of pull boxes and junction boxes.

ER1230 Conductors and Cables

Description:

This course will include knowledge of installing and terminating conductors and cables.

Pre-requisites: ER1220

Duration: 45 Hours

Objectives and Content:

1. Identify terminology associated with conductors and cables.
 - i. CSA designations
 - ii. voltage ratings
 - iii. number and size range of conductors
 - iv. number of strands
 - v. conditions of use
 - vi. allowable ampacity
 - vii. temperature ratings
2. Identify hazards and describe safe work practices pertaining to conductors and cables.
3. Identify the CEC requirements used to select and install flexible cords and equipment wire.
 - i. applications
 - ii. CSA designations
 - iii. voltage ratings
 - iv. number and size range of conductors
 - v. construction
 - vi. conditions of use
 - vii. allowable ampacity
 - viii. temperature ratings
 - ix. installation
 - x. terminations

4. Identify the CEC requirements used to select and install TECK and tray cables.
 - i. applications
 - ii. CSA designations
 - iii. voltage ratings
 - iv. number and size range of conductors
 - v. construction (outer covering and conductor insulation)
 - vi. conditions of use
 - vii. allowable ampacity
 - viii. temperature ratings
 - ix. installation
 - x. terminations
 - xi. sheath currents
 - xii. hazardous location fittings and terminations
5. Identify the CEC requirements used to select and install MI cables.
 - i. applications
 - ii. CSA designations (MI or LWMI)
 - iii. voltage ratings
 - iv. number and size range of conductors
 - v. construction (copper, aluminum, or stainless steel)
 - vi. conditions of use
 - vii. allowable ampacity
 - viii. temperature ratings
 - ix. installation
 - x. terminations and splices
 - xi. sheath currents
 - xii. high voltage surges
 - xiii. fault location
6. Describe the preparation of conductors for installation in raceways.
 - i. CEC requirements
 - ii. conductor lubricants
 - iii. identification and colour coding of conductors
 - iv. equipment preparation
7. Describe the mechanical procedures used to install conductors in raceways.
 - i. installing fish tapes
 - ii. use of jet line and air pressure
 - iii. vacuum fishing

- iv. fish lines and ropes
 - v. adding conductors to existing conduit
 - vi. installation of conductors in flexible conduit
-
- 8. Describe the procedures used to set reels on jacks and stands.
 - 9. Describe the installation of conductors in raceways with power equipment.
 - i. mechanical pullers
 - ii. power drives for cable pulling
 - iii. pulleys, rollers, and extended sheaves
 - iv. attachment of conductors to pull cords
 - 10. Locate and interpret CEC requirements related to the installation of conductors in raceways.
 - i. allowable ampacity
 - ii. temperature ratings
 - iii. protection of conductors at the ends of raceways
 - iv. radii of bends in raceways
 - v. number of conductors in conduit and tubing

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

- 1. Prepare and install conductors in raceways.
- 2. Set reels on jacks and stands.
- 3. Select and terminate MI cables.
- 4. Select and terminate armored cables.
- 5. Select and terminate TECK cables.
- 6. Select and terminate aluminum sheathed cables.
- 7. Apply CEC requirements in respect to the installation of conductors and cables.
- 8. Determine size of device and junction boxes.

ER1241 Fundamental Wiring

Description:

This course will include knowledge of wiring applications, their associated devices and components, and installation of basic wiring devices according to CEC requirements.

Pre-requisites: ER1230

Duration: 60 Hours

Objectives and Content:

1. Identify the procedures to follow when doing an electrical installation.
 - i. drawings and specifications
 - ii. rough-in and distribution
 - iii. termination procedures and inspections
2. Identify hazards and describe safe work practices pertaining to basic wiring applications.
3. Describe the procedures used to strip and splice wires.
 - i. stripping wires with proper tools
 - ii. common wire splices
4. Identify mechanical connectors and compression tools and describe their applications.
 - i. twist-on connectors
 - ii. pressure type terminals and connectors (crimp)
5. Identify lampholders and describe their connections.
 - i. types of lampholders
 - screw base sizes
 - ii. connection of lampholders

6. Identify types of switches and describe their applications and connections.
 - i. types of switches
 - toggle, decorative, key, etc.
 - single pole
 - three-way
 - four-way
 - pilot light
 - door
 - dimming control
 - motion sensor
 - ii. construction and rating of switches
 - iii. switches applications
 - single pole connection
 - three-way connection
 - four-way connection
7. Identify types of receptacles and describe their applications and connections.
 - i. types of receptacles
 - CSA configurations
 - tamper-proof
 - ground fault interrupter receptacle
 - T-slot receptacle
 - ii. split receptacle
 - split-switched duplex receptacle
 - split-receptacle for two 15A outlets
 - iii. receptacle grounding
8. Identify types of boxes and describe their applications and procedures for installation.
 - i. types of boxes
 - junction, device and outlet boxes
 - ganged boxes
 - types of cover plates
 - ii. mounting methods of boxes.
 - iii. maximum number of conductors in boxes.
 - iv. CEC requirements

9. Identify types of nonmetallic sheathed cables, and describe their standards and procedures for installation.
 - i. types of cables
 - NMD90
 - NMWU
 - ii. applications
 - iii. stripping
 - iv. termination
 - v. CEC requirements
10. Identify armored cables and describe their standards and procedures for installation.
 - i. AC90
 - ii. stripping
 - iii. termination
 - iv. CEC requirements
11. Identify extra low voltage wiring and procedures for installation.
 - i. door bell
 - ii. lighting control
 - iii. heating control
12. Describe the procedures used to protect cables.
 - i. mechanical damage
 - CEC requirements
 - ii. overcurrent protection devices
 - fuses
 - breakers
 - GFCI breakers
 - arc fault breakers
 - surge protection breakers
13. Describe the procedures used to install switches.
 - i. single-pole switch
 - source feed to the switch
 - source feed to the light
 - ii. pilot light switch
 - source feed to the switch

- source feed to the light
 - iii. three-way and four-way switches
 - source feed to the three-way switch
 - source feed to the light
 - light between the two switches
 - all other types of circuit configurations
- 14. Identify the CEC requirements used to install receptacles.
 - i. split-switched duplex receptacle
 - ii. split-receptacle for two 15A outlets
 - iii. mixed circuit with split-switched duplex receptacle and lights
- 15. Identify and describe installation standards and types of lighting equipment control devices.
 - i. general lighting circuits
 - CEC requirements
 - ii. lighting controls and timers
 - iii. installation and wiring of lighting equipment
- 16. Identify and describe residential ventilation system electrical connections.
 - i. kitchen exhaust fans
 - ii. bathroom fans
- 17. Describe the installation of water pumps and electric water heaters.
 - i. water pumps
 - jet or piston pump
 - submersible pump
 - ii. electric water heaters
 - storage tank water heater
 - tankless water heater
- 18. Identify the CEC requirements for the installation of lighting equipment.
 - i. general characteristics
 - ii. location
 - iii. installation
 - iv. wiring

- v. lampholder characteristics

19. Identify the CEC requirements for the installation of overcurrent protection devices.

- i. fuses
- ii. circuit breakers
- iii. switches
- iv. miscellaneous apparatus

20. Identify the CEC requirements for the installation of receptacles.

- i. receptacles in residential occupancies
- ii. branch circuits in residential occupancies
- iii. portable electric heating devices and cooking appliances

21. Identify the CEC requirements for the installation of pools, tubs and spas.

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Determine the branch circuit requirements for a dwelling unit according to the CEC.
2. Determine lighting and switching requirements for a dwelling unit according to the CEC and NBC.
3. Space, locate and install convenience outlets according to CEC.
4. Locate and determine the circuit requirements and install specific-use outlets according to the CEC.
5. Install a door bell/door chime system.
6. Install cables in a concealed space.
7. Conduct acceptable rough-in and finish-up.

ER1250 Protective Devices

Description:

This course will involve the selection and installation of all appropriate protective devices as per CEC requirements.

Pre-requisites: ER1230

Duration: 30 Hours

Objectives and Content:

1. Describe the function of protective devices.
 - i. overcurrent
 - ii. overload
 - iii. short circuit
2. Identify hazards and describe safe work practices pertaining to protective devices.
3. Describe the effects of short-circuit current.
 - i. fault currents
 - ii. percent impedance
 - iii. types of damage
4. Describe overcurrent devices, their characteristics and applications
 - i. voltage
 - ii. current
 - iii. interrupting capacity
 - iv. time-current characteristics
5. Identify types of fuses and disconnects, and describe their characteristics and applications.
 - i. screw-base plug fuses
 - ii. standard cartridge fuses
 - iii. renewable link fuses

- iv. high rupture capacity fuses
 - v. time delay fuses
 - vi. classifications of fuses
6. Identify types of low-voltage circuit breakers and describe their characteristics and applications.
- i. thermal trip action
 - ii. magnetic trip action
 - iii. moulded case
 - iv. high interrupting capacity type
 - v. ground fault interrupters
 - vi. arc fault circuit interrupters
 - vii. surge suppression
7. Identify the CEC requirements for the selection of protective devices.
8. Describe the coordination of protective devices.
- i. manufacturer's chart
 - ii. engineer's responsibilities
 - iii. electrician's responsibilities
9. Describe the procedures used to troubleshoot and maintain protective devices.

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

- Select fuses/breakers according to specific requirements and CEC requirements.
- 1. Determine interrupting capacity requirements of fuses/breakers.

ER1261 Transformers

Description:

This course will involve knowledge of installation, connecting, troubleshooting and maintenance procedures of transformers.

Pre-requisites: ER1190, ER1250

Duration: 60 Hours

Objectives and Content:

1. Identify hazards and describe safe work practices pertaining to transformers.
2. Define terminology associated with transformers.
3. Interpret codes and regulations pertaining to transformers.
4. Interpret information pertaining to transformers found on drawings and specifications.
5. Identify tools and equipment relating to transformers and describe their applications and procedures for use.
6. Explain the operating principles of transformers.
 - i. mutual induction
 - ii. turns ratio
 - iii. classes of transformers
 - iv. high-voltage windings
 - v. low-voltage windings
 - vi. core designs
7. Interpret information contained on transformer nameplates.
8. Describe transformer polarity and terminal markings.
 - i. additive and subtractive polarity

- ii. polarity tests
9. Describe various connections for multi-coil transformers.
- i. double-wound transformers
 - ii. series/parallel connections
10. Describe the use of schematic diagrams to illustrate how single-phase transformers are connected for parallel operation.
- i. connections for paralleling dual-winding transformers
 - ii. back-feed hazard
11. Describe the operation of various primary and secondary connections for three-phase operation.
- i. wye to wye
 - ii. wye to delta
 - iii. delta to wye
 - iv. delta to delta
 - v. three-phase four-wire delta
 - vi. open delta
12. Identify applications and connections for special transformers.
- i. instrumental
 - ii. auto transformer
 - iii. ignition
 - iv. isolation
 - v. buck and boost
 - vi. multi-tap
 - vii. zig zag
 - viii. Scott /Tee
13. Describe generic maintenance procedures for transformers and the procedures used to document work performed.

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Perform polarity tests.
2. Measure transformer voltage/current ratios.
3. Measure and calculate three-phase voltage and current.
4. Connect three-phase transformers and verify connections and voltage.
5. Conduct operational tests pertaining to transformers.
6. Perform transformer related calculations.
 - i. turns/voltage/current ratios
 - ii. voltage, current and KVA calculations

ER1270 Single-Phase Service Entrance

Description:

This course will include knowledge of overhead and underground single-phase service entrances, their applications and operation, installation, connection, troubleshooting and maintenance. It will also involve installation and connection of overhead single-phase service entrances and demand factor calculations.

Pre-requisites: ER1261

Duration: 30 Hours

Objectives and Content:

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

- iii. underground
 - iv. multiple metering
8. Identify single-phase service entrance components and accessories and describe their characteristics and applications
- i. service entrance mast
 - ii. meter connection box
 - iii. main switch and panelboard
 - iv. underground service box
9. Describe the different methods of grounding and bonding
- i. grounding electrodes types
 - ii. grounding conductors
 - iii. bonding conductors
10. Calculate demand factors.

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.
Practical Projects include:

- 1. Determine service layout and equipment/materials required.
- 2. Install a single-phase, three wire distribution system.
- 3. Install single-phase service entrance equipment.
- 4. Install grounding and bonding electrodes and conductors.

ER1280 Three-Phase Service Entrance

Description:

This course will include knowledge of three-phase service entrances, their applications and operation, installation, connection, troubleshooting, maintenance, testing and repair.

Pre-requisites: ER1270

Duration: 30 Hours

Objectives and Content:

1. Identify hazards and describe safe work practices pertaining to three-phase service entrances.
2. Define terminology associated with three-phase service entrances.
3. Interpret codes, regulations and utility drawings pertaining to three-phase service entrances.
4. Interpret information pertaining to three-phase service entrances found on drawings and specifications.
5. Identify sources of information and documentation required for the installation of three-phase service entrances.
6. Identify tools and equipment relating to three-phase service entrances and describe their applications and procedures for use.
7. Identify types of three-phase service entrances and describe their characteristics and applications.
 - i. wye systems
 - ii. delta systems

8. Identify three-phase service entrance components and accessories and describe their characteristics and applications.
 - i. distribution panel
 - ii. splitters and splitter troughs
 - iii. metering equipment, CTs and PTs
 - iv. conductors
 - v. grounding and bonding
 - vi. service disconnecting means and overcurrent protection
9. Identify the requirements and describe the procedures for conductor installation and termination.
 - i. conductors in parallel
 - ii. colour coding of conductors
 - iii. conductor terminations
10. Perform demand factor calculations for three-phase services as per CEC requirements.
11. Describe the procedures used to install and connect three-phase underground and overhead service entrances, their components and accessories.
 - i. duct requirements
 - ii. conductor requirements
 - iii. pad mounted transformers

ER1370 Distribution Equipment

Description:

This course will involve the installation and connection of various types of distribution equipment as per CEC requirements.

Pre-requisites: ER1280

Duration: 20 Hours

Objectives and Content:

1. Identify hazards and describe safe work practices pertaining to distribution equipment.
2. Define terminology associated with distribution equipment.
3. Interpret codes and regulations pertaining to distribution equipment.
4. Interpret information pertaining to distribution equipment found on drawings and specifications.
5. Identify tools and equipment relating to distribution equipment and describe their applications and procedures for use.
6. Identify types of distribution equipment and describe their characteristics and applications.
 - i. enclosure types (NEMA/EEMAC/CSA designations)
 - ii. disconnect switches and switchgear (voltage and current ratings)
 - iii. low voltage switchboards
 - iv. motor control centers
 - v. panel boards
 - distribution panel boards and loadcenters
 - ratings
 - main lugs/breakers

- pole positions
 - breaker mounting options
 - typical IC ratings of breaker
 - branch circuit breaker ratings
 - service (voltage and frequency)
 - integrated tvss systems
 - fusible panel board
-
7. Identify distribution equipment components and accessories and describe their characteristics and applications.
 8. Identify the considerations and requirements for selecting distribution equipment, its components and accessories.
 9. Describe the procedures used to install and connect distribution equipment, its components and accessories.

ER1341 Fire Alarms

Description:

This course will involve the installation and connection of fire alarm systems.

Pre-requisites: ER1370

Duration: 20 Hours

Objectives and Content:

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

- i. initiating devices (pull stations and detectors)
 - ii. signaling devices (audible and visual)
 - iii. control panel
 - iv. ancillary devices
 - communications system wiring
 - emergency visual/audio control systems
 - fire alarm/extinguishing systems
 - electromagnetic door release devices
 - fire alarm accessories
8. Identify the considerations and requirements for selecting fire alarm systems, their components and accessories.
9. Describe the procedures used to install and connect fire alarm systems, their components and accessories.
 - i. manufacturer's wire types/size requirements
 - ii. end-of-line resistors selection chart
 - iii. component connections
 - iv. control panel connections
 - v. typical test procedures
10. Describe the procedures used to verify a fire alarm system and troubleshoot problems.
 - i. system check
 - ii. systems verification

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.
Practical Projects include:

1. Install, test, and troubleshoot a fire alarm system.
2. Conduct operational tests pertaining to fire alarms.

ER1360 Electric Heating Systems and Controls

Description:

This course will involve the selection and installation of electric heaters and controls and the installation of wiring for electric heating systems.

