A PLAN OF TRAINING

FOR

INDUSTRIAL ELECTRICIAN

OCCUPATION

Approved by
Provincial Apprenticeship Board

April, 1997
Revised June, 2000

Foreword

Apprenticeship training in the Province of Newfoundland and Labrador is undergoing considerable change. This change is prompted by the need to keep pace with technological changes in industry, the need to be competitive, and the desire to be efficient and effective in meeting the needs of the apprentice. We feel that this training plan will lay the groundwork to meet both the demands of industry and the needs of the apprentice.

The plan that follows is a comprehensive one. It recognizes that apprenticeship training begins when a student first registers at a training institution, or signs a Contract of Apprenticeship with an employer, and continues until such time as the apprentice has completed all of the required technical training and has received the required industry experiences necessary to write an interprovincial examination. Passing this examination will result in the apprentice receiving Red Seal Certification which gives the journeyperson national mobility of qualifications. This plan also recognizes the need to provide flexible access to training based on the needs of the employer and the apprentice while at the same time recognizing the end goal is to complete the requirements for Red Seal Certification.

It is realized that change in all facets of education and industry is continuous and sometimes rapid. This change will necessitate the review of this document on a continuous basis to ensure that current needs of industry and apprentices are being satisfied. Through a process of accreditation, regular input from industry advisory committees, as well as input from those involved in the administration and delivery of the training, we are confident that residents of our province who elect to pursue an apprenticeable occupation as a career choice will receive high quality training and thus will be prepared to compete for jobs worldwide.

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Chair, Provincial Apprenticeship Board Minister of Education

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CONDITIONS GOVERNING APPRENTICESHIP TRAINING

1.0 GENERAL

The following general conditions will apply to all apprenticeship training programs approved by the Provincial Apprenticeship Board in accordance with the Apprenticeship Act. Where an occupation requires additional conditions, these will be noted in the specific plan of training for that occupation. In no case should there be a conflict between these conditions and the additional requirements specified in certain plans of training.

2.0 ENTRANCE REQUIREMENTS

2.1 Entry into the occupation as an apprentice requires:

The completion of designated first year courses specific to the occupation

OR

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

OR

Enrolment in a program of studies that includes all entry and advanced level skills and required work experiences as approved by the Provincial Apprenticeship Board.

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 plans 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 towards the apprenticeship program may be awarded to an apprentice for previous work experience and/or training as validated through prior learning assessment.

2.4 A Registration 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 Provincial Apprenticeship Board one week notice in writing.

4.0 TERMINATION OF A MEMORANDUM OF UNDERSTANDING

After the probationary period referred to in Section 3.0 herein, the memorandum of understanding may be terminated by the Board by mutual consent of the parties thereto or cancelled by the Board for proper and sufficient cause in the opinion of the Board.

5.0 APPRENTICESHIP PROGRESSION SCHEDULE AND WAGE RATES

5.1 Progression Schedule

7200 Hour Programs	**Requirements for Progression**	**Progress To**
First Year Apprentice	25% of Course Credit Hours, **Plus** relevant work experience totaling 1800 hours	Second Year
Second Year Apprentice	50% of Course Credit Hours, **Plus** relevant work experience totaling 3600 hours	Third Year
Third Year Apprentice	75% of Course Credit Hours, **Plus** relevant work experience totaling 5400 hours	Fourth Year
Fourth Year Apprentice	100% of Course Credit Hours, **Plus** completion and sign-off of workplace skills required for certification totaling 7200 hours	Write Certification Examination
5400/4800 Hour Programs		
First Year Apprentice	33% of Course Credit Hours, **Plus** relevant work experience totaling 1800/1600 hours	Second Year
Second Year Apprentice	66% of Course Credit Hours, **Plus** relevant work experience totaling 3600/3200 hours	Third Year
Third Year Apprentice	100% of Course Credit Hours, **Plus** completion and sign-off of workplace skills required for certification totaling 5400/4800 hours	Write Certification Examination

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 which shall not be less than:

<table>
<tr><th>Program Duration</th><th colspan="2">Wage Rates</th><th>Comments</th></tr>
<tr><td rowspan="4">7200 Hours</td><td>1st Year</td><td>55%</td><td rowspan="7">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.</td></tr>
<tr><td>2nd Year</td><td>65%</td></tr>
<tr><td>3rd Year</td><td>75%</td></tr>
<tr><td>4th Year</td><td>90%</td></tr>
<tr><td rowspan="3">5400 Hours
and
4800 Hours</td><td>1st Year</td><td>55%</td></tr>
<tr><td>2nd Year</td><td>70%</td></tr>
<tr><td>3rd Year</td><td>85%</td></tr>
<tr><td colspan="4">4000 (Hairstylist) - 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.</td></tr>
</table>

6.0 TOOLS

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

7.0 PERIODIC EXAMINATIONS

7.1 Every apprentice shall submit to such occupational tests and examinations as the Board 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 Board may shorten the term of apprenticeship and advance the date of completion accordingly.

8.0 GRANTING OF CERTIFICATES OF APPRENTICESHIP

Upon the successful completion of apprenticeship, the Board 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 normally shall not exceed one apprentice to every one journeyperson employed. Exceptions for specific occupations may occur with the approval of the Provincial Apprenticeship Board.

12.0 RELATIONSHIP OF THE PLAN OF TRAINING 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 Provincial Apprenticeship Board.

14.0 EMPLOYMENT, RE-EMPLOYMENT AND TRAINING REQUIREMENTS

14.1 The plan of training requires Apprentices to attend regularly their place of employment.

14.2 The plan of training requires Apprentices to regularly attend training programs for that occupation as prescribed by The Provincial Apprenticeship Board.

14.3 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 opportunity to be re-employed before another is hired.

14.4 The employer will permit each apprentice to attend regularly training programs as prescribed by the Provincial Apprenticeship Board.

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.

REQUIREMENTS FOR RED SEAL CERTIFICATION

1. Evidence that the required work experiences outlined in this plan of training has been obtained. This evidence must be in a format that clearly outlines the experiences and a signature (s) of an appropriate person(s) attesting that these experiences have been obtained to the level required.

2. Normally, have a combination of training from an accredited training program and suitable work experience totalling 7200 hours

   Or

   Have a total of 9000 hours of suitable work experience.

3. Completion of a National Red Seal examination to be set at a place and time determined by the Industrial Training Division of the Department of Education.

4. Pay the appropriate examination fee.

ROLES AND RESPONSIBILITIES OF STAKEHOLDERS
IN THE APPRENTICESHIP PROCESS

Apprenticeship process involves a number of stakeholders playing significant roles in the training of apprentices. This section captures, in a broad sense, these roles and the responsibilities that result from them.

Apprentices

to complete all required technical training courses as approved by the Provincial Apprenticeship Board.

to find appropriate employment

to complete all required work experiences in combination with the required hours.

to ensure that the work experiences are well documented

to approach apprenticeship training with an attitude and commitment that fosters the qualities necessary for a successful career as a qualified journeyperson.

to obtain the required hand tools as specified by the Board for each period of training of the apprenticeship program.

to provide feedback to Training Institutions, the Industrial Training Division and Employers in an effort to establish a process of continuous quality improvement**.**

Employers

to provide high quality work experiences in an environment that is conducive to learning.

to remunerate apprentices as set out in the Plan of Training or Collective Agreements.

to provide feedback to Training Institutions, Industrial Training Division and Apprentices in an effort to establish a process of continuous quality improvement.

where appropriate, to release apprentices for the purpose of returning to a training institution to complete the necessary technical courses.

to ensure that work experiences of the apprentices are documented.

Training Institutions

to provide a high quality learning environment.

to provide the necessary student support services that will enhance an apprentices ability to be successful.

to participate with other stakeholders in the continual updating of programs.

Industrial Training Division

to establish and maintain provincial program advisory committees under the direction of the Provincial Apprenticeship Board.

to promote apprenticeship training as a viable career option to prospective apprentices and other appropriate persons involved such as career guidance counsellor, teachers, parents, etc.

to establish and maintain a protocol with apprentices, training institutions, employers and other appropriate stakeholders to ensure the quality of apprenticeship training programs.

to ensure that all apprentices are appropriately registered and records are maintained as required.

to schedule all necessary technical training periods for apprentices to complete requirements for certification.

to administer provincial/interprovincial examinations.

Provincial Apprenticeship Board

to set policies to ensure that the provisions of the Apprenticeship Training Act are implemented.

to ensure that advisory and examination committees are established and maintained.

to accredit institutions to deliver apprenticeship training programs.

to designate occupations for apprenticeship training and / or certification.

SUGGESTED COURSE LAYOUT FOR THE INDUSTRIAL ELECTRICIAN OCCUPATION

Program & Apprenticeship Registration

ENTRY LEVEL COURSES

ER1400 - Safety Measures in Construction	30 hrs.
TS1510 - OHS	4 hrs.
TS1530 - Standard First Aid (with heart start)	16 hrs.
TS1520 - WHMIS	6 hrs.
ER1100 - Rigging	30 hrs.
ER1110 - Hand Tools	15 hrs.
ER1120 - Power Tools	30 hrs.
ER1130 - Fasteners	30 hrs.
ER1140 - DC Theory	30 hrs.
ER1150 - Series and Parallel Circuits	30 hrs.
ER1160 - Introduction to Building Codes	30 hrs.
ER1170 - Voltage Drop & Power Loss	30 hrs.
ER1180 - Single Phase Theory	60 hrs.
ER1190 - Three Phase Theory	30 hrs.
ER1200 - Generic Blueprint	30 hrs.
ER1210 - Electrical Blueprint	45 hrs.
ER1220 - Conduit, Tubing and Fittings	30 hrs.
ER1230 - Conductors & Cables	60 hrs.
ER1240 - Residential Wiring	60 hrs.
ER1250 - Protective Devices	30 hrs.
ER1260 - Principle of Operations of Transformers	30 hrs.
ER1270 - Single Phase Service Entrance	30 hrs.
ER1280 - Three Phase Service Entrance	30 hrs.
ER1290 - Distribution Equipment	45 hrs.
ER1300 - DC Motors & Controls	30 hrs.
ER1310 - Electric Heating Systems	45 hrs.
ER1320 - Low Voltage Temperature Control	10 hrs.
ER1330 - Line-Voltage Temperature Control	10 hrs.
ER1340 - Conventional Fire Alarms	30 hrs.
WD1310 - Oxy-Fuel Welding	15 hrs.
OT1230 - Workplace Exposure	60 hrs.
*CM2150 - Workplace Correspondence	45 hrs.
*MR1210 - Customer Service	30 hrs.
*SP2330 - QA/QC	30 hrs.
*MC1050 - Introduction to Computers	30 hrs.
*SD1700 - Workplace Skills	30 hrs.
*SD1710 - Job Search Techniques	15 hrs.
*SD1720 - Entrepreneurial Awareness	15 hrs.

Minimum Pass Mark Required in all courses is 70% in both Theory and Practical Applications.

Required Work Experience

ADVANCED LEVEL COURSES

ER2000 - Raceway, Wireways and Busways	30 hrs.
ER2010 - Lighting and Controls	45 hrs.
ER2020 - Single Phase Motors	30 hrs.
ER2030 - Three Phase Motors	45 hrs.
ER2040 - Control Devices (Discrete Input)	30 hrs.
ER2050 - Motor Starters & Controllers	60 hrs.
ER2060 - Central Heating Units	15 hrs.
ER2070 - Power Supply & Rectifiers	30 hrs.
ER2080 - Power Electronic Control Circuits	45 hrs.
ER2090 - Integrated Circuits	45 hrs.
ER2100 - Amplifiers	30 hrs.
ER2110 - Troubleshooting Techniques	30 hrs.
ER2120 - Application of Troubleshooting Techniques	30 hrs.
ER2130 - Communications & Data Systems	30 hrs.
ER2140 - Security	20 hrs.
ER2150 - Analog Devices	15 hrs.
ER2160 - Solid State Drives	30 hrs.
ER2170 - PLC Fundamentals	15 hrs.
ER2180- Programming PLC's	45 hrs.
ER2190 - Process Control	90 hrs.
ER2200 - Distributed Control Systems	75 hrs.
ER2210 - Pneumatic Control Systems	30 hrs.
ER2220 - Servomechanism	30 hrs.
ER2230 - Hydraulic Circuits and Controls	15 hrs.
ER2240 - DC Generators	30 hrs.
ER2250 - AC Generators	30 hrs.
ER2260 - Emergency Stand-by Systems	30 hrs.
ER2270 - Emergency Lighting Systems	15 hrs.
ER2280 - High Voltage Breakers and Starters	15 hrs.
ER2290 - High Voltage Splices & Terminations	15 hrs.
ER2300 - Distribution Systems Conditioning	45 hrs.
ER2310 - Furnace Control	15 hrs.
ER2320 - Boiler Control	15 hrs.
ER2330 - Heat Pumps	15 hrs.
ER2340 - Energy Management	45 hrs.
ER2350 - Electric Surface Heating Units	15 hrs.
ER2360 - Refrigeration and AC Controls	45 hrs.
ER2370 - Precipitator and Dust Collection Systems	45 hrs.
WD2320 - Arc Welding	30 hrs.
ER2380 - Vibration Analysis	30 hrs.
ER2390 - Fibre Optic	30 hrs.
ER2400 - HVAC Systems	45 hrs.

TITLE: ER1400 - Safety Measures in Construction

DURATION: 30 hours

PREREQUISITES:

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able to understand the requirements and rights of Regulation 91-191 under the Occupational Health and Safety Act as applicable to the construction trades.

OVERVIEW OF OBJECTIVES:
1. Describe basic employer and employee duties regarding compliance with the applicable act and regulation.
2. Define various terms contained in the applicable provincial regulation.
3. Identify safety measures related to sanitation and accommodation
4. Define obstacles to health and safety
5. Identify personal protective equipment required on the job site
6. Identify preventative measures for using various types of tools
7. Identify measures related to the safe movement of workers on construction sites
8. Identify preventive measures related to excavations and trenches
9. Identify preventive measures related to pits and quarries
10. Identify safety measures for using material handling equipment
11. Identify safety measures for locking out equipment
12. Identify safety measures for working in a confined space
13. Identify safety measures related to welding
14. Identify safety measures related to electricity
15. Identify proper lifting techniques and work posture
16. Identify safety measures while working around swimming pools.

CONTENT:
1. Describe basic employer and employee duties regarding compliance with the applicable act and regulation:
   general introduction and focus on training program

2. Define various terms contained in the applicable provincial regulation.
   angle of repose, hoisting apparatus, competent, industrial lift truck, adequate, life line, de-energized, aerial device, safeguard, individual fall-arresting system, swing staging, powered mobile equipment, service stairway, guardrail, zero energy state, tool, portable power-operated hand tool, powder actuated tool, work platform, air contaminant, owner of a tool, hazardous, substance, threshold limit value, and lock out.

3. Identify safety measures related to sanitation and accommodation
   drinking water requirements for construction sites
   mandatory number of toilets for a construction site

duties of the employer concerning required accessories and products in washrooms and toilets on a construction site
eating areas in relation to worker health and safety on construction sites
duties of the employer respecting the mandatory rest period in provincial regulations
clothes used on construction sites
mandatory showers on the construction site
first aid kits
requirements for first aid training
requirements for a first aid room
the need for and management of an occupational health service
sanitation, storage, and disposal of refuse in a place of employment

4. Define obstacles to health and safety
   - main stressors
   - air quality requirements for the work area
   - ventilation requirements
   - heating requirements
   - risks of injury through exposure to extreme conditions of heat or cold
   - preventive measures in the presence of air contaminants
   - preventive measures concerning

5. Identify personal protective equipment required on the job site
   - duties of stakeholders
   - individual protective equipment
   - respiratory protective equipment
   - hearing protective equipment
   - fall-arresting systems
   - water safety equipment

6. Identify preventative measures for using various types of tools
   - duties of different stakeholders
   - preventive measures for portable power-operated tools
   - preventive measures for powder actuated tools

7. Identify measures related to the safe movement of workers on construction sites
   - traffic safety
   - general preventive measures
   - engineer authorization
   - guardrails
   - removing guardrails
   - allowable stresses
   - walking surfaces
   - floor area
   - temporary floors
   - roofs
   - warning lines
   - fall-arresting system
   - monitoring work on roofs

unguarded edge of a roof
hoist used to raise material
openings
access and agress
doors
stairways
ramps
handrails
catwalks
fixed ladders
portable ladders
work platforms
elevating work platforms
wood plank scaffolds
duties of the employer concerning scaffolds
duties of workers concerning safety on safe scaffolds
metal scaffolds
horse scaffolds
ladder-jack scaffolds
pump-jack scaffolds
mobile rolling scaffold
suspended work platforms
duties of the employer and worker concerning swing stage
Bosun's chair

8. Identify preventive measures related to excavations and trenches
   preliminary precautions
   walks
   worker entry
   excavated materials
   presence of humidity
   accumulations of hazardous substances
   supervision of workers
   use of power mobile equipment
   illumination and barriers

9. Identify preventive measures related to pits and quarries
   quarry
   pit
   developing pits or quarries
   construction of a road in a quarry
   walkway from working level to surface
   excavated material from pits and quarries
   unconsolidated overburden
   utility poles and posts
   resuming operations
   examinations at beginning of each shift
   examinations and record book

quarry worked in benches
construction of a berm of ledge
undercutting the working face of a quarry
tunnelling in quarries
removing material from a pit
undercutting
preventive measures for workers close to a pit
duties of the owner

10. Identify safety measures for using material handling equipment
    - hoisting apparatus
    - safe working load of a hoisting apparatus
    - condition of hoisting apparatus
    - operator of a hoisting apparatus
    - techniques for signallers
    - safety characteristics of a mobile crane
    - safety measures for operating a mobile crane
    - mobile crane movement
    - safety characteristics of an industrial lift truck
    - preventative measures for operating and industrial lift truck
    - safety characteristics of powered mobile equipment (rollover protective structure)
    - safety measures for operating powered mobile equipment
    - duties of the employer regarding seat belts
    - protective structure welding requirements
    - safety measures for personnel carrying device
    - general safety measures

11. Identify safety measures for locking out equipment
    - lockout system
    - code of practice

12. Identify safety measures for working in a confined space
    - definition of confined space
    - definition of physical agent
    - applicable preventive measures for work in confined space
    - duty of employer concerning the identification and control of a hazard in a confined space
    - emergency intervention
    - concentrations of chemical agents in a confined space
    - safety measures used in confined space with more than 23% oxygen
    - electrical equipment in a confined space
    - work permit
    - traffic near a confined space

13. Identify safety measures related to welding
    - protection from harmful fumes and gases or particles
    - compliance with standards
    - workplace inspection

clothing protection
welding on containers
explosive or flammable substances
general safety measures for welding, cutting, burning, and soldering

14. Identify safety measures related to electricity
    risks of accidents related to humans
    injuries by electrical discharge
    intervention measures for injuries caused by electrical power
    protective devices against electrical overloads
    risk factors respecting electricity and its environment for non-qualified personnel
    circuit protection device
    qualified personnel
    personal protective equipment
    safe distance for a qualified and non-qualified employee
    work standards for electrical lines
    electrical switching devices
    code of practice for work on electrical systems
    de-energizing and re-energizing
    installation of electrical poles
    working manhole, tunnel or overhead system
    applicable safety measures for using a metal ladder near an energized electrical line
    intervention measures for electrical fires

15. Identify proper lifting techniques and work posture
    consequences of back injuries
    ergonomics
    mechanism and functioning of the back
    care in lifting and moving heavy loads
    proper lifting and moving methods of heavy loads
    lifting and moving heavy and cumber son loads
    posture lifting

16. Identify safety measures while working around swimming pools.
    identify dangers
    steps to follow

METHODOLOGY:
This course lends itself to theory lectures supplemented with interactive Cd's and videos. The instructors may involve apprentices in specific activities, including:

exercises on theory content
demonstrations
audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

- classroom exercises as determined by the instructor
- interactive computer pre-tests and post tests as determined by the instructor

NAME AND NUMBER: TS1510 - Occupational Health and Safety

SUGGESTED DURATION: 4 hours

PREREQUISITES: None

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit, the apprentice will be able to prevent accidents and illnesses and to improve health and safety conditions in the workplace.

OVERVIEW OF OBJECTIVES:
1. Interpret the Occupational Health and Safety Act laws and regulations.
2. Designate responsibilities within the laws and regulations.
3. Establish joint health and safety committees/representatives within the laws and regulations.
4. Examine right to refuse dangerous work.
5. Describe discriminatory action.
6. Explain duties of commission officers.
7. Interpret appeals of others.
8. Emphasize reporting of accidents.

CONTENT:
1. Interpret the Occupational Health and Safety Act laws and regulations

    a. Expound scope of the act
        Application of the act
        Federal/Provincial jurisdictions
        Canada Labour Code
        Rules and regulations
        Private home application
        Conformity of the Crown by the Act

    b. Define definitions
        Application of definitions
        Defining terminology

2. Designate responsibilities within the laws and regulations
    Duties of employer, owner, contractors, sub-contractors, employees, and suppliers

3. Establish joint health and safety committees/representatives within the laws and regulations
    Establish committee
    Functions of committee
    Legislated rights
    Deviation from policy standards
    Performance of other duties
    Establish health and safety representation
    Reasonable grounds for refusal

Reporting endangerment to health
Appropriate remedial action
Committee recommendation
Investigation of endangerment
Employer to take appropriate remedial action

4. Examine right to refuse dangerous work
   Reasonable grounds for refusal
   Reporting endangerment to health
   Appropriate remedial action
   Committee recommendation
   Investigation of endangerment
   Employer to take appropriate remedial action
   Action taken when employee does not have reasonable grounds for refusing dangerous work
   Employee's rights
   Assigning another employee to perform duties
   Temporary reassignment of employee to perform other duties
   Collective agreement influences
   Wages and benefits

5. Describe discriminatory action
   Definition
   Filing a complaint procedure
   Allocated period of time a complaint can be filed with the Commission
   Duties of an arbitrator under the Industrial Relations Act
   Order in writing inclusion
   Report to commission
   Allocated period of time to request Arbitrator to deal with the matter of the request
   Notice of application
   Failure to comply with the terms of an order
   Order filed in the court

6. Explain duties of commission officers
   Powers and duties of officers
   Carry out examinations and inspections
   Officer's procedure for carrying out any inspection
   Orders given by officers orally or in writing
   Specifications of an order given by an officer to owner of the place of employment, employer, contractor, sub-contractor, employee, or supplier
   Service of an order
   Prohibition of persons towards an officer in the exercise of his/her power or duties
   Rescinding of an order
   Posting a copy of the order
   Illegal removal of an order

7. Interpret appeals of others
   Allocated period of time for appeal of an order

Person who may appeal order
Action taken by Commission when person involved does not comply with the order
Enforcement of the order
Notice of application
Rules of court

8. Emphasize reporting of accidents
   Application of act
   Report procedure
   Reporting notification of injury
   Reporting accidental explosion or exposure
   Posting of act and regulations

SUGGESTED LEARNING ACTIVITIES:

1. Describe repairs or work situations around vehicles that one might want to refuse.
2. Interview someone in the motor vehicle repair trade - report results.

SUGGESTED RESOURCES:

1. Occupational, Health & Safety Act.

NAME AND NUMBER: TS1530 - First Aid

SUGGESTED DURATION: 16 hours

PREREQUISITES: None

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this course, the apprentice will be able to recognize situations requiring emergency action and to make appropriate decisions concerning first aid.

OVERVIEW OF OBJECTIVES:
First Aid Safety Oriented course offered by the St John Ambulance or equivalent.

1. Identify the objectives of first aid and the general principles of safety.
2. Describe what is involved in the application of the Priority Action Approach.
3. Recognize the interdependence of all the systems of the body.
4. Assess emergency situations by doing a primary examination to detect life-threatening conditions.
5. Do a secondary examination when the victim's life is no longer in danger.
6. Describe how sorting is done when the victim has multiple injuries or when there are several casualties.
7. Recognize the signs and symptoms of different emergencies and describe how to treat them.
8. Demonstrate the appropriate general and specific care to be provided in different emergency situations where one or more body systems are failing because of an accident or secondary illness.
9. Select the rescue and transportation method that offers maximum protection for the victim and subjects the rescuer to a minimum of risks.
10. Know when to call on more qualified persons or ask for medical assistance.
11. Prevent accidents by adopting a safety-oriented lifestyle.

CONTENT:
1. As per St John Ambulance or equivalent curriculum.

SUGGESTED LEARNING ACTIVITIES:
1. As per St John Ambulance or equivalent curriculum

NAME AND NUMBER: TS1520 - WHMIS

SUGGESTED DURATION: 6 hours

PREREQUISITES: None

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this course, the apprentice will be able to interpret and apply the Workplace Hazardous Materials Information System (WHMIS) Regulation.

OVERVIEW OF OBJECTIVES:
1. Define WHMIS.
2. Examine hazard identification and ingredient disclosure.
3. Explain labeling and other forms of warning.
4. Introduce material safety data sheets (MSDS).

CONTENT:
1. Define WHMIS safety
    - Rational and key elements
    - History and development of WHMIS
    - WHMIS legislation
    - WHMIS implementation program
    - Definitions of legal and technical terms

2. Examine hazard identification and ingredient disclosure
    - Prohibited, restricted and controlled products
    - Classification and the application of WHMIS information requirements
    - 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
    - Products excluded form 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

Comparison of classification systems - WHMIS and TDG
General comparison of classification categories
Detailed comparison of classified criteria

3. Explain labeling and other forms of warning
   - Definition of a WHMIS label
     - supplier label
     - workplace label
     - other means of identification
   - Responsibility for labels
     - supplier responsibility
     - employer responsibility
     - worker responsibility
   - Introduce label content, design and location
     - supplier labels
     - workplace labels
     - other means of identification

4. Introduce material safety data sheets (MSDS)
   - Definition of a material safety data sheet
   - Purpose of the data sheet
   - Responsibility for the production and availability of data sheets
     - supplier responsibility
     - employer responsibility
     - workers responsibility

SUGGESTED LEARNING ACTIVITIES:

1. Lectures
2. Class Participation
3. Locate WHMIS labels - describe different sections

SUGGESTED RESOURCES:

1. WHMIS Regulation
2. Sample MSDS sheets

NAME AND NUMBER: ER1100 - Rigging

SUGGESTED DURATION: 30 hrs

PREREQUISITES:

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be familiar with rigging equipment, the safe operation of this equipment, and the required inspection procedures needed to ensure safe operation.

OVERVIEW OF OBJECTIVES:
1. Define terms relating to mechanical advantage.
2. Describe the types, construction and use of ropes.
3. Tie knots, bends, and hitches used for lifting and moving equipment.
4. Select and use the appropriate sling to perform a given task.
5. Describe types and uses of rigging hardware items and method of installing them
6. Describe the procedures for lifting, moving, and securing equipment.
7. Select and use various chain blocks and rope falls.
8. Describe the different types of jacks and their uses.
9. Recognize and use standard crane signals.
10. Select and properly use ladders and scaffolds.

