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# Plan of Training

## INSTRUMENTATION & CONTROL TECHNICIAN



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

September 2009

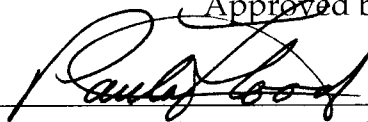
**PLAN OF TRAINING**  
**INSTRUMENTATION AND CONTROL**  
**TECHNICIAN**

SEPTEMBER 2009



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

Approved by:



Chairperson, Provincial Apprenticeship and Certification Board

Date:

Sept 23/09

# **PLAN OF TRAINING**

## **Instrumentation and Control Technician**



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**September 2009**

The Joint Planning Committee (JPC) recognizes this Interprovincial Program Guide as the national curriculum for the occupation of Instrumentation and Control Technician.

## Preface

This Apprenticeship Standard is based on the 2000 edition of the National Occupational Analysis for the Instrumentation and Control Technician trade.

This document describes the curriculum content for the Instrumentation and Control Technician apprenticeship training program and outlines each of the technical training units necessary for the completion of apprenticeship.

## Acknowledgements

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

We offer you a sincere thank you.

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## **A. Conditions Governing Apprenticeship Training**

### **1.0 General**

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

### **2.0 Entrance Requirements**

2.1 Entry into the occupation as an apprentice requires:

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

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

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

2.4 An Application for Apprenticeship form must be duly completed.

### 3.0 Probationary Period

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

### 4.0 Termination of a Memorandum of Understanding

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

### 5.0 Apprenticeship Progression Schedule and Wage Rates

#### 5.1 Progression Schedule

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



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

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

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

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

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

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

## 6.0 Tools

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

## 7.0 Periodic Examinations and Evaluation

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

7.3 For each and every course, a formal assessment is required for which 70% is the pass mark. At the discretion of the instructor, the summative mark may be for completion of a theory examination or a combination of the theory examination and an assigned practical project.

## **8.0 Granting of Certificates of Apprenticeship**

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

## **9.0 Hours of Work**

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

## **10.0 Copies of the Registration for Apprenticeship**

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

## **11.0 Ratio of Apprentices to Journeypersons**

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

## **12.0 Relationship to a Collective Bargaining Agreement**

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

### **13.0 Amendments to a Plan of Apprenticeship Training**

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

### **14.0 Employment, Re-Employment and Training Requirements**

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

## **15.0 Appeals to Decisions Based on Conditions Governing Apprenticeship Training**

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

## **B. Requirements for Red Seal Certification**

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

### **OR**

A total of 9000 hours of suitable work experience in the occupation accompanied by sign-off of required work competencies.

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

## **C. Roles and Responsibilities of Stakeholders in the Apprenticeship Process**

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

### **The Apprentice:**

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

### **The Employer:**

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

- ensures work experiences of the apprentice are documented.

### **The Training Institution:**

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

### **The Institutional and Industrial Education Division:**

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



### **The Provincial Apprenticeship and Certification Board:**

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

## D. Program Outcomes

Upon completion of the Instrumentation and Control Technician Apprenticeship Program, apprentices will have the knowledge and skills required to perform the following tasks:

- Task 1        Demonstrates safe work practices and personal protection.
- Task 2        Utilizes drawings, codes, standards and government regulations.
- Task 3        Utilizes tools and measuring equipment.
- Task 4        Demonstrates common work practices and procedures.
- Task 5        Maximizes operating efficiency of process control system.
- Task 6        Facilitates new installations.
- Task 7        Maintains field mounted pressure equipment.
- Task 8        Maintains field mounted flow equipment.
- Task 9        Maintains field mounted level equipment.
- Task 10       Maintains field mounted temperature devices.
- Task 11       Maintains analyzers.
- Task 12       Maintains speed measuring devices.
- Task 13       Maintains weight and density measuring devices.
- Task 14       Maintains vibration measurement devices.
- Task 15       Maintains consistency measuring devices.
- Task 16       Maintains final control elements.
- Task 17       Maintains calibration, reference, comparison standards and test equipment.
- Task 18       Maintains signal transmission systems.
- Task 19       Maintains transducers (signal conditioners) current/pressure, pressure/current, current/voltage, voltage/current, current/current, current/digital, frequency/voltage).
- Task 20       Maintains operator interface (panel mounted) equipment.
- Task 21       Maintains hydraulic systems.
- Task 22       Maintains pneumatic systems.
- Task 23       Maintains distributed control systems (DCS).
- Task 24       Maintains programmable logic controllers (PLC).