Pre-requisites: ER1370

Duration: 30 Hours

Objectives and Content:

1. Identify hazards and describe safe work practices pertaining to electric heating systems and controls.
2. Identify various types of electric heating systems and describe their components and procedures for installation as per CEC requirements.
 - i. baseboard heaters
 - uses
 - ratings
 - heating method
 - ii. radiant heating
 - cable sets
 - temperature control
 - spacing / CSA and manufacturer's installation procedures
 - inspection and test procedure
 - heating panels
 - iii. forced air and convection heaters
 - fan forced heaters (wall / floor / ceiling)
 - over temperature protection (liner - snap disc)
 - convector type unit
 - iv. thermostats and relays
 - use of low voltage thermostats and relays
 - thermostats operation (bimetal, hydraulic filled, solid state)
 - line voltage thermostats (single-pole, double pole, built-in)

- programmable thermostats
- magnetic, thermal and solid state relays

3. Perform heat loss calculations for a given space.

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Install forced air heaters.
2. Install a baseboard heater with relay and low-voltage thermostat control.
3. Install a baseboard heater with built-in thermostat control.
4. Install a baseboard heater with a wall mounted line-voltage thermostat control.
5. Install and program a programmable thermostat.

ER1410 Safety Practices

Description:

This course will involve knowledge and awareness of safe work practices in the workplace.

Pre-requisites: none

Duration: 30 Hours

Objectives and Content:

1. Describe basic employer and employee duties to comply with the applicable Act and safety regulations. (91-448 of OH&S Regulations)
 - i. employers responsibilities
 - ii. supervisors responsibilities
 - iii. employees rights and responsibilities
 - iv. Health and Safety Committee responsibilities
2. Describe practices used to control workplace hazards.
 - i. identification of hazards
 - ii. hazard assessment
 - iii. housekeeping
 - iv. fire extinguishers
 - v. incident investigations
 - vi. formal inspections
 - vii. regular safety meetings
 - viii. tool box meetings
3. Identify personal protective equipment (PPE) and describe procedures for use and care.
4. Describe safety practices when working in and around trenches.
5. Describe safe practices when working with tools and equipment.

6. Describe mobile equipment safety practices.
7. Identify types of access equipment and describe their construction and safe working practices.
 - i. ladders
 - ii. scaffolds
 - iii. man lifts
8. Describe potential hazards while working around welding areas.
 - i. harmful gases
 - ii. flashing
 - iii. burns
 - iv. grounding
9. Describe confined space safety practices.
10. Describe lifting techniques, work posture and ergonomics.
11. Describe safety measures related to electricity.
 - i. CSA - Workplace Electrical Safety (Standard) Z462-08
12. Describe safety measures for lockout and tagging of equipment.

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Perform isolation and de-energizing procedures and lockout / tag out.
2. Safely erect ladders and scaffolding.
3. Properly inspect and use fall arrest equipment.
4. Identify and tag out faulty equipment.

ER2000 Raceways, Wireways and Busways

Description:

This course will involve knowledge and installation of raceways, wireways and busways as per CEC requirements.

Pre-requisites: ER1220

Duration: 30 Hours

Objectives and Content:

1. Identify hazards and describe safe work practices pertaining to raceways, wireways and busways.
2. Define terminology associated with raceways, wireways and busways.
3. Interpret codes and regulations pertaining to raceways, wireways and busways.
4. Interpret information pertaining to raceways, wireways and busways found on drawings and specifications.
5. Describe the procedures used to install one-piece surface raceways.
 - i. fittings
 - ii. boxes
 - iii. connecting to conduit and armored cable
 - iv. connecting to concealed wiring
6. Describe the procedures used to install two-piece surface raceways.
 - i. single channel and multi channel
 - ii. applications
 - iii. fittings
 - iv. boxes
 - v. supporting methods

7. Describe the procedures used to install cellular floor raceways.
 - i. applications
 - ii. fittings and adapters
 - iii. outlets and boxes
 - iv. extending from underfloor ducts
5. Describe the procedures used to install multi-outlet assemblies.
 - i. plugmold
 - pre-wired
 - devices and fittings
 - ii. electro-strip
 - outlets and adapters
 - iii. pole type multi-outlet assemblies
 - channel arrangement
6. Describe the procedures used to install lighting fixture raceways.
 - i. construction
 - ii. mounting methods
7. Describe the procedures used to install undercarpet strips.
 - i. flat conductor cables (FCC)
 - ii. power systems
 - iii. undercarpet telecommunication systems
8. Describe wireways, their applications and procedures for installation.
 - i. restrictions
9. Describe busways, their applications and procedures for installation.
 - i. restrictions
 - ii. supports
10. Identify types of cable trays and describe their applications and procedures for installation.
 - i. ladder cable trays
 - ii. ventilated and non-ventilated cable trays
 - iii. cable tray accessories (fittings, adapters, etc.)
 - iv. supporting cable trays
 - v. bonding cable trays
 - vi. cable tray barriers

- vii. instrument / field tray
- 11. Describe the procedures used to install and secure cables and conductors in cable trays.
- 12. Describe the procedures used to install underfloor raceways (metallic and non-metallic).
 - i. after-set inserts
- 13. Describe the procedures used to install underground raceways.

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit
Practical Projects include:

- 1. Install one-piece surface raceways.
- 2. Install two-piece surface raceways.
- 3. Install wall and pole type multi-outlet assemblies.
- 4. Install lighting fixture raceways.
- 5. Install cable tray.
- 6. Install wireways.

ER2116 Troubleshooting Techniques

Description:

This course will involve knowledge of diagnostic and troubleshooting techniques.

Pre-requisites: ER1410

Duration: 6 Hours

Objectives and Content:

1. Record all information gathered through the troubleshooting process.
2. Describe personal and equipment safety practices.
 - i. energy isolation
 - lockout / tagout
 - OSHA requirements
 - permits
 - ii. personal protective equipment
 - iii. “insulated” mats
 - iv. quality of workmanship
3. Describe conventional troubleshooting methods.
 - i. interview operator (owner) and/or review work order to identify the problem
 - ii. verify the “facts”
 - iii. review the operating sequences of equipment
 - iv. review equipment manuals, schematics, etc.
 - v. review records / reports describing any changes to equipment or environment
 - vi. determine equipment symptoms
 - non-operational (dead)
 - marginal
 - intermittent
 - vii. isolate problem
 - dividing method (elimination process)

- use manufacturer's troubleshooting guide
- think beyond the "fix" and verify the cause
- substitution troubleshooting (substitution of components)
- comparison troubleshooting (compare similar components)

CM2150 Workplace Communications

Description:

This course is designed to introduce students to the principles of effective communication including letters, memos, short report writing, oral presentations and interpersonal communications.

Pre-requisites: None

Duration: 45 Hours

Course Outcomes:

Upon completion of the course, students will be able to:

- understand and apply communication skills as outlined in the Employability Skills 2000, Conference Board of Canada
- understand the importance of well-developed writing skills in business and in career development
- understand the purpose of the various types of business correspondence
- examine the principles of effective business writing
- examine the standard formats for letters and memos
- write effective letters and memos
- examine the fundamentals of informal reports and the report writing procedure
- produce and orally present an informal report
- examine effective listening skills and body language in communication

Pre-Requisites: None

Objectives and Content:

1. Apply rules and principles for writing clear, concise, complete sentences which adhere to the conventions of grammar, punctuation, and mechanics.

2. Explain the rules of subject-verb agreement.
3. Define and describe the major characteristics of an effective paragraph.
4. Examine the value of business writing skills.
 - i. describe the importance of effective writing skills in business
 - ii. describe the value of well-developed writing skills to career success as referenced in the Employability Skills
5. Examine principles of effective business writing.
 - i. discuss the rationale and techniques for fostering goodwill in business communication, regardless of the circumstances
 - ii. review the importance of revising and proofreading
 - iii. differentiate between letter and memo applications in the workplace and review samples
 - iv. identify the parts of a business letter and memo
 - v. review the standard formats for business letters and memos
 - vi. examine samples of well-written and poorly written letters and memos
 - vii. examine guidelines for writing sample letters and memos which convey: acknowledgment, routine request, routine response, complaint, refusal, persuasive request and letters of appeal
6. Examine the fundamentals of informal business reports.
 - i. identify the purpose of the informal report
 - ii. identify the parts and formats of an informal report
 - iii. identify methods of information gathering
 - iv. describe the methods of referencing documents
 - v. review the importance of proof reading and editing
7. Examine types of presentations.
 - i. review and discuss components of an effective presentation
 - ii. review and discuss delivery techniques
 - iii. review and discuss preparation and use of audio/visual aids
 - iv. discuss and participate in confidence building exercises used to prepare for giving presentations

8. Interpersonal communications.
 - i. examine and apply listening techniques
 - ii. discuss the importance of body language

Practical:

1. Write well-developed, coherent, unified paragraphs which illustrate the following: a variety of sentence arrangements; conciseness and clarity; and adherence to correct and appropriate sentence structure, grammar, punctuation, and mechanics.
2. Write sample letters and memos which convey: acknowledgment, routine request, routine response, complaint, refusal, persuasive request and letters of appeal.
3. Gather pertinent information, organize information into an appropriate outline and write an informal report with documented resources.
 - i. edit, proofread, and revise the draft to create an effective informal report and present orally using visual aids
 - ii. participate in confidence building exercises
4. Present an effective presentation.
5. Evaluate presentations.

MR1220 Customer Service

Description:

This course focuses on the role of providing quality customer service. It is important to have a positive attitude and the necessary skills to effectively listen and interpret customer concerns about a product, resolve customer problems, and determine customer wants and needs. Students will be able to use the skills and knowledge gained in this course to effectively provide a consistently high level of service to the customer.

Pre-requisites: None

Duration: 30 Hours

Course Outcomes:

Upon successful completion of this course, students will be able to:

- Define customer service.
- Explain why service is important.
- Describe the relationship between “service” and “sales.”
- Demonstrate an understanding of the importance of a positive attitude.
- Demonstrate methods of resolving customer complaints.

Pre-Requisites: None

Objectives and Content:

1. Define quality service.
 - i. identify and discuss elements of customer service
 - ii. explain the difference between service vs. sales or selling
 - iii. explain why quality service is important
 - iv. identify the various types of customers and challenges they may present
 - v. describe customer loyalty

- vi. examine barriers to quality customer service
2. Explain how to determine customer's wants and needs.
 - i. identify customer needs
 - ii. explain the difference between customer wants and needs
 - iii. identify ways to ensure repeat business
 3. Demonstrate an understanding of the importance of having a positive attitude.
 - i. identify and discuss the characteristics of a positive attitude
 - ii. explain why it is important to have a positive attitude
 - iii. explain how a positive attitude can improve a customer's satisfaction
 - iv. define perception and explain how perception can alter us and customers
 - v. describe methods of dealing with perception
 4. Communicating effectively with customers.
 - i. describe the main elements in the communication process
 - ii. identify some barriers to effective communication
 - iii. explain why body language is important
 - iv. define active listening and state why it is important
 - v. identify and discuss the steps of the listening process
 - vi. identify and discuss questioning techniques
 5. Demonstrate using the telephone effectively.
 - i. explain why telephone skills are important
 - ii. describe the qualities of a professional telephone interaction
 6. Demonstrate an understanding of the importance of asserting oneself.
 - i. define assertiveness
 - ii. discuss assertive techniques
 - iii. explain the use of assertiveness when dealing with multiple customers

7. Demonstrate techniques for interacting with challenging customers in addressing complaints and resolving conflict.
 - i. examine and discuss ways to control feelings
 - ii. examine and discuss ways to interact with an upset customer
 - iii. examine and discuss ways to resolve conflict/customer criticism
 - iv. examine and discuss ways to prevent unnecessary conflict with customers

Practical:

1. Participate in activities to demonstrate knowledge of the course objectives.

SP2330 Quality Assurance/Quality Control

Description:

This course is designed to give students an understanding of the concepts and requirements of QA/QC such as, interpreting standards, controlling the acceptance of raw materials, controlling quality variables and documenting the process. It includes information on quality concepts, codes and standards, documentation, communications, human resources, company structure and policy, teamwork and responsibilities.

Pre-requisites: None

Duration: 30 Hours

Course Outcomes:

Upon completion of this course, students will be able to:

- Develop the skills and knowledge required to apply quality assurance/quality control procedures as related to the trade.
- Develop an awareness of quality principles and processes.
- Apply quality assurance/quality control procedures in a shop project.

Objectives and Content:

1. Describe the reasons for quality assurance and quality plans.
2. Explain the relationship between quality assurance and quality control.
3. Describe quality control procedures as applied to the production and checking of specifications and processes in applicable occupations.
4. Describe quality control procedures as applied to the acceptance and checking of raw materials.
5. Explain the role of communications in a quality environment.

6. Explain why it is important for all employees to understand the structure of the company and its production processes.
7. Explain how human resource effectiveness is maximized in a quality managed organization.
8. Explain the role of company policy in quality management.
9. Explain the purpose of codes and standards in various occupations.
10. Explain the concepts of quality.
 - i. cost of quality
 - ii. measurement of quality
 - iii. elements of quality
 - iv. elements of the quality audit
 - v. quality standards
 - vi. role expectations and responsibilities
11. Explain the structure of quality assurance and quality control.
 - i. describe organizational charts
 - ii. identify the elements of quality assurance system such as ISO, CSA, WHMIS, Sanitation Safety Code (SSC)
 - iii. explain the purpose of the quality assurance manual
 - iv. describe quality assurance procedures
12. Examine quality assurance/quality control documentation.
 - i. describe methods of recording reports in industry
 - ii. describe procedures of traceability (manual and computer-based recording)
 - iii. identify needs for quality control procedures

Practical:

1. Apply quality control to a project
 - i. follow QA/QC procedures for drawings, plans and specifications in applicable occupations
 - ii. calibrate measuring instruments and devices in applicable occupations.
 - iii. interpret required standards
 - iv. follow QA/QC procedures for accepting raw materials
 - v. carry out the project
 - vi. control the quality elements (variables)
 - vii. complete QA/QC reports

MC1050 Introduction to Computers

Description:

This course is designed to give the student an introduction to computer systems. Particular emphasis is given to word processing, spreadsheet, e-mail and the Internet and security issues.

Pre-Requisites: None

Duration: 30 Hours

Course Outcomes:

Upon completion of this course, students will have a basic understanding of:

- Computer systems and their operation.
- Popular software packages, their applications.
- Security issues of computers.