CONTENT:
1. Define terms relating to mechanical advantage.
    - mechanical advantage and effects of friction
    - application of the basic mechanisms
    - the inclined plane
    - the wedge
    - the screw
    - the lever
    - the wheel and axle
    - pulley
    - hydraulic - introduction
    - fundamentals of rigging power transmission
    - friction

2. Describe the types, construction and use of ropes.
    - uses of rope
    - safety procedure
    - inspect rigging fibre rope
    - safety factor
    - synthetic fibre rope
    - nylon rope
    - dacron rope

saran rope
fiberglass rope
orlon rope
polyethylene rope
how to care for a rope
OHSA

3. Tie knots, bends, and hitches used for lifting and moving equipment.
   common knots
   a backlash or back splice
   overhand knot
   figure-eight knot
   half hitch
   double half hitch
   bowline knot
   running bowline
   square or reef knot
   snubbing hitch
   snubbing hitch with double half hitch
   clove hitch
   timber hitch
   barrel hitch
   fibre rope knots used as slings
   angle of sling
   safety reminders when using fibre rope

4. Select and use the appropriate sling to perform a given task.
   general
   wire rope compared to fibre rope
   wire rope clips
   safety clips - J bolt type
   U bolt clips
   wire rope slings
   common slings and end rigging for wire rope
   good rigging precautions
   safe operating precautions
   inspection of slings and removal from service

5. Describe types and uses of rigging hardware items and method of installing them.
   introduction
   eye bolts
   shackles
   points concerning shackles
   snatch blocks
   rope blocks

6. Describe the procedures for lifting, moving, and securing equipment.
   OHSA requirements

protecting your back

7. Select and use various chain blocks and rope falls.
   - common hoists
   - chain hoists
   - inspection
   - good safety practices
   - cable winch and pull lift hoists

8. Describe the different types of jacks and their uses.
   - jacks
   - screw jacks
   - ratchet jacks
   - hydraulic jack with integral pump
   - hydraulic ram jack with separate pump
   - safety and proper use of jacks
   - selecting the proper jack

9. Recognize and use standard crane signals.

10. Select and properly use ladders and scaffolds.
    - ladders
    - ladder safety
    - tubular steel sectional scaffolding
    - advantages of steel scaffolding (ease of erection,- common hoists

METHODOLOGY:
This course lends itself to shop projects supplemented by theory lectures, demonstrations, and videos showing operation of hoisting/lifting equipment. The instructors may involve apprentices in specific activities, including:

- exercises on theory content
- demonstrations
- audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

- classroom exercises
- hands-on hoisting/lifting experiences

NAME AND NUMBER: ER1110 - Hand Tools

SUGGESTED DURATION: 15 hours

PREREQUISITES: ER1400

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be familiar with the safe use and care of various hand tools associated with the electrical industry.

OVERVIEW OF OBJECTIVES:
1. Identify and maintain screwdrivers
2. Identify and maintain hammers used in the electrical trade.
3. Identify and maintain pliers used in the electrical trade.
4. Identify and properly use wrenches.
5. Select and use proper hacksaw blades when cutting various metals
6. Select and safely use files.
7. Select and use taps and dies.
8. Select and use measuring and layout tools used in the electrical industry.
9. Select and use punches and chisels used in the electrical trade.
10. Select and use handsaws.
11. Select and use a brace and bit.
12. Select and use hand-operated knock-out punches.

CONTENT:
1. Identify and maintain screwdrivers
    - general information
    - standard type
    - Robertson screwdriver
    - Phillips screwdriver
    - Reed and Prince screwdrivers
    - Posidrive, Clutch, and Torx screwdrivers
    - miscellaneous screwdrivers
    - screw-starter screwdriver
    - offset screwdriver
    - safety tips for using screwdrivers

2. Identify and maintain hammers used in the electrical trade.
    - introduction
    - claw hammer
    - ball-peen hammer
    - sledge hammer
    - soft-face hammers and mallets
    - using a hammer
    - safety
3. Identify and maintain pliers used in the electrical trade.

introduction
linesman or side cutting pliers
diagonal cutting pliers
long nose pliers
water pump pliers
high leverage cutter pliers
care of pliers

4. Identify and properly use wrenches.
   - introduction
   - open-end wrench
   - box-end wrench
   - combination wrench
   - flare-nut wrench (line wrench)
   - hex-key wrench (Allen wrench)
   - adjustable wrench
   - pipe wrenches
   - socket drives
   - sockets
   - safety
   - maintenance of wrenches

5. Select and use proper hacksaw blades when cutting various metals
   - introduction
   - hacksaw blades
   - using a hacksaw
   - safety

6. Select and safely use files.
   - cuts of files
   - file shapes
   - square files
   - half-round files
   - three-square files
   - round files
   - file handles
   - safety
   - file care

7. Select and use taps and dies.
   - taps
   - taper taps
   - plug taps
   - bottoming taps
   - using taps
   - removing broken taps
   - multiple-size taps
   - threading dies

tap and die maintenance
safety

8. Select and use measuring and layout tools used in the electrical industry.
   measuring tools
   flexible-rigid measuring tapes
   flat steel and woven tapes
   using measuring tapes
   levels

9. Select and use punches and chisels used in the electrical trade.
   introduction
   punches
   starting punches
   pin and drift punch
   long taper punch
   center punch
   chisels
   cape chisel
   round nose chisel
   diamond point chisel
   flat cold chisel
   safety tips for using chisels and punches

10. Select and use handsaws.
    introduction
    ripsaws and cross-cut saws
    using a handsaw

11. Select and use a brace and bit.
    brace
    using a brace
    bits

12. Select and use hand-operated knock-out punches.
    knockout punches
    "C "clamp punch

METHODOLOGY:
This course lends itself to hands-on projects supplemented by short theory lectures, demonstrations, and videos showing safe use of hand tools. The instructors may involve apprentices in specific activities, including:

- exercises on theory content
- demonstrations
- audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

- classroom exercises
- hands-on experiences as determined by the course instructor

NAME AND NUMBER: ER1120 - Power Tools

SUGGESTED DURATION: 30 hours

PREREQUISITES: ER1110

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be familiar with the safe use and care of the various power tools associated with the electrical industry.

OVERVIEW OF OBJECTIVES:
1. Select the proper portable drill for a specific task.
2. Safely operate a drill press.
3. Determine safe working speeds of wheels on portable and pedestal grinders.
4. Properly sharpen twist drills.
5. Properly operate circular, sabre, and reciprocating saws.
6. Properly use hydraulic operated knock-out punches, cutters, and cable benders.
7. Describe the care and safe use of a hydraulic press.
8. Describe the care and safe use of air powered tools.

CONTENT:
1. Select the proper portable drill for a specific task.
    - introduction
    - power flow
    - motor
    - brushes
    - the fan
    - lubrication
    - grounding (bonding)
    - general safety precautions
    - types of drills
    - electric drill sizes
    - three jaw drill chuck
    - types of drills
    - electric drill sizes
    - three jaw drill chuck
    - portable electric hammers
    - operating electric hammers
    - rotary hammers
    - operating the rotary hammer
    - core bits
    - mechanical safety precautions
    - electrical precautions
    - environmental precautions

electric hammer preventative maintenance

2. Safely operate a drill press.
   - general information
   - the sensitive drill press
   - tang
   - methods of holding work
   - the drill vise
   - safety precautions

3. Determine safe working speeds of wheels on portable and pedestal grinders.
   - general information
   - sharpening or grinding
   - abrasive wheels
   - safety

4. Properly sharpen twist drills.
   - general information
   - twist drills
   - wood drilling
   - the hole saw
   - safety precautions

5. Properly operate circular, sabre, and reciprocating saws.
   - general information
   - electric wiring and grounding precautions
   - maintenance
   - lubrication
   - saw blades
   - saw operation
   - plunge cutting
   - how to plunge cut
   - notching heavy timber
   - metal sawing

6. Properly use hydraulic operated knock-out punches, cutters, and cable benders.
   - uses
   - the hand pump
   - the ram
   - punch and die sets
   - cable cutters
   - cable benders

7. Describe the care and safe use of a hydraulic press.
   - operation of press
   - safety guards

securing objects on press cradle

8. Describe the care and safe use of air powered tools.
   - operating pressures
   - pressure regulators
   - in-line oilers
   - care of hoses/fittings

METHODOLOGY:
This course lends itself to hands-on projects supplemented by short theory lectures, demonstrations, and videos showing safe use of power tools. The instructors may involve apprentices in specific activities, including:

- exercises on theory content
- demonstrations
- audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

- classroom exercises
- hands-on experiences as determined by the course instructor

NAME AND NUMBER: ER1130 - Fasteners

SUGGESTED DURATION: 30 hours

PREREQUISITES: ER1120

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be familiar with the safe use and proper installation methods of the various fastening devices associated with the electrical industry.

OVERVIEW OF OBJECTIVES:
1. Describe the types, sizes, classifications and uses of various fastening devices.
2. Install various fastening devices.
3. Torque fastening devices to specifications.
4. Describe and follow the safety procedures required to operate explosive actuated tools.
5. Explain the colour coding for powder charges used to install fasteners.
6. Use a fastener to determine the hardness of a material.
7. Use explosive actuated tools safely and competently to fasten material to concrete and steel.
8. Explain the differences between low- and high-velocity tools and when they should be used.
9. Dismantle, inspect, clean and reassemble explosive actuated tools.
10. Identify the types, sizes, classifications and uses of epoxy anchoring devices.

CONTENT:
1. Describe the types, sizes, classifications and uses of various fastening devices.
    - nails
    - wood screws
    - sheet metal screws
    - machine screws and bolts
    - nuts and washers
    - masonry anchors and shields
    - cavity fasteners
    - screw anchors
    - miscellaneous anchors

2. Install various fastening devices.
    - nailing
    - tools for driving screws
    - using self-drilling fasteners
    - screw extractors
    - concrete compressive strength
    - how the sleeve anchor works
    - how the wedge anchor works
    - how the stud anchor works

how the drop-in anchor works
how the self drilling anchor works
installing lag screw expansion shields
installing spring/gravity anchors
installing metal/non-metalling inserts

3. Torque fastening devices to specifications.
   - deflection torque wrenches
   - pre-set/digital torque wrenches
   - torque break-away tabs

4. Describe and follow the safety procedures required to operate explosive actuated tools.
   - general safety precautions
   - safe operation
   - specific precautions (operator, tools, power loads, and materials)
   - qualified operator
   - general information
   - requirements for operator card

5. Explain the colour coding for powder charges used to install fasteners.
   - types of power loads
   - power load selection
   - power level settings

6. Use a fastener to determine the hardness of a material.
   - general information
   - suitable base materials
   - unsuitable base materials
   - centre punch test procedure

7. Use explosive actuated tools safely and competently to fasten material to concrete and steel.
   - fastening relatively soft material permanently to concrete
   - fastening relatively soft material permanently to steel
   - fastening metal permanently to concrete
   - fastening metal permanently to steel
   - fastening removable items or material to concrete
   - fastening removable items or material to steel
   - shields and special fixtures
   - tool accessories

8. Explain the differences between low- and high-velocity tools and when they should be used.
   - high velocity
   - low velocity tools

9. Dismantle, inspect, clean and reassemble explosive actuated tools.
   - following manufacturers' instructions

10. Identify the types, sizes, classifications and uses of epoxy anchoring devices.
    types
    sizes
    uses

METHODOLOGY:
This course lends itself to hands-on projects supplemented by short theory lectures, demonstrations, and videos showing the proper and safe use of fastening devices. The instructors may involve apprentices in specific activities, including:

- exercises on theory content
- demonstrations
- audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

- classroom exercises
- hands-on experiences as determined by the course instructor

NAME AND NUMBER: ER1140 - DC Theory

SUGGESTED DURATION: 30 hours

PREREQUISITES: ER1400

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will become familiar with the direct current circuit theory foundation.

OVERVIEW OF OBJECTIVES:
1. Describe atomic structure
2. Describe different sources of electricity
3. Describe useful applications and hazards caused by static charges
4. Describe the effects of electricity
5. Define electrical absolute values
6. Describe the types and the components of electrical circuits
7. Compute values of electrical energy and power
8. Use electrical measuring instruments

CONTENT:
1. Describe atomic structure
    - matter
    - atoms
    - electric charge
    - protons, electrons, neutrons
    - conductors, insulators

2. Describe different sources of electricity
    - friction
    - heat
    - light and solar energy
    - piezoelectric
    - mechanical (magnetism)
    - chemical (the primary and secondary cells, the action of the lead-acid cell)

3. Describe useful applications and hazards caused by static charges
    - negative charge
    - positive charge
    - law of charges
    - electrostatic field (dielectric field)
    - applications

4. Describe the effects of electricity
   - introduction
   - heat effect
   - magnetic effect
   - psychological and physiological effects

5. Define electrical absolute values
   - unit prefixes
   - electrical absolute values (resistance, pressure, flow, power, etc.)
   - basic look at Ohm's Law

6. Describe the types and the components of electrical circuits
   - the electron path
   - the load
   - the source
   - the control
   - electron current flow
   - conventional current flow
   - closed circuit
   - open circuit
   - short circuit

7. Compute values of electrical energy and power
   - introduction to mechanical power, energy, etc.
   - combining the power formula and Ohm's Law
   - kilowatts and horsepower

8. Use electrical measuring instruments
   - ammeter
   - voltmeter
   - ohmmeter
   - multimeter
   - testers

METHODOLOGY:

This course lends itself to theory lectures supplemented with interactive Cd's and videos. The instructors may involve apprentices in specific activities, including:

- exercises on theory content
- demonstrations
- audio/visual presentations

SUGGESTED LEARNING ACTIVITY

In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

- classroom exercises as determined by the instructor
- pre-tests and post tests as determined by the instructor

NAME AND NUMBER: ER1150 - Series and Parallel Circuits

SUGGESTED DURATION: 30 hours

PREREQUISITES: ER1140

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able to determine the absolute values of devices connected in series, parallel or any combination of these two.

OVERVIEW OF OBJECTIVES:
1. Analyse and measure amperage and voltage in series DC circuits.
2. Analyse and measure amperage and voltage in parallel DC circuits.
3. Analyse and measure amperage and voltage in combination DC circuits.
4. Analyse and measure resistance and/or continuity in basic DC circuits.
5. Analyse and measure power consumption in basic DC circuits.

CONTENT:
1. Analyse and measure amperage and voltage in series DC circuits.
    - current relationships
    - resistance relationships
    - voltage relationships
    - circuit fault analysis
    - circuit applications

2. Analyse and measure amperage and voltage in parallel DC circuits.
    - current relationships
    - resistance relationships
    - voltage relationships
    - circuit fault analysis
    - circuit applications

3. Analyse and measure amperage and voltage in combination DC circuits.
    - series/parallel circuits
    - parallel/series circuits
    - voltage and current relationships in complex circuits

4. Analyse and measure resistance and/or continuity in basic DC circuits.

5. Analyse and measure power consumption in basic DC circuits.

METHODOLOGY:
This course lends itself to theory lectures supplemented with interactive Cd's and videos. The instructors may involve apprentices in specific activities, including:

exercises on theory content
demonstrations
audio/visual presentations

SUGGESTED LEARNING ACTIVITY

In order to successfully complete this unit of instruction, apprentices will be expected to complete the following LabVolt experiments:

- Ex. 1-1 Voltage, Current, and Ohm's Law
- Ex. 1-2 Equivalent Resistance
- Ex. 1-3 Power in DC Circuits
- Ex. 1-4 Series and Parallel Circuits

NAME AND NUMBER: ER1160 - Introduction to Building Codes

SUGGESTED DURATION: 30 hours

PREREQUISITES: NONE

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able to understand the legalities, layout, and how to use various codes involved with the construction industry.

OVERVIEW OF OBJECTIVES:
1. Describe layout and structure of the Canadian Electrical Code, Part 1 (CEC)
2. Locate, select, and gather information from the CEC, Part 1.
3. Locate, select, and gather information from the CEC Handbook
4. Describe layout and structure of the National Building Code (NBC)
5. Locate, select, and gather information from the NBC.

CONTENT:
1. Describe layout and structure of the Canadian Electrical Code, Part 1 (CEC)
    - background of the code
    - development and issuance
    - table of contents
    - general rules (sections)
    - supplementary and amendatory sections
    - tables
    - diagrams
    - appendices and their purposes
    - alphabetical index
    - numbering system
    - subdivision of rules
    - changes in requirements ( )
    - deletion of text ( )
    - SI usage
    - approved terminology
    - reference publications
    - NBC references

2. Locate, select, and gather information from the CEC, Part 1.
    - main key word
    - secondary key words
    - using key words in the index
    - alter order of key words
    - change key words to ones used in CEC
    - scan rule captions

- scan table of contents
- scan sections/subsections

3. Locate, select, and gather information from the CEC Handbook
   - purpose of handbook
   - rational for rules
   - intent for rules
   - using diagrams/figures

4. Describe layout and structure of the National Building Code (NBC)
   - Background and purpose of code
   - preface
   - table of contents
   - numbering system
   - index
   - appendix
   - tables

5. Locate, select, and gather information from the NBC.
   - scope and definitions
   - general requirements
   - use and occupancy
   - wind, water, and vapour protection
   - heating, ventilating, and air conditioning
   - plumbing
   - safety measures at construction and demolition sites
   - housing and small buildings

METHODOLOGY:
This course lends itself to theory lectures supplemented videos. The instructors may involve apprentices in specific activities, including:

- exercises on theory content
- audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

- classroom exercises as determined by the instructor

NAME AND NUMBER: ER1170 - Voltage Drop & Power Loss

SUGGESTED DURATION: 30 hours

PREREQUISITES: ER1150 - ER1160

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will acquire the knowledge necessary to readily calculate voltage drop and power losses in conductors.

OVERVIEW OF OBJECTIVES:
1. Explain conductor terms
2. Discuss the factors affecting resistance of conductors
3. Determine the voltage loss and power loss in electrical circuits
4. Apply Kirchhoff's current and voltage laws
5. Calculate the absolute values in three-wire circuits

CONTENT:
1. Explain conductor terms
   - mils and circular mils
   - square mils
   - stranded conductors
   - the approximate wire table
   - conductor insulation requirements
   - AWG sizes
   - Calculation for circularmils (square millimeters/ohms/milfoot)

2. Discuss the factors affecting resistance of conductors
   - type of material
   - temperature
   - length
   - cross-sectional area
   - the mil-foot
   - the microhm-cm
   - temperature coefficient of resistance

3. Determine the voltage loss and power loss in electrical circuits
   - factors affecting voltage drop
   - calculations
   - CEC requirements
   - factors affecting line loss
   - line loss in three-wire circuits
   - effects of line loss
   - calculations

4. Apply Kirchhoff's current and voltage laws
   - current law
   - voltage law

5. Calculate the absolute values in three-wire circuits
   - introduction
   - purpose of neutral wire (theory only)
   - open neutral
   - solving three-wire system calculations

METHODOLOGY:
This course lends itself to theory lectures supplemented with interactive Cd's and videos. The instructors may involve apprentices in specific activities, including:

- exercises on theory content
- demonstrations
- audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

- classroom exercises as determined by the instructor
- interactive computer pre-tests and post tests as determined by the instructor

NAME AND NUMBER: ER1180 - Single-phase Theory

SUGGESTED DURATION: 60 hours

PREREQUISITES: ER1170

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be familiar with the alternating current theory foundation needed to progress in the electrical industry.

OVERVIEW OF OBJECTIVES:
1. Describe the principles of magnetism and electromagnetism.
2. Describe the concepts of AC voltage generation.
3. Describe the various values of current and voltage in AC circuits.
4. Determine the properties of an AC circuit.
5. Determine absolute values in an AC series circuit containing RLC components.
6. Determine absolute values in AC parallel circuits containing RLC components.
7. Calculate power and power factor in AC circuits.

CONTENT:
1. Describe the principles of magnetism and electromagnetism
    - natural magnets
    - magnetic substances
    - nonmagnetic substances (diamagnetic and paramagnetic)
    - domain theory of magnetism (Weber's Theory)
    - lines of flux
    - flux density
    - force between magnets
    - reluctance and permeability
    - residual and induced magnetism
    - shielding
    - magnetic field around a current carrying wire
    - characteristics of an electromagnetic field
    - direction of current and flux (left-hand rule)
    - ampere turns
    - polarity of a coil (left-hand rule for a coil)
    - magnemotive forces
    - saturation
    - applications of electromagnets

2. Describe the concepts of AC voltage generation.
    - principles of the elementary generator
    - self-induction and mutual induction
    - Faraday's Law

introduction: the AC generator
cycle
sine wave
electrical and mechanical degrees
alternating current and voltage values (maximum, effective and average values)
- relationship between generated voltages (phase)

3. Determine the properties of an AC circuit.
   resistance
   capacitance
   inductance
   impedance

4. Determine absolute values in an AC series circuit containing RLC components.
   relationships between voltage and current in resistive, capacitive, and inductive AC circuits
   characteristics of series connected resistive, capacitive, and inductive loads

5. Determine absolute values in AC parallel circuits containing RLC components.
   relationships between voltage and current in resistive, capacitive, and inductive AC circuits
   characteristics of parallel connected resistive, capacitive, and inductive loads

6. Calculate power and power factor in AC circuits.
   positive and negative power
   apparent power
   power in reactive AC circuits
   power in resistive/reactive AC circuits
   power factor
   power factor correction

METHODOLOGY:
This course lends itself to theory lectures supplemented with laboratory experiments. The instructors may involve apprentices in specific activities, including:

- exercises on theory content
- demonstrations
- audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following LabVolt experiments:

- Ex. 2-1 The Sine Wave
- Ex. 2-2 Phase Angle
- Ex. 2-3 Instantaneous Power
- Ex. 3-1 Capacitive Reactance
- Ex. 3-2 Equivalent Capacitance

- Ex. 3-3 Capacitive Phase Shift and Reactive Power
- Ex. 4-1 Inductive Reactance
- Ex. 4-2 Equivalent Inductance
- Ex. 4-3 Inductive Phase Shift and Reactive Power
- Ex. 5-1 Power in AC Circuits
- Ex. 5-2 Vectors & Phasors in Series AC Circuits
- Ex. 5-4 Impedance

NAME AND NUMBER: ER1190 - Three-phase Theory

SUGGESTED DURATION: 30 hours

PREREQUISITES: ER1180

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be familiar with the theoretical base required to work with electrical apparatus and devices which utilize a three-phase power source.

OVERVIEW OF OBJECTIVES:
1. Describe the generation of three-phase voltages
2. Describe the voltage and current values in three-phase wye connections
3. Describe voltage and current values in three-phase delta connections
4. Calculate three-phase power, volt-amperes, reactive power, and power factor
5. Measure three-phase power using wattmeters

CONTENT:
1. Describe the generation of three-phase voltages
    - introduction
    - advantages of three phase
    - voltage generation of three phase voltages
    - phase sequence
    - three phase system connections

2. Describe the voltage and current values in three-phase wye connections
    - voltage relationships in a wye connection
    - current relationships in a wye connection
    - ground connections
    - industrial applications
    - summary

3. Describe voltage and current values in three-phase delta connections
    - introduction
    - cautions regarding improper delta connections
    - voltage relationships in a delta connection
    - current relationships in a delta connection
    - open delta connections
    - advantages
    - comparing wye and delta systems

4. Calculate three-phase power, volt-amperes, reactive power, and power factor
    - three phase apparent power

three phase power
power factor
measurements of three phase power
examples

5. Measure three-phase power using wattmeters
   two wattmeter method
   three wattmeter method
   polyphase wattmeter

METHODOLOGY:
This course lends itself to theory lectures supplemented with laboratory experiments. The instructors may involve apprentices in specific activities, including:

- exercises on theory content
- demonstrations
- audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following LabVolt experiments:

- Balanced Three-Phase Circuits
- Three-Phase Power Measurement
- Phase Sequence

NAME AND NUMBER: ER1200 - Generic Blueprint

SUGGESTED DURATION: 30 hours

PREREQUISITES: ER1160

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able to extract the required information from basic blueprints, specifications, and detail drawings.

OVERVIEW OF OBJECTIVES:
1. Explain the theory of basic blueprints and components involved
2. Determine measurements from scaled drawings
3. Gather information from site plans
4. Describe construction systems
5. Extract information from floor plans
6. Gather information from foundation plans
7. Gather information from framing plans
8. Gather information from sectional detail drawings
9. Gather information from electrical plans
10. Gather information from plumbing drawings
11. Gather information from heating, ventilating, and air conditioning (HVAC) plans
12. Determine finishing details from drawings
13. Extract information from schedules, specifications, and estimates
14. Extract information from field revisions and alterations
15. Gather information from sets of drawings
16. Make construction sketches

CONTENT:
1. Explain the theory of basic blueprints and components involved
    - how blueprints are made
    - pictorial drawings
    - multiview interpretation
    - interpreting architectural symbols
    - construction terms
    - architectural abbreviations and synonyms
    - lettering

2. Determine measurements from scaled drawings
    - size description
    - scales
    - construction calculations

3. Gather information from site plans
   - survey plans
   - plat plans
   - plot plans
   - landscape plans
   - site and topographical plans

4. Describe construction systems
   - principles of construction
   - skeleton wood frame
   - heavy timber systems
   - structural steel systems
   - masonry construction systems
   - concrete construction systems

5. Extract information from floor plans
   - types of floor plans
   - floor plan symbols
   - floor level designations
   - reading floor plan dimensions

6. Extract information from floor plans
   - elevation projection and orientation
   - reading elevation symbols
   - interior elevations
   - reading elevation dimensions
   - presentation elevations

7. Gather information from foundation plans
   - foundation members
   - foundation types
   - reading basement plans
   - reading fireplace plans

8. Gather information from framing plans
   - floor framing plans
   - wall framing plans
   - roof framing plans
   - reading modular framing drawings
   - reading framing dimensions

9. Gather information from sectional detail drawings
   - full sections
   - detail sections
   - sectional materials symbols

10. Gather information from electrical plans
    - electric circuits
    - electrical symbols
    - wiring plans

11. Gather information from plumbing drawings
    - schematic plumbing plans
    - schematic plumbing elevations
    - plumbing symbols

12. Gather information from heating, ventilating, and air conditioning (HVAC) plans
    - heating systems
    - cooling systems
    - solar heating and cooling
    - HVAC conventions

13. Determine finishing details from drawings
    - built-in components
    - moldings and trim
    - surface treatments

14. Extract information from schedules, specifications, and estimates
    - schedules
    - specifications
    - construction cost estimates

15. Extract information from field revisions and alterations
    - design consistency
    - changes and revisions

16. Gather information from sets of drawings
    - relationships of drawings
    - delineation systems an symbols
    - combination plans
    - working with CAD plans

17. Make construction sketches
    - isometric sketches
    - oblique sketches

METHODOLOGY:
This course lends itself to hands-on projects supplemented by theory lectures, demonstrations, and videos. The instructors may involve apprentices in specific activities, including:

- exercises on theory content
- demonstrations
- audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

- gather information from blueprints as required by instructor
- complete construction sketches as determined by course instructor
- classroom exercises

NAME AND NUMBER: ER1210 - Electrical Blueprints

SUGGESTED DURATION: 45 hours

PREREQUISITES: ER1200

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able to extract the required information from electrical blueprints, specifications, and detail drawings in order to complete an effective wiring system.