## E. Program Structure

For each and every course, a formal assessment is required for which 70% is the pass mark. At the discretion of the instructor, the summative mark may be for completion of a theory examination or a combination of the theory examination and an assigned practical project.

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

Entry Level Courses – Block 1			
NL Course No.	Course Name	Hours	Pre-requisites
TS1510	Occupational Health and Safety	6	-
TS1520	WHMIS	6	-
TS1530	Standard First Aid	14	-
ER1110	Hand Tools	15	-
ER1120	Power Tools	30	ER1110
ER1130	Fasteners & Adhesives	15	ER1120
ER1140	Direct Current (DC) Theory	30	-
ER1150	Series and Parallel Circuits	45	ER1140
ER1160	Codes	30	-
ER1170	Voltage Drop & Power Loss	30	ER1150; ER1160
ER1180	Single-Phase Theory	60	ER1170
ER1190	Three-Phase Theory	30	ER1180
ER1200	Blueprint (Generic)	30	ER1160
ER1225	Conduit, Tubing & Fittings	15	ER1130; ER1160
ER1710	Signal Transmission	30	ER2156
ER1732	Electronics	135	ER1190
ER1760	Motors	45	ER1190

<b>Entry Level Courses – Block 1</b>			
<b>NL Course No.</b>	<b>Course Name</b>	<b>Hours</b>	<b>Pre-requisites</b>
ER2156	Process Measurement	300	ER1150
ER2215	Pneumatic Systems (Instrument Air Supply)	30	-
AP1100	Introduction to Apprenticeship	15	-
CM2150	Workplace Communications	45	-
MR1220	Customer Service	30	-
SP2330	Quality Assurance/Quality Control	30	-
MC1050	Introduction to Computers	30	-
SD1700	Workplace Skills	30	-
SD1710	Job Search Techniques	15	-
SD1720	Entrepreneurial Awareness	15	-
<b>Total Hours</b>		<b>1106</b>	

**Required Work Experience**

<b>Block 2</b>			
<b>NL Course No.</b>	<b>Course Name</b>	<b>Hours</b>	<b>Pre-requisites</b>
ER1740	On-Off Control	60	ER1760
ER2196	Process Control	135	ER2156
<b>Total Hours</b>		<b>195</b>	

**Required Work Experience**

<b>Block 3</b>			
<b>NL Course No.</b>	<b>Course Name</b>	<b>Hours</b>	<b>Pre-requisites</b>
ER2160	Solid State Drives	30	ER1732
ER2170	PLC Fundamentals	15	ER1732, ER1740
ER2180	Programming PLC's	30	ER2170
ER2226	Control Valves	60	ER2156
ER2235	Hydraulic Systems	30	-
ER2325	Boiler Control	30	ER2196
<b>Total Hours</b>		<b>195</b>	

<b>Required Work Experience</b>
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<b>Block 4</b>			
<b>NL Course No.</b>	<b>Course Name</b>	<b>Hours</b>	<b>Pre-requisites</b>
ER1770	Process Analysers	60	ER2156
ER1780	DCS Process Applications	45	ER1770
ER1790	PLC Process Applications	45	ER2180
ER2116	Troubleshooting Techniques	6	-
ER2200	Distributed Control Systems	30	ER2180
ER2380	Vibration	15	-
<b>Total Hours</b>		<b>201</b>	

<b>Total Course Credit Hours</b>	<b>1697</b>
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## Entry Level – Block 1

### **TS1510 Occupational Health and Safety**

#### **Description:**

This course is designed to give participants the knowledge and skills necessary to interpret the Occupational Health and Safety Act, laws and regulations; understand the designated responsibilities within the laws and regulations; the right to refuse dangerous work; and the importance of reporting accidents.