Objectives and Content:

1. Identify the major components of microcomputer system hardware and software system.
2. Describe the functions of the microprocessor.
 - i. describe and give examples of I/O DEVICES
 - ii. describe primary storage (RAM, ROM, Cache)
 - iii. define bit, byte, code and the prefixes k.m. and g.
 - iv. describe secondary storage (diskettes and hard disks, CD ROMS, Zip drives, etc.)
 - v. describe how to care for a computer and its accessories

3. Describe microcomputer software.
 - i. define software
 - ii. describe types of operational and application software
 - iii. define file and give the rules for filenames and file extensions
4. Describe windows software.
 - i. start and quit a program
 - ii. demonstrate how to use the help function
 - iii. locate a specific file using the find function
 - iv. identify system settings: wall paper, screen saver, screen resolution, background
 - v. start a program by using the run command
 - vi. shutting down your computer
5. Identify file management commands.
 - i. create folders
 - ii. maximize and minimize a window
 - iii. describe windows task bar
6. Describe keyboards.
 - i. identify and locate alphabetic and numeric keys
 - ii. identify and locate function key and special keys
7. Describe word processing.
 - i. describe windows components
 - ii. menu bar
 - iii. menu indicators
 - iv. document window
 - v. the status bar
 - vi. the help feature
 - vii. insertion point movements
8. Describe the procedure used to develop a document.
 - i. enter text
 - ii. change the display
9. Describe the procedure for opening, saving and exiting documents.
 - i. saving a document

- ii. closing a document.
 - iii. starting a new document Window
 - iv. opening a document
 - v. exiting word processor
10. Describe the procedure for editing a document.
- i. adding new text
 - ii. deleting text
 - iii. using basic format enhancement (split and join paragraphs, insert text)
11. Describe the main select features.
- i. identify a selection
 - ii. moving a selection
 - iii. copying a selection
 - iv. deleting a selection
 - v. saving a selection
12. Explain how to change layout format.
- i. changing layout format: (margins, spacing, alignment, paragraph indent, tabs, line spacing, page numbering)
13. Explain how to change text attributes.
- i. changing text attributes: (bold, underline, font, etc.)
14. Describe the auxiliary tools.
- i. using spell check and thesaurus
15. Describe print features.
- i. selecting the print feature: (i.e. number of copies and current document)
 - ii. identifying various options in print screen dialogue box
16. Examine and discuss electronic spreadsheet.
- i. spreadsheet basics
 - ii. the worksheet window
17. Describe menus.
- i. menu bar

- ii. control menu
 - iii. shortcut menu
 - iv. save, retrieve form menus
18. Describe the components of a worksheet.
- i. entering constant values and formulas
 - ii. using the recalculation feature
19. Describe use ranges.
- i. typing a range for a function
 - ii. pointing to a range for a function
 - iii. selecting a range for toolbar and menu commands
20. Describe how to print a worksheet.
- i. printing to the screen
 - ii. printing to the printer
 - iii. printing a selected range
21. Describe how to edit a worksheet.
- i. replacing cell contents
 - ii. inserting and deleting rows and columns
 - iii. changing cell formats
 - iv. changing cell alignments
 - v. changing column width
 - vi. copying and moving cells
22. State major security issues in using computers.
- i. pass words
 - ii. accessing accounts
 - iii. viruses and how they can be avoided
 - iv. identity theft and ways to protect personal information
 - v. demonstrate how to view directory structure and folder content
 - vi. organize files and folders
 - vii. copy, delete, and move files and folders
23. Describe how to use electronic mail.
- i. e-mail etiquette
 - ii. e-mail accounts

- iii. e-mail messages
 - iv. e-mail message with attachments
 - v. e-mail attachments
 - vi. print e-mail messages
 - vii. deleting e-mail messages
24. Explain the internet and its uses.
- i. the world wide web(www)
 - ii. accessing web sites
 - iii. internet web browsers
 - iv. internet search engines
 - v. searching techniques
 - vi. posting documents on-line

Practical:

1. Create a document using word processing.
2. Complete word processing exercises to demonstrate proficiency in word processing.
3. Prepare and send e-mails with attachments.
4. Retrieve documents and e-mail attachments and print copies.
5. Develop and print a spread sheet.
6. Post a document on-line.

SD1700 Workplace Skills

Description:

This course involves participating in meetings, information on formal meetings, unions, workers' compensation, employment insurance regulations, workers' rights and human rights.

Pre-Requisites: None

Duration: 30 Hours

Course Outcomes:

Upon completion of this course, students will be able to:

- Participate in meetings.
- Define and discuss basic concepts of:
 - unions
 - workers' compensation
 - employment insurance
 - workers' rights
 - human rights
 - workplace diversity
 - gender sensitivity

Objectives and Content:

1. Meetings.
 - i. identify and discuss meeting format and preparation required for a meeting
 - ii. explain the purpose of an agenda
 - iii. explain the roles and responsibilities of meeting participants
 - iv. explain the purpose of motions and amendments and withdrawals
 - v. explain the procedure to delay discussion of motions
 - vi. explain the voting process

2. Unions.

- i. state why unions exist
- ii. give a concise description of the history of Canadian labour
- iii. explain how unions function
- iv. explain labour's structure
- v. describe labour's social objectives
- vi. describe the relationship between Canadian labour and the workers
- vii. describe the involvement of women in unions

3. Worker's Compensation.

- i. describe the aims, objectives, benefits and regulations of the
i. Workplace Health, Safety and Compensation Commission
- ii. explain the internal review process

4. Employment Insurance.

- i. explain employment insurance regulations
- ii. describe how to apply for employment insurance
- iii. explain the appeal process
- iv. identify the components of a letter of appeal

5. Worker's rights.

- i. define labour standards
- ii. explain the purpose of the Labour Standards Act
- iii. identify regulations pertaining to:
 - hours of work
 - minimum wages
 - employment of children
 - vacation pay
- iv. explain the purpose of the Occupational Health and Safety Act as it refers to workers' rights

6. Human Rights.

- i. describe what information cannot be included on an employment
i. application
- ii. describe what information cannot be included in an interview
- iii. examine the Human Rights Code and explain the role of the
i. Human Rights Commission
- iv. define harassment in various forms and identify strategies for

prevention

7. Workplace diversity.

- i. define and explore basic concepts and terms related to workplace inclusively including age, race, culture, religion, socio-economic, sexual orientation with an emphasis on gender issues and gender stereotyping.

8. Gender sensitivity.

- i. explore gender and stereotyping issues in the workplace by identifying strategies for eliminating gender bias

Practical:

1. Prepare an agenda.
2. Participate in a meeting.
3. Analyze a documented case of a human rights complaint with special emphasis on the application, time frame, documentation needed, and legal advice available.

SD1710 Job Search Techniques

Description:

This course is designed to give students an introduction to the critical elements of effective job search techniques.

Pre-Requisites: None

Duration: 15 Hours

Course Outcomes:

Upon completion of this course, students will be able to:

- Demonstrate effective use of job search techniques.

Objectives and Content:

1. Identify and examine employment trends and opportunities.
2. Identify sources that can lead to employment.
3. Access and review information on the Newfoundland and Labrador Apprenticeship and Certification Web site and the Apprenticeship Employment Gateway.
4. Analyze job ads and discuss the importance of fitting qualifications to job requirements.
5. Identify and discuss employability skills as outlined by the Conference Board of Canada.
6. Discuss the necessity of fully completing application forms.

7. Establish the aim/purpose of a resume.
8. Explore characteristics of effective resumes, types of resumes, and principles of resume format.
9. Explore characteristics of an effective cover letter.
10. Identify commonly asked questions in an interview.
11. Explore other employment related correspondence.
12. Explore the job market to identify employability skills expected by an employer.
13. Conduct a self-analysis and compare with general employer expectations.
14. Discuss the value of establishing and maintaining a portfolio.

Practical:

1. Complete sample application forms.
2. Write a resume.
3. Write an effective cover letter.
4. Establish a portfolio.
5. Write out answers to commonly asked questions asked during interviews.
6. Identify three potential employers from the Apprenticeship Employment Gateway, Apprenticeship and Certification website.

SD1720 Entrepreneurial Awareness

Description:

This course is designed to introduce the student to the field of entrepreneurship, including the characteristics of the entrepreneur, the pros and cons of self-employment, and some of the steps involved in starting your own business.

Pre-Requisites: None

Duration: 15 Hours

Course Outcomes:

Upon completion of this course, the student will be able to:

- Identify the various types of business ownership, the advantages and disadvantages of self-employment and identify the characteristics of an entrepreneur.
- State the purpose and identify the main elements of a business plan.

Objectives and Content:

1. Explore self-employment: An alternative to employment.
 - i. identify the advantages and disadvantages of self-employment vs. regular employment
 - ii. differentiate between an entrepreneur and a small business owner
 - iii. evaluate present ideas about business people
2. Identify and discuss various types of business ownership.
 - i. explore the characteristics of entrepreneurs
 - ii. identify characteristics common to entrepreneurs
 - iii. compare one's own personal characteristics with those of entrepreneurs
 - iv. examine one's present ideas about business people

3. Identify business opportunities.
 - i. distinguish between an opportunity and an idea
 - ii. examine existing traditional and innovative business ventures
 - iii. identify and summarize the role of various agencies that support business development
4. Review the entrepreneurial process.
 - i. explain the entrepreneurial process
 - ii. describe the purpose of a business plan

AP1100 Introduction to Apprenticeship

Description:

This course is designed to give participants the knowledge base and skills necessary to understand and successfully navigate the apprenticeship/red seal program.

Pre-Requisites: None

Duration: 15 Hours

Course Outcomes:

Upon successful completion of this course, the apprentice will be able to:

- identify the requirements for registering in an Apprenticeship Program
- describe the registration process
- explain the steps to complete the Apprenticeship Program
- articulate the roles of the Apprentice, Journeyperson, Training Institutions, Industry and Governing Bodies in the Apprentice Program
- explain the significance of the Red Seal Program

Objective and Content:

1. Define apprenticeship.
 - i. define Apprenticeship and Red Seal Certification
 - ii. discuss the definition of Apprenticeship and Red Seal Certification
 - iii. distinguish between Red Seal and Provincial Certification
2. Explore how apprenticeship is governed and administered.
 - i. explain who is responsible for administering apprenticeship
 - Department of Education
 - Provincial Apprenticeship and Certification Board

3. Explore the roles and responsibilities of those involved in the apprenticeship process.
 - i. apprentice
 - ii. employer/journeyperson
 - iii. Industrial Training Division
 - explain when and where to take the in-class portion of advance training
 - discuss class calls
 - iv. Training Institutions
 - various delivery methods
 - v. Provincial Apprenticeship and Certification Board
4. List and explain the steps in the apprenticeship process.
 - i. explain the registration process
 - ii. describe apprenticeship as an agreement between employee, employer and Provincial government
 - iii. review a Memorandum of Understanding
 - iv. legal document
 - v. review an application of apprenticeship
 - original high school certificate or equivalent
 - original transcript from the applicant's training institution
 - vi. describe the roles of Institutional and Industrial Education Division of the Department of Education in apprenticeship
 - vii. explain the role of the Program Development Officer
 - define probation period
 - discusses what constitutes a cancellation of apprenticeship
 - explain the consequences of an apprenticeship cancellation
 - discuss the purpose of the Record of Occupational Progress (Log Book)
 - explore how to maintain your log book
 - discuss who is responsible for tracking and signing-off on trade skills
 - explain how and where to record hours worked
 - identify the importance of updating your file with the Program Development Officer
 - viii. differentiate between provincial and interprovincial exams

5. Describe the training and education requirements.
 - i. discuss the factors affecting on-the-job and in class portions of your training
 - ii. define in school and on the job training
 - review a Plan of Training
 - identify the percentage of on-the-job and in class training time
 - current labour market implications on completing an apprenticeship program
6. Explain Plans of Training.
 - i. identify what is included in the Plan of Training
 - entrance requirements
 - duration of in-school and on-the-job training
 - course content
 - entry level or advanced level
 - ii. explain how a Journeyperson Certificate is achieved
 - discuss Certificate of Qualification.
 - discuss Certificate of Apprenticeship.
 - discuss Red Seal endorsement
7. Discuss the Red Seal Program.
 - i. define designated trade
 - ii. explore the National Occupational Analysis for your trade
 - iii. explain Interprovincial Standards Red Seal Program and how it works.
 - labor mobility
 - qualification recognition
 - iv. discuss the range of careers possible in your chosen trade
8. Explain apprenticeship progression schedule and wage rates.
 - i. review a Record of Occupational Progress (Log Book)
 - ii. hours per program
 - iii. requirements for progression
 - iv. wage rates per year of apprenticeship

9. Identify the examinations and evaluation process used in Apprenticeship.
 - i. discuss occupational tests and examinations as directed by the Provincial Apprenticeship and Certification Board
 - theory
 - practical
 - ii. explain formal assessment and the pass mark of 70%
10. Examine some of the financial incentives available to apprentices.
 - i. Employment Insurance (E.I.) Benefits
 - ii. government sponsored student loans
 - iii. apprenticeship incentive Federal and Provincial
 - iv. scholarships
11. Continuing training outside the Province of Newfoundland Labrador.
 - i. training in other provinces and territories
 - procedure for registration and recognition of hours and skills in other provinces
 - ii. options for dual certification
 - transfer of credits
12. Review and define the following terms:
 - i. Apprenticeship Program Accreditation
 - ii. Cancellation of Apprenticeship
 - iii. Certificate of Apprenticeship
 - iv. Certificate of Qualification
 - v. Certification Renewal
 - vi. Criteria for Eligibility
 - vii. Journeyperson
 - viii. Practical Examination
 - ix. Prior Learning
 - x. Record of Occupational Progress (Logbook)
 - xi. Red Seal Certification
 - xii. Registered Apprentice
 - xiii. Theoretical Examination
 - xiv. National Occupational Analysis (NOA)
 - xv. Class Call
 - xvi. Dual certification

Practical:

1. Review the Provincial Apprenticeship web site: www.gov.nl.ca/app.
 - i. identify the requirements for registering as an apprentice and the registration process
 - ii. explain the steps to complete an apprenticeship program
 - iii. identify who is responsible for tracking and signing-off on trade skills
 - iv. identify the nearest Industrial Training Office to your community
 - v. identify the current incentives available to apprentices
2. Review a plan of training on the Provincial Apprenticeship web site.
 - i. identify the hours for your trade (in-school and on-the-job)
 - ii. explain the roles and responsibilities of the following stakeholders in the apprenticeship process: employer, apprentice, training institution and the Industrial Training Division
3. Visit the Red Seal Web site <http://www.red-seal.ca>, review the National Occupational Analyses for your trade.
 - i. review the scope of work for your occupation and identify the industry sectors and job types requiring your trade
 - ii. identify the trends of your trade
 - iii. provide a list of personal protective equipment required for your trade

MA1060 Basic Math

Description:

This course in Basic Math requires knowledge of general mathematical concepts and processes to enable trades persons to function in the institutional setting by developing numeracy skills required for technical courses. This math course should also provide a foundation for experiential learning through knowledge of math relating to on-the-job skills and practices. A detailed course outline is available from Institutional and Industrial Education, Standards and Curriculum Division to training institutions upon request.

Pre-Requisites: None

Duration: 60 Hours

Course Outcomes:

- To develop numeracy skills and knowledge required for institutional and on-the-job learning.
- To develop the capability to apply mathematical concepts in the performance of trade practices.
- To develop an appreciation for mathematics as a critical element of the learning environment
- To use mathematical principles accurately for the purposes of problem solving, job and materials estimation, measurement, calculation, system conversion, diagram interpretation and scale conversions, formulae calculations, and geometric applications.

Course Objectives (Knowledge):

1. Define and calculate using whole number operations.

2. Define and demonstrate use of correct orders of operations.
3. Demonstrate examples of operations with fractions and mixed numbers.
4. Demonstrate examples of operations with decimals.
5. Demonstrate examples of operations with percentages.
6. Employ percent/decimal/fraction conversion and comparison.
7. Define and calculate with ratios and proportions.
8. Use the Imperial Measurement system in relevant trade applications.
9. Use the Metric Measurement system in relevant trade applications.
10. Perform Imperial/Metric conversions.
11. Define and demonstrate the formulation of variables.
12. Demonstrate and define the various properties of angles and make relevant calculations.

Major Tasks/Sub-tasks (Skills):

Note: To emphasize or further develop specific knowledge objectives, students may be asked to complete practical demonstrations which confirm proper application of mathematical theory to job skills.

BLOCK 2

ER2010 Lighting and Controls

Description:

This course will involve the installation, maintenance and troubleshooting of various types of lighting systems as per CEC requirements.

Pre-requisites: Completion of all Entry Level Programs

Duration: 30 Hours

Objectives and Content:

1. Define terms associated with lighting.
2. Identify various types of incandescent lamps and describe their physical and
 - i. electrical characteristics and applications.
3. Describe the procedures used to install incandescent lighting as per CEC requirements.
4. Identify various types of fluorescent lamps and describe their physical and electrical characteristics and applications.
5. Identify components of fluorescent lighting systems.
6. Describe the procedures used to install fluorescent lighting systems as per CEC requirements.
7. Describe the procedures used to maintain and troubleshoot fluorescent lighting systems.
 - i. lamp testers
 - ii. ballast testers

8. Describe the procedure used to handle, store and dispose of ballasts and capacitors.
9. Identify types of high intensity discharge (H.I.D.) fixtures and describe their characteristics and applications.
10. Describe the procedures used to install high intensity discharge (H.I.D.) fixtures as per CEC requirements.
11. Describe the procedures used to maintain and troubleshoot high intensity discharge (H.I.D.) fixtures.
12. Describe the procedures used to install line voltage system controls as per CEC requirements.
 - i. lighting control function
 - ii. line voltage switches
 - iii. dimming circuits
 - iv. photocells
 - v. timers and time clocks
 - vi. passive infrared lighting control
 - vii. lighting contractor
 - viii. programmable lighting controls
13. Describe the procedures used to install low voltage system control as per CEC requirements.
 - i. wires
 - ii. 2 wires
 - iii. wireless

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Install incandescent lighting according to CEC requirements in a specified location.
2. Install fluorescent lighting systems according to CEC requirements in a specified location.
3. Troubleshoot problems with fluorescent lighting systems.