OVERVIEW OF OBJECTIVES:
1. Gather and interpret information from site plans.
2. Gather and interpret information from elevation/floor plans.
3. Interpret reference/key diagrams used on blueprints.
4. Gather and interpret information from distribution system layout drawings.
5. Gather and interpret information from single-line drawings.
6. Gather and interpret information from equipment schedules.
7. Gather and interpret information from motor control diagrams.
8. Gather and interpret information from floor plans in order to complete an efficient and effective installation.
9. Extract information from project documents

CONTENT:
1. Gather and interpret information from site plans.
    - protected areas
    - original contours/grades
    - underground pipe lines
    - bench marks/datum points
    - grounding grid
    - area lighting
    - trench details
    - service/utility location
    - symbols

2. Gather and interpret information from elevation/floor plans.
    - general building design
    - exterior finishes
    - control joints
    - exterior finishes
    - location of doors/windows, air intake/exhaust
    - number of floors c/w elevations

3. Interpret reference/key diagrams used on blueprints.
    - structural reference grids
    - key diagrams
    - reference bubbles
    - sectional reference bubbles

4. Gather and interpret information from distribution system layout drawings.
    - switchboards/substations
    - metering centers
    - component tables

5. Gather and interpret information from single-line drawings.
    - feeder sizes/risers
    - transformers
        - voltage ratings
        - capacity
        - connections
    - panelboard designations
    - distribution boards
    - connected apparatus
    - power conditioning devices
    - stand-by/emergency systems
    - motor control centers
    - equipment layout elevations
    - fire alarm systems
    - communication systems
    - energy management systems

6. Gather and interpret information from equipment schedules.
    - panel schedules
    - lighting fixture schedules
    - equipment schedules
    - cable schedules

7. Gather and interpret information from motor control diagrams.
    - starter/controller locations
    - wiring diagrams (generic)
    - overload/overcurrent
    - conductor sizes
    - interconnections/interlocking

8. Gather and interpret information from floor plans in order to complete an efficient and effective installation.
    - architectural
    - structural
    - mechanical

9. Extract information from project documents
    - project specifications
    - electrical specifications
        - index
        - sections/subsections
        - general provisions
    - construction critical flow charts
    - shop drawing
    - manufacturer's installation guides
    - field revisions and alterations
    - as built documents

METHODOLOGY:
This course lends itself to hands-on projects supplemented by theory lectures, demonstrations, and videos. The instructors may involve apprentices in specific activities, including:

- exercises on theory content
- demonstrations
- audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

- gather information from blueprints/specifications as required by instructor
- classroom exercises

NAME AND NUMBER: ER1220 - Conduit, Tubing, and Fittings

SUGGESTED DURATION: 30 hours

PREREQUISITES: ER1130 - ER1160

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be acquainted with the methods of installing rigid conduit, PVC conduit and EMT along with the associated fittings used in these raceway systems.

OVERVIEW OF OBJECTIVES:
1. Describe the advantages/disadvantages of the various types of conduit and tubing
2. Describe the terms associated with the bending of conduits and tubing
3. Describe the various fittings, couplings, and device boxes used with conduit and tubing
4. Apply proper cutting, coupling, and termination methods used with rigid conduit
5. Describe how to choose appropriate type of conduit
6. Install rigid metal conduit
7. Apply proper preparation and bending of EMT
8. Apply proper installation methods of EMT
9. Prepare and install PVC conduit
10. Describe the limitations and uses of ENT
11. Describe the limitations and uses of EB1, DB2/ES2 and RE conduit
12. Describe the limitations and uses of flexible conduit
13. Determine the size requirements of pull boxes and junction boxes

CONTENT:
1. Describe the advantages/disadvantages and construction of the various types of conduit and tubing
    - rigid metal conduit
    - sizes of rigid metal conduit
    - corrosion resistant rigid conduit
    - types of non-metallic rigid conduit
    - aluminum conduit
    - silicon bronze alloy conduit
    - PVC coated rigid conduit
    - PVC conduit
    - advantages of PVC
    - EMT - definition and description
    - sizes of EMT
    - uses of EMT
    - flexible conduit
    - ENT - definition and description
    - rigid RE conduit

rigid types EB1 and DB2/ES2 PVC conduit

2. Describe the various fittings, couplings, and device boxes used with conduit and tubing
   - LB's
   - LR's
   - LL's
   - TEE
   - "C" fittings
   - pull elbows
   - TA's
   - couplings
   - connectors
   - FS boxes
   - utility boxes

3. Describe the terms associated with the bending of conduits and tubing
   - back-to-back
   - 90^{o} -bend
   - come back
   - concentric bends
   - "dog leg" or "kick"
   - gain
   - leg length
   - offsets
   - rise on stub-up
   - spring back
   - segment bend
   - round saddle
   - square saddle
   - developed length

4. Apply proper cutting, coupling, and termination methods used with rigid conduit
   - preparing rigid conduit
   - cutting conduit by hand (hacksaw, pipe cutter)
   - cutting conduit using power devices
   - reamers
   - reaming rigid conduit
   - threading rigid conduit by hand
   - machine threading
   - portable power units
   - CEC threading requirements

5. Describe how to choose appropriate type of conduit
   - type of wires
   - type of fitting

6. Install rigid metal conduit
   - introduction to bending conduit
   - hand benders
   - hickeys
   - power benders
   - factory bends
   - CEC bending requirements
   - CEC installation requirements

7. Apply proper preparation and bending of EMT
   - cutting EMT
   - safety precautions
   - reaming EMT
   - bending EMT
   - hand benders
   - mechanical benders
   - hydraulic benders
   - the little “kicker”
   - CEC bending requirements

8. Apply proper installation methods of EMT
   - couplings and connectors
   - raintight and watertight types
   - general purpose types
   - fittings
   - boxes
   - CEC requirements

9. Prepare and install PVC conduit
   - cutting PVC conduit
   - joining PVC conduit
   - preparing PVC conduit for bending
   - hand-held heaters
   - floor model heaters
   - liquid PVC heaters
   - precautions to observe when bending PVC
   - prefabricated PVC bends
   - expansion and contraction of PVC
   - CEC requirements

10. Describe the limitations and uses of ENT
    - general information
    - couplings and connectors
    - CEC requirements

11. Describe the limitations and uses of EB1, DB2/ES2 and RE conduit
    - uses
    - restrictions
    - methods of installation
    - CEC requirements

12. Describe the limitations and uses of flexible conduit
    - uses
    - cutting flexible conduit
    - liquid-tight flexible conduit
    - connectors
    - CEC requirements

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

METHODOLOGY:
This course lends itself to hands-on projects supplemented by theory lectures, demonstrations, and videos. The instructors may involve apprentices in specific activities, including:

- exercises on theory content
- demonstrations
- audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

- conduit and tubing projects as determined by course instructor
- classroom exercises

NAME AND NUMBER: ER2000 - Raceways, Wireways, and Busways

SUGGESTED DURATION: 30 hours

PREREQUISITES: ER1160

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will acquire the skills required to install "accessible after installation" means of conductor support or to install systems which provide a flexible power distribution system.

OVERVIEW OF OBJECTIVES:
1. Describe how to install one-piece surface raceways
2. Describe how to install two-piece surface raceways
3. Describe how to install pancake raceways
4. Describe how to install multi-outlet assemblies
5. Describe how to install lighting fixture raceways
6. Describe how to install underfloor raceways
7. Describe how to install headers for cellular floors
8. Describe how to install cable tray
9. Describe how to install wireways
10. Describe how to install busways
11. Describe how to install HFT underground ducts

CONTENT:
1. Describe how to install one-piece surface raceways
    - introduction
    - one-piece surface raceways
    - fittings for one-piece surface raceway
    - boxes used with one-piece surface raceway
    - installing one-piece surface raceway
    - tools used with one-piece surface raceway
    - connecting to conduit and armoured cable
    - connecting to concealed wiring

2. Describe how to install two-piece surface raceways
    - introduction
    - single channel and multi-channel
    - applications
    - fittings
    - boxes used with two-piece raceway
    - supporting methods

3. Describe how to install pancake raceways
   - introduction
   - applications
   - installation
   - fittings and adapters
   - outlets and boxes
   - extending from underfloor ducts

4. Describe how to install multi-outlet assemblies
   - introduction
   - plugmold
   - pre-wired plugmold
   - installation of plugmold
   - plugmold devices and fittings
   - electro-strip
   - electro-strip construction
   - outlets and adapters for electro-strip
   - pole type multi-outlet assemblies
   - channel arrangements for pole type multi-outlet assemblies
   - installing pole type multi-outlet assemblies

5. Describe how to install lighting fixture raceways
   - introduction
   - construction
   - mounting methods

6. Describe how to install underfloor raceways
   - introduction
   - general installation practices
   - steel-duct raceways
   - trenchduct
   - fibre-duct raceways
   - afterset inserts

7. Describe how to install headers for cellular floors
   - introduction
   - cellular-metal floor raceways
   - accessories
   - cellular-concrete floor raceways
8. Describe how to install cable tray
   - introduction
   - methods of installation
   - ladder cable tray
   - ventilated cable tray
   - non-ventilated cable tray
   - supporting cable tray

- bonding cable tray
- cable support

9. Describe how to install wireways
   - introduction
   - uses
   - method of installation
   - restrictions

10. Describe how to install busways
    - introduction
    - uses
    - restrictions
    - supports
    - applications
    - installation

11. Describe how to install HFT underground ducts
    - installation
    - supports

METHODOLOGY:
This course lends itself to hands-on projects supplemented by theory lectures, demonstrations, and videos. The instructors may involve apprentices in specific activities, including:

- exercises on theory content
- demonstrations
- audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

- perform miscellaneous raceway projects as determined by course instructor
- classroom exercises

NAME AND NUMBER: ER1230 - Conductors and Cables

SUGGESTED DURATION: 60 hours

PREREQUISITES: ER1170

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able to determine the installation procedures, termination devices and applications of the various types of conductors and metal-sheathed cables.

OVERVIEW OF OBJECTIVES:
1. Properly identify wires and cables (other than flexible cords and fixture wires)
2. Properly prepare conductors for installation in raceways
3. Safely set reels on jacks and stands
4. Install conductors in raceways
5. Use power drives for conductor installation
6. Install conductors in cable tray
7. Identify, select, and install MI cables
8. Identify, select, and install armoured cables
9. Identify, select, and install TECK90 cable
10. Identify, select, and install aluminum sheathed cable
11. Apply CEC requirements in respect to the installation of conductors and cables
12. Apply CEC requirements in respect to the installation of flexible cords and equipment wire
13. Determine size of devices and junctions.

CONTENT:
1. Properly identify wires and cables (other than flexible cords and fixture wires)
    - CSA designations
    - maximum voltage ratings
    - number and size range of conductors (cables only)
    - number of strands (building wire)
    - construction
    - conditions of use
    - allowable ampacity
    - temperature ratings

2. Properly prepare conductors for installation in raceways
    - introduction
    - number of conductors in a conduit
    - CEC requirements
    - conductor lubricants
    - identification and colour coding of conductors
    - installing fish tapes

raceway layout
equipment preparation
use of jet line and air pressure
vacuum fishing
fish lines and ropes

3. Safely set reels on jacks and stands
   - introduction
   - reel jacks, supports and dispensers

4. Install conductors in raceways
   - mechanical pullers
   - power drives for cable pulling
   - pulleys, rollers, and extended sheaves
   - conductor installation preparations
   - installing conductors in conduit
   - adding conductors to existing conduit
   - attachment of conductors to pull cords
   - installation of conductors in flexible metal conduit
   - conductors in pull boxes

5. Use power drives for conductor installation

6. Install conductors in cable tray
   - introduction
   - cable crews
   - installing conductors in cable trays
   - safety precautions
   - measuring and securing cable in tray
   - bonding cable tray
   - tray barriers
   - cable bending (hydraulic and manual)
   - cable cutting (hydraulic and manual)

7. Identify, select, and install MI cables
   - introduction
   - application
   - construction (copper, aluminum, or stainless steel)
   - CSA designation (MI or LWMI)
   - voltage ratings
   - number and size range of conductors
   - conditions of use
   - maximum allowable conductor temperature
   - sheath currents
   - installation
   - termination and splices

high voltage surges
fault location

8. Identify, select, and install armoured cables
   - introduction
   - applications
   - CSA designations (ACWU75, AC90, ACWU90, ACL90)
   - construction (outer covering and conductor insulation)
   - voltage ratings
   - number and size range of conductors
   - conditions of use
   - maximum allowable conductor temperature
   - sheath currents
   - terminations

9. Identify, select, and install TECK90 cable
   - introduction
   - applications
   - construction
   - voltage ratings
   - number and size range of conductors
   - conditions of use
   - maximum allowable conductor temperature
   - sheath currents
   - terminations
   - hazardous location fittings and terminations

10. Identify, select, and install aluminum sheathed cable
    - introduction
    - applications
    - construction
    - CSA designations (RA75, RA90, VA, and A-7A)
    - voltage ratings
    - number and size range of conductors
    - conditions of use
    - maximum allowable conductor temperature
    - sheath currents
    - installation
    - terminations

11. Apply CEC requirements in respect to the installation of conductors and cables
    - CSA designations
    - maximum voltage ratings
    - number and size range of conductors (cables only)
    - number of strands (building wire)
    - construction

conditions of use
allowable ampacity
temperature ratings

12. Apply CEC requirements in respect to the installation of flexible cords and equipment wire
    CSA designations
    voltage ratings
    allowable ampacity
    construction
    conditions of use
    temperature rating

13. Determine size of devices and junctions.

METHODOLOGY:
This course lends itself to hands-on projects supplemented by theory lectures, demonstrations, and videos. The instructors may involve apprentices in specific activities, including:

- exercises on theory content
- demonstrations
- audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

- projects as determined by course instructor
- classroom exercises

NAME AND NUMBER: ER1240 - Residential Wiring

SUGGESTED DURATION: 60 hours

PREREQUISITES: ER1230 - ER1270

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able to install an effective and efficient wiring system in dwelling units.

OVERVIEW OF OBJECTIVES:
1. Discuss the requirements of the Applicable Provincial Electrical Installation and Inspection Act in regards to a residential wiring installation
2. Determine the location of service equipment
3. Determine the branch circuit requirements for a dwelling unit according to the CEC
4. Determine lighting and switching requirements for a dwelling unit according to the National Building Code
5. Determine the spacing and location for convenience outlets according to the CEC
6. Determine the location and circuit requirements for specific-use outlets according to the CEC
7. Apply CEC and Provincial requirements for smoke alarms
8. Describe how to install signal systems in dwelling units
9. Apply acceptable roughing-in and finish-up procedures
10. Describe how to install various convenience systems in dwelling units

CONTENT:
1. Discuss the requirements of the Applicable Provincial Electrical Installation and inspection Act in regards to a residential wiring installation
   - application for wiring permit
   - wiring permit
   - approval of plans
   - wiring inspections

2. Determine the location of service equipment
   - introduction
   - service equipment
   - equipment location

3. Determine the branch circuit requirements for a dwelling unit according to the CEC
   - introduction
   - general lighting circuits
   - installing residential lighting outlets
   - lighting control
   - toggle switch
   - lighting fixture connections

- installing luminaries
- installation points

4. Determine lighting and switching requirements for a dwelling unit according to the National Building Code
   - section 9.34.2 - lighting outlets

5. Determine the spacing and location for convenience outlets according to the CEC
   - outlet requirements
   - outlets in hallways
   - types of receptacles

6. Determine the location and circuit requirements for specific-use outlets according to the CEC
   - general information
   - kitchen counter requirements
   - refrigerator receptacle
   - dining area receptacle
   - electric range receptacle
   - bathroom receptacle
   - dryer outlet
   - washer outlet
   - outdoor receptacles
   - garage/carport receptacles
   - other household equipment
   - entertainment centers (transient voltage suppressors)
   - isolated ground receptacles
   - aluminum hot water heater (Austin water heater)

7. Apply CEC and Provincial requirements for smoke alarms
   - smoke alarms
   - location of detectors
   - electrical requirements
   - multiple dwellings

8. Describe how to install signal systems in dwelling units
   - signal systems
   - single dwelling
   - multiple dwelling units
   - annunciators
   - communication
   - auxiliary systems
   - security
   - protective alarm
   - standards
   - wiring
   - protective devices

- perimeter
- intericore
- door opening systems
- closed-circuit television monitoring systems

9. Apply acceptable roughing-in and finish-up procedures
   - introduction
   - blueprints or drawings
   - rough-in procedures
   - finish-up procedures
   - panel "tie-in"

10. Describe how to install various convenience systems in dwelling units
    - water pump connections
    - jet or piston pumps
    - submersible pumps
    - storage tank water heaters
    - tankless water heaters
    - central vacuum systems
    - appliance garages

METHODOLOGY:
This course lends itself to hands-on projects supplemented by theory lectures, demonstrations, and videos. The instructors may involve apprentices in specific activities, including:

- exercises on theory content
- demonstrations
- audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

- complete wiring layout on blueprints for single dwelling unit
- determine service layout and equipment/materials required
- complete rough-in and finish-up for single dwelling unit
- classroom exercises

NAME AND NUMBER: ER2010 - Lighting and Controls

SUGGESTED DURATION: 45 hours

PREREQUISITES: ER1260

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able to install various types of lighting systems, maintain them and troubleshoot problems associated with these systems.

OVERVIEW OF OBJECTIVES:
1. Describe the general terms associated with lighting
2. Determine the required lighting requirements using the zonal cavity method
3. Describe the various types of incandescent lamps
4. Describe how to install incandescent lighting according to the requirements of the CEC
5. Describe the various forms of fluorescent lighting
6. Describe how to install flourescent lighting systems
7. Troubleshoot problems with fluorescent lighting
8. Properly handle, store and dispose of ballasts and capacitors
9. Describe how to install mercury vapour fixtures
10. Describe how to install metal halide fixtures
11. Describe how to install low/high pressure sodium fixtures
12. Describe how to install line voltage system controls
13. Describe how to install voltage system control

CONTENT:
1. Describe the general terms associated with lighting
    - introduction
    - light
    - electric terms
    - lighting terms
    - measuring light
    - reflection, glare, and brightness
    - mounting height and spacing of lamps
    - coefficient of utilization
    - maintenance factor
    - lighting fixture control
    - lighting voltage

2. Determine the required lighting requirements using the zonal cavity method
    - space requirements
    - type of fixtures
    - fixture efficacy
    - colour co-efficiency

- determining light level requirements

3. Describe the various types of incandescent lamps
   - introduction
   - incandescent lamp operation
   - bulb shapes
   - glass for bulbs
   - bulb finishes
   - types of bases
   - voltage ratings
   - types of incandescent lamps (rough service, vibration service, safety bulbs, sign lamps, long-life, dichroic, reflectorized, krypton, tungsten, halogen)
   - incandescent lighting fixtures
   - maintenance
   - install incandescent lighting according to the requirements of the CEC
   - Describe the various forms of flourescent lighting

4. Describe how to install incandescent lighting according to the requirements of the CEC

5. Describe the various forms of fluorescent lighting

6. Describe how to install fluorescent lighting systems
   - introduction
   - advantages of fluorescent lighting
   - fixtures
   - theory of operation
   - lamp construction (bulbs, phosphors, electrodes, bases)
   - types (preheat, instant start, rapid start, rapid start - high output, rapid start - very high output, low temperature, weather shield, circline, curvline, reflector, gro-lux, blacklight, blacklight blue, and gemicidal)
   - operating circuits (ballast, thermal protection, starters, pre-heat circuits)
   - operating characteristics (life, burning periods, effects of temperature, humidity, voltage, frequency)
   - dimming ballasts
   - solid-state ballasts
   - installing fixtures
   - maintenance of fixtures
   - CEC requirements
   -

7. Troubleshoot problems with flourescent lighting
   - lamp testers
   - ballast testers

8. Properly handle, store and dispose of ballasts and capacitors
   - listing of manufacturers of ballasts and capacitors
   - identification of ballasts and capacitors by codes
   - storage and disposal

9. Describe how to install mercury vapour fixtures
   - theory of operation
   - lamp designations
   - types of mercury lamps (self-ballast lamps)
   - mercury lamp ballast (low power factor - reactor, low power factor - autotransformer, high power factor, constant wattage - autotransformers)
   - lamp starting and warm up
   - lamp life (burning periods)
   - maintenance
   - troubleshooting
   - CEC requirements

10. Describe how to install metal halide fixtures
   - lamp construction
   - operating principles (horizontal and vertical lamps)
   - operating positions (burning position)
   - effects of temperature
   - effects of line voltage
   - ballasts
   - start up and warm up
   - lamp life (burning periods)
   - applications of metal halide
   - safety around metal halide lamps
   - maintenance and lumens output
   - troubleshooting
   - CEC requirements

11. Describe how to install low/high pressure sodium fixtures
   - lamp construction
   - operating principles
   - lamp ballasts
   - lamp life (burning periods)
   - lumen output and maintenance
   - burning position
   - warm up and restrike time
   - effects of line voltage
   - high pressure sodium retrofit (for use on mercury ballasts)
   - low pressure sodium
   - safety around sodium lamps
   - CEC requirements

12. Describe how to install line voltage system controls
   - introduction
   - lighting control function
   - line voltage switches
   - dimming circuits

- photocells
- timers and time clocks
- passive infrared lighting control
- lighting contactors
- programmable lighting controls

13. Describe how to install low voltage system control
    - 3 wires
    - 2 wires
    - wireless

METHODOLOGY:
This course lends itself to hands-on projects supplemented by theory lectures, demonstrations, and videos. The instructors may involve apprentices in specific activities, including:

- exercises on theory content
- demonstrations
- audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

- projects as determined by course instructor
- classroom exercises

NAME AND NUMBER: ER1250 - Protective Devices

SUGGESTED DURATION: 30 hours

PREREQUISITES: ER1230

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able describe the operating characteristics and installation procedures for protective devices rated at 750 volts or less.

OVERVIEW OF OBJECTIVES:
1. Describe the function of protective devices
2. Explain the effects of short-circuit current
3. Describe the voltage and current rating, interrupting capacity, and time characteristics of overcurrent devices
4. Describe the features of cartridge fuses
5. Describe the features of low-voltage circuit breakers
6. Interpret CEC rules and regulations concerning protective devices
7. Identify the needs of coordinations of protective devices.

CONTENT:
1. Describe the function of protective devices
   - overcurrent
   - short circuit
   - overload

2. Explain the effects of short-circuit current
   - fault currents
   - percent impedance
   - types of damage

3. Describe the voltage and current rating, interrupting capacity, and time characteristics of overcurrent devices
   - voltage
   - current
   - interrupting capacity
   - time-current characteristics

4. Describe the features of cartridge fuses
   types
   classifications
   - standard cartridge fuses
   - renewable link fuses
   - time delay fuses

- high rupture capacity fuses
- power breakers
- system breakers
- sensors
    - overcurrent
    - undercurrent

5. Describe the features of low-voltage circuit breakers
    - thermal trip action
    - magnetic trip action
    - moulded case
    - high interrupting capacity type
    - ground fault interrupters
    - shunt trip
    - power breakers
    - system breakers
    - sensors
        - overcurrent
        - undercurrent

6. Interpret CEC rules and regulations concerning protective devices
    - Section 14

7. Identify the needs of coordination of protective devices
    - manufacturer's chart
    - engineered
        - responsibilities
        - awareness

METHODOLOGY:
This course lends itself to hands-on projects supplemented by theory lectures, demonstrations, and videos. The instructors may involve apprentices in specific activities, including:

- exercises on theory content
- demonstrations
- audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

- classroom exercises
- select fuses/breakers according to specific requirements
- determine interrupting capacity requirements of fuses/breakers

NAME AND NUMBER: ER1260 - Principle of Operations of Transformers

SUGGESTED DURATION: 30 hours

PREREQUISITES: ER1180

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able describe the operating characteristics and installation procedures for transformers.

OVERVIEW OF OBJECTIVES:
1. Explain the operating principles of a transformer
2. Identify and describe the major components of transformers
3. Explain transformer polarity and terminal markings
4. Describe various connections for multi-coil transformers
5. Perform transformer calculations
6. Use schematic diagrams to illustrate how single-phase transformers are connected for parallel operation
7. Describe the operation for various primary and secondary connections for three-phase operation
8. Identify the different application of special transformers

CONTENT:
1. Explain the operating principles of a transformer
   - mutual induction
   - turns ratio
   - classes of transformers

2. Identify and describe the major components of transformers
   - high-voltage windings
   - low-voltage windings
   - core designs

3. Explain transformer polarity and terminal markings
   - additive and subtractive polarity
   - polarity tests

4. Describe various connections for multi-coil transformers
   - double-wound transformer
   - series/parallel connections

5. Perform transformer calculations
   - turns/voltage/current ratios
   - voltage, current and kVA calculations

6. Use schematic diagrams to illustrate how single-phase transformers are connected for parallel operation
   - connections for parallelling dual-winding transformers
   - back-feed hazard

7. Describe the operation for various primary and secondary connections for three-phase operation
   - wye to wye transformer bank
   - wye to delta transformer bank
   - delta to wye transformer bank
   - delta to delta transformer bank
   - three-phase four-wire delta transformer bank
   - open delta transformer bank

8. Identify the different application of special transformers
   - instrumental
   - auto transformer
   - ignition
   - isolation

METHODOLOGY:
This course lends itself to hands-on projects supplemented by theory lectures, demonstrations, and videos. The instructors may involve apprentices in specific activities, including:

- exercises on theory content
- demonstrations
- audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following LabVolt experiments:

- Voltage and Current ratios
- Transformer Polarity
- Transformer Regulation
- The Autotransformer
- Transformers in Parallel
- Distribution Transformers
- Three-Phase Transformer Connections
- Voltage and Current Relationships
- The Open Delta Connection

NAME AND NUMBER: ER1270 - Single-phase Service Entrance

SUGGESTED DURATION: 30 hours

PREREQUISITES: ER1220 - ER1250 - ER1260

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able to install an overhead or underground single-phase service entrance.

OVERVIEW OF OBJECTIVES:
1. Describe how to install a single-phase, three-wire distribution system
2. Describe how to install a single-phase service entrance equipment
3. Describe grounding and bonding requirements
4. Interpret CEC rules and regulations and demand factor calculations for single-phase services

CONTENT:
1. Describe how to install a single-phase, three-wire distribution system
   - overhead distribution systems
   - underground distribution systems
   - circuit connections
   - main disconnect means

2. Describe how to install a single-phase service entrance equipment
   - service supply authority
   - consumer's service
   - overhead service components
   - underground service components

3. Describe grounding and bonding requirements
   - grounding electrodes
   - grounding conductors
   - bonding conductors

4. Interpret CEC rules and regulations and demand factor calculations for single-phase services
   - demand factor calculations
   - service entrance conductors
   - load demands
   - overcurrent protection

METHODOLOGY:
This course lends itself to hands-on projects supplemented by theory lectures, demonstrations, and videos. The instructors may involve apprentices in specific activities, including:

- exercises on theory content
- demonstrations
- audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

- determine service ampacities for residential, and light commercial/industrial applications
- determine service layout and equipment/materials required
- classroom exercises

NAME AND NUMBER: ER1280 - Three-phase Service Entrance

SUGGESTED DURATION: 30 hours

PREREQUISITES: ER1270

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able to acquire the skills needed to efficiently install a three-phase service entrance.

OVERVIEW OF OBJECTIVES:
1. Describe how to install a three-phase commercial and industrial distribution system
2. Describe how to install a three-phase service entrance equipment
3. Describe the requirements for conductor installation and termination
4. Describe the application of instrument transformers
5. Interpret CEC rules and regulations and demand factor calculations three phaze service

CONTENT:
1. Describe how to install a three-phase commercial and industrial distribution system
    - service entrance types
    - wye systems
    - delta systems

2. Describe how to install a three-phase service entrance equipment
    - distribution panels
    - splitters and splitter troughs
    - metering
    - service disconnecting means

3. Describe the requirements for conductor installation and termination
    - conductors in parallel
    - colour coding of conductors
    - conductor terminations

4. Describe the application of instrument transformers
    - description and purpose of instrument transformers
    - operation and bonding of instrument transformers
    - instrument transformer connections

5. Interpret CEC rules and regulations and demand factor calculations three phase service
    - CEC demand factors
    - calculation examples

METHODOLOGY:
This course lends itself to hands-on projects supplemented by theory lectures, demonstrations, and videos. The instructors may involve apprentices in specific activities, including:

- exercises on theory content
- demonstrations
- audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

- determine service ampacities for commercial/industrial applications
- determine service layout and equipment/materials required
- classroom exercises

NAME AND NUMBER: ER1290 - Distribution Equipment

SUGGESTED DURATION: 45 hours

PREREQUISITES: ER1280

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able to acquire the skills needed to efficiently install distribution equipment.