**Pre-Requisites:** None

#### **Course Outcomes:**

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

- prevent accidents and illnesses
- improve health and safety conditions in the workplace

#### **Theory:**

1. Interpret the Occupational Health and Safety Act laws and regulations.
  - i. explain the 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
2. Explain responsibilities under the Act & Regulations.
  - i. duties of employer, owner, contractors, sub-contractors, employees, and suppliers
3. Explain the purpose of joint health and safety committees.
  - i. formation of committee
  - ii. functions of committee

- iii. legislated rights
  - iv. health and safety representation
  - v. reporting endangerment to health
  - vi. appropriate remedial action
  - vii. investigation of endangerment
  - viii. committee recommendation
  - ix. employer's responsibility in taking remedial action
4. Examine right to refuse dangerous work.
- i. reasonable grounds for refusal
  - ii. reporting endangerment to health
  - iii. appropriate remedial action
  - iv. investigation of endangerment
  - v. committee recommendation
  - vi. employer's responsibility to take appropriate remedial action
  - vii. action taken when employee does not have reasonable grounds for refusing dangerous work
  - viii. employee's rights
  - ix. assigning another employee to perform duties
  - x. temporary reassignment of employee to perform other duties
  - xi. collective agreement influences
  - xii. wages and benefits
5. State examples of work situations where one might refuse work.
6. Describe discriminatory action.
- i. definition
  - ii. filing a complaint procedure
  - iii. allocated period of time a complaint can be filed with the Commission
  - iv. duties of an arbitrator under the Labour Relations Act
  - v. order in writing inclusion
  - vi. report to commission Allocated period of time to request Arbitrator to deal with the matter of the request
  - vii. notice of application
  - viii. failure to comply with the terms of an order
  - ix. order filed in the court
7. Explain duties of commission officers.
- i. powers and duties of officers
  - ii. procedure for examinations and inspections

- iii. orders given by officers orally or in writing
  - iv. specifications of an order given by an officer to owner of the place of employment, employer, contractor, sub-contractor, employee, or supplier
  - v. service of an order
  - vi. prohibition of persons towards an officer in the exercise of his/her power or duties
  - vii. rescinding of an order
  - viii. posting a copy of the order
  - ix. illegal removal of an order
8. Interpret appeals of others.
- i. allocated period of time for appeal of an order
  - ii. person who may appeal order
  - iii. action taken by Commission when person involved does not comply with the order
  - iv. enforcement of the order
  - v. notice of application
  - vi. rules of court
9. Explain the process for reporting of accidents.
- i. application of act
  - ii. report procedure
  - iii. reporting notification of injury
  - iv. reporting accidental explosion or exposure
  - v. posting of act and regulations

**Practical:**

1. Conduct an interview with someone in your occupation on two or more aspects of the act and report results.
2. Conduct a safety inspection of shop area.



## **TS1520 Workplace Hazardous Materials Information System (WHMIS)**

### **Description:**

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

**Pre-Requisites:** None

### **Course Outcomes:**

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

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

### **Required Knowledge and Skills:**

1. Define WHMIS safety.
  - i. rational and key elements
  - ii. history and development of WHMIS
  - iii. WHMIS legislation
  - iv. WHMIS implementation
  - v. Definitions of legal and technical terms
  
2. Examine hazard identification and ingredient disclosure.
  - i. prohibited, restricted and controlled products
  - ii. classification and the application of WHMIS information requirements
  - iii. responsibilities for classification
    - the supplier
    - the employer
    - the worker-classification: rules and criteria
    - information on classification
    - classes, divisions and subdivisions in WHMIS
    - general rules for classification
    - class A – compresses gases

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

- employer responsibility
- workers responsibility

**Practical:**

Practical skills enhance the apprentices' ability to meet the objectives of this course. The learning objectives outlined below are mandatory in Newfoundland and Labrador, but are provided as suggestions for Nova Scotia, Prince Edward Island and New Brunswick.

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

**SUGGESTED RESOURCES:**

1. WHMIS Regulation.
2. Sample MSDS sheets.

## **TS1530 Standard First Aid**

### **Description:**

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

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

**Pre-Requisites:** None

## **ER1110 Hand Tools**

### **Outcomes:**

Upon successful completion of this unit, the apprentice will be able to select, use and care for basic hand tools.

**Pre-Requisites:** None

### **Objectives and Content:**

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

### **Practical Projects:**

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

Practical Projects include:

1. Identify, use and maintain screwdrivers.
2. Identify, use and maintain hammers.

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

## **ER1120 Power Tools**

### **Outcomes:**

Upon successful completion of this unit, the apprentice will be able to select, use and service power tools.