ER2030 Three-Phase Motors

Description:

This course will involve the installation, testing and maintenance of three-phase motors as per CEC requirements.

Pre-requisites: Completion of all Entry Level Programs

Duration: 30 Hours

Objectives and Content:

1. Identify types of three-phase motors and describe their characteristics and applications.
 - i. compare single-phase and three-phase motors
 - ii. data on nameplates
2. Describe the operating principles of three-phase squirrel cage induction motors.
 - i. construction
 - ii. calculations
 - synchronous speed
 - rotor speed
 - slip and speed regulation
 - power output and efficiency
 - power factor
 - iii. three-phase motor reversal
 - iv. motor connections
 - multi-speed motors
 - multi-voltage motors
 - v. fast reversing motors
3. Describe the operating principles of three-phase wound rotor induction motors.
 - i. construction
 - ii. speed control
 - iii. terminal markings
 - iv. characteristics

- v. applications
- 4. Describe the operating principles of synchronous motors.
 - i. construction
 - ii. principles of operation
 - starting
 - DC field excitation to obtain synchronous speed
 - starting torque and damper winding
 - iii. power factor
 - under, normal and over excitation
 - operating under different loads
 - iv. industrial application
 - constant speed application
 - synchronous condenser
 - v. field discharge resistor
- 5. Identify devices for protection of motors and describe their applications.
 - i. overcurrent protection
 - non-time delay fuse
 - time delay fuse
 - circuit breaker
 - ii. overload protection
 - eutectic and bimetallic
 - time-delay fuse
 - built-in overheating protection
 - iii. bonding
- 6. Describe the procedures used to calculate the rating of protection devices and conductor size as per CEC requirements.
 - i. conductor size supplying a motor
 - ii. motor branch circuit overcurrent protection device rating
 - iii. motor overload protection device rating
 - iv. feeder conductor size supplying a group of motors
 - v. feed overcurrent protection device rating for a group of motors
- 7. Describe the procedures used to maintain three-phase motors.
- 8. Describe generic maintenance procedures for three-phase motors and the procedures used to document work performed.

9. Describe the procedures used to test motors.
 - i. speed testing and indicating
 - speed testing
 - speed indicators
 - tachometers
 - stroboscope
 - magnetos and impulse converters
 - using speed measuring devices
 - ii. torque testing instruments
 - development of torque
 - torque measurement
 - iii. frequency testing instruments
 - frequency indicators
 - vibrating reed frequency meter
 - shading coil frequency meters
 - resonant circuit frequency meter
 - electronic type frequency meter
 - iv. phase indicating instruments
 - phase rotation tester
 - phase sequence indicator
 - marking of phase conductors

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Connect and operate three-phase squirrel cage motors in accordance with CEC requirements.
2. Connect and operate three-phase wound rotor motors in accordance with CEC requirements.
3. Connect and operate three-phase synchronous motors in accordance with CEC requirements.
4. Conduct operational tests pertaining to three-phase motors.

ER2041 Control Devices

Description:

This course will involve the selection, installation, and maintenance of control devices as per CEC requirements.

Pre-requisites: ER2030

Duration: 30 Hours

Objectives and Content:

1. Describe the construction and operation of pushbuttons.
 - i. pushbutton operators
 - ii. contact assemblies
 - iii. palm operator pushbuttons
 - iv. special purpose pushbuttons
2. Describe the construction and operation of selector switches.
 - i. cam operators
 - ii. joy stick operators
 - iii. contact assemblies
3. Describe the construction and operation of centrifugal switches.
 - i. purpose
 - ii. circuit connections
4. Describe the construction and operation of limit switches.
 - i. operating units
5. Describe the operation/limitations of proximity switches.
 - i. inductive proximity sensors
 - operation and examples
 - installation techniques
 - ii. ultrasonic proximity sensors
 - operation

- detection and accuracy
 - iii. capacitive proximity sensors
 - operation
 - iv. wiring proximity sensors
 - v. troubleshooting techniques
- 6. Describe the operation of photo sensors and switches.
 - i. phototubes (photoemissive cells)
 - ii. solar cells (photovoltaic cells)
 - iii. photoresistive cells (photoconductive)
 - iv. photodiodes/phototransistors
 - v. installation of photo switches
- 7. Describe the operation of time switches.
 - i. time switches and timing logic
 - ii. associated terms
 - iii. timing charts
 - iv. wiring diagrams/connections
- 8. Describe types of counters and totalizers and describe their characteristics, applications and operation.
 - i. associated terms
 - ii. electronic counters
 - iii. applying input signals
 - iv. electromechanical counter
- 9. Describe types of relays and describe their characteristics, applications and operation.
 - i. general purpose
 - ii. definite purpose
 - iii. machine tool relays
 - iv. protective relays
 - v. construction
 - vi. programmable
- 10. Describe the operation of temperature-operated devices.
 - i. types
 - ii. R.T.D
 - iii. thermo couple

- iv. purpose
 - v. associated terms
 - vi. selecting temperature controls
 - vii. input devices
 - viii. connections
-
- 11. Describe the methods of controlling/determining liquid levels.
 - i. type of liquid levels
 - float switches/controls
 - probe-type level detector
 - pressure switches
 - radiation absorption types of level control
 - 12. Describe the methods of controlling/determining pressure levels.
 - i. types of pressure switches
 - ii. installation and wiring
 - 13. Describe the methods used to determine the flow of air or liquids.
 - i. types of flow switches
 - ii. installation and wiring

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.
Practical Projects include:

- 1. Classroom exercise as determined by the instructor.

ER2050 Motor Starters and Controllers

Description:

This course will involve the installation, maintenance and troubleshooting of motor starters and controllers.

Pre-requisites: ER2041

Duration: 60 Hours

Objectives and Content:

1. Describe the procedures used to interpret wiring and schematic diagrams.
2. Describe the characteristics, purpose and construction of common magnetic starters.
 - i. magnetic starters
 - contactor relay (armature, contact)
 - auxiliary contact
 - magnetic operation
 - removing and replacing contacts and coil
 - ii. low voltage protection and release
 - iii. control devices (pushbutton, limit switch, etc.)
 - iv. power contacts
 - v. starter size
3. Describe the construction, operation and installation of overload devices.
 - i. overload relay trip characteristics
 - ii. types of overload units
 - melting alloy
 - bimetallic
 - magnetic
 - iii. thermal overload relay selection (charts and CEC tables)
 - iv. ambient temperature compensation

4. Identify common circuits and describe their applications.
 - i. two-wire control
 - ii. three-wire control
5. Identify various types of circuits and describe their applications.
 - i. single station
 - ii. multiple station
 - iii. forward and reverse
 - iv. jogging
 - v. sequential control
6. Identify motor interlock circuits and describe their applications.
 - i. mechanical
 - ii. electrical
 - iii. push button
7. Identify quick stop circuits and describe their applications.
 - i. plugging
 - ii. dynamic braking
 - iii. electro-magnetic brakes
8. Identify time delay relays and describe their applications.
 - i. on-delay
 - ii. off-delay
9. Identify circuit sources and describe their applications.
 - i. separate voltage source
 - ii. control circuit transformer
 - selection
10. Describe the operation, construction and installation of wound rotor motor controllers as per CEC requirements.
11. Describe the construction of motor control centers and procedures for assembly and installation.

12. Identify types of reduced voltage starters and describe their applications.
 - i. primary resistor starters
 - ii. autotransformer starters
 - iii. wye-delta starters
 - iv. reactor starters
13. Identify types of multi-speed controllers and describe their applications.
 - i. magnetic relays
 - manual control
 - automatic control
 - ii. drum controllers
 - iii. identify and describe basic frequency drives
 - iv. soft-start electronic starters
14. Identify and describe programmable controllers (PLC).
 - i. basic operation overview (input card, CPU and output card)
15. Describe the procedures used to troubleshoot control circuits, starters and controllers.
16. Describe the procedures used to install and maintain motor starters and controllers.
 - i. care for enclosures
 - ii. cleaning
 - iii. eliminating vibration problems
 - iv. providing adequate ventilation
 - v. preventing condensation
 - vi. torquing connections
17. Program programmable relays.

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Connect and operate common magnetic starters and controllers.
2. Install overload devices.
3. Maintain and troubleshoot control circuits, starters and controllers.
4. Connect and operate manual starters.
5. Install/connect input devices according to specific requirements.
6. Install/connect input devices in a sequential operation.

ER2021 Single-Phase AC Motors

Description:

This course will involve knowledge of installation, as well as connection, troubleshooting and testing of single-phase AC motors as per CEC requirements.

Pre-requisites: ER1270

Duration: 30 Hours

Objectives and Content:

1. Identify hazards and describe safe work practices pertaining to single-phase AC motors.
2. Define terminology associated with single-phase AC motors.
3. Interpret codes and regulations pertaining to single-phase AC motors.
4. Interpret information pertaining to single-phase AC motors found on drawings and specifications.
5. Identify various types of single-phase AC motors and describe their components, characteristics and principles of operation.
 - i. split-phase induction motor
 - ii. capacitor start motor
 - iii. permanent-split capacitor motor
 - iv. two-capacitor motor
 - v. capacitor-autotransformer motor
6. Describe the operation of single-phase series motors (universal).
 - i. construction
 - ii. speed regulation

7. Identify the considerations and requirements for selecting a single-phase motor.
 - i. motor classification
 - ii. starting characteristics and motor enclosures
 - starting current
 - running current (FLC)
 - locked-rotor current
 - motor enclosures types
 - effect of duty cycle
 - iii. temperature
 - considerations
 - rate of rise
 - iv. physical characteristics
 - frame size
 - motor mounts
 - power supply and connections (120 V and 240 V)
8. Identify and describe devices for protection of motors.
 - i. overcurrent protection
 - non-time delay fuse
 - time delay fuse
 - circuit breaker
 - ii. overload protection
 - eutectic and bimetallic
 - time-delay fuse
 - built-in overheating protection
 - low voltage protection and release
 - selection table of heater elements
9. Describe the procedures used to calculate the rating of protection devices and conductor size as per CEC requirements.
 - i. conductor size supplying a motor
 - ii. motor branch circuit overcurrent protection device rating
 - iii. feeder conductor size supplying a group of motors
 - iv. feeder overcurrent protection device rating for a group of motors
 - v. bonding
10. Describe generic maintenance procedures for single-phase AC motors and the procedures used to document work performed.

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Connect and operate single phase motors.
2. Troubleshoot single phase motors.
3. Conduct operational tests pertaining to single-phase AC motors.

ER2073 Power Supply and Rectifiers

Description:

This course will involve the installation and troubleshooting of power supply and rectifiers.

Pre-requisites: Completion of all entry level courses

Duration: 50 Hours

Objectives and Content:

1. Describe the construction, characteristics and power ratings of resistors.
 - i. carbon
 - ii. wire wound
 - iii. identification and colour code
 - iv. variable resistors
 - connection as a rheostat
 - connection as a potentiometer
 - v. testing a resistor
 - ohmmeter test
 - symbol
2. Identify types of capacitors and describe their construction, characteristics and applications.
 - i. types of capacitors
 - standard (mica, ceramic etc.)
 - electrolytic
 - ii. construction of capacitors
 - plate/area
 - isolation (dielectric)
 - iii. capacitor operation
 - farad
 - charging and discharging
 - time constant
 - iv. testing a capacitor

- ohmmeter test
 - capacitor tester
 - symbol
 - capacitor rating
- 3. Identify types of inductors and describe their construction, characteristics and applications.
 - i. types of inductors
 - air-core
 - iron-core
 - ii. inductance effect
 - Ienz-law
 - time constant
 - iii. value (henry) and symbol
- 4. Describe the basic characteristics of semiconductor materials.
 - i. semiconductor theory
 - ii. covalent bonding
 - iii. N-type semiconductor material
 - iv. P-type semiconductor material
- 5. Describe the characteristics of the PN junction diode.
 - i. the pn junction
 - ii. reverse bias
 - iii. forward bias
 - iv. voltage/current graph
 - v. diode specifications
 - vi. diode polarity
 - vii. ohmmeter tests
- 6. Describe the operation of single-phase rectifier circuits.
 - i. rectifier wave form
 - half-wave rectifier
 - full-wave bridge rectifier
 - ii. ripple frequency

7. Describe the operation of the Zener diode.
 - i. voltage/current graph
 - ii. DC voltage regulator circuits
 - iii. AC clipping action
 - iv. terminal and symbol
8. Describe the procedures used to calculate and measure power, current and voltage values in rectifier circuits.
 - i. average values
 - ii. effective (RMS) values
 - iii. peak inverse voltage
 - iv. power value
 - v. simple power supply calculations
9. Identify types of filter circuits for single-phase rectifiers.
 - i. capacitor filter
 - ii. choke filter
 - iii. LC Filter arrangements
 - iv. PI filter
10. Describe the features of the silicon-controlled rectifier (SCR).
 - i. construction
 - terminal and symbol
 - layers
 - ii. operation
 - triggering action (two-transistors equivalent circuit)
 - iii. characteristics
 - current/voltage graph
 - typical rating
11. Describe the action of the SCR in a circuit.
 - i. AC circuit
 - half-wave rectification
 - phase control
 - firing point
 - full-wave rectification
 - ii. DC circuit

- commutation circuit
12. Describe the features of the TRIAC.
- i. construction
 - terminal and symbol
 - SCR equivalent circuit
 - ii. operation
 - triggering action
 - iii. characteristics
 - current/voltage graph
 - typical rating
13. Describe the procedures used to test SCR's and TRIAC's
- i. Ohmmeter test
 - SCR testing
 - TRIAC testing
14. Describe the common triggering circuit for achieving phase control with the SCR.
- ii. resistance only triggering
 - iii. resistance-capacitance triggering (time-constant)
15. Describe three-phase rectifiers and their operation.
- i. wye connected half-wave rectifier
 - ii. compute the average dc output of a half-wave, three-phase rectifier
 - iii. bridge connected full-wave rectifier
 - iv. compute the average dc output of a full-wave, three-phase rectifier
 - v. applications
 - basic example of three-phase motor speed controller
 - basic example of DC motor speed controller
 - vi. ripple frequency
16. Describe basic circuit application using thyristors.
- i. small dc motor speed control circuit example
 - ii. small ac motor speed control circuit example
 - iii. small ac and dc motor speed control circuit example
 - iv. regulated battery charging circuit example
 - v. static motor starting switch
 - vi. incandescent lamp dimmer

17. Describe other diode applications.

- i. free-wheeling diodes
- ii. light-emitting diodes
 - single LED's
 - seven segment LED display
- iii. photodiodes

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Use an oscilloscope to measure and test regulated power supply.
2. Connect, operate and troubleshoot half wave and full wave rectifiers.
3. Connect, operate and troubleshoot regulated power supply.
4. Calculate and measure power, current and voltage values in rectifier circuits.

ER2133 Signaling and Communication Systems

Description:

This course will involve knowledge and installation of various signaling and communication systems such as nurse calls, public address, intercom / video, voice / data, and building automation systems as per CEC requirements.

Pre-requisites: ER1370

Duration: 10 Hours

Objectives and Content:

1. Identify hazards and describe safe work practices pertaining to signaling and communication systems.
2. Define terminology associated with signaling and communication systems.
3. Interpret codes and regulations pertaining to signaling and communication systems.
4. Interpret information and symbols pertaining to signaling and communication systems found on drawings and specifications.
5. Identify types of communication systems and describe their characteristics and applications.
 - i. voice/data
 - ii. public address (PA)
 - iii. nurse call
 - control consoles
 - patient stations
 - emergency stations
 - corridor lights
 - annunciator modules
 - power supplies
 - iv. building automation

- lighting controls
 - heating and ventilation controls
 - load shedding
6. Identify communication system components and accessories and describe their characteristics and applications.
 7. Identify methods of data transfer and describe their applications.
 - i. copper
 - ii. fiber optic
 - iii. wireless
 8. Identify types of residential intercoms / video systems and describe their components.
 - i. basic master/sub units
 - ii. door answering system
 - iii. residential voice communication
 - iv. radio intercom
 - v. residential video intercoms
 9. Describe a typical apartment building intercom system, its main components and operation.
 - i. vestibule assemblies
 - ii. back boxes
 - iii. amplifiers
 - iv. vestibule panel/directory
 - v. suite stations
 - vi. electric door strike
 - vii. wiring connections as per manufacturer's schematics
 - viii. interfacing telephone and intercom/door release systems
 10. Describe commercial sound/intercom systems, their components and operation.
 - i. telephone-access paging
 - ii. access modules communication/sound systems

BLOCK 3

ER1300 DC Motors and Controls

Description:

This course will involve the installation and maintenance of DC motors and controls as per CEC requirements.