OVERVIEW OF OBJECTIVES:
1. Describe the construction and EEMAC/CSA designations of enclosures **
2. Describe disconnect switch sizes, ratings, and requirements for installation
3. Describe panelboard classification, ratings, and requirements for installation
4. Describe application, installation and features of low-voltage switchboards
5. Describe the application and features of metal-enclosed low voltage power switchgear
6. Describe the application and features of medium-voltage metal-clad switchgear
7. Receiving, handling, storage and installation of switchgear
8. Determine size of junction/pull boxes

CONTENT:
1. Describe the construction and EEMAC/CSA designations of enclosures **
    - descriptions/construction of enclosure types
    - EEMAC/CSA designations
    - CEC applications

2. Describe disconnect switch sizes, ratings, and requirements for installation
    - voltage and current ratings
        - intended application
            - isolation use
            - service use
        - motor-circuit switches
            - high interrupting capacity switches
            - horsepower ratings
            - dual-horsepower ratings
        - contact assembly
            - quick-make, quick-break
            - non-teasing mechanism
            - bolted-pressure contact
            - optional attachments
        - ground fault protection
        - phase-failure relay
        - shunt tripping
        - auxiliary contacts

antisingle-phasing blown fuse indicator

3. Describe panelboard classification, ratings, and requirements for installation
    - loadcentres
        - construction
        - applications
        - ratings
        - pole positions
        - stab ratings
        - service entrance applications
        - breaker mounting options
        - typical IC ratings of breakers
        - add-on features
    - lighting and distribution panelboards
        - construction
        - applications
        - main lugs/breakers
        - branch circuit breaker ratings and IC
        - stab ratings
        - pole positions
        - on-site assembly
        - add-on features
    - breaker and fusible power panelboards
        - service (voltage and frequency)
        - interrupting capacity (fully or IER rating)
        - ampere rating of main device
        - incoming cable size
        - ampere rating of branch devices
        - environment (enclosure types)
        - enclosure layout/dimensions
        - integrated TVSS systems
        - diagnostic options
        - determining breaker/fusible disconnect spaces
        - selecting breaker mounting kits

4. Describe application, installation and features of low-voltage switchboards
    - applications
    - current and voltage ratings
    - incoming arrangements
        - bottom entry
        - top entry/top hat
        - side wireways
            - bussed
            - not bussed
            - mandatory bussed
        - bus way entry

- bus stub
- construction
  - cell dimensions
  - bus bracing standards
  - bus options
  - inside/outside corner units
  - receiving, storage and assembly of shipping units
- main disconnect section
- utility compartments
- distribution arrangements
  - twin mounted breakers
  - single mounted breakers
  - breaker/fusible switch units
  - subpanels
- metering centres
- customer metering, relay functions
  - digital meter/analog meters
    - volts
    - amps
    - PF
    - kW
    - kWh
    - kVA
    - Hz
- communications/transducers
    - pulse initiator outputs
- relaying and protective functions
    - undervoltage
    - single-phase
    - phase sequence
- check list before energizing
  - ground system for continuity
  - retourque all bolted connections
  - tighten bus mountings
  - align breakers, switches and other mechanisms for proper operation
- megger test/hipot test
  - switches/breakers open
    - phase-to-phase
    - phase-to-ground
  - switches/breakers closed
    - phase-to-phase
    - phase-to-ground
  - check wiring and operation of relays, meters and instrumentation
  - test electrically operated switches and breakers
  - test ground fault operation

5. Describe the application and features of metal-enclosed low voltage power switchgear
    - ANSI definition
    - current and voltage ratings
    - switchgear construction
        - indoor
    - 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
    - transformer unit
        - liquid-filled
        - air-cooled
        - single-ended
        - double-ended

6. Describe the application and features of medium-voltage metal-clad switchgear

7. Receiving, handling, storage and installation of switchgear
    - ANSI definition
    - current and voltage ratings
    - switchgear construction
        - indoor
        - outdoor
    - breaker/bus module
        - circuit breaker
        - stationary disconnect contacts
        - main bus
        - current transformers
        - levering-in device
        - shutter
        - interlocks
        - auxiliary switches
    - line modules
        - line terminations
            - cable connectors
            - potheads

- control module
  - control relays
  - molded case circuit breakers
  - fuses
  - terminal blocks
  - mechanically operated cell switches
- upper rear modules
  - potential transformers
  - lightning arrestors
  - special buses

8. Receiving, handling, storage and installation of switchgear
   - receiving switchgear
     - checking damage
     - checking material received
     - filing claim
       - transportation company
       - manufacturer
   - handling switchgear
     - lifting by crane
       - lifting hooks
       - using spreader bars
     - skidded on rollers
       - longitudinal skidding
       - front-to-back skidding
       - removing rollers
   - temporary storage
     - environmental conditions
     - surface considerations
     - outdoor storage
       - temporary storage building
       - heating requirements
   - installation
     - location
       - foundation
       - floor steel
       - conduits
       - shipping skids
       - shipping braces
   - 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
   - connections

bus connections
ground bus connections
main power connections
bolt torque
control connections
moving parts
removal of blocking and bracing
key operated interlocks

9. Determine size of junction/pull boxes
   - straight through pulls
   - U pulls
   - angle pulls
   - depth of box

METHODOLOGY:
This course lends itself to hands-on projects supplemented by theory lectures, demonstrations, and videos. The instructors may involve apprentices in specific activities, including:

- exercises on theory content
- demonstrations
- audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

- classroom exercises
- hands-on experiences

NAME AND NUMBER: ER1300 - DC Motors and Controls

SUGGESTED DURATION: 30 hours

PREREQUISITES: ER1170

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able describe the operating characteristics and installation procedures for various types of DC motors and their associated controls.

OVERVIEW OF OBJECTIVES:
1. Describe the construction of direct current motors
2. Explain the basic differences between shunt, series, and compound motors.
3. Explain the operating characteristics of direct-current motors.
4. Determine the armature current for given values of armature resistance, terminal voltage, and counter emf.
5. Explain the operation of automatic motor control.
6. Discuss the operation of variable speed DC drives.
7. Describe how to install and connect DC motors and their controls according to the CEC.

CONTENT:
1. Describe the construction of direct current motors
    - introduction
    - DC motor construction
    - field poles
    - armature
    - commutator
    - motor nameplate data

2. Explain the basic differences between shunt, series, and compound motors.
    - shunt motors
    - DC compound motors
    - differentially compound motors
    - series motors
        - step motor
        - electronically communative
        - permanent magnet

3. Explain the operating characteristics of direct-current motors.
    - introduction
    - right-hand motor rule
    - torque
    - counter-electromotive force (CEMF)

- voltage of self-induction
- motor effect
- armature reaction
- motor operation
- the shunt motor
- compound motors
- differentially compound motors
- series motors
- load variations
- speed control
- above-normal speed control
- below-normal speed control
- standard terminal markings
- motor connections - series, shunt, long compound, short compound

4. Determine the armature current for given values of armature resistance, terminal voltage, and counter emf.
   - mathematical representation

5. Explain the operation of automatic motor control.
   - introduction
   - control components
   - wiring diagrams
   - counter-electromotive force motor controllers
   - protection in CEMF controllers
   - shunt motors
   - DC compound motors
   - differentially compound motors
   - series motors
   - lockout controllers
   - voltage drop acceleration controllers
   - magnetic time controllers

6. Discuss the operation of variable speed DC drives.
   - introduction
   - Ward Leonard System
   - solid state DC drives
   - tachometer feedback

7. Describe how to install and connect DC motors and their controls according to the CEC.
   - overcurrent protection
   - overload protection
   - connections
   - conductor sizing

METHODOLOGY:
This course lends itself to laboratory projects supplemented by theory lectures, laboratory demonstrations, and videos showing operation of motors. The instructors may involve apprentices in specific activities, including:

- exercises on theory content
- mathematical computation involving motor operating values
- conductor/overload/overcurrent requirements
- demonstrations
- audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following LabVolt laboratory experiments:

- - The Separately-Excited DC Motor
- - Separately-Excited, Series, Shunt, and Compound DC Motors
- - Armature Reaction and Saturation Effect
- - The Universal Motor

NAME AND NUMBER: ER2020 - Single-phase Motors

SUGGESTED DURATION: 30 hours

PREREQUISITES: ER1190

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able to discuss the operating characteristics and install various types of single-phase motors as well as install the control devices for these motors.

OVERVIEW OF OBJECTIVES:
1. Describe the components of a typical split-phase motor
2. Describe the operating principles of split-phase motors
3. Describe the operating principles of capacitor type split-phase motors
4. Describe the operating principles of repulsion motors
5. Describe the operating principles of series motors
6 Describe the operating principles of small induction motors
7. Select motor to meet requirements
8. Install fractional-horsepower motors
9. Determine proper overload/overcurrent protection for motors
10. Install/connect starters/controller for single-phase motors

CONTENT:
1. Describe the components of a typical split-phase motor
    - basic motor parts
    - stator
    - rotor
    - armatures
    - end bells
    - stator winding
    - split-phase stator design
    - rotor design
    - centrifugal switch
    - direction of rotation
    - three-lead reversible split-base motor
    - centrifugal-clutch, split phase motor

2. Describe the operating principles of split-phase motors
    - introduction
    - reference terms
    - induction motor principles
    - rotating magnetic field
        - current and voltage

- frequency
- calculations (synchronous speed, slip, power out put, efficiency, power factor)

3. Describe the operating principles of capacitor type split-phase motors
   - introduction
   - capacitor-start, induction run
   - capacitor-start, capacitor-run motor
   - high-torque, single value capacitor motor
   - double-value capacitor motor (two-capacitor, capacitor-autotransformer, applications)
   - capacitor motor comparisons

4. Describe the operating principles of repulsion motors
   - introduction
   - simple repulsion motors
   - principle of operation
   - direction of rotation
   - characteristics
   - compensation repulsion motor
   - variable-speed repulsion motor
   - electrically reversible repulsion motors
   - double-voltage repulsion motors
   - synchronous repulsion motor
   - repulsion-start, induction run (Master, Leland, Wagner)
   - direction of rotation and bruch position
   - repulsion induction motor

5. Describe the operating principle of series motors
   - introduction
   - speed regulation
   - automatic speed regulator
   - direction of rotation
   - compensated series motor
   - applications

6. Describe the operating principles of small induction motors
   - introduction
   - shaded-pole motors
   - characteristics
   - single-phase synchronous motors
   - hysteresis motor (telechron)
   - subsynchronous hysteresis motor

7. Select motors to meet requirements
   - introduction
   - specific-use motors
   - specially designed motors

- motor selection
- motor enclosures
- duty cycles
- temperature considerations
- motor attachment considerations
- motor attachment and mounting
- rigid base
- resilient base
- side mounting
- face mounting
- clamp mounting
- bearings and thrust

8. Install fractional horsepower motors
   - installation of fractional horsepower motors
   - pulley selection
   - speed formula
   - thermal protection
   - motor bonding
   - motor operation
   - motor rotation
   - power supply and connections
   - motor control

9. Determine proper overload/overcurrent protection for motors
   - introduction
   - definitions
   - overcurrent protection
   - overload protection
   - overheating protection
   - low voltage protection or release

10. Install/connet starters/controllers for single-phase motors
    - introduction
    - manual starters for motor rated less than 1 HP (single-pole, double-pole, pilot lights, heater elements, locking devices)
    - combination AC manual starters
    - two speed starters
    - starters without overload protection
    - reversing switches
    - full voltage AC manual starters
    - drum reversing switches
    - drum reversing switches without overload protection
    - applications
    - auxiliary indication or control

METHODOLOGY:
This course lends itself to laboratory projects supplemented by theory lectures, laboratory demonstrations, and videos showing operation of motors. The instructors may involve apprentices in specific activities, including:

- exercises on theory content
- mathematical computation involving motor operating values
- conductor/overload/overcurrent requirements
- demonstrations
- audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following LabVolt laboratory experiments:

- \- Single-phase Induction Motors

NAME AND NUMBER: ER2030 - Three-Phase Motors

SUGGESTED DURATION: 45 hours

PREREQUISITES: ER2050

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able to select and install three-phase motors.

OVERVIEW OF OBJECTIVES:
1. Describe the components and construction of three-phase motors.
2. Describe the operating principles of three-phase motors.
3. Describe the operating principles of wound-rotor motor.
4. Describe the starting and running operating of a synchronous motor.
5. Install and connect motors according to the CEC.

CONTENT:
1. Describe the components and construction of three-phase motors.
    - introduction
    - comparing single phase and three phase motors
    - three phase motors (squirrel-cage and wound-rotor) stator windings
    - three phase synchronous motors
    - EEMAC classifications of three phase squirrel cage motors
    - locked-rotor ratings

2. Describe the operating principles of three-phase motors (SCIMs)
    - rotating magnetic field
    - calculations (synchronous speed, slip, power output, efficiency, power factor)
    - three phase motor reversal
    - wye and delta motor connections
    - fast reversing motors
    - high torque motors
    - wye-delta starting motors
    - multi-speed and multi-voltage induction motors
    - power factor
    - problems and solutions
    - effects of load on power factor

3. Describe the operating principles of three-phase motors (WRIMs)
    - introduction
    - construction
    - external circuit
    - method of operation

- advantages and disadvantages
- applications
- wound rotor motor with internal resistance

4. Describe the starting and running operating of a synchronous motor.
   - introduction
   - construction
   - starting and running operation
   - starting torque and damper winding
   - power factor
   - power output
   - effect of excitation
   - current curves
   - voltage curves at no load
   - advantages and disadvantages
   - applications
   - synchronous condenser
   - autosynchronous or synchronous induction motors (advantages, disadvantages, applications)

5. Install and connect motors according to the CEC.
   - code requirements

METHODOLOGY:
This course lends itself to laboratory projects supplemented by theory lectures, laboratory demonstrations, and videos showing operation of motors. The instructors may involve apprentices in specific activities, including:

- exercises on theory content
- mathematical computation involving motor operating values
- conductor/overload/overcurrent requirements
- demonstrations
- audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following LabVolt laboratory experiments:

- The Three-phase Squirrel-cage Induction Motor
- Eddy-current Brakes and Asynchronous Generators
- Effect of Voltage on the Characteristics of Induction Motors
- The Three-phase Synchronous Motor
- Synchronous Motor Pull-out Torque

NAME AND NUMBER: ER2040 - Control Devices (Discrete Input)

SUGGESTED DURATION: 30 hours

PREREQUISITES: ER2030

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able to select and install the various discrete control devices.

OVERVIEW OF OBJECTIVES:
1. Interpret control circuit logic.
2. Describe the construction and operation of pushbuttons.
3. Describe the construction and operation of selector switches.
4. Describe the construction and operation of centrifugal switches.
5. Describe the construction and operation of limit switches.
6. Describe the operation/limitations of proximity switches.
7. Describe the operation of photo sensors and switches.
8. Describe the operation of time switches.
9. Describe the operation of counters and totalizers.
10. Describe the operation of temperature operated switches.
11. Describe the methods of controlling/determining liquid levels.
12. Describe the methods of controlling/determining pressure levels.
13. Describe the methods used to determine the movement of air or liquids.
14. Describe the operation of general purpose, definite purpose, and machine tool relays.
15. Install and connect control devices according to the CEC.

CONTENT:
1. Interpret control circuit logic.
    - introduction
    - relay logic
    - AND, OR, NOR, NOT, NAND, MEMORY circuits
    - diagrams and explanations

2. Describe the construction and operation of pushbuttons.
    - introduction to pushbutton stations
    - pushbutton operators
    - contact assemblies
    - palm operator pushbuttons
    - special purpose pushbuttons

3. Describe the construction and operation of selector switches.
    - construction of selection switches
    - cam operators

joy stick operators
contact assemblies

4. Describe the construction and operation of centrifugal switches.
   description, operation and purpose of centrifugal switches
   circuit connections

5. Describe the construction and operation of limit switches.
   description/operation of operating units
   selecting and installing limit switches

6. Describe the operation/limitations of proximity switches.
   inductive proximity sensors
   definitions and examples
   installation techniques
   ultrasonic proximity sensors
   operation
   detection and accuracy
   capacitive proximity sensors
   wiring proximity sensors
   troubleshooting techniques

7. Describe the operation of photo sensors and switches.
   operation of photo switches
   phototubes (photoemissive cells)
   solar cells (photovoltaic cells)
   photoresistive cells (photoconductive)
   photodiodes/phototransistors
   installation of photo switches

8. Describe the operation of time switches.
   introduction to time switches and timing logic
   glossary of terms
   timing charts
   wiring diagrams/connections

9. Describe the operation of counters and totalizers.
   introduction to the purpose/operation of counters/totalizers
   types and uses
   definitions and terms
   electronic counters
   applying input signals
   electromechanical counters

10. Describe the operation of temperature operated switches.
    purpose and operation of temperature operated switches

definitions and terms
selecting temperature controllers
input devices
connections

11. Describe the methods of controlling/determining liquid levels.
    introduction
    sight glass
    float switches/controls
    photo-type level detectors
    pressure switches
    radiation absorption types of level control

12. Describe the methods of controlling/determining pressure levels.
    introduction
    types of flow switches
    installation and wiring

13. Describe the methods used to determine the movement of air or liquids.
    introduction
    types of flow switches
    installation and wiring

14. Describe the operation of general purpose, definite purpose, and machine tool relays.
    introduction
    general purpose relays
    machine tool relays
    protective relays
    characteristics
    construction

15. Install and connect control devices according to the CEC.
    interpret applicable rules for the installation of input devices

METHODOLOGY:
This course lends itself to laboratory projects supplemented by theory lectures, laboratory demonstrations, and videos showing operation of discrete input devices. The instructors may involve apprentices in specific activities, including:

- exercises on theory content
- demonstrations
- audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete

the following:

- complete ladder diagrams according to specific requirements
- install/connect input devices according to specific requirements
- install/connect input devices in a sequential operation

NAME AND NUMBER: ER2050 - Motor Starters and Controllers

SUGGESTED DURATION: 60 hours

PREREQUISITES: ER2020

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able to select and install motor starters / controllers and their associated overload devices according to design criteria.

OVERVIEW OF OBJECTIVES:
1. Interpret wiring and schematic diagrams.
2. Describe the purpose and operation of common magnetic starters and controllers
3. Install and connect common magnetic starters and controllers
4. Describe the construction and operation of overload devices and mechanical overload
5. Describe control circuits used with starters
6. Describe the construction of motor control centres
7. Describe the operation and construction of wound-rotor controllers
8. Troubleshoot control circuit, starters and controllers
9. Describe the operation of manual starters
10. Select and install manual starters

CONTENT:
1. Interpret wiring and schematic diagrams.
    - standard electrical symbols
    - diagrams and interpretation
    - wiring diagram
    - schematic diagram
    - tracing control circuit current flow
    - tracing power circuit current flow

2. Describe the purpose and operation of common magnetic starters and controllers.
    - magnetic starters (magnetic contactor, overload relay)
    - electromagnet operation
    - advantages of a magnetic starter
    - the control station (limit switch, snap switch, etc.)
    - descriptions and application
    - selection of control-circuit transformers
    - magnetic motor starter sizes
    - power contacts

3. Install and connect common magnetic starters and controllers.

4. Describe the construction and operation of overload devices.

electrical overloads
mechanical overloads
thermal overload relay trip characteristics
compensation units
ambient compensation
type of overload units
thermal overload relay selection
overload current transformer
installation of Heater Elements (making compensation adjustments when necessary)
solid state overload units

5. Describe control circuits used with starters.
   - two-wire control
   - three-wire control
   - four-wire control
   - common control
   - control circuit transformer
   - separate source control
   - purpose of jogging
   - pushbutton connections
   - pushbutton jog
   - selector knob jog
   - plugging
   - plugging switches (setting speed points, physical interfacing, lock-out solenoids)
   - dynamic braking (diode bank)
   - electro-mechanical brakes (adjustable shoe and disc type)

6. Describe the construction of motor control centres.
   - description of general structure
   - wiring classes and types
   - incoming line connections
   - meters and accessories
   - fixed mount and draw-out units
   - assembly and installation

7. Describe the operation and construction of wound-rotor controllers.
   - slip rings and brushes
   - external resistors
   - manual control
   - automatic acceleration controllers
   - speed selection with pushbuttons
   - stepless controllers

8. Troubleshoot control circuits, starters, and controllers.
   - switch/breaker mechanisms (interlocks)

fuses
wiring
electromagnets (main contactor, timer relays, acceleration relays and contactors)
mechanical interlocks
contact assemblies (main contactor, auxiliary contacts, relay contacts, accelerating contactors, control circuit interlocks)
arc chutes
overload relays
control devices (pushbuttons, selector switches, pressure switches, etc.)
care for enclosures
cleaning (compressed air, non-conducting solvents)
eliminating vibration problems
physical protection of the controller
providing adequate ventilation
preventing condensation
cleaning resistor grids
resistor grid terminal connections (checking torque)
troubleshoot

9. Describe the operation of manual starters.

10. Install and connect manual starters

METHODOLOGY:
This course lends itself to laboratory projects supplemented by theory lectures, laboratory demonstrations, and videos showing operation of electric motor starters/controllers. The instructors may involve apprentices in specific activities, including:

- exercises on theory content
- demonstrations
- audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

- complete ladder diagrams according to specific requirements
- install/connect motor starters according to specific requirements
- install/connect motor controllers according to specific requirements

NAME AND NUMBER: ER2060 - Central Heating Units

SUGGESTED DURATION: 15 hours

PREREQUISITES: ER1230

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able to properly wire and troubleshoot duct heaters and central heating units.

OVERVIEW OF OBJECTIVES:
1. Install Wiring and Controls for Electric Furnaces
2. Install Wiring and Controls for Duct Heaters
3. Install Wiring and Controls for Electric Boilers
4. Install wiring and controls for dual energy heating units
5. Install Wiring and Controls for Heat Pumps
6. Troubleshoot Wiring for Central Heating Units

CONTENT:
1. Install Wiring and Controls for Electric Furnaces
   - electric furnace ratings
   - control systems
   - switching and relays
   - multi stage control
   - electric furnace limit protection
   - zone control for hot air systems

2. Install Wiring and Controls for Duct Heaters
   - applications: primary, preheat, reheat, supplemental or auxiliary
   - installation
   - velocity
   - heater position
   - air flow direction
   - control

3. Install Wiring and Controls for Electric Boilers
   - controls
   - adjustable aquastat
   - high limit aquastat
   - pressure / temperature relief valves, gauges
   - zone control for hydronic systems

4. Install wiring and controls for dual energy heating units

- hot water
- forced air
- load management panels

5. Install Wiring and Controls for Heat Pumps
   - types and sizes of heat pumps
   - basic operating principles of heat pumps
   - outdoor and indoor fans
   - auxiliary outdoor and indoor heaters
   - high pressure and low pressure control
   - indoor staging thermostats
   - CEC requirements
   - fusing and disconnect/isolating switch requirements

6. Power and Control Wiring
   - over current devices
   - control wiring
   - hot water furnaces
   - hot air furnaces
   - duct heaters

METHODOLOGY:
This course lends itself to hands-on projects supplemented by theory lectures, demonstrations, and videos. The instructors may involve appearances in specific activities, including:

- exercise on theory content
- demonstrations
- audio-visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

- Classroom exercises as determined by the instructor
- Hands on experience as determined by the instructor

NAME AND NUMBER: ER1310 - Electric Heating Systems

SUGGESTED DURATION: 45 hours

PREREQUISITES: ER1230

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able to properly install electric heaters and related wiring.

OVERVIEW OF OBJECTIVES:
1. Perform Heat Loss Calculations
2. Install Baseboard Heaters
3. Install Fan Heaters “Wall - Floor Units - Ceiling - Cabinet”
4. Install Forced Air Units Heaters
5. Install Convector Type Unit Heaters
6. Install radiant heaters
7. Install infrared heaters
8. Describe over temperature protection
9. Maintain and Service Electric heating Systems
10. Apply C.E.C. (Canadian Electrical Code) requirements

CONTENT:
1. Perform Heat Loss Calculations
    - introduction
    - heating comfort
    - heat
    - heat and temperature
    - methods of heat transfer
    - insulation and vapor barriers
    - heat loss calculations
    - example problems
    - work sheets

2. Install Baseboard Heaters
    - uses
    - ratings
    - heating method
    - control (electronic control boards)
    - installation

3. Install Fan Heaters “Wall - Floor Units - Ceiling - Cabinet”
    - introduction
    - over-temperature protection

- installation
- temperature control

4. Install Forced Air Units Heaters
   - introduction
   - insert unit heaters
   - suspension unit heaters
   - cabinet unit heaters

5. Install Convector Type Unit Heaters
   - introduction
   - commercial
   - cabinet
   - explosion proof heaters

6. Install radiant heaters
   - introduction
   - panels
   - flexible strips
   - installation
   - temperature control

7. Install infrared heaters
   - heating lamps (features, types)
   - lay-in heating panels (ratings and dimensions)

8. Describe over temperature protection
   - linear
   - snap disc

9. Maintain and Service Electric heating Systems In Residential Buildings
   - fin position
   - throat clearance
   - curtain/drape clearance
   - replacing thermal cut-outs
   - built-in thermostats

10. Apply C.E.C. (Canadian Electrical Code) requirements
    - Section 14
    - Section 62

METHODOLOGY:
This course lends itself to hands-on projects supplemented by theory lectures, demonstrations, and videos. The instructors may involve appearances in specific activities, including:

exercises on theory content

demonstrations
audio-visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

Classroom exercises as determined by the instructor
Hands on experience as determined by the instructor

NAME AND NUMBER: ER1320 - Low-voltage Temperature Control

SUGGESTED DURATION: 10 hours

PREREQUISITES: ER1310

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able select and install low voltage thermostats and relays.

OVERVIEW OF OBJECTIVES:
1. Understand the Operation and Construction of Thermostats
2. Understand the Operation and Construction of Relays
3. Install Baseboard Heaters Controlled by Low Voltage Thermostat and Relay Combination

CONTENT:
1. Thermostat types and operation
    - bi-metal
    - hydraulic filled
    - solid state
    - programmable
    - power smart

2. Thermostat location and installation
    - wall mounted
    - unit mounted
    - relay (contactor)

3. Heat Anticipation
    Types of Relays
    - thermal
    - magnetic

METHODOLOGY:
This course lends itself to hands-on projects supplemented by theory lectures, demonstrations, and videos. The instructors may involve appearances in specific activities, including:

- exercises on theory content
- demonstrations
- audio-visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

Classroom exercises as determined by the instructor
Hands on experience as determined by the instructor

NAME AND NUMBER: ER1330 - Line-voltage Temperature Control

DURATION: 10 hours

PREREQUISITES: ER1310

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able select and install the various types of line voltage thermostats.

OVERVIEW OF OBJECTIVES:
1. Install Baseboard Heaters Controlled by Line Voltage Thermostat
2. Install Baseboard Heaters with Built-in Thermostat
3. Understand the Operation and Construction of Line Voltage Thermostats

CONTENT:
1. Types of thermostats
    - single pole
    - two pole
    - built-in
    - dual diaphram
    - hydraulic filled
    - programmable
    - power smart
    - Advantage of each type

2. Install Baseboard Heaters with Built-in Thermostat

3. Understand the Operation and Construction of Line Voltage Thermostats

METHODOLOGY:
This course lends itself to hands-on projects supplemented by theory lectures, demonstrations, and videos. The instructors may involve appearances in specific activities, including:
- exercises on theory content
- demonstrations
- audio-visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:
- Classroom exercises as determined by the instructor
- Hands on experience as determined by the instructor

NAME AND NUMBER: ER2070 - Power Supply and Rectifiers

SUGGESTED DURATION: 15 hours

PREREQUISITES: ER1190

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able to install, connect and troubleshoot power supplies and rectifiers.