**Pre-Requisites:** ER1110

### **Objectives and Content:**

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

### **Practical Projects:**

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

Practical Projects include:

1. Select and use a portable drill and bits for a specific task.
2. Use rotary hammer.
3. Operate a drill press.

4. Determine safe working speeds of wheels on portable and pedestal grinders.
5. Select wheels and discs for portable and pedestal grinders.
6. Operate portable and pedestal grinders.
7. Sharpen bits.
8. Operate circular, saber and reciprocating saws.



## **ER1130 Fasteners and Adhesives**

### **Outcomes:**

Upon the successful completion of this unit, the apprentice will be able to select and install fasteners.

**Pre-Requisites:** ER1120

### **Objectives and Content:**

1. Identify types of nails and describe their applications and procedures for use.
2. Identify types of screws and bolts and describe their applications and procedures for use.
  - i. wood screws
  - ii. sheet metal screws
  - iii. machine screws and bolts
  - iv. nuts and washers
3. Identify types of anchors and shields and describe their applications and procedures for use.
  - i. masonry anchors
  - ii. cavity fasteners
  - iii. screw anchors
    - fiber
    - metal
    - lead
    - plastic
    - E-Z anchor
  - iv. miscellaneous fasteners
    - concrete screws
    - hollow rivets
    - spring-steel fasteners
    - chemical fasteners
  - v. joining dissimilar metals (electrolysis)
4. Explain the operation of explosive actuated tools.

**Practical Projects:**

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

Practical Projects include:

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

## ER1140 Direct Current (DC) Theory

### Outcomes:

Upon the successful completion of this unit the apprentice will be able to demonstrate knowledge of direct current circuit theory and the selection and use of measuring instruments.

**Pre-Requisites:** None

### Objectives and Content:

1. Describe the atomic structure of matter.
  - i. electron theory
    - matter
    - atoms
    - electric charge
    - protons, electrons, neutron
  - ii. static electricity and electrostatics
    - positive and negative charge
    - electrostatic field
    - transferring static electricity
      - conduction
      - induction
    - discharging static charges
  - iii. electrons in motion
    - causes of current
    - conductors, insulators
    - electron current flow
    - conventional current flow
  
2. Identify electrical units and symbols
  - i. absolute electrical units
    - current
    - voltage
    - resistance
  - ii. prefixes for absolute units

3. Identify different forms of energy and describe the effects of dynamic electricity.
  - i. different forms of energy to produce electricity
    - chemical action
    - piezoelectric effect
    - magnetism
    - heat
    - light and solar energy
    - friction
  - ii. effects of dynamic electricity
    - heating effects
    - chemical effects
    - magnetic effects
    - psychological and physiological effects
4. Describe the procedures used to analyze the components necessary for the assembly of an electric circuit.
  - i. the electron path (conductors)
  - ii. the load
  - iii. the source
  - iv. the control
  - v. closed circuit
  - vi. open circuit
  - vii. short circuit
5. Identify and describe the three basic electrical properties.
  - i. voltage
  - ii. current
  - iii. resistance
6. Describe the relationship among the three basic electrical properties.
  - i. Ohm's Law
7. Describe the relationship between work done and electricity.
  - i. work
  - ii. power
  - iii. electrical work
  - iv. joules and coulombs
  - v. electrical power (watt)
  - vi. combination of the Power formulas and Ohm's Law

- vii. watts and horsepower
  - viii. electrical energy
  - ix. energy and BTU
  - x. kilowatt hours
  - xi. meter reading and cost
8. Identify measuring instruments and describe their applications and procedures for use.
9. ammeter
- i. voltmeter
  - ii. ohmmeter
  - iii. multimeter
  - iv. circuit tester
  - v. continuity tester

**Practical Projects:**

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

Practical Projects include:

1. Compute values of electrical energy and power.
2. Use electrical measuring instruments.

## ER1150 Series and Parallel Circuits

### Outcomes:

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

**Pre-Requisites:** ER1140

### Objectives and Content:

1. Describe the characteristics of a series circuit.
  - i. resistance
  - ii. current
  - iii. voltage
  - iv. power
  - v. open resistor
  - vi. shorted resistor
  - vii. troubleshooting
2. Calculate series circuit values.
3. Describe the characteristics of a parallel circuit.
  - i. resistance
  - ii. current
  - iii. voltage
  - iv. power
  - v. open resistor
  - vi. shorted resistor
  - vii. troubleshooting
4. Calculate parallel circuit values.
5. Explain Kirchhoff's Laws.
  - i. current law
  - ii. voltage law

6. Describe the characteristics of a combination circuit.
7. Calculate combination circuit values.

**Practical Projects:**

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

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

## ER1160 Codes

### Outcomes:

Upon the successful completion of this unit the apprentice will be able to use the Canadian Electrical Code and the National Building Code to find various rules and regulations required to work safely.