Pre-requisites: Completion of Block II

Duration: 30 Hours

Objectives and Content:

1. Describe the construction of direct current (DC) motors.
 - i. motor nameplate data
2. Identify various types of DC motors and describe their characteristics and applications.
3. Describe the operation of automatic motor controls.
 - i. motor braking
 - dynamic
 - ii. voltage drop acceleration controller
 - iii. CEMF acceleration controller
4. Describe the procedures used to install and connect DC motors and their
 - i. controls
5. Describe the procedures used to maintain DC motors.
6. Describe generic maintenance procedures for DC motors and controls and the procedures used to document work performed

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Connect and operate DC motors.
2. Dismantle, identify, test and reassemble DC motors.
3. Troubleshoot DC motors.
4. Conduct operational tests pertaining to DC motors and controls.

ER2161 Solid State Drives

Description:

This course will involve the installation and troubleshooting of solid state controls for motors.

Pre-requisites: ER2073

Duration: 20 Hours

Objectives and Content:

1. Describe the operation of solid state DC motor controllers.
 - i. power converters
 - ii. field voltage control
 - iii. armature voltage control
 - iv. protection
 - v. speed control
 - vi. reversing
2. Describe the procedures used to install, maintain and troubleshoot solid state DC motor controllers.
3. Describe the procedures used to install, maintain and troubleshoot variable frequency AC drives.
 - i. DC power section
 - ii. AC power section
 - iii. control section
 - iv. size and ratings
4. Describe the operation of the frequency converter (inverter).
 - i. Variable Voltage Inverter (VVI)
 - ii. Pulse Width Modulated Inverter (PMW)
 - iii. Current Source Inverter (CSI)

5. Describe the operation of motors used with variable frequency AC drives.
 - i. filtering
 - ii. speed characteristics
 - iii. torque characteristics
 - iv. braking
 - v. reversing
 - vi. protection

8. Describe the procedures used to test and troubleshoot variable frequency AC drives.
 - i. start-up and adjustments
 - ii. voltage readings
 - iii. oscilloscope readings
 - iv. harmonics

9. Identify types of drives and describe their operation.

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Connect, operate, test and troubleshoot solid state DC motor controllers.
2. Connect, operate, test and troubleshoot solid state frequency AC drives.

ER2240 DC Generators

Description:

This course will involve the installation, maintenance and troubleshooting of DC generators.

Pre-requisites: ER1300

Duration: 30 Hours

Objectives and Content:

1. Identify and describe the basic components of a typical DC generator.
2. Describe the generation of voltage.
 - i. magnets and magnetic fields
 - ii. magnetic terms and definitions
 - iii. permanent and temporary magnets
 - iv. left-hand coil rule
 - v. current flow (electron and conventional)
 - vi. losses in magnetic coils (eddy current and hysteresis)
 - vii. induced voltages
 - viii. generator effect
 - ix. left-hand generator rule
 - x. generating an emf
 - xi. motor effect in a generator
 - xii. losses and efficiency of a generator
3. Describe the characteristics of series, shunt and compound DC generators.
 - i. method of field excitation
 - ii. shunt generators
 - iii. series generators
 - iv. compound generators
 - v. generator rheostats
 - field rheostats
 - diverter rheostats

- vi. static excitation
- 4. Describe the procedures used to install and maintain DC generators as per CEC requirements.
 - i. installation of generators and peripheral devices
 - ii. pre-commissioning checks
- 5. Describe generic maintenance procedures for DC generators and the procedures used to document work performed.
- 6. Describe the procedures used to troubleshoot generator problems.
 - i. failure to generate voltage
 - lack of residual magnetism (field flashing and motorizing)
 - loose connection
 - poor brushes contact
 - wrong brushes position
 - wrong field polarity
 - field rheostat
 - ii. brush tension
 - iii. care of commutator
 - iv. generator reversal

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.
Practical Projects include:

- 1. Identify the basic components of a typical DC generator.
- 2. Connect and operate DC generators in accordance with CEC requirements.
- 3. Troubleshoot problems with DC generators.
- 4. Conduct operational tests pertaining to DC generators.

ER2250 AC Generators

Description:

This course will involve the installation, maintenance and troubleshooting of AC generators and identification of alternative power systems.

Pre-requisites: ER2030

Duration: 30 Hours

Objectives and Content:

1. Identify types of AC generators.
 - i. salient
 - ii. cylindrical
2. Describe the construction and characteristics of AC generators.
 - i. construction
 - frame, rotor, field pole
 - exciter
 - rectifier assembly
 - ii. characteristics
 - armature reaction
 - reactance
 - factors affecting the output voltage
 - effects of load power factor
 - voltage regulation
 - automatic regulators
 - efficiency
 - ratings
 - nameplate information
3. Explain the operating principles of AC generators.
 - i. three-phase generators
 - wye connection
 - delta connection

- stator windings (formed coil)
 - ii. methods of ac generation
 - revolving field
 - revolving armature
 - iii. amortisseur windings
 - iv. field discharge circuits
 - v. ventilation and cooling
- 4. Describe the construction and operation of brushless synchronous generators.
 - i. construction
 - frame, rotor, field pole, etc.
 - exciter
 - rectifier assembly
 - ii. operation
 - iii. static voltage regulation
 - iv. voltage sensing
 - v. compensation for parallel operation
- 5. Describe the procedures used to control the output voltage and frequency of AC generators.
 - i. prime mover relationship
 - ii. excitation
- 6. Describe the procedures used to install, maintain and troubleshoot AC generators.
- 7. Describe the procedures used to connect AC generators in parallel.
 - i. generator requirements
 - voltage relationships
 - frequency relationships
 - in-phase relationships
 - phase sequence relationships
 - ii. load sharing
 - iii. synchronization
 - one-dark, two-bright method
 - three-dark method
 - synchroscopes
 - iv. hunting

8. Identify alternative power systems.
 - i. solar
 - ii. wind
 - iii. thermal
9. Describe generic maintenance procedures for AC generators and the procedures used to document work performed.

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Connect, operate, test and troubleshoot
 - i. AC generators in parallel
 - ii. AC generators
2. Conduct operational tests pertaining to AC generators.

ER2261 Emergency Stand-By Units

Description:

This course will involve the installation, maintenance and troubleshooting of emergency stand-by systems and their associated devices as per code requirements.

Pre-requisites: ER2250

Duration: 20 Hours

Objectives and Content:

1. Determine the requirements of emergency stand-by power units according to applicable codes and standards.
 - i. National Building Code (NBC)
 - ii. Canadian Electrical Code (CEC)
 - iii. Canadian Standards Association (CSA)
2. Describe the procedures used to install a generator stand-by emergency power unit.
3. Describe the procedures used to install manual and automatic transfer switches.
 - i. neutral transfer switches
 - ii. optional controls for transfer switches
 - iii. two source system
4. Describe the construction and operation of uninterruptible power supplies.
 - i. power line problems
 - ii. UPS system configurations
 - iii. UPS selection
5. Describe the procedures use to troubleshoot stand-by power systems.
 - i. storage battery units
 - ii. uninterruptable power supplies
 - iii. engine generator sets
 - iv. transfer switches

6. Describe the construction and operating principles of primary and secondary batteries.
7. Describe the cell characteristics of nickel-iron and nickel-cadmium batteries.
8. Identify battery stand-by power system units and describe the procedures used to size and install as per CEC requirements.
 - i. cell/battery ampere/hour ratings
 - ii. effects of temperature
 - iii. room location/requirements
 - iv. rack assemblies
 - v. cell interconnections
9. Describe the procedures used to maintain stationary battery systems.
 - i. condition of charge
 - ii. use of float hydrometer
 - iii. variation with temperature
 - iv. variation with electrolyte level
 - v. loss after water addition
 - vi. correcting low specific gravity
 - vii. charge indicators
 - viii. open voltage test
 - ix. measuring cell voltage under load
 - x. ampere hour measurements
10. Describe the procedures used to connect and set-up battery chargers.
 - i. charging process
 - ii. charging cycle
 - iii. safety conditions
 - iv. cleaning
 - v. initial charge
 - vi. constant voltage method
11. Identify solar energy charging systems and describe their use.
 - i. solar cells
 - ii. photovoltaic cells

12. Describe generic maintenance procedures for emergency stand-by units and the

procedures used to document work performed.

13. Describe the procedures used to conduct operational tests pertaining to emergency stand-by units.

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Classroom exercise as determined by the instructor.

ER2270 Emergency Lighting Systems

Description:

This course will involve the installation, maintenance and troubleshooting of emergency lighting systems.

Pre-requisites: Completion of Block II

Duration: 15 Hours

Objectives and Content:

1. Determine the requirements of emergency lighting systems according to applicable codes and standards.
 - i. National Building Code (NBC)
 - ii. Canadian Electrical Code (CEC)
2. Describe the procedures used to install self-contained lighting units.
 - i. batteries
 - ii. battery chargers
 - iii. cabinets
 - iv. industrial emergency lighting units
3. Describe the procedures used to install central-powered emergency lighting units.
4. Determine exit sign requirements according to NBC.
 - i. types
 - nuclear powered
 - conventional powered
 - ii. applicable regulations
5. Identify types of inverters and converters used on emergency lighting systems and describe their operation.
 - i. types
 - inverter
 - converter

- cyclo-inverter
 - ii. characteristics of solid state inverters/converters
 - iii. configurations
 - iv. circuit description
 - v. accessories
 - overcurrent protection
 - open-circuit
 - sine wave
 - vi. output, regulated output
 - vii. fluorescent inverters
6. Determine conductor requirements for remote lighting units according to the CEC.
- i. voltage drop
 - ii. sizing conductors according to distance
7. Describe generic maintenance procedures for emergency lighting systems and the procedures used to document work performed.
8. Describe the procedures used to conduct operational tests pertaining to emergency lighting systems.

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

ER2300 Distribution System Conditioning

Description:

This course will involve the knowledge of procedures to improve power quality.

Pre-requisites: ER2161

Duration: 30 Hours

Objectives and Content:

1. Describe the significance of power quality.
 - i. sensitive loads
 - ii. technological complexity
 - iii. disturbance-producing equipment
2. Identify the reactive power needed to raise power factor.
3. Describe different meters used in power measurements.
 - i. wattmeters
 - ii. power factor meters
 - iii. phase angle meters
4. Describe the procedures used to install power factor correction equipment.
 - i. capacitor banks
 - characteristics
 - ratings and tolerances
 - considerations for installation
 - temperature and ventilation
 - fusing
 - conductor size
 - disconnecting means
 - capacitor life
 - capacitor PCB considerations and safety
 - ii. synchronous motors
 - iii. locating of power factor correction equipment

- individual
 - group
 - central correction units
5. Describe power system harmonics and their effects.
- i. harmonics theory
 - triplen
 - linear loads
 - non-linear loads
 - ii. effects of harmonics on:
 - phase conductors and conduit
 - circuit breakers
 - neutral conductors
 - neutral-to-ground voltage at receptacles
 - neutral bus bar and neutral lug
 - transformers
 - power factor correction capacitors
 - kW and kVar meters
 - multi-meter readings
6. Describe the methods of reducing power system harmonics as per CEC requirements.
- i. shunt harmonic filters
 - ii. series harmonic filters
 - iii. Wye-delta zero sequence harmonic trap
 - iv. zig-zag autotransformer zero sequence harmonic trap
 - v. Wye-delta with tuned capacitor zero sequence harmonic trap
7. Describe abnormal voltage fluctuations in power distribution systems.
- i. tingle voltage
 - ii. swell
 - iii. transient
 - iv. sustained power interruption
 - v. momentary power interruption
 - vi. brownout
 - vii. lightning

8. Describe the mitigating equipment used to correct voltage problems.

- i. transient suppressors
 - lightning arrester
 - line clamp (surge suppressor)
- ii. power line filters
 - linear (passive)
 - hybrid
 - tingle voltage
- iii. isolation transformers
- iv. line voltage regulators
 - ferroresonant transformers
 - tap switching transformers
- v. power line conditioners
 - linear amplifier
 - ferroresonant
 - tap switching
 - motor-generator
- vi. uninterruptible power supply system (UPS)
 - on-line
 - rotary
 - static
 - continuous
 - line-interactive
- vii. standby power supply system (SPS)
 - off-line
 - static
 - simple
 - ferroresonant

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Lab Projects as required by the Instructor.

ER2350 Electric Surface Heating Units

Description:

This course will involve the installation of various types of electric surface heating units.

Pre-requisites: Completion of Block II

Duration: 15 Hours

Objectives and Content:

1. Describe types of snow melting and floor warming cables, their characteristics and procedures for installation.
 - i. over-temperature protection
 - ii. controls
2. Describe the procedures used to install pipe tracing and tank heating cables.
 - i. types of cables
 - ii. tracing cable temperature control
 - iii. tracing cable selection
 - iv. tracing cable installation
3. Describe de-icing cables, their components, characteristics, applications and procedures for installation.
 - i. loading requirements
 - ii. controls
4. Describe types of immersion heaters and their procedures for installation.
 - i. construction features
 - ii. temperature control
 - iii. bonding and grounding requirements for livestock waters

5. Describe heat tracing systems, their components, applications and procedures for installation.
 - i. manufacturer's instruction
 - ii. devices
 - iii. sidewalk/driveways
 - iv. pipes
 - v. series and parallel

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Classroom exercise as determined by the instructor.

ER1380 Distribution Equipment and Installation

Description:

This course will involve the installation and connection of various types of commercial and industrial distribution equipment as per CEC requirements.

Pre-requisites: Completion of Block II

Duration: 20 Hours

Objectives and Content:

1. Describe disconnect switch sizes, ratings and requirements for distribution equipment installation.
 - i. intended applications
 - isolation use (motors and equipment)
 - service use
 - ii. motor-circuit switches
 - high interrupting capacity switches
 - horsepower ratings
 - dual-horsepower ratings
 - iii. contact assembly
 - quick-make, quick-break
 - non-teasing mechanism
 - bolted-pressure contact
 - iv. optional attachments
 - v. ground fault protection
 - vi. phase-failure relay
 - vii. shunt tripping
 - viii. auxiliary contacts
 - ix. anti-single-phasing blown fuse indicator
 - x. neutral grounding device

2. Describe the features, installation procedures and applications of low-voltage switchboards.
 - i. applications
 - ii. current and voltage ratings
 - iii. incoming arrangements
 - bottom entry
 - top entry/top hat
 - side wireways
 - bussed
 - not bussed
 - mandatory bussed
 - busway entry
 - bus sub
 - iv. construction
 - cell dimensions
 - bus bracing standards
 - bus options
 - inside/outside corner units
 - receiving, storage and assembly of shipping units
 - v. main disconnect section
 - vi. utility compartments
 - vii. distribution arrangements
 - twin mounted breakers
 - single mounted breakers
 - breaker/fusible switch units
 - subpanels
 - viii. metering centres
 - ix. customer metering, relay functions
 - digital meter/analog meter
 - volts
 - amps
 - pf
 - kW
 - kWh
 - kVA
 - Hz
 - communications/transducers
 - pulse initiator outputs

- relaying and protective functions
 - undervoltage
 - single-phase
 - phase sequence
 - x. check list before energizing
 - ground system for continuity
 - retorque all bolted connections
 - tighten bus mountings
 - align breakers, switches and other mechanisms for proper operation
 - xi. megger test
 - switches/breakers open
 - phase-to-phase
 - phase-to-ground
 - switches/breakers closed
 - phase-to-phase
 - phase-to-ground
 - xii. check wiring and operation of relays meters and instrumentation
 - xiii. test electrically operated switches and breakers
 - xiv. test ground fault operation
3. Describe the applications and features of metal-enclosed low voltage power switchgear.
- i. ANSI definition
 - ii. current and voltage ratings
 - iii. switchgear construction
 - indoor
 - outdoor
 - iv. free standing units (cells)
 - front enclosure
 - breaker cells
 - auxiliary cell
 - fixed-metering
 - bus compartment
 - horizontal main bus
 - vertical bus
 - cable and termination compartment
 - cable load terminations
 - bus load terminations

- neutral bus
 - ground bus
 - ground detection transformers
 - v. transformer unit
 - liquid-filled
 - air-cooled
 - single-ended
 - double-ended
- 4. Describe the applications and features of medium-voltage metal-clad switchgear.
- 5. Describe the procedures used to receive, handle, store and install switchgear.
 - i. receiving switchgear
 - checking damage
 - ii. handling switchgear
 - lifting by crane
 - lifting hooks
 - using spreader bars
 - skidded on rollers
 - longitudinal skidding
 - front-to-back skidding
 - removing rollers
 - iii. temporary storage
 - environmental conditions
 - surface considerations
 - outdoor storage
 - temporary storage building
 - heating requirements
 - iv. installation
 - location
 - foundation
 - floor steel
 - conduits
 - shipping skids
 - shipping braces
 - v. final assembly
 - setting reference lines for front panels
 - centre to centre spacing of units
 - setting units plumb

- securing shipping groups together
 - secure entire assembly to floor channels or base pad
- vi. connections
 - bus connections
 - ground bus connections
 - main power connections
 - bolt torque
 - control connections
 - moving parts
 - removal of blocking and bracing
- vii. key operated interlocks

ER1211 Advanced Drawings, Schematics and Specifications

Description:

This course will involve interpreting and extracting information from construction drawings, schematics and specifications relevant to electrical installations.