OVERVIEW OF OBJECTIVES:
1. Describe the basic fundamental characteristics of semiconductor materials
2. Describe the characteristics of the PN junction diode
3. Describe the operation of single-phase rectifier circuits
4. Calculate and measure power, current and voltage values in rectifier circuits
5. Describe filter circuits for single-phase rectifiers
6. Describe the operation of the zener diode
7. Discuss the operation of three-phase rectifier
8. Describe other diode applications
9. Install and connect power supplies

CONTENT:
1. Describe the basic fundamental characteristics of semiconductor materials
    - semiconductor atoms
    - covalent bonding
    - N-type semiconductor material
    - P-type semiconductor material
    - negative temperature coefficient of resistance
2. Describe the characteristics of the PN junction diode
    - The PN junction
    - reverse bias
    - forward bias
    - voltage/current graph
    - diode specifications
    - diode polarity
    - ohmmeter tests

3. Describe the operation of single-phase rectifier circuits

- rectifier wave forms
- half-wave rectifier
- full-wave rectifier
- full-wave bi-phase rectifier
- full-wave bridge rectifier
- ripple frequency

4. Calculate and measure power, current and voltage values in rectifier circuits
   - average values
   - effective (RMS) values
   - peak inverse voltage
   - power
   - simple calculations

5. Describe filter circuits for single-phase rectifier
   - capacitor filter
   - choke filter
   - LC filter arrangements
   - PI filter

6. Describe the operation of the zener diode
   - voltage/current graph
   - DC voltage regulator circuits
   - AC clipping action

7. Discuss the operation of three-phase rectifier
   - wye connected half-wave rectifier
   - compute the average dc output of a half-wave, three-phase rectifier
   - three-phase bridge rectifier
   - poly-phase rectifiers

8. Describe other diode applications
   - free-wheeling diodes
   - light-emitting diodes
   - photodiodes
9. Install and connect power supplies
   - wire size
   - polarity
   - overcurrent protection conductor

METHODOLOGY:
This course lends itself to theory lectures supplemented with laboratory experiments. The instructors may involve apprentices in specific activities, including:

- exercises on theory content
- demonstrations

- audio/visual presentations

SUGGESTED LEARNING ACTIVITY

In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

- laboratory experiments as determined by course instructor

NAME AND NUMBER: ER2080 - Power Electronic Control Circuits

SUGGESTED DURATION: 15 hours

PREREQUISITES: ER2070

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able to troubleshoot problems with power electronic control circuits.

OVERVIEW OF OBJECTIVES:
1. Describe the features of the bi-polar junction transistor
2. Describe the basic action of the transistor as a DC amplifier
3. Perform simple transistor circuit calculations
4. Describe the basic action of the transistor as a switch
5. Describe the basic action of the transistor as an AC amplifier
6. Identify special types of bi-polar junction transistors
7. Describe the features of the silicon controlled rectifier
8. Describe the action of the SCR in a DC circuit
9. Describe the action of the SCR in an AC circuit
10. Describe the common triggering circuits for achieving phase control with the SCR
11. Describe the characteristics of the unijunction transistor (UJT)
12. Describe the characteristics of the light-activated (SCR)
13. Describe basic circuit applications of DC thyristors
14. Describe the characteristics of the bi-directional triode thyristor (triac)
15. Describe the characteristics of the bi-directional diode thyristor (diac)
16. Describe basic circuit applications of AC thyristors
17. Describe the features of the field-effect transistor (fet)
18. Describe the basic operation of the field-effect transistors

CONTENT:
1. Describe the features of the bi-polar junction transistor
    - NPN transistor
    - PNP transistor
    - common case styles
    - ohmmeter test

2. Describe the basic action of the transistor as a DC amplifier
   - common relay anology
   - common emitter amplifier
   - transistor terms/abbreviations
   - transistor specifications

3. Perform simple transistor circuit calculations
   - values for saturation
   - values for cutoff
   - values for biasing

4. Describe the basic action of the transistor as a switch
   - single-transistor switch
   - two-transistor switch

5. Describe the basic action of the transistor as an AC amplifier
   - simple audio amplifier circuit
   - DC biasing
   - gain

6. Identify special types of bi-polar junction transistors
   - Darlington transistor
   - phototransistors

7. Describe the features of the silicon controlled rectifier
   - symbols and leads
   - typical ratings
   - common case styles

8. Describe the action of the SCR in a DC circuit
   - diode analogy
   - triggering action
   - commutation
   - ohmmeter tests

9. Describe the action of the SCR in an AC circuit
   - half-wave rectification
   - phase control
   - conduction angles
   - full-wave rectification

10. Describe the common triggering circuits for achieving phase control with the SCR
    - resistance only triggering
    - resistance-capacitance triggering-time constance
    - waveforms
11. Describe the characteristics of the unijunction transistor (UJT)

- symbol and leads
- typical ratings
- oscillator circuit

12. Describe the characteristics of the light-activated (SCR)
    - symbol and leads
    - typical ratings

13. Describe basic circuit applications of DC thyristors
    - DC motor speed control
    - regulated battery charger

14. Describe the characteristics of the bi-directional triode thyristor (triac)
    - symbol and leads
    - typical ratings
    - ohmmeter testing

15. Describe the characteristics of the bi-directional diode thyristor (diac)
    - symbol and leads
    - typical ratings
    - oscillator circuit

16. Describe basic circuit applications of AC thyristors
    - incandescent lamp dimmer
    - static motor starting switch

17. Describe the features of the field-effect transistor (fet)
    - junction FET
    - metal-oxide semiconductor FET

18. Describe the basic operation of the field-effect transistors
    - N-channel FET
    - pinch-off voltage
    - cut-off voltage
    - enhancement mode
    - depletion mode
    - basic FET amplifier
    - AC single amplification

METHODOLOGY:
This course lends itself to theory lectures supplemented with laboratory experiments. The instructors may involve apprentices in specific activities, including:

- exercises on theory content

- demonstrations
- audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

- laboratory experiments as determined by course instructor

NAME AND NUMBER: ER2090 - Integrated Circuits

SUGGESTED DURATION: 15 hours

PREREQUISITES: ER2080

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able to understand and troubleshoot problems with the logic functions provided by integrated circuits.

OVERVIEW OF OBJECTIVES:
1. Describe the number systems used in digital systems
2. Identify the common binary codes
3. Describe the operation of common logic gates
4. Describe the features of integrated circuits
5. Describe the application of Demorgan's theorems
6. Identify integrated circuit logic families
7. Describe the operation of flip-flop circuits and related devices
8. Describe basic troubleshooting techniques

CONTENT:
1. Describe the number systems used in digital systems
   - decimal system
   - binary system
   - octal system
   - hexadecimal system
   - conversion between systems

2. Identify the common binary codes
   - binary coded decimal (BCD)
   - American Standard Code for Information Interchange (ASCII)
   - Gray code

3. Describe the operation of common logic gates
   - And gate
   - Or gate
   - Not gate
   - Nand gate

- Nor gate
- Exclusive-or circuit
- interpretation of histographs

4. Describe the features of integrated circuits
   - classification
   - construction
   - packaging

5. Describe the application of Demorgan's theorems
   - Boolean algebra
   - implications
   - encoding and decoding

6. Identify integrated circuit logic families
   - terminology
   - TTL logic
   - CMOS logic
   - I/P and O/P voltage levels
   - fanout
   - floating inputs
   - noise margin

7. Describe the operation of flip-flop circuits and related devices
   - truth tables
   - symbols
   - practical flip-flops
     - RS type
     - RST type
     - D type
     - JK type
   - multivibrators
   - counters

8. Describe basic troubleshooting techniques
   - digital logic probes
   - digital pulser probes
   - oscilloscopes

METHODOLOGY:
This course lends itself to theory lectures supplemented with laboratory experiments. The instructors may involve apprentices in specific activities, including:

- exercises on theory content

- demonstrations
- audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

- laboratory experiments as determined by course instructor

NAME AND NUMBER: ER2100 - Amplifiers

SUGGESTED DURATION: 15 hours

PREREQUISITES: ER2090

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able to troubleshoot problems with amplifier circuits.

OVERVIEW OF OBJECTIVES:
1. Describe the features of the operational amplifier
2. Describe common circuit applications for the operational amplifier
3. Describe basic troubleshooting techniques

CONTENT:
1. Describe the features of the operational amplifier
   - symbol
   - packaging
   - operation as comparator

2. Describe common circuit applications for the operational amplifier
   - voltage follower
   - inverting amplifier
   - non-inverting amplifier
   - summing amplifier
   - integrator
   - digital to analogue converters
   - analogue to digital converters

3. Describe basic troubleshooting techniques
   - inputs and outputs
   - oscilloscopes

METHODOLOGY:
This course lends itself to theory lectures supplemented with laboratory experiments. The instructors may involve apprentices in specific activities, including:

- exercises on theory content
- demonstrations
- audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

- laboratory experiments as determined by course instructor

NAME AND NUMBER: ER2110 - Troubleshooting Techniques

SUGGESTED DURATION: 15 hours

PREREQUISITES:

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able to use conventional troubleshooting methods.

OVERVIEW OF OBJECTIVES:
1. Apply personal and equipment safety practices
2. Apply conventional troubleshooting methods

CONTENT:

1. Apply personal and equipment safety practices
2. power isolation
3. personal apparel
4. using temporary "insulated" mats
5. food or beverage near machines
6. covering "attractive nuisances"
7. quality of workmanship
8. Apply conventional troubleshooting methods
9 operator (owner) interview
10. verifying "facts"
11. getting to know the operating sequences of the machine
12. using machine manuals, schematics, etc.
13. operator or record check for changes to machine or environmental changes
14. determine symptoms
    - marginal
    - intermittent
    - "dead" machine
    - isolating problem
        - dividing method
    - setting up and following logical troubleshooting sequence
    - using manufacturer's troubleshooting guide
    - acting hastily and its consequences

- think beyond the "fix"
- verifying the results
- substitution troubleshooting
- parts changing
- comparison troubleshooting
- making record of work done

METHODOLOGY:
This course lends itself to theory lectures supplemented with laboratory experiments. The instructors may involve apprentices in specific activities, including:

- exercises on theory content
- demonstrations
- audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

- laboratory experiments as determined by course instructor

NAME AND NUMBER: ER2120 - Application of Troubleshooting Techniques

SUGGESTED DURATION: 30 hours

PREREQUISITES: ER2110

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able to use meters, devices and equipment to assist in troubleshooting.

OVERVIEW OF OBJECTIVES:
1. Use meters, high voltage probe adapters, and indicators to troubleshoot faults
2. Use support devices/equipment to aid the troubleshooting process

CONTENT:
1. Use meters, high voltage probe adapters, and indicators to troubleshoot faults
    - voltmeter
    - ohmmeter
    - clamp-on ammeter
    - adapters
    - dividers
        - multimeters
        - meggers
        - infrared or thermal scanners
        - hipot
        - motor direction rotation indicator
        - phase sequence indicator
        - capacitance meter and capacitor analyzer
        - signal transmitting source locator
        - miscellaneous testers
            - logic probe
            - digital pulser
            - neon indicators
            - continuity testers
        - tachomter
            - mechanical
            - strobe
            - portable phototachometer

temperature measuring instruments
oscilloscopes
operation
environmental considerations
control panel layout
basic operations
calibrations
measurements

2. Use support devices/equipment to aid the troubleshooting process
desoldering braid
desoldering iron (solder suckers)
clip-clip jumpers
patch or extension cables
extender boards
spray cleaners
freeze sprays
IC monitor clips

METHODOLOGY:
This course lends itself to theory lectures supplemented with laboratory experiments. The instructors may involve apprentices in specific activities, including:

- exercises on theory content
- demonstrations
- audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

- laboratory experiments as determined by course instructor

NAME AND NUMBER: ER1340 - Conventional Fire Alarms

SUGGESTED DURATION: 30 hours

PREREQUISITES: ER1140

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able to understand the basic parts of a fire alarm system, how these parts work together, and how to troubleshoot the system.

OVERVIEW OF OBJECTIVES:
1. Identify the components of a fire alarm system
2. Describe common detection and alarm devices
3. Describe the function of the control panel
4. Describe the installation requirements for fire alarm systems
5. Test and troubleshoot fire alarm systems
6. Identify rules and standards governing fire alarm installations

CONTENT:
1. Identify the components of a fire alarm system
   - initiating devices
   - signaling devices
   - control panels

2. Describe common detection and alarm devices
   - manual pull stations
     - general information
     - pull station location requirements
   - audible signals
     - types of audible signals
     - principles of sound
     - typical dB levels
     - the effects of distance on sound pressure
     - how to select audible signals
     - suggested sound pressure levels
     - audible signal mounting requirements
     - electric bells
     - installing a bell

electric chimes
installing a chime
electric horns
types of horns
installing horns
speakers

- visual signals
  - introduction
  - types of visual signals
  - requirements
- thermal detectors
  - terminology
  - non-restorable thermal detectors
  - self-restoring thermal detectors
  - combination thermal detectors
  - color coding of thermal detectors
  - location requirements
  - wiring thermal detectors
- smoke alarm initiating devices
  - ionization detection
  - photoelectronic smoke detection
  - combination smoke detectors
  - location requirements
  - wiring smoke detectors
  - sensitivity testing
  - maintenance and cleaning
- duct type smoke detectors
  - introduction
  - sensitivity testing
  - detector installation
  - wiring duct detectors

addressable system

3. Describe the function of the control panel
   - selecting a fire alarm system
     - basic considerations
     - additional considerations for high buildings
     - national and local fire codes
   - single stage/single zone
     - application
     - operation
     - fire alarm control unit
     - control unit installation
   - multi-zone fire alarm systems
     - introduction
     - supervisory mode

alarm mode
trouble mode
typical control unit components
annunciators

- two -stage systems
  - single stage or two stage systems
  - evacuation zoning
  - general alarm manual stations
  - two stage control units
- fire department connections
- communication systems
  - introduction
  - emergency voice communication systems
  - firefighters telephone system
  - construction
  - emergency communications common control
  - audio paging control module
  - power amplifiers
  - tone generators
  - telephone stations
  - speaker placement guidelines
  - typical apartment hallways
  - stairwells
  - garage areas
  - communication system wiring
- emergency visual/audio control systems
- fire alarm/extinguishing systems
  - characteristics
  - components
  - safety concerns
- electromagnetic door release devices
  - characteristics
  - magnetic door holder/closure
- fire alarm accessories
  - introduction
  - fire signs
  - corridor lights
  - remote indicator lights
  - fire alarm relay
  - grille and boxes

4. Describe the installation requirements for fire alarm systems
   - CEC requirements

- manufacturer's wire size requirements
- component connections
- control panel connections
- typical test procedures

5. Test and troubleshoot fire alarm systems
   - system check-out, testing, and troubleshooting
     - introduction
     - troubleshooting guide
     - supervisory sequence
     - troubleshooting
     - system testing
   - systems verification and certification

6. Identify rules and standards governing fire alarm installations
   - National Fire Code
   - National Building Code
   - National Research Standards
   - Underwriter’s Laboratories
   - Canadian Electrical Code
   - Provincial Fire Marshall
   - Provincial Regulations and Acts
   - Resources: Fire Alarm-Canadian Association
   - Fire alarm Systems

METHODOLOGY:
This course lends itself to hands-on projects supplemented by theory lectures, demonstrations, and videos. The instructors may involve appearances in specific activities, including:

exercises on theory content
demonstrations
audio-visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

Classroom exercises as determined by the instructor
Hands on experience as determined by the instructor

NAME AND NUMBER: ER2130 - Communications & Data Systems

SUGGESTED DURATION: 30 hours

PREREQUISITES: ER1140

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able to understand the basics of communication systems, installation and troubleshooting

OVERVIEW OF OBJECTIVES:
1. Identify the main components in a typical apartment building intercom
2. Identify the main components in various types of intercoms
3. Troubleshoot intercom system
4. Apply CEC requirements in respect to communication cables
5. Identify components of data systems
6. Install, terminate & test cables

CONTENT:
1. Identify the main components in a typical apartment building intercom
    - introduction
    - vestibule assemblies
    - back boxes
    - amplifiers
    - vestibule panel/directory
    - suite stations
    - electric door strike
    - wiring connections
    - interfacing telephone and intercom/door release systems

2. Identify the main components in various types of intercoms
    - residential intercoms
        - introduction
        - basic master/sub units
        - door answering system
        - residential voice communication
        - radio-intercom
        - residential video intercoms

- video intercoms
  - introduction
  - system operation
  - system interconnections
  - system operational logic
- nurse call systems
  - introduction
  - control consoles
  - patient stations
  - emergency stations
  - corridor lights
  - annunciator modules
  - power supplies
  - sequence of operation
- commercial sound/intercom systems
  - introduction
  - telephone-access paging
  - access modules
  - communication/sound systems
- noise/sound masking equipment
- architectural acoustics
- sound masking
- how masking works

3. Troubleshoot intercom system
   - sound/communication systems
   - video intercom systems

4. Apply CEC requirements in respect to communication cables
   - CEC - section 16, 60

5. Identify components of data systems

6. Install, terminate and test cables
   - length of runs
   - hub
   - testers

METHODOLOGY:
This course lends itself to hands-on projects supplemented by theory lectures, demonstrations, and videos. The instructors may involve appearances in specific activities, including:

- exercises on theory content
- demonstrations
- audio-visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

Classroom exercises as determined by the instructor
Hands on experience as determined by the instructor

NAME AND NUMBER: ER2140 - Security

SUGGESTED DURATION: 20 hours

PREREQUISITES: ER1110

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able to understand the basics of security systems, installation and troubleshooting.

OVERVIEW OF OBJECTIVES:
1. Describe regulations for qualifications and licensing in the security alarm industry
2. Describe the purpose and types of security systems
3. Describe a basic alarm system and it's detection circuit operation
4. Describe common detection and alarm devices
5. Describe control panel basic functions
6. Install and troubleshoot security system

CONTENT:
1. Describe regulations for qualifications and licensing in the security alarm industry
   - requirements, regulations, and Acts,
     - introduction
     - provincial requirements
     - agency licence application
     - private investigators and security services act
     - employee licence application
     - underwriters laboratories of Canada standards
     - Canadian Electrical Code requirements
     - other considerations

2. Describe the purpose and types of security systems
   - alarm system classification
     - classification
     - local alarm system
     - central and monitoring stations
     - typical alarm systems

3. Describe a basic alarm system and it's detection circuit operation
   - perimeter protection
   - space invasion

4. Describe common detection and alarm devices
   - space protection devices (ultrasonic)
     - introduction
     - ultrasonic motion detectors
     - transceiver units
     - transceiver theory
     - the Doppler effect
     - receiver transducer units and transmitter units
     - ultrasonic noise compensation
     - determining noise levels
     - system noise reduction
     - deflectors
     - application information
     - general transducer information
     - general transceiver information
     - installation considerations
   - space protection devices (microwave)
     - microwave deflection detector
     - microwave sensitivity
     - microwave detector installation
     - microwave applications
   - infrared body heat detector
     - introduction
     - detector operation
     - coverage patterns
     - system applications
     - installation considerations
   - photoelectric beam interruption
     - introduction
     - photoelectric detectors
   - perimeter protection devices
     - introduction
     - magnetic contacts
     - floor mat detectors
     - audio detectors
     - glass break detectors
     - foil protection
     - shock detectors
     - detector installation
   - alarm signals

5. Describe control panel basic functions
    - introduction
    - local alarm control unit
        - 24 hour loop (instant)
        - permanent loop (instant)
        - moveable protection loop (delayed)
        - remote control inputs
        - tamper protection
        - panel tamper switch operation
        - auxiliary contacts
        - auxiliary power output
        - signal circuit
        - standby power
    - proprietary alarm control panel
        - remote station

6. Install and troubleshoot security system

METHODOLOGY:
This course lends itself to hands-on projects supplemented by theory lectures, demonstrations, and videos. The instructors may involve appearances in specific activities, including:

exercises on theory content
demonstrations
audio-visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

Classroom exercises as determined by the instructor
Hands on experience as determined by the instructor

NAME AND NUMBER: ER2150 - Analog Devices

SUGGESTED DURATION: 15 hours

PREREQUISITES: ER2040

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able to understand the terminology, units of measurement, and operating principles of measuring devices and instruments commonly found in processing plants.

OVERVIEW OF OBJECTIVES:

1. Perform calculations that relate to pressure measurement and the properties of fluids
2. Define the following terms: transducer, pressure element, primary standard, guage pressure, absolute pressure
3. Explain the principles involved in pressure measurement
4. Identify and compare common applications utilizing differential pressure instruments
5. Test pressure measurement instruments both in the field and the laboratory to verify proper operation within an acceptable tolerance of error
6. Demonstrate the mounting details of pressure and differential pressure instruments
7. Explain the accepted terminology and concepts of theory for the measurement of temperature
8. Analyze and describe the various methods of measuring temperature in an industrial process
9. Describe the practical considerations, limitations and procedures of installing temperature measuring elements and devices in an industrial process
10. Explain the basic concepts and terminology used in industrial flow measurement
11. Determine the practical considerations, limitations and procedures of installing flow measuring devices in a process
12. Select the correct method of measuring flow in a particular process
13. Calculate calibration points for flow measuring instruments
14. Explain the basic concepts of theory for the measurement of level
15. Describe the various methods of measuring level in an industrial process
16. Install/replace, wire and test analogue devices

CONTENT:

1. Perform calculations that relate to pressure measurement and the properties of fluids;
   - introduction
   - fluids and pressure
   - pressure units
   - guage and absolute pressure
   - manometric principles

2. Define the following terms: transducer, pressure element, primary standard, guage pressure, absolute pressure;
    - introduction
    - pressure transducers
    - mechanical transducers or pressure elements
    - C-tubes
    - spiral and helical pressure elements
    - bellows
    - diaphrams
    - applications
    - mounting

3. Explain the principles involved in pressure measurement;
    - introduction
    - motion detectors
    - linear potentiometer
    - linear motion variable inductor
    - linear variable differential transformer - LVDT
    - linear motion variable capacitor
    - flapper-nozzle transmitters

4. Identify and compare common applications utilizing differential pressure instruments;
    - introduction
    - differential pressure transducers
    - differential pressure applications
    - level measurement by differential pressure
    - density measurement by differential pressure
    - flow measurement by differential pressure

5. Test pressure measurement instruments both in the field and the laboratory to verify proper operation within an acceptable tolerance of error;
    - introduction
    - calibration standards
    - process simulation
    - dead weight testers
    - test instruments for pressure measurement
    - test guages
    - manometers
    - pneumatic calibrators
    - calibration principles
    - calibration procedures - zero and span
    - link and lever calibration

6. Demonstrate the mounting details of pressure and differential pressure instruments;
    - introduction
    - zero suppression and elevation

impulse lines
seal pots and instrument seals
mechanical pressure seals
pulsation dampers
differential pressure instrument installation
special precaution for temperature protection
steam or heat trace

7. Explain the accepted terminology and concepts of theory for the measurement of temperature
   - temperature scales
   - accuracy
   - general considerations
   - calibration procedures
   - standards

8. Analyze and describe the various methods of measuring temperature in an industrial process
   - temperature filled systems
     - thermometers
     - gas thermometers
     - liquid thermometers
     - vapour thermometers
     - immersion limitations
     - accuracy
   - bimetallic thermometers
     - types and uses
     - accuracy
   - thermocouples
     - introduction
     - the Seebeck effect
     - the origin of the Seebeck effect
     - Seebeck coefficients of materials
     - thermocouple circuit theory
     - laws of thermoelectric circuits
     - parallel thermoelectric circuits
     - summary of thermocouple properties
     - thermocouple characteristics
     - properties of thermocouple materials
     - types of thermocouples
     - thermocouple reference tables
     - thermocouple limits of error and accuracy
     - thermocouple reference junctions
     - temperature limits for thermocouples
     - thermocouple sensor types and styles
     - selection of thermocouples for specific applications
     - thermocouple readout circuits and instruments
     - checking thermocouple circuits

- connections
- calibration, accuracy, specifications, and standards
- calibration of unused thermocouples
- calibration of used thermocouples
- summary: methods of calibrating
- used thermocouples
- calibration of thermocouple indicators
- sources of errors in thermocouples
- reference junction errors
- measurement system errors
- drift, aging, and hysteresis in thermocouple materials

resistance thermometers - RTD's

- introduction
- principle of operation
- accuracy of RTDs
- readout instrumentation
- insulation resistance
- instability
- typical resistance thermometers
- immersion sensors
- surface sensor
- resistance thermometer
- nonlinear temperature-resistance relations
- thermoelectric EMF
- padding resistors
- specialized resistance thermometers

thermistors

- introduction
- thermistor characteristics
- accuracy of thermistors
- thermistor applications
- thermistor readout instrumentation
- typical thermistors

pyrometry

- introduction
- basics
- practical blackbodies
- pyrometer types
- total radiation pyrometer
- brightness pyrometer

9. Describe the practical considerations, limitations and procedures of installing temperature measuring elements and devices in an industrial process

- introduction

materials selection and endurance of thermowells and protection tubes
effect on stem losses
effect on response
fillers
typical thermowells and installations
typical protection tubes

10. Explain the basic concepts and terminology used in industrial flow measurement
    introduction to flowmeters
        introduction
        flowmeter categories
        flowmeter types
        introduction to flowmeter technology
    - measurement of flowmeter performance
        introduction
        applicable range
        flowmeter composite accuracy
        transmitter accuracy
        linearization accuracy
        digital conversion accuracy
        indicator accuracy
        totalization accuracy
        overall flowmeter system accuracy
    totalization
        introduction
        analog and digital flowmeters
        implementation

11. Determine the practical considerations, limitations and procedures of installing flow measuring devices in a process
    - differential pressure flowmeters
        introduction
        orifice plate flowmeters
        principle of operation
        construction
        operating constraints
        performance
        applications
        sizing
        installation
        maintenance
        other technologies
        elbow flowmeters
        flow nozzles
        laminar flow elements
        low loss flow tubes
        segmental wedge

- venturi
- variable area rotameters
  - introduction
  - principle of operation
  - construction
  - operating constraints
  - performance
- open channel flowmeters
  - introduction
  - weirs
  - principle of operation
  - construction
  - operating constraints
  - performance
  - applications
  - sizing
  - installation
- positive displacement flowmeters
  - introduction
  - principle of operation
  - sizing
  - installation
  - maintenance
  - construction
  - operating constraints
  - performance
  - applications
- magnetic flowmeters
  - introduction
  - principle of operation
  - AC magnetic flowmeters
  - DC magnetic flowmeters
  - miniature DC magnetic flowmeters
  - construction
  - operating constraints
  - performance
  - applications
  - sizing
  - installation
  - maintenance
- mass flowmeters
  - introduction
  - principle of operation
  - construction
  - operating constraints
  - performance

applications
sizing
installation
maintenance

- turbine flowmeters
  - introduction
  - turbine flowmeter
  - principle of operation
  - construction
  - operating constraints
  - performance
  - applications
  - sizing
  - installation
  - maintenance
- target flowmeters
  - introduction
  - principle of operation
  - construction
  - operating constraints
  - performance
  - applications
  - sizing
  - installation
  - maintenance

12. Select the correct method of measuring flow in a particular process
    - introduction
    - flowmeter categories
    - flowmeter types
    - performance
    - end use
    - power requirements
    - safety
    - rangeability
    - materials of construction

13. Calculate calibration points for flow measuring instruments
    - introduction
    - calibration techniques
    - flow laboratory
    - flow calibration facility
    - dry calibration
    - physical dimensions
    - electronic techniques
    - analog output calibration

14. Explain the basic concepts of theory for the measurement of level
    - introduction
    - dip sticks and lead lines
    - the sight glass
    - float-actuated level measurement
    - magnetic-type float devices

15. Describe the various methods of measuring level in an industrial process
    - constant displacement principles
        - introduction
        - variable displacement measuring devices
        - variable displacers used for interface measurement
        - field-mounted interface controllers
        - application of displacer actuated level controllers
        - maintenance and calibration
        - instrument mounting and special applications
    - hydrostatic head level measurement
        - introduction
        - principle of operation
        - open-tank head-type level measurement
        - pressurized vessel head-type level measurement
        - diaphragm box
        - air-trap method
        - air purge or bubble system
        - mounting considerations - zero adjustments
        - elevation and suppression
    - electronic level measuring systems
        - capacitance
        - conductivity
        - heated element
        - ultrasonic
        - weighing
        - radioactive
        - granular solids
        - level measurements

16. Install/replace, wire and test anlogue devices
    - temperature
    - pressure
    - humidity

METHODOLOGY:
This course lends itself to theory lectures supplemented with laboratory experiments. The instructors may involve apprentices in specific activities, including:

exercises on theory content
demonstrations
audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

- laboratory experiments as determined by course instructor

NAME AND NUMBER: ER2160 - Solid State Drives

SUGGESTED DURATION: 30 hours

PREREQUISITES: ER2090

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able to properly install and maintain solid state controls for motors.