**Pre-Requisites:** None

### Objectives and Content:

#### Canadian Electrical Code

1. Explain the structure of the Canadian Electrical Code.
  - i. general information
    - importance of interpretation of the CEC
    - introduction to the CEC
  - ii. profile
    - contents of the CEC
    - general rules (sections)
    - supplementary and amendatory sections
    - tables
    - diagrams
    - appendices
    - contents and index
    - definitions (Section 0)
    - division, subdivision, etc.
    - numbering system and symbol use
2. Describe the procedures used to locate information contained in the CEC.
  - i. initiation to general aspects
  - ii. application
    - main key word
    - using key words in the index
    - using main contents



3. Describe the procedures used to locate, select and gather information from the CEC handbook.
  - i. purpose of the handbook
  - ii. rationale for rules
  - iii. intent for rules
  - iv. using diagrams and figures

National Building Code

4. Describe the structure of the National Building Code (NBC).
  - i. background and purpose of the code
  - ii. preface
  - iii. table of contents
  - iv. numbering system
  - v. index
  - vi. appendix
  - vii. tables
5. Describe the procedures used to locate, select and gather information from the NBC.
  - i. scope and definitions
  - ii. general requirements
  - iii. use and occupancy

**Practical Projects:**

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

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

## ER1170 Voltage Drop and Power Loss

### Outcomes:

Upon the successful completion of this unit the apprentice will be able to calculate voltage drop and power loss.

**Pre-Requisites:** ER1150; ER1160

### Objectives and Content:

1. Describe the characteristics of:
  - i. conductors
    - wire type
    - cable
    - flexible cord
    - size
      - mils, circular mils, square mils
      - area
      - AWG size
  - ii. insulators/insulation
    - terminology
2. Describe the effects of resistance of wires in circuits.
  - i. conductor resistance
    - resistivity(ohms/mil-foot)
    - cross-sectional area(circular mil, millimeter squared)
    - length
    - temperature coefficient of resistance
  - ii. line voltage drop
    - factor affecting voltage drop
    - calculations
    - CEC requirements
    - voltage drop percentage
    - effects of voltage drop
  - iii. power loss
    - calculations
    - effects of power loss

3. Describe the operation of a three-wire system.
  - i. purpose of a three-wire system
  - ii. neutral wire
  - iii. solving a three-wire system

**Practical Projects:**

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

Practical Projects include:

1. Apply Kirchoff's current and voltage laws.
2. Calculate the absolute values in three-wire circuits.
3. Use CEC tables to calculate voltage drop.

## ER1180 Single Phase Theory

### Outcomes:

Upon the successful completion of this unit the apprentice will demonstrate knowledge of the basic concepts of alternating current (AC) and perform calculations.

**Pre-Requisites:** ER1170

### Objectives and Content:

1. Describe the principles of magnetism and the action of magnets.
  - i. magnetic and nonmagnetic substances categories
    - magnetic and nonmagnetic substances
    - ferromagnetic, diamagnetic, and paramagnetic
    - poles of a magnet and the earth
    - magnetic laws
  - ii. the theory of magnetism
    - magnetized and unmagnetized
    - magnetic field
    - magnetic lines
    - magnetism properties
    - flux density (weber's theory)
    - forces between magnetic poles
    - induced magnetism
    - permeability
    - reluctance
    - shielding
    - permanent and temporary magnet
    - retentivity
    - residual magnetism
    - demagnetizing
2. Describe the principles of electromagnetism.
  - i. the theory of electromagnetism
    - characteristics of an electromagnetic field
    - magnetic field around a current-carrying conductor
  - ii. direction of current flow and magnetic flux