Pre-requisites: Completion of Block II

Duration: 30 Hours

Objectives and Content:

1. Review and interpret information from site plans.
 - i. protected areas
 - ii. original contours/grades
 - iii. underground pipe lines
 - iv. bench marks/datum points
 - v. grounding grid
 - vi. area lighting
 - vii. trench details
 - viii. service/utility location
 - ix. symbols and legends
2. Review and interpret information from elevations, floor plans and reflected ceiling plans.
 - i. general building design
 - ii. interior finishes
 - iii. control joints
 - iv. exterior finishes
 - v. location of door/windows, air intake/exhaust
 - vi. number of floors c/w elevations
3. Review and interpret reference/key diagrams used on drawings.
 - i. structural reference grids
 - ii. key diagrams
 - iii. reference bubbles

- iv. section reference bubbles
 - v. detail reference
4. Review and interpret information from distribution system layout drawings.
- i. switchboards/substations
 - ii. metering centres
 - iii. component tables
5. Review and interpret information from single-line drawings.
- i. feeder size/risers
 - ii. transformers
 - voltage ratings
 - capacity
 - connections
 - iii. panel board designations
 - iv. distribution boards
 - v. connected apparatus
 - vi. equipment layout elevations
 - vii. fire alarm systems
 - viii. communication and security systems
 - ix. energy management systems
6. Review and interpret information from equipment schedules.
7. Review and interpret information from motor control center diagrams.
- i. starter/controller locations
 - ii. wiring diagrams (generic)
 - iii. overload/overcurrent
 - iv. conductor sizes
 - v. interconnections/interlocking
8. Describe the function of a CAD system.

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Extract and interpret information from:
 - i. site plans
 - ii. elevation/floor plans
 - iii. distribution system layout drawings
 - iv. single-line drawings
 - v. equipment schedules
 - vi. equipment shop drawings
2. Determine measurements from scaled drawings.
3. Extract information from project documents.
4. Interpret reference/key diagrams used on drawings.

BLOCK 4

ER2061 Central Heating Units

Description:

This course will involve the installation of central heating systems and their wiring.

Pre-requisites: Completion of Block III

Duration: 20 Hours

Objectives and Content:

1. Describe the procedures used to install wiring and controls for electric furnaces.
 - i. electric furnace controls
 - ii. control switches
 - iii. switching and relays
 - iv. multi stage control
 - v. electric furnace limit protection
2. Describe the procedures used to install wiring and controls for duct heaters.
 - i. applications
 - primary
 - preheat
 - reheat
 - supplemental or auxiliary
 - ii. installation
 - iii. velocity
 - iv. heater position
 - v. air flow direction
 - vi. control
3. Describe the procedures used to install wiring and control for electric boilers.
 - i. controls
 - ii. adjustable aquastat

- iii. high limit aquastat
 - iv. pressure/temperature relief valves, gauges
 - v. zone control for hydronic systems
4. Describe the procedures used to install wiring and controls for dual energy heating units.
- i. hot water
 - ii. forced air
 - iii. load management panels
5. Describe heat pumps and the procedures used to install wiring and controls.
- i. types and sizes of heat pumps
 - ii. basic operating principles of heat pumps
 - iii. outdoor and indoor fans
 - iv. auxiliary outdoor and indoor heaters
 - v. high pressure and low pressure control
 - vi. indoor staging thermostats
 - vii. fusing and disconnecting/isolating switch requirements
6. Describe power and control wiring.
- i. over current devices
 - ii. control wiring
 - iii. hot water furnaces
 - iv. hot air furnaces
 - v. duct heaters
7. Describe generic maintenance procedures for central heating systems and the procedures used to document work performed.
8. Describe the procedures used to conduct operational tests pertaining to central heating systems.

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

Classroom exercise as determined by the instructor.

ER2123 Application of Troubleshooting Techniques

Description:

This course will involve the selection and application of troubleshooting techniques and equipment.

Pre-requisites: ER2116

Duration: 20 Hours

Objectives and Content:

1. Identify meters, high voltage probe adapters and indicators used to troubleshoot faults and describe their applications and operation.
 - i. voltmeter
 - ii. ohmmeter
 - iii. clamp-on ammeter
 - adapters
 - dividers
 - iv. multimeters
 - digital
 - analog
 - v. mega ohm meter
 - vi. infrared or thermal scanners
 - vii. hi-pot
 - viii. motor direction rotation indicator
 - ix. phase sequence indicator
 - x. signal transmitting source locator
 - xi. miscellaneous testers
 - logic probe
 - digital pulsar
 - neon indicators
 - continuity testers
 - xii. tachometer
 - mechanical
 - strobe

- portable photo tachometer
 - xiii. temperature measuring instruments
2. Describe requirements for recalibration of meters.
 3. Describe the procedures used to interpret the readings taken from meters, high voltage probe adapters and indicators.

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.
Practical Projects include:

ER2171 PLC Fundamentals

Description:

This course will involve the installation, maintenance and troubleshooting of PLC's as well as the identification of basic programming instructions.

Pre-requisites: ER2050

Duration: 20 Hours

Objectives and Content:

1. Describe the central processing unit of a PLC.
 - i. CPU diagnostics
 - ii. memory types
 - iii. memory organizations
 - iv. program execution (scan)
 - v. power supply
 - power to PLC
 - emergency stop requirement
2. Describe the I/O system of a PLC.
 - i. I/O addressing
 - ii. discrete inputs
 - iii. discrete outputs
 - iv. analog I/O
 - v. remote I/O (racks and slots)
3. Describe the programming terminals and peripheral devices used with PLC's.
 - i. dedicated programming terminals
 - ii. mini-programming devices (hand held)
 - iii. computer-based programming terminals
 - iv. peripheral devices

4. Describe the procedures used to install, maintain and troubleshoot a programmable logic controller.
 - i. safety considerations
 - ii. system layout
 - iii. proper grounding techniques
 - iv. source of electrical interference
 - v. input/output connection
 - vi. field checkout of PLC's
 - vii. PLC maintenance
 - viii. PLC troubleshooting
5. Describe the physical characteristics and applications of programmable relays.
6. Describe generic maintenance procedures for PLC's and the procedures used to document work performed.

ER2180 Programming PLC'S

Description:

This course will include knowledge of programming a PLC and working with PLC's connected to a network.

Pre-requisites: ER2171

Duration: 30 Hours

Objectives and Content:

1. Describe the procedures used to program a PLC using ladder logic or "instruction set" type languages.
 - i. ladder logic programs
 - ii. I/O instruction and addressing
 - examine if close (ON) input instruction
 - examine if open (OFF) input instruction
 - output instruction
 - internal control bit (sealing contact)
 - iii. inserting and closing rungs
 - iv. inserting branches
 - v. file manipulating
 - saving
 - opening
 - copying
 - printing
 - vi. program testing
 - downloading to PLC
 - uploading from PLC
 - online monitoring
2. Describe the procedures used to program timers in a PLC.
 - i. types of PLC timers
 - ON delay
 - OFF delay

- ii. timer addressing
 - iii. timer output bits
 - iv. timer reset
- 3. Describe the procedures used to insert counters in a PLC system.
 - i. types of PLC counters
 - up counter
 - down counter
 - ii. counter addressing
 - iii. counter output bits
 - iv. counter reset
- 4. Identify DATA manipulation commands and insert them in a PLC.
 - i. DATA comparison command
 - ii. DATA transferring commands
 - move function
 - iii. DATA logic commands and gates
 - iv. special functions
 - force ON/OFF
 - latch coil
- 5. Describe the procedures used to insert math functions in a PLC.
 - i. addition
 - ii. subtraction
 - iii. multiplication
 - iv. division
- 6. Identify the general principles for testing and troubleshooting PLC data highway systems.
 - i. data highway types
 - protocol and terminology(LAN, TCP/IP etc.)
 - ii. LAN and ethernet
 - the Local Area Network (LAN)
 - LAN topology
 - bus or branch
 - star
 - ring
 - LAN token
 - ethernet

- iii. transmission media
 - factor for selection the type of medium
 - cable types (twisted-pair, coaxial, fiber-optic)
- 7. Describe the procedures used to install and maintain a PLC data highway system.
 - i. system layout
 - ii. connect PLC's to a network interface devices
 - iii. program a PLC controlling other PLC's on a network system

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit
Practical Projects include:

1. Program a PLC using ladder logic or 'instruction set' type language.
2. Conduct operational tests pertaining to PLC's.

ER2310 Furnace Controls

Description:

This course will involve the installation of wiring and controls for fossil-fuel residential central heating units.

Pre-requisites: ER2050

Duration: 15 Hours

Objectives and Content:

1. Describe the function of combustion control on furnaces.
 - i. control systems
 - ii. power wiring
 - iii. emergency switches
 - iv. control wiring
 - v. low-voltage thermostats

2. Describe types of controls installed on a forced-air heating unit and their operation.
 - i. system controls
 - ii. limit switches
 - iii. temperature settings
 - iv. types of limit switches
 - v. installation of limit switches
 - vi. primary controls
 - vii. thermal operated primary controls
 - viii. thermal control operation
 - ix. visual primary controls
 - x. operation of cad cell primary control

3. Describe types of controls installed on a hydronic heating system and their operation.
 - i. system controls
 - ii. combination controls
 - iii. temperature settings

- iv. zone valves
- 4. Describe controls installed on a combination heating system and their operation.
 - i. wood/oil furnaces
 - ii. solid fuel combustion control
 - iii. interlock relays
 - iv. wood/electric combinations
- 5. Describe the procedures used to troubleshoot furnace control and associated wiring.
 - i. low-voltage wiring and controls
 - ii. line-voltage wiring and controls
- 6. Describe the procedures used to interpret schematic diagrams for furnaces and controls.

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.
Practical Projects include:

- 1. Classroom exercise as determined by the instructor.

ER2421 Heat Pumps and HVAC Electrical Systems

Description:

This course will involve the connection of heat pumps and HVAC electrical systems and their associated devices as per CEC requirements.

Pre-requisites: Completion of Block III courses

Duration: 20 Hours

Objectives and Content:

1. Locate and interpret information related to heat pumps and HVAC electrical systems and their installations.
 - i. drawings and symbols
 - ii. schematics
 - iii. manufacturer's specifications
2. Describe the basic operating principles of heat pumps and HVAC electrical systems.
3. Describe the operation and connection of heating / cooling thermostats in HVAC electrical systems.
4. Describe the procedures used to install heat pump power and control wiring and overcurrent / disconnect devices as per CEC requirements.
5. Describe generic maintenance procedures for heat pumps and HVAC electrical systems and the procedures used to document work performed.
6. Describe the procedures used to conduct operational tests pertaining to heat pumps and HVAC electrical systems.

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Code-related exercise related to installation of heat pumps and HVAC power and control electrical systems.

ER2363 Refrigeration and Air Conditioning Controls

Description:

This course will involve the connection of power and control wiring of electrical components and controls for refrigeration and air conditioning systems as per CEC requirements.

Pre-requisites: Completion of Block III courses

Duration: 15 hours

Objectives and Content:

1. Locate and interpret information related to refrigeration and air conditioning controls.
 - i. drawings and symbols
 - ii. schematics
 - iii. manufacturer's specifications
2. Describe the basic operating principles of refrigeration and air conditioning units.
3. Describe the procedures used to connect power and controls for refrigeration and air conditioning systems.
4. Describe safety considerations.
 - i. CFC's
 - ii. WHMIS
 - iii. Ammonia and other types of refrigerants
5. Describe generic maintenance procedures for refrigeration and air conditioning units and the procedures used to document work performed.
6. Describe the procedures used to conduct operational tests pertaining to refrigeration and air conditioning controls.

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Code-related exercise related to installation of refrigeration and air conditioning power and control electrical systems.

ER2390 Fibre Optics

Description:

This course will involve the installation and termination of fibre optic cables.

Pre-requisites: Completion of Block III Courses

Duration: 15 Hours

Objectives and Content:

1. Describe the fundamental principles of fibre optics.
 - i. propagation of light through the optical fibre
 - ii. basic fibre construction
 - internal light reflection
 - iii. fibre classification
 - material makeup
 - modes: multimode step index
 - single-mode step index
 - multimode graded index
2. Describe fibre optic cable structures, their construction and applications.
 - i. main parts
 - ii. indoor cables
 - iii. outdoor cables
 - iv. hybrid cables
 - v. characteristics
 - lengths
 - colour coding
 - loads
3. Describe the components of a fibre optic system.
 - i. sources
 - LED's
 - lasers
 - ii. detectors

- PN photodiode
 - PIN photodiode
 - APD avalanche photodiode
 - iii. transmitters and receivers
4. Describe the procedures used to install fibre optic cables.
- i. bending radius
 - ii. pulling tension
 - iii. lubrication
5. Describe the procedures used to terminate fibre optic cables.
- i. splicing, termination and test equipment
 - tube splitter
 - stripper cleaver
 - fusion splicer
 - optimiser
 - stable light source
 - variable optical attenuator
 - photodyne optical power meter
 - identifibre (fibre status tester)
 - ii. splicing materials and accessories
 - preparation kit
 - splice packs
 - closures
 - filling kits
 - installation kits
 - filled splice protector assembly
 - fibre splice protectors
 - fibre splice organizer trays
 - iii. termination assemblies and components
 - optical fibre terminating cable
 - optical fibre patch cords
 - optical fibre pigtails
 - fibre interface panel
 - fibre patch panel assembly
 - small office termination assembly
 - optical connector assemblies

6. Describe safety precautions when working with laser light sources.
7. Locate and interpret CEC rules and regulations concerning fibre optic cables.

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Terminate, splice and test fibre optic cables.

ER2440 High Voltage Wiring

Description:

This course will involve the installation, maintenance, splicing and termination of high voltage cables and their breakers and starters.