OVERVIEW OF OBJECTIVES:
1. Describe the operation of solid state DC motor controllers
2. Describe basic maintenance and troubleshooting procedures for solid state DC motor controllers
3. Describe the features of variable frequency AC drives
4. Describe the operation of the frequency converter (inverter)
5. Describe the operation of motors used with variable frequency AC drives
6. Describe the testing and troubleshooting of variable frequency AC drives
7. Describe operation of various types of drives.

CONTENT:
1. Describe the operation of solid state DC motor controllers
   - power converters
   - field voltage control
   - armature voltage control
   - protection
   - speed control
   - reversing

2. Describe basic maintenance and troubleshooting procedures for solid state DC motor controllers
   - electrical
   - cause/remedy situations

3. Describe the features of variable frequency AC drives
   - DC power section
   - AC power section
   - control section

- size and ratings

4. Describe the operation of the frequency converter (inverter)
   - variable voltage inverter (VVI)
   - pulse width modulated inverter (PMW)
   - current source inverter (CSI)

5. Describe the operation of motors used with variable frequency AC drives
   - speed characteristics
   - torque characteristics
   - braking
   - reversing
   - protection

6. Describe the testing and troubleshooting of variable frequency AC drives
   - start-up and adjustments
   - voltage readings
   - oscilloscope readings

7. Describe operation of various types of drives.
   CCV
   LCI
   CSR

METHODOLOGY:
This course lends itself to theory lectures supplemented with laboratory experiments. The instructors may involve apprentices in specific activities, including:

- exercises on theory content
- demonstrations
- audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

- laboratory experiments as determined by course instructor

NAME AND NUMBER: ER2170 - PLC Fundamentals

SUGGESTED DURATION: 15 hours

PREREQUISITES: ER2040

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able to understand what a PLC is, what it can do, where it is used, and how it is installed as well as how to troubleshoot basic problems.

OVERVIEW OF OBJECTIVES:
1. Describe the features of a programmable controller
2. Install and maintain a programmable controller

CONTENT:
1. Describe the features of a programmable controller
   - central processing unit
     - CPU diagnostics
     - memory types
     - memory organization
     - (scan) program execution
     - power supply
   - I/O system
     - I/O addressing
     - discrete inputs
     - discrete outputs
     - analog I/O
     - remote I/O
   - programming terminals and peripheral devices
     - dedicated programming terminals
     - mini-programmers
     - computer-based programming terminals
     - peripheral devices

2. Install and maintain a programmable controller
   - safety considerations
   - system layout

proper grounding techniques
sources of electrical interference
I/O installation
field checkout of programmable controllers
PLC maintenance
PLC troubleshooting

METHODOLOGY:
This course lends itself to theory lectures supplemented with laboratory experiments. The instructors may involve apprentices in specific activities, including:

exercises on theory content
demonstrations
audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

- projects as determined by course instructor

NAME AND NUMBER: ER2180 - Programming PLC's

SUGGESTED DURATION: 30 hours

PREREQUISITES: ER2170

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able to enter a set of operating instructions in a programmable controller.

OVERVIEW OF OBJECTIVES:
1. Program a PLC using ladder logic or "instruction set" type languages
2. Apply the general principles, transmission media, protocols, testing and troubleshooting of PLC data highway systems

CONTENT:
1. Program a PLC using ladder logic or "instruction set" type languages
   - ladder logic
     - ladder logic programs
     - I/O instructions
     - controller scan
     - programming restrictions
     - safety circuitry
     - I/O. addressing
   - timers
     - types of PLC timers
     - cascading timers
     - reciprocating timers
   - counters
     - types of PLC counters
     - cascading counters
     - combining counter and timer circuits
   - math functions
     - data comparison
     - addition
     - subtraction
     - multiplication
     - division

2. Apply the general principles, transmission media, protocols, testing and troubleshooting of PLC data highway systems

- data highways
  - protocol
  - token passing
  - topology
  - transmission media
  - data highway types

METHODOLOGY:
This course lends itself to theory lectures supplemented with laboratory experiments. The instructors may involve apprentices in specific activities, including:

- exercises on theory content
- demonstrations
- audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

- projects as determined by course instructor

NAME AND NUMBER: ER2190 - Process Control

SUGGESTED DURATION: 90 hours

PREREQUISITES: ER2150

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able to apply the basic theoretical concepts of automatic process control.

OVERVIEW OF OBJECTIVES:
1. Describe the basic control concepts
2. Describe the functional structure of feedback control
3. Describe sensors and transmission systems
4. Describe the controllers used with process control
5. Describe process dynamics
6. Describe tuning control systems
7. Describe cascade, ratio, and dead time control
8. Describe digital control
9. Describe the characteristics of radioactivity and radioactive devices used in the process industries
10. Describe the procedures involved in humidity measurement and how it affects control process.

CONTENT:
1. Describe the basic control concepts
    - control history
    - the variables involved
    - typical manual control
    - feedback control
    - manual feedforward control
    - automatic feedforward control
    - process control and process management

2. Describe the functional structure of feedback control
    - a single feedback control loop
    - block diagrams
    - the functional layout of a feedback loop
    - dynamic components
    - mathematical model of a loop

3. Describe sensors and transmission systems
   - the sensor and the transmitter
   - sensor dynamics
   - selection of sensing devices
   - accuracy and precision
   - sensitivity
   - pneumatic transmission
   - electronic transmission

4. Describe the controllers used with process control
   - controllers
   - on-off control
   - proportional control action
   - reset control action
   - rate control action - PID control
   - summary

5. Describe process dynamics
   - dead time
   - closed-loop response vs open-loop response
   - some generalizations

6. Describe tuning control systems
   - what is good control?
   - the tuning concept
   - closed-loop tuning methods
   - a simple open-loop method
   - integral methods
   - summary

7. Describe cascade, ratio, and dead time control
   - cascade control
   - guiding principles for implementing cascade control
   - selection of cascade controller modes and tuning
   - ratio control
   - dead time

8. Describe digital control
   - digital capabilities
   - digital control history
   - data logging
   - direct digital control (DDC)
   - supervisory digital control
   - the hierarchy concept
   - distributed control

PLCs in control
PCs in control

9. Describe the characteristics of radioactivity and radioactive devices used in the process industries
   - alpha particles
   - beta particles
   - gamma rays
   - radiation detectors
   - nuclear radiation units
   - inverse square law
   - personnel dosimeters
   - radioisotopes
   - half life
   - uses

10. Describe the procedures involved in humidity measurement and how it affects control process.
   - definition
   - psychometric chart
   - hygrometers
   - relative humidity
   - dew point
   - absolute humidity
   - measuring devices

METHODOLOGY:
This course lends itself to theory lectures supplemented with laboratory experiments. The instructors may involve apprentices in specific activities, including:

1. exercises on theory content
2. demonstrations
3. audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

Controller Calibration
Controller Tuning
Process Operation
Process Flow Diagrams
Process Tuning

NAME AND NUMBER: ER2200 - Distributed Control Systems

SUGGESTED DURATION: 75 hours

PREREQUISITES: ER2180

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able to operate, install, maintain, and understand the applications of distributed control systems.

OVERVIEW OF OBJECTIVES:
1. Analyze and compare systems from various manufacturers
2. Program a DCS via an interface and a PC
3. Install field equipment, run data highways, and make connections to the DCS system
4. Analyze video displays, use a system keyboard, and troubleshoot DCS control systems
5. Describe the typical UPS system used to supply a distributed control system

CONTENT:
1. Analyze and compare systems from various manufacturers
   - definition of DCS
   - basic DCS functions
   - the role of the computer in DCS
   - DCS and expert systems overview
   - overall structure
   - I/O modules
   - local I/O bus
   - controller modules
   - communication modules
   - real time data highway
   - host computer interfaces and PLC gateways
   - power distribution systems
   - long term buying
   - expanding and upgrading a DCS
   - dealing with obsolescence
   - upgrading a DCS

2. Program a DCS via an interface and a PC
    - write program
    - programming concepts
    - executive software
    - system support software
    - application software
    - communication software

3. Install field equipment, run data highways, and make connections to the DCS system
    - physical location
    - environmental conditioning
    - power source
    - wiring
    - intrinsically safe barriers
    - system checkout and site power up
    - typical system layouts
    - start up services
    - system documentation

4. Analyze video displays, use a system keyboard, and troubleshoot DCS control systems
    - historical overview
    - operator interface hardware
        - CRT display monitors
        - alphanumeric keyboard
        - operator keyboard
        - hard copy devices
        - Displays
        - engineering workstations
    - levels of support programs
    - categories of maintenance
    - enhancement maintenance
    - preventive maintenance
    - corrective maintenance
    - service contracts

5. Describe the typical UPS system used to supply a distributed control system
    - introduction to UPS
    - power line problems
    - uninterruptible power supplies
    - UPS system configurations
    - UPS selection

METHODOLOGY:
This course lends itself to theory lectures supplemented with laboratory experiments. The instructors may involve apprentices in specific activities, including:

- exercises on theory content
- demonstrations
- audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

- programming exercises as determined by course instructor

NAME AND NUMBER: ER2210 - Pneumatic Control Systems

SUGGESTED DURATION: 30 hours

PREREQUISITES: WD1310

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able to install, maintain, and understand the applications of instrument air supply systems and equipment.

OVERVIEW OF OBJECTIVES:
1. Interpret pneumatic drawings
2. Describe the parts and characteristics of various types of compressors and associated equipment
3. Install conditioning devices in instrument air supply systems
4. Select and install tubing and fittings
5. Install pressure instruments
6. Install special instrument hook-ups
7. Use the proper equipment to detect leaks in tubing runs

CONTENT:
1. Interpret pneumatic drawings
   - symbols

2. Describe the parts and characteristics of various types of compressors and associated equipment
   - instrument air requirements
     - pressure
     - estimation of air requirements
   - types of compressors
     - principles of operation
     - location of air intake
     - location of air intake filters
     - compressor operation

3. Install conditioning devices in instrument air supply systems
   - moisture removal
     - absolute and relative humidity of air
     - dew point
     - use of psychometric chart

mathematics
problems involving use of psychometric charts
dehydrators
traps
separators
desiccant dehydrators
air coolers
air dryers
oil removal

4. Select and install tubing and fittings
   - main branch lines
     - piping size and sizing
     - piping materials
     - pipe cutting; deburring and threading
   - copper (P V C) covered
   - brass
   - steel
   - aluminum
   - plastic
   - other types used in instrumentation as to process
   - selection of tubing; size and type
   - selection of tubing fittings
   - tubing run
   - cut, ream and assemble copper and brass pipe
   - solder and silver braze fittings and tubing
   - flare tubing

5. Install pressure instruments
   - pressure taps
     - position
     - types of connections
     - methods of installing taps
     - working pressure unit

6. Install special instrument hook-ups
   - process fluids in leads
     - methods of sealing out process
     - choice of suitable sealing liquid
   - protection of instruments
     - corrosive vapours
     - weather
     - dust
     - vibration

7. Use the proper equipment to detect leaks in tubing runs
   - pressure test

lighted candle
odoriferous air
soap test

METHODOLOGY:
This course lends itself to theory lectures supplemented with laboratory experiments. The instructors may involve apprentices in specific activities, including:

- exercises on theory content
- demonstrations
- audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

- hands-on projects as determined by course instructor

NAME AND NUMBER: ER2220 - Servomechanism

SUGGESTED DURATION: 30 hours

PREREQUISITES: ER2190
ER2210
ER2230

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able to select and install final control elements in a loop operation.

OVERVIEW OF OBJECTIVES:
1. Describe the different types of final control elements found in an industrial process
2. Describe the accessories used with control valves
3. Select the correct control valve for a process
4. Install and maintain control valves

CONTENT:

1. Describe the different types of final control elements found in an industrial process
    - control valve nomenclature
        - rotary-shaft valve nomenclature
        - control valve functions and characteristics
        - terminology
    - control valve actuators
        - diaphragm actuators
        - piston actuators
        - electro-hydraulic actuators
        - manual actuators
    - control valve bodies
        - single-ported valve bodies
        - balanced-plug cage-style valve bodies
        - high-capacity cage-guided valve bodies
        - reverse-acting cage-guided valve bodies
        - double-ported valve bodies
        - three-way valve bodies
        - boot-style valve bodies

- butterfly valve bodies
- V-notch ball control valve bodies
- eccentric-disc control valve bodies
- control valve end connectors
- screwed pipe threads
- bolted gasket flanges
- welding end connections

valve body bonnets
- extension bonnets
- bellows seal bonnets

control valve packing
- TFE V-ring
- TFE-impregnated asbestos
- graphited asbestos
- laminated and filament graphite
- semi-metallic

valve stem packing lubrication
- conventional characterized valve plugs
- characterization of cage-guilded valve bodies
- valve plug guiding
- restricted capacity control valve trim

special control
- high pressure control valves
- high temperature control valves
- small flow control valves
- large flow control valves

non-valves
- dampers
- fluid couplings
- eddy current drives
- variable frequency drives
- DC drives
- metering pumps
- electro hydraulic actuators

2. Describe the accessories used with control valves
   - the old guidelines
   - the new guidelines
   - other control valve accessories
     - handwheels and manual operations
     - hydraulic snubber
     - limit switches
     - solenoid valve manifold
     - supply pressure regulator
     - pneumatic lock-up systems
     - fail-safe systems for pistons

electro-pneumatic transducers
electro-pneumatic valve positioners

3. Select the correct control valve for a process
   - considerations
   - valve body materials and dimensions
   - pressure-temperature ratings
   - wear and galling resistance chart
   - leakage classifications
   - corrosion information
   - elastomer information
     - general properties
     - fluid compatibility
     - service temperature limitations
   - control valve flow characteristics
   - control valve sizing
   - liquid service
     - gas or stream service
     - liquid and gas mixtures
     - representative sizing coefficients
       - single-ported globe-style valve bodies
       - rotary-shaft valve bodies
   - actuator sizing
   - control valve noise

4. Install and maintain control valves
   - control valve installation
   - recommended piping arrangements
   - importance for pipeline cleanliness
   - inspection of control valve before installation
   - low pressure piping manifold dimensions
   - high pressure piping manifold dimensions
   - good piping practice
   - control valve maintenance
   - replacing actuator diaphragm
   - replacing stem packing
   - replacing threaded seat rings
   - grinding metal seats
   - lubricating control valve packing
   - adjusting travel and connecting stem

METHODOLOGY:
This course lends itself to theory lectures supplemented with laboratory experiments. The instructors may involve apprentices in specific activities, including:

- exercises on theory content
- demonstrations
- audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

- classroom exercises as determined by course instructor
- laboratory experiments as determined by the course instructor

NAME AND NUMBER: ER2230 - Hydraulic Circuits and Control

SUGGESTED DURATION: 15 hours

PREREQUISITES: WD1310

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able to troubleshoot hydraulic system problems.

OVERVIEW OF OBJECTIVES:
5. Use hydraulic formulas to solve problems
6. Identify the components needed to make up a basic hydraulic system
7. Describe the operation of various plumbing components used in hydraulic systems
8. Describe the operation and purpose of various valves used in hydraulic systems
9. Use schematic diagrams to troubleshoot systems
10. Describe preventative maintenance procedures

CONTENT:
1. Use hydraulic formulas to solve problems
    - Pascal's Law
    - Bernoulli's Principle
    - pressure drop and flow
    - horsepower and torque

2. Identify the components needed to make up a basic hydraulic system
    - pumps
    - actuators
    - hydraulic fluid
    - piping and sealing
    - motors

3. Describe the operation of various plumbing components used in hydraulic systems
    - filters
    - accumulators
    - intensifiers
    - pressure switches
    - gauges and flowmeters

4. Describe the operation and purpose of various valves used in hydraulic systems
   - directional control valves
   - pressure control valves
   - volume control valves

5. Use schematic diagrams to troubleshoot systems
   - schematic symbols

6. Describe preventative maintenance procedures
   - seals
   - motor vanes
   - checking for leaks
   - cavitating pumps

METHODOLOGY:
This course lends itself to theory lectures supplemented with laboratory experiments and videos. The instructors may involve apprentices in specific activities, including:

- exercises on theory content
- demonstrations
- audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following LabVolt experiments:

- classroom exercises as determined by course instructor
- laboratory experiments as determined by the course instructor

NAME AND NUMBER: ER2240 - DC Generators

SUGGESTED DURATION: 30 hours

PREREQUISITES: ER1230
ER1300

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will become familiar with the operating characteristics and installation procedures of various types of DC generators.

OVERVIEW OF OBJECTIVES:
1. List the basic components of a typical DC generator and motor
2. Describe the generation of a voltage
3. Describe the characteristics of a series, shunt, and compound DC generator and motor
4. Explain the load/voltage characteristics of separately and static excited generators
5. Install and connect DC generators
6. Describe the process of connecting generators in parallel
7. Troubleshoot generator problems

CONTENT:
1. List the basic components of a typical DC generator and motor
   - construction (frame, end bells, and armature)
   - armature and field windings

2. Describe the generation of a voltage
   - magnets and magnetic fields
   - magnetic terms and definitions
   - permanent and temporary magnets
   - left-hand coil rule
   - current flow (electron and conventional)
   - losses in magnetic coils (eddy current and hysteresis)
   - induced voltages
   - generator effect
   - left-hand generator rule
   - generating an EMF
   - losses and efficiency of a generator

3. Describe the characteristics of a series, shunt, and compound DC generator and motor
   - generator polarity markings
   - shunt generators (voltage regulation)
   - armature reaction (brush movement, compensating windings and interpoles)
   - series generators (voltage regulation)compound generators (differential, cumulative, overcompound, undercompound, flat compound)
   - generator rheostats
   - static excitation

4. Explain the load/voltage characteristics of separately and static excited generators
   - load/voltage characteristics

5. Install and connect dc generators
   - installation of generators and peripheral devices
   - pre-commissioning checks
   - CEC requirements

6. Describe the process of connecting generators in parallel
   - necessary conditions before parallelling
   - load/voltage characteristics
   - parallelling shunt generators (load sharing)
   - parallelling compound generators

7. Troubleshoot generator problems
   - failure to generate voltage
   - brush tension
   - care of commutator
   - generator reversal

METHODOLOGY:
This course lends itself to theory lectures supplemented with laboratory experiments and videos. The instructors may involve apprentices in specific activities, including:

- exercises on theory content
- demonstrations
- audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following LabVolt experiments:

- Separately-Excited, Shunt, and Compound DC Generators

NAME AND NUMBER: ER2250 - AC Generators

SUGGESTED DURATION: 30 hours

PREREQUISITES: ER1190

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will become familiar with the operating characteristics and installation procedures of various types of AC generators.

OVERVIEW OF OBJECTIVES:
1. Describe the construction of AC generators
2. Explain the operating principles of AC generators
3. Describe the operation of brushless synchronous generators
4. Describe the methods for controlling the output voltage and frequency of AC generators
5. Describe the procedure for connecting AC generators in parallel

CONTENT:
1. Describe the construction of AC generators
    - interchangeable terms (AC generator, synchronous generator, synchronous alternator, alternator)
    - revolving field
    - revolving armature
    - salient and cylindrical poles
    - amortisseur windings

2. Explain the operating principles of AC generators
    - single-phase
    - three-phase
    - armature reaction
    - regulation curves
    - alternator reactance
    - automatic regulators
    - alternator effects
    - ratings
    - effects of load power factor
    - winding connections
3. Describe the operation of brushless synchronous generators

- exciter
- rectifier assembly
- static voltage regulation
- voltage sensing
- compensation for parallel operation

4. Describe the methods for controlling the output voltage and frequency of AC generators
   - prime mover relationship
   - excitation

5. Describe the procedure for connecting AC generators in parallel
   - voltage
   - frequency
   - phase relationships
   - synchronizing by one-dark-and-two-bright method
   - synchronizing by all-dark method
   - synchroscopes
   - hunting

METHODOLOGY:
This course lends itself to theory lectures supplemented with laboratory experiments and videos. The instructors may involve apprentices in specific activities, including:

- exercises on theory content
- demonstrations
- audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following LabVolt experiments:

- Synchronous Generator No-Load Operation
- Voltage Regulation Characteristics
- Frequency and Voltage Regulation
- Generator Synchronization

NAME AND NUMBER: ER2260 - Emergency Stand-by Systems

SUGGESTED DURATION: 30 Hours

PREREQUISITES: ER2250

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be familiar with the equipment and devices used in the installation of an emergency stand-by system.

OVERVIEW OF OBJECTIVES:

1. Determine requirements of emergency stand-by power units according to NBC.
2. Determine requirements of emergency stand-by power units according to CSA standard CSA282-1977
3. Determine genset requirements for a particular application
4. Install a generator stand-by emergency power unit applying all safety considerations.
5. Install manual and automatic transfer switches.
6. Describe the construction and principles of operation of primary and secondary cells.
7. Describe the cell characteristics of nickel-iron and nickel-cadmium batteries
8. Determine the size requirements and install a battery stand-by power system units.
9. Determine condition of cell charge and provide proper maintenance for stationary battery systems.
10. Describe the construction and operation of uninterruptible power supplies
11. Connect and set up battery chargers.
12. Describe methods of using solar energy to charge battery systems
13. Troubleshoot and maintain standby power systems

CONTENT:

1. Determine requirements of emergency stand-by power units according to NBC.

2. Determine requirements of emergency stand-by power units according to CSA standard CSA282-1977

3. Install a generator stand-by emergency power unit applying all safety considerations
   - safety precautions
   - general requirements
   - fuel system

electrical hazards
exhaust gases

4. Determine genset requirements for a particular application
   - general information
   - factors affecting genset output
   - fuel
   - high altitude
   - high ambient temperature
   - selecting a portable generator
   - selecting large capacity generators
   - generator output

5. Install manual and automatic transfer switches.
   - manual transfer switches
   - automatic transfer switches
   - circuit breaker type ATS
   - neutral transfer switches
   - optional controls for transfer switches
   - two source system
   - three source systems (two gensets)
   - two priority loads (two gensets)
   - parallel gensets and multiple gensets

6. Describe the construction and principles of operation of primary and secondary cells.
   - glossary of terms
   - safety considerations
   - introduction to primary cells
   - principle of operation
   - the dry cell
   - dry cell capacity
   - miscellaneous dry cells
   - introduction to secondary cells
   - secondary cell elements of construction
   - introduction to fuel cells
   - advantages of fuel cells
   - hydrox fuel cells
   - ion-exchange membrane fuel cell
   - redox fuel cell
   - hydrocarbon fuel cell
   - nuclear battery
   - theory of lead acid cell operation

7. Describe the cell characteristics of nickel-iron and nickel-cadmium batteries
   - advantages/disadvantages of nickel-iron cells
   - construction of nickel-iron cells

operation of nickel-iron cells
cell characteristics of nickel-iron cells
advantages/disadvantages of nickel-cadmium cells
operation of nickel-cadmium cells
cell characteristics of nickel-cadmium cells

8. Determine the size requirements and install a battery stand-by power system units.
   - cell/battery ratings
   - effects of temperature
   - room location/requirements
   - rack assembly
   - cell interconnections
   - CEC requirements

9. Determine condition of cell charge and provide proper maintenance for stationary battery systems.
   - condition of charge
   - specific gravity loss after discharge
   - use of float hydrometer
   - pilot cells
   - variation with temperature
   - variation with electrolyte level
   - loss after water addition
   - specific gravity lag on recharge
   - correcting low specific gravity
   - charge indicators
   - cadmium electrode testing
   - open voltage test
   - measuring cell voltage under load
   - ampere hour measurements

10. Connect and set up battery chargers.
    - introduction to the charging process
    - charging cycle
    - charging efficiency
    - safety considerations when charging cells/batteries
    - initial charge
    - constant voltage method

11. Describe the construction and operation of uninterruptible power supplies
    - introduction to UPS
    - power line problems
    - uninterruptible power supplies
    - UPS system configurations
    - UPS selection

12. Describe methods of using solar energy to charge battery systems
    - solar cells (photovoltaic cells)

13. Troubleshoot and maintain standby power systems
    - storage battery units
    - uninterruptible power supplies
    - engine generator sets
    - transfer switches

METHODOLOGY:
This course lends itself to theory lectures supplemented with videos. The instructors may involve apprentices in specific activities, including:

- exercises on theory content
- demonstrations
- audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

- classroom exercises as determined by the instructor

NAME AND NUMBER: ER2270 - Emergency Lighting Systems

SUGGESTED DURATION: 15 hours

PREREQUISITES: ER2080
ER2260

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be familiar with the operating characteristics and installation procedures of various types of emergency lighting units.

OVERVIEW OF OBJECTIVES:
1. Determine requirements of emergency lighting according to the NBC
2. Install self-contained lighting units
3. Install central-power lighting units
4. Determine exit sign requirements according to NBC
5. Describe the operation of inverters and converters used on emergency lighting systems
6. Determine conductor requirements for remote lighting units according to the CEC

CONTENT:
1. Determine requirements of emergency lighting according to the NBC
   - regulations and requirements
   - meeting illumination level requirements
   - wiring emergency lighting units
   - NBC requirements

2. Install self-contained lighting units
   - introduction
   - batteries
   - battery chargers
   - cabinets
   - remote lamps
   - installation and wiring of remote lamps
   - industrial emergency lighting units
   - description of various units

3. Install central-power lighting units
   - introduction to AC and DC central power systems
   - AC emergency power systems
   - fast transfer AC emergency systems
   - uninterruptible power supplies

4. Determine exit sign requirements according to NBC
   - introduction to exit signs
   - various types
   - applicable regulations

5. Describe the operation of inverters and converters used on emergency lighting systems
   - definitions (inverter, converter, cycloinverter)
   - advantages of solid state inverters/converters
   - configurations
   - circuit description
   - accessories (overcurrent protection, open-circuit protection, sine wave output, regulated output, the ability to operate into inductive loads)
   - introduction to fluorescent inverters
   - description of various types of inverters

6. Determine conductor requirements for remote lighting units according to the CEC
   - voltage drop
   - sizing conductors according to distance

METHODOLOGY:
This course lends itself to theory lectures supplemented with videos. The instructors may involve apprentices in specific activities, including:

- exercises on theory content
- demonstrations
- audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

- classroom exercises as determined by the instructor

NAME AND NUMBER: ER2280 - High-Voltage Breakers & Starters

SUGGESTED DURATION: 15 hours

PREREQUISITES: ER1290

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able describe the construction and manufacture of high voltage breakers as well as install and maintain them.