- direction of current and flux
  - dot-cross method
  - left-hand conductor rule
  - electromagnetic coil
  - left-hand coil rule
  - iii. the electromagnet
    - characteristic of electromagnets (core, turns, strength)
    - magnetic saturation
    - core losses (hysteresis, eddy current,  $I^2R$ )
    - uses of electromagnets
3. Describe the principles and characteristics of electromagnetic induction.
- i. principles of electromagnetic induction
    - Faraday's Law
    - factors affecting amount of induced voltage
  - ii. self and mutual induction
    - self induction
    - henries
    - CEMF
    - mutual induction
4. Describe the generation of alternating current.
- i. direction of induced voltage
  - ii. left-hand generator rule
  - iii. alternation/revolution
  - iv. cycle
  - v. sine wave/plotting
  - vi. electrical and mechanical degrees
5. Define different values and terms of alternating current.
- i. alternating current values
    - instantaneous values
    - maximum (peak) values
    - peak to peak values
    - effective (rms) values
    - average values
  - ii. terminology of alternating current circuits
    - frequency / hertz
    - period
    - phase (in phase, lagging, leading)

6. Describe the characteristics of RL, RC, and RLC circuits.
  - i. resistance in an AC circuit
  - ii. inductance in an AC circuit
  - iii. capacitance in an AC circuit
  - iv. impedance in an AC circuit
    - series RCL
    - trigonometric functions
    - impedance vector
  - v. AC power and power factor correction in an AC circuit
    - power factor introduction
    - pure resistive circuit
    - pure inductive circuit
    - pure capacitive circuit
    - resistive-reactive circuit
    - apparent power and reactive power
    - power factor correction
  
7. Solve RL, RC, and RLC AC series circuits.
  - i. AC series circuit calculations
    - circuits with resistance and inductive reactance
    - circuits with resistance capacitive reactance
    - circuits with resistance, inductive reactance and capacitive reactance
    - power factor calculation
  
8. Solve RL, RC and RLC AC parallel circuits.
  - i. AC parallel circuit calculations
    - circuits with resistance and inductive reactance
    - circuits with resistance capacitive reactance
    - circuits with resistance, inductive reactance and capacitive reactance
    - power factor calculation

**Practical Projects:**

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

Practical Projects include:

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

## ER1190 Three-Phase Theory

### Outcomes:

Upon the successful completion of this unit the apprentice will be able to perform three-phase voltage, current and power calculations.

**Pre-Requisites:** ER1180

### Objectives and Content:

1. Describe the generation of three-phase voltages.
  - i. characteristics of three-phase
  - ii. voltage generation of three-phase voltages
  - iii. phase sequence
  
2. Describe the voltage and current values in three-phase wye connections.
  - i. voltage relationships in a wye connection
  - ii. current relationships in a wye connection
  - iii. ground connections
  - iv. 3-wire wye connections
  - v. 4-wire wye connections
  - vi. phase loss calculations
  
3. Describe the voltage and current values in three-phase delta connections.
  - i. cautions regarding improper delta connections
  - ii. voltage relationships in a delta connection
  - iii. current relationships in a delta connection
  - iv. open delta connections
  - v. 3-wire delta connections
  - vi. 4-wire delta connections
  - vii. comparing wye and delta systems
  
4. Describe the procedures used to calculate three-phase power, volt-amperes, reactive power and power factor.
  - i. three-phase apparent power
  - ii. three-phase power
  - iii. power factor



- iv. measurements for three-phase power
5. Describe the procedures used to measure three-phase power using wattmeters.
- i. two watt meter method
  - ii. three watt meter method
  - iii. polyphase watt meter

**Practical Projects:**

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

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

## ER1200 Blueprint (Generic)

### Outcomes:

Upon the successful completion of this unit the apprentice will be able to interpret basic blueprints and specifications.

**Pre-Requisites:** ER1160

### Objectives and Content:

1. Identify different projections and drawings and describe their purpose
  - i. general information
    - how blueprints are made
  - ii. orthographic projections
    - multi view
  - iii. pictorial drawings
    - perspective drawings
    - oblique drawings
    - isometric drawings
  
2. Describe the procedures used to determine measurements from scaled drawings.
  - i. alphabet of lines
  - ii. sketching
  - iii. scaling a dimension
    - i. scales
      - ratios
      - imperial/metric scales
      - using a scale
  
3. Describe the procedures used to read plans.
  - i. symbols
  - ii. site plans
    - survey plans
    - subdivision plans
    - landscape plans
    - plot plans
  - iii. floor plans

- iv. foundation plans
4. Identify and describe different types of views and details.
    - i. elevations
    - ii. sections and details
  5. Identify and describe the information shown in schedules and specifications.
    - i. schedules
      - doors
      - windows
      - finishing material
    - ii. specifications
  6. Identify drawings and describe their purpose.
    - i. electrical
    - ii. heating, ventilation and air conditioning (hvac)
    - iii. plumbing
    - iv. shop drawings
    - v. as-built drawings
  7. Describe procedures used to obtain material lists.