Pre-requisites: Completion of Block III Courses

Duration: 45 Hours

Objectives and Content:

1. Identify types of high voltage circuit breakers and motor starters and describe their characteristics and applications.
 - i. ratings of circuit breakers
 - ii. types of operating mechanisms
 - iii. air circuit breakers
 - iv. oil circuit breakers
 - v. air blast circuit breakers
 - vi. vacuum circuit breakers
 - vii. gas circuit breakers
 - viii. reclosers
 - ix. multi-speed starters
2. Describe the procedures used to operate high-voltage circuit breakers and motor starters.
 - i. approved line tools
 - ii. safety inspections
 - iii. voltage testing
 - iv. key interlock systems
 - v. safety lockout procedures and grounding
3. Locate and interpret CEC requirements concerning high voltage protective equipment.
 - i. service equipment and disconnecting means
 - ii. indoor installations

- iii. outdoor installations
- 4. Describe the features of high voltage cables.
 - i. cable types
 - ii. types of dielectric
 - iii. dielectric strength
 - iv. conductor shielding
 - v. electric field around an energized conductor
 - vi. insulation levels
- 5. Describe the construction and ratings of concentric neutral type of cables.
 - i. cable layers and parts
 - ii. AWG sizes
 - iii. voltage and current ratings
 - iv. applications
- 6. Describe the termination and splicing of non-shielded cables.
 - i. preparing the conductor
 - ii. making a splice or termination
- 7. Describe the termination and splicing of shielded cables.
 - i. preparing the cable
 - ii. making a splice or termination
 - iii. Hipot test
- 8. Locate and interpret CEC requirements concerning wiring methods for high voltage installations.
 - i. conductors, cables and raceways
 - ii. radii of bends
 - iii. shielding
 - iv. spacing and support of conductors
 - v. joints and terminations
 - vi. torquing requirements
- 9. Describe the procedures used to terminate parallel runs.

10. Identify the various types of hi-pot tests and describe the procedures used to perform them.
 - i. AC and DC tests
 - ii. conventional test
 - iii. ramp test
 - iv. step test
 - v. OH&S requirements

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.
Practical Projects include:

1. Prepare high voltage cable and complete splice on shielded cable.
2. Prepare high voltage cable and complete termination on shielded cable
3. Prepare high voltage cable and complete splice on non-shielded cable.
4. Prepare high voltage cable and complete termination on non-shielded cable.

ER2141 Security Systems

Description:

This course will involve knowledge and installation of to install and troubleshoot security systems.

Pre-requisites: ER1230

Duration: 10 hours

Objectives and Content:

1. Describe the types and classifications of security systems.
 - i. local alarm system
 - ii. central and monitoring stations
 - iii. building access
2. Describe basic alarm systems, their components and operation.
 - i. ultrasonic space protection devices
 - ii. microwave space protection devices
 - iii. infrared body heat detector
 - iv. photoelectric beam devices
 - v. perimeter protection devices
 - vi. alarm signals
 - vii. cable types
3. Describe basic control panel functions.
 - i. local alarm control unit
 - ii. control loops
 - 24 hour loop (instant)
 - permanent loop (instant)
 - moveable protection loop (delayed)
 - iii. remote control inputs
 - iv. tamper protection

- v. panel tamper switch operation
- vi. auxiliary contacts
- vii. auxiliary power output
- viii. signal circuit
- ix. standby power
- x. proprietary alarm control panel
- xi. remote station

ER2500 Explosion Proof Equipment

Description:

This course will include knowledge of installation, inspection and maintenance of electrical apparatus in explosive gas atmospheres.

Pre-requisites: Completion of Block III courses.

Duration: 30 Hours

Objectives and Content:

1. Identify hazardous areas as per the CEC.
 - i. principles and documentation
 - ii. criteria for identification of hazardous areas
 - iii. explosion hazards
2. Identify the various classifications of hazardous atmospheres.
 - i. classes
 - ii. division
3. Identify the grouping of gases and temperature codes.
 - i. gas groups
 - ii. temperature classifications
 - iii. ingress protection
4. Identify apparatus standards, certification and markings.
 - i. standards
 - Canadian Standards Association (CSA)
5. Explain the methods of explosion protection.
 - i. explosion proof or flammable
 - definitions
 - principle of operation
 - ambient conditions

- joint types
- cable and conduit entry
- gap dimensions
- obstruction of flamepaths
- weatherproofing
- ingress protection methods
- pressure piling
- modifications
- electrical protection
- ii. class 1, division 2
 - definitions
 - principle of operation
 - ambient conditions
 - energy limiting circuit device
- iii. pressured equipment
 - definitions
 - applications
 - principle of operation
 - purging
 - enclosures
 - safety requirements
- iv. intrinsic safety
 - principles
 - apparatus
 - equipment marking
 - Zener barrier systems
- v. oil immersed equipment
 - definitions
 - principle of operation
 - construction
- vi. sand filled equipment
 - definitions
 - principle of operation
 - construction
- vii. encapsulation
 - definitions
 - principle of operation
 - construction

6. Describe wiring systems, enclosure entries and cable glands.
 - i. standards, Canadian Electrical Code (CEC) Part 1
 - ii. wiring methods, cables, conduits
 - iii. installation of conduit, cables and glands
 - class 1, zone 0 locations
 - class 1, zone 1 locations
 - class 1, division 1 location
 - iv. sealing of cables and conduits

Block 5

ER2520 Emerging Technologies

Description:

This course will include knowledge of installation, configuration and maintenance of multimedia and networking systems.

Pre-requisites: Completion of Block IV

Duration: 30 Hours

Objectives and Content:

1. Install, configure, and maintain multimedia systems.
 - i. identify codes and regulations regarding the installation, servicing and repair of multimedia systems
 - ii. explain the difference between analog and digital multimedia systems
 - iii. identify and explain the operation of multimedia system components
 - speakers, monitors, computers, receivers, screens, projectors and cameras
 - iv. explain procedures used to install, configure, and maintain multimedia systems
2. Install, configure, and maintain networking systems.
 - i. explain general types of network topologies used in industry. (bus, ring, star).
 - ii. explain the use of addressing with different network topologies
 - iii. identify and explain the operation of networking components.
 - modems, routers, switches, structured cabling, racks, punch blocks, cross connects, gateways
 - iv. specialty tools such as punch downs, crimp tools
 - v. identify and describe cables used for industrial networks
 - vi. identify and explain the codes and standards for installation and maintenance of industrial networks
 - vii. identify and explain the operation of network testing devices

- wire mappers
 - multimeters
 - network analyzers (OTDR)
 - viii. describe the methods used for converting from one network protocol to another
3. Install, configure, and maintain PLC controlled analog systems.
- i. describe the applications for PLC's as a process controller
 - ii. describe the procedure used to scale analog I/O signals
 - iii. explain the use of Tag Names
 - iv. explain the configuration of the PID Block.
 - v. describe the procedure used to setup, configure and run a process using a PLC as the PID Controller
 - vi. define HMI
 - vii. describe the procedure used to create and run a HMI

Practical:

1. Use networked I/O to run a process. (Stop/Start). The program, located on one PLC, must use the I/O of another PLC on that network.

ER2082 Transistors

Pre-requisites: ER2073

Duration: 30 Hours

Outcomes:

Upon the successful completion of this unit the apprentice will be able to troubleshoot transistor circuits.

Objectives and Content:

1. Identify types of transistors and describe their purpose and applications.
 - i. action of the transistor
 - switching
 - counting
 - memory
 - amplifying
 - ii. bi-polar junction transistor symbols
 - NPN transistor
 - PNP transistor
2. Describe the construction and operation of a bi-polar transistor.
 - i. transistor structure
 - emitter, base, collector
 - ii. transistor operation
 - polarization
 - forward and reverse biasing
 - hole flow and electron flow
 - beta
3. Describe the features of the metal-oxide semiconductor field effect transistor (MOSFET).
 - i. terminal and symbol

4. Describe the procedures used to maintain and test transistors.
 - i. common case styles
 - ii. ohmmeter test
 - iii. heat sink mounting
5. Describe miscellaneous controlling devices.
 - i. uni-junction transistors (UJT)
 - terminal and symbol
 - operation
 - typical rating
 - ii. programmable uni-junction transistor (PUT)
 - terminal and symbol
 - operation
 - typical rating
6. Describe the common triggering circuit for achieving phase control with the TRIAC.
 - i. common PUT relaxation oscillator circuit controlling a TRIAC or an SCR
 - ii. common UJT relaxation oscillator circuit controlling a TRIAC or an SCR
7. Describe procedures used to troubleshoot problems related to transistor circuits.

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Connect, operate, test and troubleshoot:
 - i. transistors
 - ii. transistor biasing circuit
 - iii. transistor amplifier circuits
 - iv. field-effect transistor circuits
 - v. field-effect transistors

ER2092 Digital Electronics

Pre-Requisites: ER2101

Duration: 30 Hours

Outcomes:

Upon the successful completion of this unit the apprentice will be able to troubleshoot logic devices.

Objectives and Content:

1. Describe the number systems used in digital systems.
 - i. Decimal system
 - ii. Octal system
 - iii. Hexadecimal system
 - iv. Conversion between systems
 - v. Binary Coded Decimal (BCD)
 - vi. American Standard Code for Information Interchange (ASCII).
2. Describe the operation of common logic gates.
3. Describe the application of Demorgan's theorems.
 - i. Boolean algebra
4. Describe the features of integrated circuits.
 - i. classification
 - ii. construction
 - iii. packaging
5. Describe the operation of flip-flop circuits and related devices.
 - i. practical flip-flops
 - ii. multi-vibrators
 - iii. counters

- iv. shift register
 - v. truth tables
 - vi. symbols
6. Describe integrated circuit logic families.
7. Describe the basics of analog to digital conversion.
- i. periodic cycle sampling
 - ii. quantizing
 - iii. applying binary code
8. Describe the basics of digital to analog conversion.
- i. multiplexer
9. Describe basic optoelectronic components.
- i. construction and operation
 - ii. component symbols
 - light emitting diode
 - photo transistor
 - photoresistor
 - light activated SCR
 - photo darlington transistor
 - iii. optocoupler/optoisolator
10. Describe basic troubleshooting techniques.
- i. digital logic probes
 - ii. digital pulsar probes
 - iii. oscilloscopes

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Connect, operate, test and troubleshoot:
- i. common logic gates
 - ii. Transistor Transistor Logic (TTL) gates
 - iii. CMOS logic
 - iv. flip flop circuits

ER2101 Operational Amplifiers

Pre-Requisites: ER2082

Duration: 15 Hours

Outcomes:

Upon the successful completion of this unit the apprentice will troubleshoot operational amplifiers.

Objectives and Content:

1. Describe the features of the operational amplifier.
 - i. symbol
 - ii. packaging
2. Describe the common circuit applications for the operational amplifier.
 - i. inverting op-amp
 - gain
 - ii. non-inverting op-amp
 - gain
 - iii. summing op-amp
 - adding value
 - averaging value
 - iv. voltage comparator
3. Describe basic troubleshooting techniques.
 - i. inputs and outputs

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Connect, operate, test and troubleshoot:
 - i. inverting amplifiers
 - ii. non-inverting amplifiers
 - iii. voltage follower
 - iv. inverting summer
 - v. non-inverting summer
 - vi. integrator

ER2152 Analog Devices

Pre-Requisites: ER2092

Duration: 90 Hours

Outcomes:

Upon the successful completion of this unit of instruction, the apprentice will be able to install and maintain analog devices.

Objectives and Content:

1. Identify types of analog devices and describe their characteristics.
 - i. analog vs. digital
 - ii. transducers
 - iii. transmitters
 - iv. tachometers
2. Identify types of signals used with analog devices and describe their operating characteristics.
 - i. current
 - ii. voltage
3. Describe the uses of analog devices to measure values.
 - i. pressure
 - ii. temperature
 - iii. flow
 - iv. level
 - v. mass
4. Describe the procedures used to install analog devices.
 - i. location
 - ii. direction
 - iii. verification of proper operation
 - iv. range and span

5. Describe the procedures used to maintain and calibrate analog devices.

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. To be provided by training institution.

ER2192 Process Control

Pre-Requisites: ER2152

Duration: 30 Hours

Outcomes:

Upon the successful completion of this unit the apprentice will be able to install and maintain control loops.

Objectives and Content:

1. Locate and interpret information related to process control systems.
 - i. drawings
 - ii. flow charts
 - iii. schematics
 - iv. blueprints
2. Define terms relating to automatic controllers.
 - i. set point
 - ii. offset
 - iii. gain
 - iv. proportional band
 - v. process variable
 - vi. feedback
 - vii. reset action
3. Describe the procedures used to install control equipment.
 - i. tag and lockout equipment
 - ii. install controller and analog field devices
4. Describe process controllers, their characteristics and uses.
 - i. proportional
 - ii. proportional integral
 - iii. proportional integral derivative

5. Identify control systems and describe their applications.
 - i. open loop
 - ii. closed loop
6. Describe the procedures used to install analog and discrete devices on control systems.
7. Describe the procedures used to test equipment to verify the operation of a control system.
8. Identify regulatory requirements relating to the installation of a process control system.

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Configure controller.
2. Connect, operate and test process control loop.
3. Calibrate and tune controllers.

ER2202 Distributed Control Systems (DCS)

Pre-Requisites: ER2192

Duration: 30 Hours

Outcomes:

Upon the successful completion of this unit the apprentice will be able to install and maintain Distributed Control Systems.

Objectives and Content:

1. Locate and interpret information related to distributed control systems.
 - i. drawings and specifications
 - ii. schematic diagrams
 - iii. manufacturers specifications
 - iv. function blocks
 - v. A/D converters
2. Describe the procedures to install DCS and SCADA systems and their components.
 - i. environmental conditions
 - ii. wiring and grounding procedures
 - iii. cabinet assembly
 - iv. remote drop installation
 - v. selection and installation of cards
3. Describe the procedures used to maintain DCS and SCADA systems
 - i. back-up copies
 - making
 - loading
 - ii. use light emitting diodes
 - iii. service of cooling fans
 - iv. clean air filters
 - v. test power supplies
 - vi. change cards

- vii. change power supply
 - viii. verify proper operation using test equipment
- 4. Identify regulatory requirements relating to the installation of distributed control systems.

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Connect DCS hardware components and configure software.
2. Connect operator/engineering work stations via data.
3. Highway to DCS hardware components.
4. Connect I/O devices to DCS I/O interface modules.
5. Configure DCS engineering software and operate a workstation to control a simple feedback control loop.

ER2210 Pneumatic Control Systems

Pre-Requisites: Completion of Block IV

Duration: 15 Hours

Outcomes:

Upon the successful completion of this unit, the apprentice will be able to install and maintain electrical pneumatic control system components.

Objectives and Content:

1. Locate and interpret information related to pneumatic control equipment.
 - i. drawings and symbols
 - ii. schematics
 - iii. manufacturers specifications
 - iv. classes of compressors
2. Describe the operation of pneumatic control systems.
 - i. components and their functions
 - ii. safety considerations
3. Describe the procedures used to install electrical equipment used in pneumatic applications.
 - i. tag and lockout procedures
 - ii. safety considerations
 - iii. energize/de-energize equipment
 - iv. check the system for leaks
4. Describe the procedures used to maintain electrical equipment used in pneumatic applications.
 - i. use test equipment
 - ii. verify control loop component operation
 - iii. clean, repair and replace equipment
 - iv. dew point of air

- v. calibrate controls
- 5. Identify types of solenoid valves and describe their operating principles, characteristics and applications.
- 6. Identify regulatory requirements relating to the installation of pneumatic control systems.

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

- 1. Interpret pneumatic drawings and create a circuit.

ER2220 Servomechanism

Pre-Requisites: ER2230

Duration: 15 Hours

Outcomes:

Upon the successful completion of this unit the apprentice will be able to install and maintain servomechanisms.

Objectives and Content:

1. Locate and interpret information related to servomechanisms.
 - i. schematics
 - ii. blueprints
 - iii. manufacturers specifications
 - iv. service manuals
2. Describe the basic operating principles of robotic systems.
3. Describe the procedure used to install servomechanisms.
 - i. safety considerations
 - ii. tag and lockout
 - iii. install servomechanisms and controls
 - iv. verify proper operation
4. Describe the procedures used to maintain servomechanisms.
 - i. clean, repair and calibrate system control components
 - ii. test equipment for troubleshooting
 - iii. replace faulty components
5. Identify regulatory requirements relating to Servomechanisms.

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Classroom exercise as determined by the instructor.

ER2230 Hydraulic Circuits and Control

Pre-Requisites: ER2210

Duration: 15 Hours

Outcomes:

Upon the successful completion of this unit of instruction the apprentice will be able to install and maintain electrical hydraulic circuits and controls.

Objectives and Content:

1. Locate and interpret information related to hydraulic circuits and control
 - i. equipment
 - ii. drawings and symbols
 - iii. schematics
 - iv. manufacturer's specifications
2. Describe the operation of hydraulic control systems.
 - i. components and their functions
 - ii. safety considerations
 - iii. environmental conditions
3. Describe the procedures used to install electrical equipment used in hydraulic applications.
 - i. tag and lockout procedures
 - ii. safety considerations
 - iii. energize/de-energize equipment
 - iv. check the system for leaks
4. Identify hydraulic control valves and describe their applications.