OVERVIEW OF OBJECTIVES:
1. Describe the features of high-voltage circuit breakers and motor starters
2. Describe safe procedures for operating high-voltage circuit breakers and motor starters
3. Interpret CEC rules and regulations concerning high-voltage protective equipment

CONTENT:
1. Describe the features of high-voltage circuit breakers and motor starters
    - ratings of circuit breakers
    - types of operating mechanisms
    - air circuit breakers
    - oil circuit breakers
    - air blast circuit breakers
    - vacuum circuit breakers
    - gas circuit breakers
    - circuit reclosers
    - 2 speed starters
    - types
    - reversing
    - vacuum

2. Describe safe procedures for operating high-voltage circuit breakers and motor starters
    - approved line tools
    - safety inspections
    - voltage testing
    - key interlock systems
    - safety lockout procedures and grounding

3. Interpret CEC rules and regulations concerning high-voltage protective equipment
    - service equipment and disconnecting means
    - indoor installations
    - outdoor installations

METHODOLOGY:
This course lends itself to hands-on projects supplemented by theory lectures, demonstrations, and videos. The instructors may involve apprentices in specific activities, including:

- exercises on theory content
- demonstrations
- audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

- rack and remove high-voltage breaker from enclosure
- clean and prepare high-voltage breaker for return to service
- perform necessary tests and calibrations on high-voltage breaker before return to service

NAME AND NUMBER: ER2290 - High Voltage Splices and Terminations

SUGGESTED DURATION: 15 hours

PREREQUISITES: ER2280

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able describe the construction and manufacture of high voltage cables as well as apply the proper methods and materials used when splicing and terminating such cables.

OVERVIEW OF OBJECTIVES:
1. Describe the features of high voltage cables
2. Describe the construction and ratings of concentric neutral type of cables
3. Describe the termination and splicing of non-shielded cables
4. Describe the termination and splicing of shielded cables
5. Interpret CEC rules and regulations concerning wiring methods for high voltage installations
6. Terminate and splice cables
7. Install and terminate parallel runs

CONTENT:
1. Describe the features of high voltage cables
   - cable types
   - types of dielectric
   - dielectric strength
   - conductor shielding
   - electric field around an energized conductor
   - insulation levels

2. Describe the construction and ratings of concentric neutral type of cables
   - cable layers and parts
   - AWG sizes
   - voltage and current ratings
   - uses

3. Describe the termination and splicing of non-shielded cables
   - preparing the conductor
   - making a splice or termination

4. Describe the termination and splicing of shielded cables
   - preparing the cable
   - making a termination or splice

5. Interpret CEC rules and regulations concerning wiring methods for high voltage installations
   - conductors, cables and raceways
   - radii of bends
   - shielding
   - spacing and support of conductors
   - joints and terminations

6. Terminate and splice cables
   CEC
   torquing requirements

7. Install and terminate parallel runs

METHODOLOGY:
This course lends itself to hands-on projects supplemented by theory lectures, demonstrations, and videos. The instructors may involve apprentices in specific activities, including:

- exercises on theory content
- demonstrations
- audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

- prepare high voltage cable and complete splice on shielded cable
- prepare high voltage cable and complete termination on shielded cable
- prepare high voltage cable and complete splice on non-shielded cable
- prepare high voltage cable and complete termination on non-shielded cable

NAME AND NUMBER: ER2300 - Distribution System Conditioning

SUGGESTED DURATION: 45 hours

PREREQUISITES: ER1290

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able describe the operating characteristics of electric power that affects the performance of electrical equipment.

OVERVIEW OF OBJECTIVES:
1. Describe the significance of power quality
2. Determine the reactive power needed to raise power factor
3. Install power factor correction units
4. Describe the results of power system harmonics
5. Describe the methods of reducing power system harmonics
6. Describe abnormal voltage fluctuations in power distribution systems
7. Describe the mitigating equipment used for voltage problems

CONTENT:
1. Describe the significance of power quality
   - sensitive loads
   - technological complexity
   - disturbance-producing equipment

2. Determine the reactive power needed to raise power factor
   - comparison of AC and DC power
   - inductive reactance
   - capacitive reactance
   - impedance
   - inductance and capacitance effects on currents
   - power factor
   - results of reactive power components
   - meters used in power measurements
   - wattmeter
   - energy measurements
   - power factor meters
   - phase angle meters

- power factor correction calculations
- raising power factor to less than unity

3. Install power factor correction units
   - advantages of capacitors
   - capacitor ratings and tolerances
   - considerations for capacitor installation
   - temperature and ventilation
   - fusing of capacitors
   - conductor size for capacitors
   - disconnecting means
   - capacitor life
   - locating power factor correction equipment
     - individual
     - group
     - central correction units
   - PCB considerations and safety
   - synchronous motors
   - synchronous motors used for power factor correction
   - dual operation of synchronous motors

4. Describe the results of power system harmonics
   - harmonics theory
   - electrical harmonics
     - classification of harmonics
     - linear loads
     - non-linear loads
   - effects of harmonics on a power distribution system
     - phase conductors and conduit
     - circuit breakers
     - neutral conductors
     - neutral-to-ground voltage at receptacles
     - neutral bus bar and neutral lug
     - panel steel
     - transformers
     - power factor correction capacitors
     - kW and kvar meters
     - multimeter readings

5. Describe the methods of reducing power system harmonics
   - shunt harmonic filters
   - series harmonic filters
   - wye-delta zero sequence harmonic trap
   - zig-zag autotransformer zero sequence harmonic trap
   - wye-delta with tuned capacitor zero sequence harmonic trap
   - applying CEC requirements with zero sequence transformers

6. Describe abnormal voltage fluctuations in power distribution systems
   - tingle voltage
   - swell
   - transient
   - sustained power interruption
   - momentary power interruption
   - brownout
   - lightning

7. Describe the mitigating equipment used for voltage problems
   - transient suppressors
     - lightning arrester
     - line clamp (surge suppressor)
   - power line filters
     - linear (passive) filter
     - hybrid filter
     - tingle voltage filter
   - isolation transformers
   - line voltage regulators
     - general
     - ferroresonant transformers
     - tap switching transformers
   - power line conditioners
     - linear amplifier power conditioner
     - ferroresonant power conditioner
     - tap switching conditioner
     - motor-generator
   - uninterruptible power supply system (UPS):on-line
     - rotary
     - static
       - continuous
       - line-interactive
   - standby power supply system (SPS): off-line
     - static
       - simple
       - ferroresonant

METHODOLOGY:
This course lends itself to theory lectures, supplemented by demonstrations and videos. The instructors may involve apprentices in specific activities, including:

- exercises on theory content
- demonstrations
- audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

- classroom exercises
- calculations involving power factor correction

NAME AND NUMBER: ER2310 - Furnace Control

DURATION: 15 hours

PREREQUISITES: ER2060

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able to install safety controls, comfort controls, and wiring to fossil-fuel residential central heating units.

OVERVIEW OF OBJECTIVES:
1. Describe the function of combustion control on furnaces
2. Describe the operation of controls installed on a forced-air heating unit3
3. Describe the operation of controls installed on a hydronic heating system
4. Describe the operation of controls installed on a combination heating system
5. Troubleshoot furnace control and associated wiring
6. Interpret schematic diagrams for furnaces and controls
7. Install and connect furnace controls
8. Verify system operation in cooperation with related trades

CONTENT:
1. Describe the function of combustion control on furnaces
    - general information
    - control systems
    - power wiring
    - emergency switches
    - control wiring
    - thermostats

2. Describe the operation of controls installed on a forced-air heating unit
    - system controls
    - limit switches
    - temperature settings
    - types of limit switches
    - installation of limit switches
    - primary controls
    - thermal operated primary controls
    - thermal control operation

visual primary controls
operation of cad cell primary control

3. Describe the operation of controls installed on a hydronic heating system
   - system controls
   - combination controls
   - temperature settings
   - zone valves

4. Describe the operation of controls installed on a combination heating system
   - wood/oil furnaces
   - solid fuel combustion control
   - interlock relays
   - wood/electric combinations

5. Troubleshoot furnace control and associated wiring
   - low-voltage wiring and controls
   - line-voltage wiring and controls

6. Interpret schematic diagrams for furnaces and controls

7. Install and connect furnace controls
   - weighting

8. Verify system operation in cooperation with related trades

METHODOLOGY:
This course lends itself to theory lectures, supplemented by laboratory experiments. The instructors may involve apprentices in specific activities, including:

- exercises on theory content
- demonstrations
- audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

- hands on experiments as determined by course instructor

NAME AND NUMBER: ER2320 - Boiler Control

SUGGESTED DURATION: 15 hours

PREREQUISITES: ER2310

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able to install and troubleshoot controls on boilers.

OVERVIEW OF OBJECTIVES:
1. Describe the basic operating priniciples of a boiler
2. Troubleshoot and maintain boiler controls and motors

CONTENT:

1. Describe the basic operating priniciples of a boiler
   - burner control
   - burners
   - pulverizing mill
   - bunker preheaters
   - feedwater purifiers/chemical plants
   - oil pumps

2. Troubleshoot and maintain boiler controls and motors
   - burner controls
   - boiler feed pumps
   - condensate pumps
   - feedwater pumps
   - forced-draft fans
   - induced draft fans
   - electrodes and elements

METHODOLOGY:
This course lends itself to theory lectures, supplemented by laboratory experiments. The instructors may involve apprentices in specific activities, including:

- exercises on theory content
- demonstrations
- audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

- hands on experiments as determined by course instructor

NAME AND NUMBER: ER2330 - Heat Pumps

SUGGESTED DURATION: 15 hours

PREREQUISITES: ER2360

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able to select and install heat pumps.

OVERVIEW OF OBJECTIVES:
1. Describe the operation of a heat pump
2. Describe the components used in a heat pump
3. Describe the electrical components used in a heat pump
4. Install wiring for heat pumps
5. Troubleshoot control circuits used with heat pumps

CONTENT:
1. Describe the operation of a heat pump
    - heating cycle
    - cooling cycle
    - defrost cycle
    - coefficient of performance (COP)
    - balance point

2. Describe the components used in a heat pump
    - compressor
    - reversing valve
    - expansion valve
    - check valve
    - restrictor
    - evaporator coil
    - condensing coil
    - outdoor fan
    - drier
    - accumulator
    - auxiliary heating units
3. Describe the electrical components used in a heat pump

compressor contactor
start compacitor and potential relay
transformer
thermostat
emergency heat sub-base
reversing valve
outdoor fan and defrost relay
defrost controls
clock timer control
solid state control
mechanical switch control
air switch control
pressure controls
crankcase heater
low ambient thermostat
external overloads

4. Install wiring for heat pumps
   CEC requirements
   control wiring

5. Troubleshoot control circuits used with heat pumps
   checking power supply
   checking transformers and speed controllers
   checking relays, solenoids, and contactors
   checking capacitors
   checking overloads compressor motor
   expansion valves
   checking defrost control
   refrigerant charge
   icing of indoor coils
   pressure and temperature checks

METHODOLOGY:
This course lends itself to theory lectures, supplemented by laboratory experiments. The instructors may involve apprentices in specific activities, including:

- exercises on theory content
- demonstrations
- audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

- hands on experiments as determined by course instructor

NAME AND NUMBER: ER2340 - Energy Management

SUGGESTED DURATION: 30 hours

PREREQUISITES: ER1600

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able to understand what an energy management system is, what it can do, where it is used, and how it is installed as well as how to troubleshoot basic problems.

OVERVIEW OF OBJECTIVES:
1. Describe the features of an energy management system
2. Install and maintain an energy management system

CONTENT:
1. Describe the features of an energy management system
    - time schedules
    - relative time schedules
    - calendar schedules
    - holiday schedules
    - heating/cooling optimized start/stop
    - plan rotation
    - load cycling
    - PID control
    - maximum demand/load shedding
    - night purge
    - outside high limit
    - enthalpy control
    - standby generator
    - zone control

2. Install and maintain an energy management system
    - safety considerations
    - system layout
    - proper grounding techniques
    - sources of electrical interference
    - unitary controllers/field devices

controllers/field devices
field wiring
    copper
    fiber
    ethernet 802.3/802.4
    TCP/IP
    PSTN/ISDN X.25
maintenance
troubleshooting

METHODOLOGY:
This course lends itself to theory lectures, supplemented by laboratory experiments. The instructors may involve apprentices in specific activities, including:

- exercises on theory content
- demonstrations
- audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

- hands on experiments as determined by course instructor

NAME AND NUMBER: ER2350 - Electric Surface Heating Units

SUGGESTED DURATION: 15 hours

PREREQUISITES: ER2060

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able to select and install electrical surface heating units.

OVERVIEW OF OBJECTIVES:
1. Install snow melting and floor warming cables
2. Install pipe tracing and tank heating cables
3. Install de-icing cables
4. Install immersion heaters
5. Install heat tracing system

CONTENT:
1. Install snow melting and floor warming cables
    - styles
    - characteristics
    - installation methods
    - over-temperature protection
    - controls

2. Install pipe tracing and tank heating cables
    - pipe tracing heat cable
    - types of cables: pipe tracing, tank heating
    - tracing cable temperature control
    - tracing cable selection
    - tracing cable installation
    - tank warming cables

3. Install de-icing cables
    - uses
    - components/characteristics
    - loading requirements
    - controls

installation

4. Install immersion heaters
   - introduction
   - construction features
   - types of immersion heaters
   - temperature control
   - bonding and grounding requirements for livestock waters

5. Install heat tracing system
   - manufacturer's instruction
   - devices
   - sidewalk/driveways
   - pipes
   - series and parallel

METHODOLOGY:
This course lends itself to theory lectures, supplemented by laboratory experiments. The instructors may involve apprentices in specific activities, including:

- exercises on theory content
- demonstrations
- audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

- hands on experiments as determined by course instructor

NAME AND NUMBER: ER2360 - Refrigeration and AC Controls

SUGGESTED DURATION: 45 hours

PREREQUISITES: ER2330

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able to install and troubleshoot control circuits on refrigeration and air conditioning systems.

OVERVIEW OF OBJECTIVES:
1. Describe the operation of controls used with a refrigeration system
2. Describe the operation principles of a refrigeration system
3. Troubleshoot holding coils
4. Troubleshoot starting relays
5. Troubleshoot overload protectors
6. Troubleshoot solenoids
7. Troubleshoot low pressure control
8. Troubleshoot high pressure control
9. Troubleshoot thermostatic control

CONTENT:
1. Describe the operation of controls used with a refrigeration system
   - types and uses: cycling, operating, safety
   - function in system
   - application
   - installation of controls: high pressure, low pressure oil failure
   - maintenance

2. Describe the operation principles of a refrigeration system
   - definition
   - terminology

3. Troubleshoot holding coils
   - types of magnetic starters
   - size and construction
   - coil data
   - overload protection

care of contacts
wiring diagram
installation of controls
maintenance of controls

4. Troubleshoot starting relays
   - types and uses
   - voltage relay
   - amperage relay
   - mounting requirements
   - results of high voltage
   - results of low voltage
   - hot wire relays
   - care of contacts
   - use of capacitors
   - installation
   - maintenance

5. Troubleshoot overload protectors
   - types and function
   - electrical connections
   - inherent overload
   - thermal overload
   - location of overload
   - overload rating
   - installation
   - troubleshooting

6. Troubleshoot solenoids
   - function of solenoid
   - location in system
   - voltages
   - line connections
   - refrigerant connections
   - manual adjustments
   - direction of flow
   - recognition of parts result of low voltage
   - causes of breakdown
   - results of breakdown
   - installation of solenoid
   - maintenance

7. Troubleshoot low pressure controls
   - construction of control
   - location of control
   - purpose of control

function
control differential
control range
snap action
line connections
care of contacts
results of wrong adjustment
method of adjusting
use as cycling control
use as safety control
installation
maintenance

8. Troubleshoot high pressure control
   types and uses
   function in system
   location in system
   adjustments of control
   differential
   range
   installation of control
   safety features
   maintenance

9. Troubleshoot thermostatic control
   types and uses
   application
   location in system
   functions in system
   adjustments
   electrical characteristics
   control installation
   maintenance

METHODOLOGY:
This course lends itself to theory lectures, supplemented by laboratory experiments. The instructors may involve apprentices in specific activities, including:

- exercises on theory content
- demonstrations
- audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the

following:

- hands on experiments as determined by course instructor

NAME AND NUMBER: ER2370 - Precipitator and Dust Collection Systems

SUGGESTED DURATION: 30 hours

PREREQUISITES: ER2050

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able to troubleshoot problems precipitators and dust collection systems as well as provide regular maintenance to these devices.

OVERVIEW OF OBJECTIVES:
1. Describe the basic operation of electrostatic precipitators
2. Describe the basic operation of pre-filters
3. Troubleshoot and maintain precipitator components

CONTENT:
1. Describe the basic operation of electrostatic precipitators
   - dry electrostatic precipitators (DESP)
   - wet electrostatic precipitators (WESP)
   - pre-filters/scrubber
   - high voltage generator/power supply
   - ionization screen
   - collector plates

2. Describe the basic operation of pre-filters
   - packed tower scrubber
   - cross flow scrubber
   - co-current flow scrubber
   - multi-channel bed scrubber
   - jet venturi scrubber
   - activated carbon absorbers
   - fabric filters

3. Troubleshoot and maintain precipitator components
   - high voltage power supplies
   - automatic voltage controls
   - high voltage insulators

rapper components
high voltage discharge electrodes
collecting electrodes
sway brace assemblies
gravity impact rappers and mounting systems
power-down rapping
insulator compartment heating systems

METHODOLOGY:
This course lends itself to theory lectures, supplemented by laboratory experiments. The instructors may involve apprentices in specific activities, including:

- exercises on theory content
- demonstrations
- audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

- hands on experiments as determined by course instructor

NAME AND NUMBER: WD1310 - Oxy-Fuel Welding

SUGGESTED DURATION: 15 hours

PREREQUISITES: ER1400

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able to cut and weld thin metals by using oxy-fuel equipment.

OVERVIEW OF OBJECTIVES:
1. Describe the purpose of various safety devices and precautions to follow when using oxy-fuel equipment
2. Set up oxy-fuel equipment
3. Select proper tips for various cutting and welding jobs on different metals
4. Cut, fusion weld and weld with filler rods

CONTENT:
1. Describe the purpose of various safety devices and precautions to follow when using oxy-fuel equipment
    - the oxy-fuel process
    - oxygen cylinders
    - cylinder capacity
    - oxygen cylinder valve
    - safety in the use and storage of fuel
    - backfire
    - flashfire
    - personal safety
    - fire prevention

2. Set up oxy-fuel equipment
    - cylinder trucks
    - regulators
    - welding hoses
    - the hose clamp
    - the "Y" connector
    - the coupler "T"
    - the fiber washer

the equipment wrench
the cylinder valve
the check valve
the torch, tip, and mixer
the cutting attachment

3. Select proper tips for various cutting and welding jobs on different metals
   - standard cutting torches
   - cutting tips
   - tip cleaners
   - quality of the cut
   - tip cleaning
   - tip cleaning drills
   - tip drill kit

4. Cut, fusion weld and weld with filler rods
   - steps to light torch and adjust the flame
   - types of flame
   - flame adjustments (neutral, carburizing, oxidizing
   - free hand and straight edge cutting
   - tip alignment
   - bevel cutting by hand
   - cutting flame adjustment
   - common cutting faults
   - use of filler rods
   - description of fusion welding, brazing and soldering

METHODOLOGY:
This course lends itself to hands-on projects supplemented by theory lectures, demonstrations, and videos. The instructors may involve apprentices in specific activities, including:

- exercises on theory content
- demonstrations
- audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

- cut mild steel 90^{o} freehand
- cut regular and irregular shapes freehand
- cut mild steel 90^{o} guided
- weld mild steel single vee butt joint
- weld mild steel open-corner butt joint

- weld mild steel lap joint
- braze weld tee joint (m.s. in flat position)
- braze weld butt joint (m.s. in flat position)
- perform silver brazing

NAME AND NUMBER: WD2320 - Arc Welding

SUGGESTED DURATION: 30 hours

PREREQUISITES: WD1310

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able setup and use arc welding equipment safely and effectively.

OVERVIEW OF OBJECTIVES:
1. Describe the shielded metal arc welding (SMAW) welding process and its application
2. Identify safety requirements for SMAW
3. Identify types of current and the application of each
4. Describe the effects of a volt-ampere curve on the welding arc
5. Describe the operation of common electrodes for SMAW
6. Identify the classification of mild steel electrodes
7. Select common electrodes for SMAW
8. Describe correct handling and storage of common electrodes
9. Identify basic joint design
10. Describe weld types
11. Identify welding positions for plate
12. Identify main factors of SMAW
13. Strike an arc on steel plate
14. Weld beads in the flat position on mild steel plate
15. Weld fillet welds in the flat (if) position on lap joints on mild steel plate
16. Describe procedures for SMAW on grey cast iron
17. Weld groove welds in the flat (ig) position on grey cast iron

CONTENT:

1. Describe the shielded metal arc welding (SMAW) welding process and its application
    - principles of SMAW
    - the arc welding circuit
    - the SMAW
    - process
    - electrodes
    - power source

- applications of SMAW
- arc welding station
- welding station inspection

2. Identify safety requirements for SMAW
   - electric shock
   - damp ground
   - treatment of shock victims
   - WCB safety regulations
   - maintenance of equipment
   - power circuit ground
   - welding cables
   - fire prevention
   - eye protection
   - helmets
   - arc burn
   - ventilation
   - electrode holder
   - electrode stubs
   - slag

3. Identify types of current and the application of each
   - alternating current
   - direct current
   - polarity
   - arc blow

4. Describe the effects of a volt-ampere curve on the welding arc
   - volt-ampere curve
   - constant current welding machines
   - constant potential welding machines
   - adjusting the voltage
   - adjusting the amperage

5. Describe the operation of common electrodes for SMAW
   - bare electrodes
   - coated or shielded electrodes
   - function of electrode coatings
   - metal transfer with SMAW
     - gravity
     - gas expansion
     - electro-magnetic force
     - electromotive force
     - surface tension
6. Identify the classification of mild steel electrodes
   - standards of coated electrode manufacture

- CSA and AWS designations
- electrode length
- electrode wire diameter

7. Select common electrodes for SMAW
   - principles of electrode selection
     - good arc stability
     - maximum weld strength
     - minimum weld splatter
     - good handling in the given position
     - swift deposition of filler metal
     - good weld appearance
     - easy slag removal
   - properties of the base metal
   - base metal dimensions
   - welding position and thickness of weld deposit
   - welding current
   - service conditions
   - common mild steel electrodes
     - E41010 (E6010)
     - E41011 (E6011)
     - E41012 (E6012)
     - E41013 (E6013)

8. Describe correct handling and storage of common electrodes
   - handling of electrodes
     - before use
     - in use
     - after use
   - storage of electrodes
   - electrode ovens

9. Identify basic joint design
   - basic joints
     - tee
     - lap
     - corner
     - edge
     - butt

10. Describe weld types
    - basic weld types
      - bead
      - tack
      - fillet
      - plug

groove

11. Identify welding positions for plate
    - flat position
    - horizontal position
    - vertical position
    - overhead position
    - abbreviations for weld position

12. Identify main factors of SMAW
    - operator comfort and position
    - machine setting
    - arc length
    - electrode angle
    - speed of travel

13. Strike an arc on steel plate
    - scratch method
    - tap method

14. Weld beads in the flat position on mild steel plate
    - stringer beads in the flat position

15. Weld fillet welds in the flat (if) position on lap joints on mild steel plate
    - single pass fillet welds on lap joints in the (if) position

16. Describe procedures for SMAW on grey cast iron
    - welding grey cast iron
    - hot welding
    - cold welding
    - peening to control bead shrinkage
    - SMAW electrodes for grey cast iron
    - ENI group
    - joint preparation

17. Weld groove welds in the flat (ig) position on grey cast iron
    - single pass groove weld on a single vee butt joint in the flat (ig) position

METHODOLOGY:
This course lends itself to hands-on projects supplemented by theory lectures, demonstrations, and videos. The instructors may involve apprentices in specific activities, including:

- exercises on theory content
- demonstrations

- audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

- weld beads in the flat position on mild steel plate
- weld fillet welds in the flat position on lap joints on mild steel plate
- weld groove welds in the flat position on grey cast iron

NAME AND NUMBER: ER2380 - Vibration Analysis

SUGGESTED DURATION: 30 hours

PREREQUISITES: ER2030

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able to analyze and correct vibration problems with rotating machinery.

OVERVIEW OF OBJECTIVES:
1. Describe vibration and its causes
2. Describe the characteristics and significance of vibration
3. Describe the measurement of vibration amplitude and its effect on machine operation
4. Describe the methods of measuring machinery vibration
5. Describe the basic operation and mounting requirements of pickups
6. Describe the measuring of machinery vibration
7. Describe the features of vibration analyzers and their uses
8. Describe the data acquisition procedures
9. Interpret vibration data to locate problem
10. Describe basic causes of unbalance
11. State the units for expressing unbalance
12. Describe the basic principles of balancing
13. Describe single-plane balancing
14. Describe the single-plane vector method of balancing
15. Describe the types of unbalance
16. Describe the alignment and levelling of drive systems

CONTENT:
1. Describe vibration and its causes
    - motion
    - unbalance
    - misalignment
    - bent shafts
    - gears
    - belts and chains
    - bearings
    - torque variations

- electromagnetic forces
- aerodynamic forces
- hydraulic forces
- looseness
- rubbing
- resonance

2. Describe the characteristics and significance of vibration
   - frequency
   - displacement
   - velocity
   - acceleration
   - phase

3. Describe the measurement of vibration amplitude and its effect on machine operation
   - displacement
   - velocity
   - acceleration
   - severity charts
   - complex vibrations

4. Describe the methods of measuring machinery vibration
   - meters
   - monitors
   - analyzers
   - transducers
   - seismic pickups
   - accelerometer pickups

5. Describe the basic operation and mounting requirements of pickups
   - seismic pickups
   - accelerometer pickups
   - frequency
   - stud mounting
   - hand held
   - probe
   - vice grip pliers
   - magnetic pickup holders
   - shaft stick
   - magnetic interference
   - non-contact pickups

6. Describe the measuring of machinery vibration
   - horizontal direction
   - vertical direction
   - axial direction

- select type of measurement
- upper two-thirds of scale

7. Describe the features of vibration analyzers and their uses
   - characteristics of vibration
   - pickups
   - amplitude meter
   - frequency meter
   - tunable filter
   - strobe light
   - internal oscillator

8. Describe the data acquisition procedures
   - complete records
   - machine sketch
   - supporting information
   - filter out readings
   - filter in readings

9. Interpret vibration data to locate problem
   - frequency
   - RPM
   - strobe light
   - amplitude
   - phase
   - possible causes

10. Describe basic causes of unbalance
    - blow holes
    - eccentricity
    - keyways
    - distortion
    - clearance tolerances
    - corrosion and wear
    - deposit build up

11. State the units for expressing unbalance
    - ounces
    - grams
    - inches
    - centimetres
    - kilograms
    - radius
    - use formula {$F = 0.01 \times (rpm/1000)_2 \times$ Gram-centimetres}

12. Describe the basic principles of balancing
    - heavy spot and position
    - vibration amplitude to unbalance
    - reference mark shift with weight

13. Describe single-plane balancing
    - original unbalance
    - original readings
    - trial weight
    - new balance
    - new readings

14. Describe the single-plane vector method of balancing
    - vectors
    - angular position
    - length of vector
    - polar-coordinate graph paper
    - original balance
    - trial weight
    - correct weight

15. Describe the types of unbalance
    - static
    - couple
    - quasi-static
    - dynamic
    - two-plane balancing

16. Describe the alignment and levelling of drive systems
    - V-belts
    - chains
    - gears
    - couplings
    - ships
    - jacking screws

METHODOLOGY:
This course lends itself to theory lectures supplemented with videos. The instructors may involve apprentices in specific activities, including:

- exercises on theory content
- demonstrations
- audio/visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

- classroom exercises as determined by the instructor
- perform static balance
- perform dynamic balance

NAME AND NUMBER: ER2390 - Fibre Optics

SUGGESTED DURATION: 30 hours

PREREQUISITES: ER1110

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentice will be able to understand the basic of fiber optics and how to install and terminate cables.