**Practical Projects:**

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

1. Gather and interpret information from site plans.
2. Gather and interpret information from elevation/floor plans.
3. Gather and interpret information from floor plans in order to complete an efficient and effective installation.
4. Determine measurements from scaled drawings.
5. Gather and interpret information as per course content.

## ER1225 Conduit, Tubing and Fittings

### Outcomes:

Upon the successful completion of this course, the apprentice will be able to install various types of conduits and fittings.

**Pre-Requisites:** ER1130; ER1160

### Objectives and Content:

1. Describe the various types of conduits and fittings and their applications and procedures for installation.
2. Describe the terms associated with the bending of conduits and tubing.
3. Describe the procedures for cutting, coupling, and termination methods used with rigid conduits.
4. Describe sources of corrosion.
  - i. dissimilar metals
  - ii. electrolysis
  - iii. environmental contaminants

### Practical:

Practical skills enhance the apprentices' ability to meet the objectives of this course. The learning objectives outlined below are **mandatory** in Newfoundland, but are provided as suggestions for Nova Scotia, Prince Edward Island and New Brunswick.

1. Install various types of conduits and fittings.

## ER1710 Signal Transmission

### Outcomes:

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

- install signal wiring.
- install, calibrate and maintain transducers and related equipment.

**Pre-Requisites:** ER2156

### Objectives and Content:

1. Describe types of signal cable.
2. Describe the installation and testing procedures for signal cable.
3. Describe methods of wiring, calibration and maintenance of signal transducers.
  - i. current/pressure
  - ii. pressure/current
  - iii. current/voltage
  - iv. voltage/current
  - v. current/current
  - vi. current/digital
  - vii. frequency/voltage
4. Describe the application and installation of intrinsic safety barriers.
  - i. hazardous location classes
  - ii. intrinsic barrier types
  - iii. wiring requirements
5. Describe the application and installation of surge suppressors.
  - i. gas filled breakdown devices
  - ii. metal-oxide varistors (MOV)
  - iii. R-C networks
  - iv. free wheeling and zener diodes
6. Describe the application and installation of multiplexers.

7. Describe the application and installation of radio telemetry systems.

**Practical:**

Practical skills enhance the apprentices' ability to meet the objectives of this course. The learning objectives outlined below are **mandatory** in Newfoundland, but are provided as suggestions for Nova Scotia, Prince Edward Island and New Brunswick.

1. Install and calibrate various signal transducers and related equipment.

## ER1732 Electronics

### Outcomes:

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

- understand basic problems with power supply and rectifiers.
- troubleshoot basic problems with power circuits.

**Pre-Requisites:** ER1190

### Objectives and Content:

1. Describe the basic fundamental characteristics of semiconductor materials.
  - i. semiconductor atoms
  - ii. covalent bonding
  - iii. n-type semiconductor material
  - iv. p-type semiconductor material
  - v. negative temperature coefficient of resistance
  
2. Describe the characteristics of PN junction diode.
  - i. reverse bias
  - ii. forward bias
  - iii. voltage/current graph
  - iv. diode specifications
  - v. diode polarity
  
3. Describe the operation of single-phase rectifier circuits.
  - i. rectifier wave forms
  - ii. half-wave rectifier
  - iii. full-wave rectifier
  - iv. full-wave bridge rectifier
  - v. ripple frequency
  
4. Describe the procedures used to calculate and measure power, current and voltage values in rectifier circuits.
  - i. average values
  - ii. effective (RMS) values
  - iii. peak inverse voltage

5. Describe filter circuits for single-phase rectifiers.
  - i. capacitor filter
  - ii. choke filter
  - iii. LC filter
  - iv. PI filter
  
6. Describe the operation of the zener diode.
  - i. voltage/current graph
  - ii. DC voltage regulator circuits
  - iii. AC clipping action
  