5. Describe the procedures used to maintain electrical components in hydraulic control systems.
 - i. use test equipment
 - ii. verify control loop component operation
 - iii. clean, repair and replace equipment
 - iv. dew point of air
 - v. calibrate controls
6. Identify regulatory requirements relating to the installation of pneumatic control systems.

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Use hydraulic formulas to solve problems.
2. Use schematic diagrams to troubleshoot systems.
3. Connect and operate hydraulic circuits and controls.

ER2320 Boiler Control

Pre-Requisites: ER2192

Duration: 15 Hours

Outcomes:

Upon the successful completion of this unit, the apprentice will be able to install and maintain boiler controls.

Objectives and Content:

1. Locate and interpret information related to boiler controls.
 - i. drawings and symbols
 - ii. schematics
 - iii. manufacturers specifications
2. Describe the operation of boilers and their components.
 - i. safety considerations
 - ii. motors
 - iii. control devices
 - iv. sensing devices
 - v. igniters
 - vi. flame detectors and sensors
 - vii. boiler startup sequence
3. Describe the procedures used to install boiler controls.
 - i. protective devices
 - ii. wiring
4. Describe the procedures used to maintain boilers controls.
 - i. inspect
 - ii. repair components
 - iii. replace components
 - iv. lubricate components

5. Describe the procedures used to troubleshoot safety interlocks.
6. Identify regulatory requirements related to boiler controls.
 - i. Boiler and Pressure Vessel Act

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Classroom exercise as determined by the instructor.

ER2342 Energy Management

Pre-Requisites: ER2092

Duration: 15 Hours

Outcomes:

Upon the successful completion of this unit the apprentice will be able to install and maintain energy management systems.

Objectives and Content:

1. Locate and interpret information related to energy management systems.
 - i. drawings and symbols
 - ii. schematics
 - iii. manufacturer's specifications
2. Describe the operating principles of energy management systems.
3. Describe the features of an energy management system.
4. Describe the procedures used to install and maintain energy management systems.
 - i. clean
 - ii. inspect
 - iii. lubricate
 - iv. replace components
 - v. test
 - vi. calibrate
5. Identify regulatory requirements relating to energy management systems.

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Classroom exercise as determined by the instructor.

ER2372 Precipitators and Dust Collection Systems

Pre-Requisites: ER2320

Duration: 15 Hours

Outcomes:

Upon the successful completion of this unit the apprentice will be able to install and maintain precipitators and dust collection systems.

Objectives and Content:

1. Locate and interpret information related to precipitators and dust collection systems.
 - i. drawings
 - ii. schematics
 - iii. manufacturer's specifications
2. Describe safety considerations related to precipitators and dust collection systems.
 - i. in house procedures
3. Describe the operating principles of precipitators.
4. Describe the procedures used to install precipitators.
 - i. transformers
 - ii. rectifiers
 - iii. controls
 - iv. monitors
 - v. annunciators
5. Describe the procedures used to maintain precipitators.
 - i. inspect
 - ii. repair components
 - iii. replace components

6. Describe the operating principles of dust collectors.
 - i. probe theory
 - ii. threshold level of dust

7. Describe the procedures used to install dust collectors.
 - i. monitor systems
 - ii. fan motors and controls

8. Describe the procedures used to maintain dust collectors.
 - i. calibrate timers
 - ii. clean probes
 - iii. replace probes
 - iv. repair components
 - v. replace components
 - vi. maintain static control
 - vii. clean bag filters and efficiency

9. Describe potential hazards when installing dust collectors.
 - i. spark detection

10. Identify regulatory requirements relating to precipitators and dust collection systems.

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.
Practical Projects include:

1. Classroom exercise as determined by the instructor.

ER2382 Vibration

Pre-Requisites: ER2152

Duration: 15 Hours

Outcomes:

Upon the successful completion of this unit the apprentice will be able to install, maintain and calibrate vibration devices as well as perform various tests using this equipment.

Objectives and Content:

1. Locate and interpret information related to vibration installations.
 - i. drawings
 - ii. schematics
2. Describe the principles of vibration.
 - i. causes
 - ii. effects
3. Describe the procedures used to install and maintain vibration devices.
 - i. fasten and mount methods
 - ii. calibrate
 - iii. inspect
 - iv. replace components
4. Describe the procedures used to measure vibration using portable vibration testing equipment.
5. Identify regulatory requirements relating to vibration equipment.

Practical:

Practical skills enhance the apprentices' ability to meet the objectives of the unit.

Practical Projects include:

1. Classroom exercise as determined by the instructor.

NOA Comparison Table

2010 NOA Tasks		2011 POT
BLOCK A – COMMON OCCUPATIONAL SKILLS		
Task 1 - Performs Safety-Related Functions		
1.01	Maintains safe work environment	ER1410, ER2116, Included in all courses
1.02	Uses personal protective equipment (PPE) and safety equipment	ER1410, ER2116
1.03	Performs lock-out and tagging procedures	ER1410, ER2116
Task 2 - Uses and Maintains Tools and Equipment		
2.01	Maintains tools and equipment	ER1110, ER1121
2.02	Uses access equipment	ER1410, ER1121
2.03	Uses rigging, hoisting and lifting equipment	ER1100
Task 3 - Organizes Work		
3.01	Interprets codes and regulations	ER1600
3.02	Uses plans, schematics, drawings and specifications	ER1201, ER1211
3.03	Selects materials and supplies	ER1131, ER1110, ER1241, ER1201
3.04	Plans project tasks and procedures	ER1410
3.05	Prepares work site	ER1410, ER1160, ER1201, ER1211
3.06	Documents maintenance work	Included in all courses
Task 4 -Performs Routine Trade Activities		
4.01	Installs fasteners, fittings and connectors	ER1131
4.02	Conducts operational tests	Included in all courses
BLOCK B - POWER DISTRIBUTION AND GENERATING SYSTEMS		
Task 5 - Maintains High Voltage Power Distribution Systems		
5.01	Installs high voltage power distribution systems	ER2440, ER2041, ER2050
5.02	Services high voltage power distribution systems	ER2440, ER2041, ER2050
5.03	Troubleshoots high voltage power distribution systems	ER2440, ER2041, ER2050
5.04	Repairs high voltage power	ER2440, ER2041, ER2050

2010 NOA Tasks		2011 POT
	distribution systems	
Task 6 - Maintains Low Voltage Power Distribution Systems		
6.01	Installs low voltage power distribution systems	ER1270, ER1280, ER1370, ER2000, ER2133, ER2010
6.02	Services low voltage power distribution systems	ER1270, ER1280, ER1370, ER2000, ER2133, ER2010
6.03	Troubleshoots low voltage power distribution systems	ER1270, ER1280, ER1370, ER2000, ER2133, ER2010
6.04	Repairs low voltage power distribution systems	ER1270, ER1280, ER1370, ER2000, ER2133, ER2010
Task 7 - Maintains Alternating Current (AC) Systems		
7.01	Installs AC systems	ER1270, ER1280, ER1370, ER2000, ER2133, ER2010, ER2030, ER2250, ER2261, ER2300
7.02	Services AC systems	ER1270, ER1280, ER1370, ER2000, ER2133, ER2010, ER2030, ER2250, ER2261, ER2300
7.03	Troubleshoots AC systems	ER1270, ER1280, ER1370, ER2000, ER2133, ER2010, ER2030, ER2250, ER2261, ER2300
7.04	Repairs AC systems	ER1270, ER1280, ER1370, ER2000, ER2133, ER2010, ER2030, ER2250, ER2261, ER2300
Task 8 - Maintains Direct Current (DC) Systems		
8.01	Installs DC systems	ER1270, ER1280, ER1370, ER2000, ER2133, ER2010, ER2030, ER2250, ER2261, ER2300, ER1300, ER2073
8.02	Services DC systems	ER1270, ER1280, ER1370, ER2000, ER2133, ER2010, ER2030, ER2250, ER2261, ER2300, ER1300, ER2073
8.03	Troubleshoots DC systems	ER1270, ER1280, ER1370, ER2000, ER2133, ER2010, ER2030, ER2250, ER2261, ER2300, ER1300, ER2073
8.04	Repairs DC systems	ER1270, ER1280, ER1370, ER2000, ER2133, ER2010, ER2030, ER2250, ER2261, ER2300, ER1300, ER2073
Task 9 - Maintains Grounding And Bonding Systems		
9.01	Installs grounding and bonding systems	ER1160, ER1241, ER1270, ER1280, ER1370, ER1220, ER1230
9.02	Services grounding and bonding systems	ER1160, ER1241, ER1270, ER1280, ER1370, ER1220, ER1230
9.03	Troubleshoots grounding and	ER1160, ER1241, ER1270, ER1280, ER1370,

2010 NOA Tasks		2011 POT
	bonding systems	ER1220, ER1230
9.04	Repairs grounding and bonding systems	ER1160, ER1241, ER1270, ER1280, ER1370, ER1220, ER1230
Task 10 - Maintains Power Generating Systems		
10.01	Installs power generating systems	ER2240, ER2250, ER2261
10.02	Servises power generating systems	ER2240, ER2250, ER2261
10.03	Troubleshoots power generating systems	ER2240, ER2250, ER2261
10.04	Repairs power generating systems	ER2240, ER2250, ER2261
BLOCK C – ELECTRICAL EQUIPMENT		
Task 11 - Maintains Equipment, Wiring, Cabling, and Terminations		
11.01	Installs electrical wiring, cabling, and terminations	ER2000, ER1230, ER1241
11.02	Installs raceways, cable trays, busways and associated components	ER2000, ER2440
11.03	Repairs electrical wiring, cabling, and terminations	ER2000, ER1230, ER1241
11.04	Maintains seismic restraint systems	
Task 12 - Maintains Lighting Systems		
12.01	Installs lighting systems	ER2210, ER2270
12.02	Servises lighting systems	ER2210, ER2270
12.03	Troubleshoots lighting systems	ER2210, ER2270
12.04	Repairs lighting systems	ER2210, ER2270
Task 13 - Maintains Protection Devices		
13.01	Installs protection devices	ER1250
13.02	Servises protection devices	ER1250
13.03	Troubleshoots protection devices	ER1250
13.04	Repairs protection devices	ER1250
Task 14 - Maintains Rotating Equipment and Associated Controls		
14.01	Installs rotating equipment and associated controls	ER2030, ER2021, ER1300, ER2240, ER2250
14.02	Servises rotating equipment and associated controls	ER2030, ER2021, ER1300, ER2240, ER2250

2010 NOA Tasks		2011 POT
14.03	Troubleshoots rotating equipment and associated controls	ER2030, ER2021, ER1300, ER2240, ER2250
14.04	Repairs rotating equipment and associated controls	ER2030, ER2021, ER1300, ER2240, ER2250
Task 15 - Maintains Drives And Associated Controls		
15.01	Installs drives and associated controls	ER1300, ER2161
15.02	Services drives and associated controls	ER1300, ER2161
15.03	Troubleshoots drives and associated controls	ER1300, ER2161
15.04	Repairs drives and associated controls	ER1300, ER2161
Task 16 - Maintains Non-Rotating Equipment and Associated Controls		
16.01	Installs non-rotating equipment and associated controls	ER1261, ER1370, ER1250, ER1341, ER1230, ER2010, ER2133, ER2161, ER2300, ER2350, 2072
16.02	Services non-rotating equipment and associated controls	ER1261, ER1370, ER1250, ER1341, ER1230, ER2010, ER2133, ER2161, ER2300, ER2350, 2072
16.03	Troubleshoots non-rotating equipment and associated controls	ER1261, ER1370, ER1250, ER1341, ER1230, ER2010, ER2133, ER2161, ER2300, ER2350, 2072
16.04	Repairs non-rotating equipment and associated controls	ER1261, ER1370, ER1250, ER1341, ER1230, ER2010, ER2133, ER2161, ER2300, ER2350, 2072
BLOCK D – EMERGENCY AND STANDBY SYSTEMS		
Task 17 - Maintains Uninterrupted Power Supply (UPS) Systems		
17.01	Installs UPS systems	ER2261
17.02	Services UPS systems	ER2261
17.03	Troubleshoots UPS systems	ER2261
17.04	Repairs UPS systems	ER2261
Task 18 - Maintains Standby Power Generating Systems		
18.01	Installs standby power generating systems	ER2261
18.02	Services standby power generating systems	ER2261
18.03	Troubleshoots standby power generating systems	ER2261
18.04	Repairs standby power	ER2261

2010 NOA Tasks		2011 POT
	generating systems	
BLOCK E - COMMUNICATION SYSTEMS		
Task 19 - Maintains Alarm Systems		
19.01	Installs alarm systems	ER2133, ER1341
19.02	Services alarm systems	ER2133, ER1341
19.03	Troubleshoots alarm systems	ER2133, ER1341
19.04	Repairs alarm systems	ER2133, ER1341
Task 20 - Maintains Paging Systems		
20.01	Installs paging systems	ER2133
20.02	Services paging systems	ER2133
20.03	Troubleshoots paging systems	ER2133
20.04	Repairs paging systems	ER2133
Task 21 - Maintains Multimedia Systems		
21.01	Installs multimedia systems	ER2520
21.02	Services multimedia systems	ER2520
21.03	Troubleshoots multimedia systems	ER2520
21.04	Repairs multimedia systems	ER2520
Task 22 - Maintains Network Systems		
22.01	Installs network systems	ER2520
22.02	Services network systems	ER2520
22.03	Troubleshoots network systems	ER2520
22.04	Repairs network systems	ER2520
BLOCK F – PROCESS CONTROL SYSTEMS		
Task 23 - Maintains Input/Output (I/O) Field Devices		
23.01	Installs I/O field devices	ER2133, ER2152, ER2192, ER2202, 2170, ER2180
23.02	Services I/O field devices	ER2133, ER2152, ER2192, ER2202, 2170, ER2180
23.03	Troubleshoots I/O field devices	ER2133, ER2152, ER2192, ER2202, 2170, ER2180
23.04	Repairs I/O field devices	ER2133, ER2152, ER2192, ER2202, 2170, ER2180
Task 24 - Maintains Control Systems		
24.01	Installs control systems	ER2171, ER2180, ER2041, ER2050, ER1300, ER2161
24.02	Services control systems	ER2171, ER2180, ER2041, ER2050, ER1300, ER2161
24.03	Troubleshoots control systems	ER2171, ER2180, ER2041, ER2050, ER1300, ER2161
24.04	Repairs control systems	ER2171, ER2180, ER2041, ER2050, ER1300, ER2161
23.05	Optimizes programmable logic controller (PLC)	ER2171, ER2180
BLOCK G – BUILDING AND ENVIRONMENTAL CONTROL SYSTEMS		

2010 NOA Tasks		2011 POT
Task 25 - Maintains Electrical Components of Heating and Cooling Systems		
25.01	Installs electrical components of heating and cooling systems	ER1360, ER2350, ER2061, ER2310, ER2421, ER2363
25.02	Services electrical components of heating and cooling systems	ER1360, ER2350, ER2061, ER2310, ER2421, ER2363
25.03	Troubleshoots electrical components of heating and cooling systems	ER1360, ER2350, ER2061, ER2310, ER2421, ER2363
25.04	Repairs electrical components of heating and cooling systems	ER1360, ER2350, ER2061, ER2310, ER2421, ER2363
Task 26 - Maintains Building Automation Systems		
26.01	Installs building automation systems	ER2171, ER2180, ER2421, ER2363
26.02	Services building automation systems	ER2171, ER2180, ER2421, ER2363
26.03	Troubleshoots building automation systems	ER2171, ER2180, ER2421, ER2363
26.04	Repairs building automation systems	ER2171, ER2180, ER2421, ER2363
Task 27 - Maintains Environmental Control Systems		
27.01	Installs environmental control systems	ER2171, ER2180, ER2421, ER2363
27.02	Services environmental control systems	ER2171, ER2180, ER2421, ER2363
27.03	Troubleshoots environmental control systems	ER2171, ER2180, ER2421, ER2363
27.04	Repairs environmental control systems	ER2171, ER2180, ER2421, ER2363