OVERVIEW OF OBJECTIVES:
1. Describe the features of fiber optic cables
2. Describe the components of a fiber optic communication system
3. Describe how to install fiber optic cables
4. Describe how to terminate fiber optic cables
5. Interpret CEC rules and regulations concerning fiber optic cables

CONTENT:
1. Describe the features of fiber optic cables
   - fibre type
     - Step-Index Multi-mode
     - Graded-Index Multi-mode
     - Single Mode
   - fibre fabrication methods
     - modified chemical vapor deposition
     - outside vapor deposition
     - axial vapor deposition
   - fibre cable design and construction
     - TubeStar
     - LiteTube
     - LiteStar

2. Describe the components of a fiber optic communication system
   - optical sources
     - LED's
     - semiconductor lasers
   - optical detectors
     - PIN diodes

avalanche photodiodes
- light propagation through core
  - monochromatic
  - coherent
- signal
  - digital
  - analogue

3. Describe how to install fiber optic cables
   - bending radius
   - pulling tension
   - lubricants

4. Describe how to terminate fiber optic cables
   - Splicing, termination and test equipment
     - tube splitter
     - stripper cleaver
     - fusion splicer
     - optomizer
     - stable light source
     - variable optical attenuator
     - photodyne optical power meter
     - Identifiber (fibre status tester)
   - Splicing materials and accessories
     - preparation kit
     - splice packs
     - closures
     - filling kits
     - installation kits
     - filled splice protector assembly
     - fibre splice protectors
     - fibre splice organizer trays
   - 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
   - Safety Precautions with Laser Light Sources

5. Interpret CEC rules and regulations concerning fiber optic cables
   - Section 56

METHODOLOGY:
This course lends itself to hands-on projects supplemented by theory lectures, demonstrations, and videos. The instructors may involve appearances in specific activities, including:

- exercises on theory content
- demonstrations
- audio-visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

- Classroom exercises as determined by the instructor
- Hands on experience as determined by the instructor

NAME AND NUMBER: ER2400 HVAC Systems

SUGGESTED DURATION: 45 hours

PREREQUISITES: ER2150

EVALUATIONS: Theory and practical applications require a minimum pass mark of 70%

OUTCOME:
Upon successful completion of this unit of instruction, the apprentise will be able to understand the operation of a Heating, Ventilating and Air Conditioning system installed in buildings.

OVERVIEW OF OBJECTIVES:
1. Describe the basic types of HVAC control systems
2. Interpret and apply HVAC control system drawings and specifications
3. Install and wire system control devices
4. Install and wire compressor, fan, and pump motors and starters
5. Test and replace system control devices
6. Test and replace valve and damper actuators
7. Test and replace compressor, fan, and pump motors and starters
8. Describe direct digital (DDC) HVAC control systems
9. Test and replace system control sensors

CONTENT:
1. Describe the basic types of HVAC control systems

2. Interpret and apply HVAC control system drawings and specifications

3. Install and wire system control devices

4. Install and wire compressor, fan, and pump motors and starters

5. Test and replace system control devices

6. Test and replace valve and damper actuators

7. Test and replace compressor, fan, and pump motors and starters

8. Describe direct digital (DDC) HVAC control systems

9. Test and replace system control sensors

METHODOLOGY:
This course lends itself to theory lectures, supplemented by laboratory experiments. The instructors may involve appearances in specific activities, including:

- exercises on theory content
- demonstrations
- audio-visual presentations

SUGGESTED LEARNING ACTIVITY:
In order to successfully complete this unit of instruction, apprentices will be expected to complete the following:

- Hands on experience as determined by the instructor

REQUIRED RELATED COURSES

COURSE NAME & NUMBER: CM2150 - Workplace Correspondence

DESCRIPTIVE TITLE: Workplace Correspondence

CALENDAR TITLE:

1.0 Type and Purpose Communications 2150 gives students the opportunity to study the principles of effective writing. Applications include letters, memos, and short report writing.

2.0 Major Topics Review of Sentence and Paragraph Construction; Business Correspondence; Informal Report; Job Search Techniques.

PREREQUISITES: Nil

CO-REQUISITES: Nil

COURSE DURATION 45hrs

SUGGESTED TEXT/ LEARNING RESOURCES:

Textbooks: Business English and Communications, Fourth Canadian Edition, Clark, Zimmer, et al., McGraw-Hill Ryerson, 1990

Student Projects and Activities for Business English and Communications, Fourth Canadian Edition, Clark, et al., McGraw-Hill, 1990

Effective Business Writing, Jennifer MacLennon

Simon and Shuster Handbook for Writers, Second Edition, Troyka Lynn Quitman, Prentice Hall

College English Communication, Third Canadian Edition, Stewart, Zimmer, et al., McGraw-Hill Ryerson Limited, 1989

Business and Administrative Communication, Second Edition, Kitty O. Locker. IRWIN, 1991

References: Pittman Office Handbook, Smith/Hay-Ellis

The Gregg Reference Manual, Fourth Canadian Edition, Sabin/O'Neill

McGraw Hill Handbook

Other Resources: Business Letter Business (Video), Video Arts

Guest Speakers

Sell Yourself (Video)

COURSE AIMS:

1. To help students understand the importance of well-developed writing skills in business and in career development.
2. To help students understand the purpose of the various types of business correspondence.
3. To examine the principles of effective business writing.
4. To examine the standard formats for letters and memos.
5. To provide opportunities for students to practice writing effective letters and memos.
6. To examine the fundamentals of informal reports and the report writing procedure.
7. To provide an opportunity for students to produce and informal report.

MAJOR TOPICS/TASKS:

1.0 Review of Sentence and Paragraph Construction
2.0 Business Correspondence
3.0 Informal Report/Present Orally

COURSE OUTLINE:

1.0 Review of Sentence and Paragraph Construction

- 1.1 Examining and applying principles of sentence construction
- 1.2 Examining and applying principles of paragraph construction

2.0 Business Correspondence

- 2.1 Examining the value of well-developed business writing skills
- 2.2 Examining principles of effective business writing
- 2.3 Examining business letters and memos

3.0 Informal Report

3.1 Examining the fundamentals of informal business reports

3.2 Applying informal report writing skills

LEARNING OBJECTIVES:

1.0 Review of Sentences and Paragraph Construction

- 1.1.1 Define a sentence and review the four types.

1.1.2 Identify the essential parts of a sentence, particularly subject and predicate, direct and indirect object.
1.1.3 Differentiate among phrases, clauses, and sentences.
1.1.4 Explore the major concepts related to subject-verb agreement.
1.1.5 Apply rules and principles for writing clear, concise, complete sentences which adhere to the conventions of grammar, punctuation, and mechanics.

1.2 Examine and Apply Principles of paragraph Construction

1.2.1 Discuss the basic purposes for writing.
1.2.2 Define a paragraph and describe the major characteristics of an effective paragraph.
1.2.3 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.

2.0 Business Correspondence

2.1 Examine the Value of Business Writing Skills

2.1.1 Discuss the importance of effective writing skills in business
2.1.2 Discuss the value of well-developed writing skills to career success

2.2 Examine Principles of Effective Business Writing

2.2.1 Discuss the rationale and techniques for fostering goodwill in business communication, regardless of the circumstances
2.2.2 Review the importance of revising and proofreading writing

2.3 Examine Business Letters and Memos

2.3.1 Differentiate between letter and memo applications in the workplace
2.3.2 Identify the parts of a business letter and memo
2.3.3 Explore the standard formats for business letters and memos
2.3.4 Examine guidelines for writing an acceptable letter and memo which convey: acknowledgment, routine request, routine response, complaint, refusal, and persuasive request, for three of the six types listed
2.3.5 Examine samples of well-written and poorly written letters and memos

3.0 Informal Report

3.1 Examine the Fundamentals of Informal Business Reports

3.1.1 Identify the purpose of the informal report
3.1.2 Identify the parts and formats of an informal report

3.1.3 Identify methods of information gathering

3.2 Apply Informal Report Writing Skills and Oral Reporting Skills

3.2.1 Gather pertinent information
3.2.2 Organize information into an appropriate outline
3.2.3 Draft a five minute informal report
3.2.4 Edit, proofread, and revise the draft to create an effective informal report and present orally using visual aids.

RECOMMENDED EVALUATION:

Required Pass Mark 70%

DEVELOPMENT HISTORY:

Date Developed:

Date Revised: 1999 05 03

Name and Number: Customer Service MR1210

Descriptive Title: Customer Service

Summary 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.

Prerequisites: None

Co-requisites: None

Suggested Duration: 30 hrs

Evaluation: Theory and Practical Applications Require a Pass Mark of 70%.

Course Aims:

1. To know and understand quality customer service

2. To know why quality service is important

3. To know and understand the relationship between “service” and “sales”

4. To understand the importance of and to demonstrate a positive attitude

5. To recognize and demonstrate handling of customer complaints

Course Objectives (Knowledge):

1. Providing Quality Service

- Define quality service
- List the types of quality service
- Define Service vs. Sales or Selling
- Explain why quality service is important
- Identify the various types of customers
- Define customer loyalty

2. Determining Customers Wants and Needs

- List four levels of customer needs
- Identify important customer wants and needs
- Identify ways to ensure repeat business

3. Demonstrating a Positive Attitude

- List the characteristics of a positive attitude
- Explain why it is important to have a positive attitude
- List ways that a positive attitude can improve a customer's satisfaction
- Define perception
- Explain how perception can alter us and customers
- Understand how to deal with perception

4. Effectively Communicating with customers

- Describe the main elements in the communication process
- Identify some barriers to effective communication
- Define body language
- Explain how body language would affect customers
- Determine why body language is important
- Define active listening and state why it is important
- Describe the four components of active living
- Contrast good and bad listeners
- List and discuss the steps of the listening process

5. Effectively using Questioning Techniques

- List questioning techniques
- Write two example of an open question
- Perform a questioning and listening role play

6. Using the Telephone Effectively

- List the qualities of a professional telephone voice
- Explain why telephone skills are important
- Demonstrate effective telephone skills

7. Asserting Oneself: Handling Complaints and Resolving Conflict

- Define assertiveness
- Define communication behaviors
- Relate assertions to effective communication
- Practice being assertive
- Understand the process of assertive guidelines for action
- Practice giving an assertive greeting
- Acknowledge multiple customers

8. Dealing with Difficult Customers

- Describe how you would deal with anger
- Complete a guide to controlling feelings
- Determine how you would feel dealing with an upset customer
- Suggest some techniques that might control your own feelings
- Understand leadership styles and the nature of organizations
- List ways to dealing with conflict / customer criticism
- Be aware of certain guidelines when confronting customers
- List ways of preventing unnecessary conflict with customers
- Review current skills and knowledge of customer service
- Develop a customer satisfaction improvement plan

COURSE NAME & NUMBER: SP2330 - QA / QC

DESCRIPTIVE TITLE: Quality Assurance / Quality Control

DESCRIPTION:

This general studies course requires the use of basic tools and equipment and materials and supplies. It requires controlling drawings and specifications and/or calibrating measuring devices in applicable occupations.It involves 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.

PREREQUISITES: None

CO-REQUISITES: None

SUGGESTED DURATION: 30 Hrs

COURSE AIMS:

1. To develop the skills and knowledge required to apply quality assurance/quality control procedures

2. To develop an awareness of quality management principles and processes

COURSE OBJECTIVES (KNOWLEDGE):

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 engineering drawings 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 quality management.

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.

10. Explain the concepts of quality

    a. cost of quality
    b. measurement of quality
    c. quality control and quality assurance
    d. elements of quality
    e. elements of the quality audit
    f. quality standards
    g. role expectations and responsibilities

11. Explain the structure of quality assurance and quality control

    a. Define quality assurance, quality control and documentation terminology
    b. Describe organizational charts
    c. List the elements of a quality assurance system
    d. Explain the purpose of the quality assurance manual
    e. Describe quality assurance procedures
    f. Explain the key functions and responsibilities of personnel

12. Complete quality assurance/quality control documentation

    a. Describe methods of recording reports in industry
    b. Describe procedures of traceability (manual and computer-based recording)
    c. Identify needs for quality control procedures

MAJOR TASKS / SUBTASKS (SKILLS):

1. Apply quality control to projects

    a. Follow QA/QC procedures for drawings, plans and specifications in applicable occupations.
    b. Calibrate measuring instruments and devices in applicable occupations.
    c. Interpret required standards
    d. Follow QA/QC procedures for accepting raw materials
    e. Carry out the project
    f. Control the quality elements (variables)
    g. Complete QA/QC reports

EVALUATION:

Pass Mark Required 70%

DEVELOPMENT HISTORY:

Date Developed: February 1994
Date Revised: April, 1999

COURSE NAME & NUMBER: MC1050 - Introduction to Computers

DESCRIPTIVE TITLE: Introduction to Computers

CALENDAR ENTRY:

Type and Purpose: 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.

Major Topics: Microcomputer System Hardware and Software Components; Word Processing; Electronic Spreadsheets; Electronic Mail and the Internet.

PRE-REQUISITES: Nil

CO-REQUISITES: Nil

SUGGESTED DURATION: 30 hours

SUGGESTED TEXT/

LEARNING RESOURCES:

Textbook(s):

References:

Other Resources:

COURSE AIMS:

1. To provide students with a introduction to computer systems and their operation.

2. To introduce students to popular software packages, their applications and future trends in computer applications.

MAJOR TOPICS:

1. Microcomputer System Hardware and Software Components
2. Word Processing
3. Spreadsheet
4. E-Mail and the Internet

COURSE OUTLINE:

1.0 Microcomputer System Hardware and Software Components

- 1.1 Microcomputer Hardware
  - 1.1.1 System Components
  - 1.1.2 Function of each Component
- 1.2 Microcomputer Software
  - 1.2.1 Software Definition and Types
  - 1.2.2 System Software (Windows 95)
  - 1.2.3 File Management Commands (Windows 95)

2. Word Processing

- 2.1 Keyboarding Techniques
- 2.2 Word Processing
  - 2.2.1 Understanding Word Processing
  - 2.2.2 Create a Document
  - 2.2.3 Save, Open and Edit a Document
  - 2.2.4 Edit a Document: Cut and Paste
  - 2.2.5 Understand Hidden codes.
  - 2.2.6 The Select Feature (Block)
  - 2.2.7 Change Layout Format
  - 2.2.8 Change Text Attributes
  - 2.2.9 Use Auxiliary Tools
  - 2.2.10 Select the Print Feature (number of copies and current document)

3. Electronic Spreadsheet

- 3.1 Spreadsheet Basics
- 3.2 Operate Menus
- 3.3 Create a Worksheet
- 3.4 Use Ranges
- 3.5 Print a Worksheet
- 3.6 Edit a worksheet

4. Electronic Mail and the Internet

- 4.1 Electronic Mail
- 4.2 The Internet

LEARNING OBJECTIVES:

1. Microcomputer System Hardware and Software Components

1.1 Microcomputer Hardware

1.1.1 System Components

1.1.1.1 Identify major components of a computer system.

1.1.2 Function of each Component

1.1.2.1 Describe the function of the microprocessor.
1.1.2.2 Describe and give examples of I/O DEVICES.
1.1.2.3 Describe primary storage (RAM, ROM, Cache).
1.1.2.4 Define bit, byte, code and the prefixes k.m. and g.
1.1.2.5 Describe secondary storage (diskettes and hard disks, CD ROMS, Zip Drives etc).
1.1.2.6 Describe how to care for a computer and its accessories.

1.2 Microcomputer Software

1.2.1 Software Definition and Types

1.2.1.1 Define software.
1.2.1.2 Describe, operational and application software used in this course.
1.2.1.3 Define file and give the rules for filenames and file extensions..

1.2.2 System Software (Windows 95)

1.2.2.1 Getting Started with Windows
1.2.2.2 Start and quit a Program
1.2.2.3 Get Help
1.2.2.4 Locate a specific file using the **find** function of Win95
1.2.2.5 Changing system settings: wall paper, screensaver, screen resolution, background.
1.2.2.6 Starting a program by using the Run Command
1.2.2.7 Shutting down your computer

1.2.3 File Management Commands (Windows 95)

1.2.3.1 View directory structure and folder content
1.2.3.2 Organizing files and folders
1.2.3.3 Copy, delete, and move files and folders

1.2.3.4 Create folders
1.2.3.5 Maximize and minimize a window
1.2.3.6 Print directory/folder content
1.2.3.7 Describe the Windows 95 taskbar

2. Word Processing

2.1 Keyboarding Techniques

2.1.1 Identify and locate alphabetic and numeric keys
2.1.2 Identify and locate function keys: special keys, home keys, page up key, page down key, numeric key pad, shift keys, punctuation keys, tab key

2.2 Word Processing

2.2.1 Understanding word processing

2.2.1.1 The Windows Component
2.2.1.2 The Menu Bar
2.2.1.3 Menu Indicators
2.2.1.4 The Document Window
2.2.1.5 The Status Bar
2.2.1.6 The Help Feature
2.2.1.7 Insertion Point Movements

2.2.2 Create a document

2.2.2.1 Change the Display
2.2.2.2 The Enter Key
2.2.2.3 Enter Text

2.2.3 Save, Open and Exit a document.

2.2.3.1 Save a document
2.2.3.2 Close a document.
2.2.3.3 Start a new document Window
2.2.3.4 Open a document
2.2.3.5 Exit Word Processor

2.2.4 Edit a Document

2.2.4.1 Add New Text
2.2.4.2 Delete text
2.2.4.3 Basic Format Enhancement (split and join paragraphs, insert text)

2.2.5 Understand Hidden Codes

2.2.5.1 Display Hidden Codes
2.2.5.2 Delete Text Enhancements

2.2.6 The Select Feature

2.2.6.1 Identify a Selection
2.2.6.2 Move a Selection
2.2.6.3 Copy a Selection
2.2.6.4 Delete a Selection
2.2.6.5 Select Enhancements
2.2.6.6 Save a Selection
2.2.6.7 Retrieve a Selection

2.2.7 Change Layout Format

2.2.7.1 Change layout format: (margins, spacing, alignment, paragraph indent, tabs, line spacing, page numbering)

2.2.8 Change Text Attributes

2.2.8.1 Change text attributes: (bold, underline, font, etc.)

2.2.9 Use Auxiliary Tools

2.2.9.1 Spell Check

2.2.10 Select the Print Feature

2.2.10.1 Select the Print Feature: (i.e; number of copies and current document)
2.2.10.2 Identify various options in print screen dialogue box

3. Electronic Spreadsheet

3.1 Spreadsheet Basics

3.1.1 The Worksheet Window

3.2 Operates Menus

3.2.1 Use a Menu Bar
3.2.2 Use a Control Menu
3.2.3 Use a Shortcut Menu

3.2.4 Save, Retrieve form Menus

3.3 Create a Worksheet

3.3.1 Enter Constant Values and Formulas
3.3.2 Use the Recalculation Feature
3.3.3 Use Cell References (relative and absolute references)

3.4 Use Ranges

3.4.1 Type a Range for a Function
3.4.2 Point to a Range for a Function
3.4.3 Select a Range for Toolbar and Menu Commands

3.5 Print a Worksheet

3.5.1 Print to the Screen
3.5.2 Print to the Printer
3.5.3 Print a Selected Range

3.6 Edit a Worksheet

3.6.1 Replace Cell Contents
3.6.2 Insert and Delete Rows and Columns
3.6.3 Change Cell Formats
3.6.4 Change Cell Alignments
3.6.5 Change Column Width
3.6.6 Copy and Move Cells

4. Electronic Mail and the Internet

4.1 Electronic Mail

4.1.1 Compose and send an e-mail message
4.1.2 Retrieve an e-mail attachments
4.1.3 Send an e-mail message with attachments
4.1.4 Retrieve and save e-mail attachments
4.1.3 Print an e-mail message
4.1.4 Delete an e-mail message

4.2 The Internet

4.2.1 Overview of the World Wide Web
4.2.2 Accessing Web sites
4.2.3 Internet Web Browsers
4.2.4 Internet Search Engines

4.2.5 Searching Techniques

STUDENT EVALUATION:

Required Pass Mark 70%

DEVELOPMENT HISTORY:

Date Designed	**1998**
Date Revised	**1999**

COURSE NAME & NUMBER: SD1700 - Workplace Skills

DESCRIPTIVE TITLE: Workplace Skills

DESCRIPTION:

This course involves participating in meetings, doing safety inspections, completing employment insurance forms, writing letters of employment insurance appeal, and filing a human rights complaint. Includes information on formal meetings, unions, worker's compensation, employment insurance regulations, worker's rights and human rights.

PREREQUISITES: None

CO-REQUISITES: None

SUGGESTED DURATION: 30 Hrs

COURSE AIMS:

1. Participate in meetings (conduct meetings).

2. Be aware of union procedures.

3. Be aware of workers' compensation regulations.

4. Be aware of occupational health and safety regulations.

5. Be aware of employment insurance regulations

6. Be aware of workers' rights.

7. Be aware of human rights

COURSE OBJECTIVES (KNOWLEDGE):

1. Meetings
    a. Explain preparation requirements prior to conducting a meeting
    b. Explain the procedures for conducting a meeting.
    c. Explain participation in meetings.
    d. Explain the purpose of motions.
    h. Explain the procedure to delay discussion of motions.
    i. Explain how to amend and vote upon a motion.

2. Unions
    a. Why do unions exist?
    b. Give a concise description of the history of Canadian labour.
    c. How do unions work?
    d. Explain labour's structure.
    e. Describe labour's social objectives.
    f. Describe the relationship between Canadian labour and the workers.
    g. Describe the involvement of women in unions.

3. Worker's Compensation
    a. Describe the aims, objectives, benefits and regulations of the Workers Compensation Board.
    b. Explain the internal review process.

4. Occupational Health and Safety
    a. Describe the rules and regulations directly related to your occupation.

5. Employment Insurance Regulations
    a. Explain employment insurance regulations
    b. Describe how to apply for employment insurance.
    c. Explain the appeal process.

6. Worker's Rights
    a. Define labour standards.
    b. Explain the purpose of the Labour Standards Act.
    c. List regulations pertaining to:
        i. Hours of work.
        ii. Minimum wage.
        iii. Employment of children.
        iv. Vacation pay

7. Human Rights
    a. Describe what information cannot be included on an application.
    b. Describe what information cannot be included in an interview
    c. Why is there a Human Rights Code?
    d. Define sexual harassment.

MAJOR TASKS / SUBTASKS (SKILLS):

1. Participate in meetings.
    a. Follow the form of getting a motion on the floor
    b. Discuss a motion
    c. Amend a motion
    d. Vote on a motion.

2. Complete a safety inspection of your shop.

3. Complete an employment insurance application form.

4. Write a letter of appeal.

5. Analyze a documented case of a human rights complaint with special emphasis on the application form, time-frame, documentation needed, and legal advice available.

EVALUATION:

Required Pass Mark 70%

DEVELOPMENT HISTORY:

Date Developed:
Date Revised: April, 1999

Name and Number: Job Search Techniques SD 1710

Descriptive Title: Job Search Techniques

Prerequisites: None

Co-requisites: None

Suggested Duration: 15 hrs.

Evaluation: Theory and Practical Applications Require a Pass Mark of 70%.

Course Objectives (Knowledge):

1. Examine and Demonstrate Elements of Effective Job Search Techniques

- Identify and examine employment trends and opportunities
- Identify sources that can lead to employment
- Discuss the importance of fitting qualifications to job requirements
- Discuss and demonstrate consideration in completing job application forms
- Establish the aim/purpose of a resume
- Explore characteristics of effective resumes, types of resumes, and principles of resume format
- Explore characteristics of and write an effective cover letter
- Explore, and participate in a role play of a typical job interview with commonly asked questions and demonstrate proper conduct
- Explore other employment related correspondence
- Explore the job market to identify employability skills expected by employer
- Conduct a self-analysis and compare with general employer expectations

DEVELOPMENT HISTORY:

Date Developed:

Date Revised: 1999 05 03

Name and Number: Entrepreneurial Awareness SD 1720

Descriptive Title: Entrepreneurial Awareness

Prerequisites: None

Co-requisites: None

Suggested Duration: 15 hrs

Evaluation: Theory and Practical Applications Require a Pass Mark of 70%.

Course Objectives (Knowledge):

1. Explore Self-Employment: An Alternative to Employment

- Identify the advantages and disadvantages of self-employment vs. regular employment
- Differentiate between an entrepreneur and a small business owner
- Evaluate present ideas about being in business

2. Explore the Characteristic of Entrepreneurs

- Identify characteristics common to entrepreneurs
- Relate their own personal characteristics with those of entrepreneurs.
- Evaluate their present ideas about business people

3. Identifying Business Opportunities

- Distinguish between an opportunity and an idea.
- List existing traditional and innovative business ventures in the region.
- Explain the general parameters between which business ventures should fit.
- Summarize the role of such agencies Regional Economic Development Boards, Business Development Corporations, etc.
- Identify potential business opportunities within the region.

4. Demystifying the Entrepreneurial Process.

- Explain the entrepreneurial process
- Describe the purpose of a business plan
- Identify the main ingredients of a business plan
- Summarize the role of such agencies as BDC's, ACOA, Women's Enterprise Bureau etc.
- List other agencies where assistance - financial and otherwise - is available to those interested in starting a business venture.

REQUIRED WORK EXPERIENCE

National Red Seal Certification requires that all Apprentices obtain appropriate industry base work experiences. The required work experiences identified in this section are written in the broadest terms so as to ensure the apprentices receive experiences in each of the required areas and to ensure that employers have a degree of flexibility in applying the terms and conditions implicit in a Contract of Apprenticeship. What is important is that both the apprentice and the employer understand the obligations laid out in this plan of training which is designed to ensure that at the completion of both the technical training and the required hours of work experience the apprentice has both the knowledge and the skills necessary to successfully complete the Red Seal Examination.

REQUIRED WORK EXPERIENCES:

Read basic drawings and diagrams, sketch drawings, interpret specifications, and operate computer assisted drafting software.

Install, terminate, test, and maintain miscellaneous cables and wiring.

Install, maintain, and troubleshoot residential lighting and heating circuits.

Set up oxy-fuel welding equipment; prepare, cut, and weld metal; shut down, disassemble, and store equipment.

Install, test, and maintain rigging; tie knots and splice rope.

Install, connect, and troubleshoot single phase transformers.

Install and maintain residential heating and control circuits.

Prepare, install, and maintain single family service entrance and tubular raceway.

Install, maintain, and ground industrial raceway.

Install, connect, and troubleshoot three phase systems.

Install, parallel, synchronize, and maintain AC generators.

Select, locate, install, maintain, and troubleshoot industrial heating and lighting circuits.

Install and maintain commercial and industrial service entrances.

Install, connect, maintain, troubleshoot, dismantle, clean, reassemble, and repair AC motors.

Install, terminate, and splice high voltage cables.

Install, troubleshoot, and maintain DC motors, generators, and control circuits.

Install, operate, and maintain control circuits and devices.

Install, maintain, and troubleshoot fire alarm systems, and standby units.

Install, maintain, and troubleshoot communication systems, clock systems, and burglar alarm systems.

Plan control circuits and prepare schematic and wiring diagrams.

Install, maintain, and program programmable logic controllers; run and troubleshoot programs.

Plan, build, test, and troubleshoot rectifier circuits and power supplies.

Plan, build, test, and troubleshoot transistor circuits.

Build a logic probe and use it to test binary logic gates.

Design, build, test, and troubleshoot operational amplifiers and active filters.

Select, install, calibrate, maintain, and repair instrumentation devices including temperature sensors, pressure and vacuum sensors, flow measuring devices, level and density measuring devices, and physical measuring devices.