7. Describe the operation of three-phase rectifiers.
  - i. wye connected half-wave rectifier
  - ii. compute the average dc output of a half-wave, three-phase rectifier
  - iii. three-phase bridge rectifier
  
8. Describe other diode applications.
  - i. free wheeling diodes
  - ii. light-emitting diodes
  - iii. photo diodes
  
9. Describe the features of the bi-polar junction transistor.
  - i. NPN transistor
  - ii. PNP transistor
  - iii. common case styles
  
10. Describe the basic action of the transistor as a switch.
  - i. single-transistor switch
  - ii. two-transistor switch
  
11. Identify special types of bi-polar junction transistors.
  - i. darlington transistor
  - ii. photo transistors
  
12. Describe the features of the silicon controlled rectifier (SCR).
  - i. symbols and leads
  - ii. typical ratings
  - iii. common case styles



13. Describe the action of the SCR in a DC circuit.
  - i. diode analogy
  - ii. triggering action
  - iii. commutation
  
14. Describe the action of the SCR in an AC circuit.
  - i. half-wave rectification
  - ii. phase control
  - iii. conduction angles
  - iv. full-wave rectification
  
15. Describe the characteristics of the bi-directional triode thyristor (triac).
  - i. symbol and leads
  - ii. typical ratings
  
16. Describe the features of the operational amplifier.
  - i. symbol
  - ii. packaging
  - iii. operation as comparator
  
17. Describe the number systems used in digital systems.
  - i. decimal system
  - ii. binary system
  - iii. octal system
  - iv. hexadecimal system
  - v. conversion between systems
  
18. Identify the common binary codes.
  - i. binary coded decimal (BCD)
  - ii. American standard code for information interchange (ASCII)
  - iii. gray code
  
19. Describe the operation of common logic gates.
  - i. and gate
  - ii. or gate
  - iii. not gate
  - iv. nand gate
  - v. nor gate
  - vi. exclusive -or circuit

**Practical:**

Practical skills enhance the apprentices' ability to meet the objectives of this course. The learning objectives outlined below are **mandatory** in Newfoundland, but are provided as suggestions for Nova Scotia, Prince Edward Island and New Brunswick.

1. Troubleshoot basic problems with electric circuits.

## **ER1760 Motors**

### **Outcomes:**

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

- maintain DC and AC motors.

### **Pre-Requisites:** ER1190

### **Objectives and Content:**

1. Describe the construction of direct current motors.
  - i. field poles
  - ii. armature
  - iii. commutator
  - iv. motor nameplate data
2. Explain the basic differences between shunt, series and compound motors.
  - i. DC compound motors
  - ii. stepper motor
  - iii. electronically commutative
  - iv. permanent magnet
3. Explain the operating characteristics of various types of direct-current motors.
4. Describe the components of a typical single phase motor.
5. Describe the operating principles of single phase motors.
  - i. induction motor principles
  - ii. rotating magnetic field
  - iii. current and voltage
  - iv. frequency
6. Describe the operating principles of a universal (series) motor.
7. Describe the operating principles of three-phase squirrel cage induction motors.
8. Describe motor testing devices.
  - i. tachometers

- ii. stroboscope
- iii. frequency indicators
- iv. phase rotation tester
- v. phase sequence indicator

**Practical:**

Practical skills enhance the apprentices' ability to meet the objectives of this course. The learning objectives outlined below are **mandatory** in Newfoundland, but are provided as suggestions for Nova Scotia, Prince Edward Island and New Brunswick.

1. Use test equipment to test motors.
2. Identify the motor types and components.
3. Install, service and maintain DC And AC motors.

## ER2156 Process Measurement

### Outcomes:

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

- calibrate instruments and devices.
- install instruments and devices.
- maintain instruments and devices.
- configure smart instruments
- maintain calibration standards

**Pre-Requisites:** ER1150

### Objectives and Content:

1. Define terminology associated with pressure measurement.
2. Describe procedures used to perform calculations that relate to pressure measurement and the properties of fluids.
3. Explain the principles involved in pressure measurement equipment such as:
  - i. motion detectors
  - ii. linear potentiometer
  - iii. linear motion variable inductor
  - iv. linear variable differential transformer - LVDT
  - v. linear motion variable capacitor
  - vi. flapper-nozzle transmitters
  - vii. strain gauge
4. Identify and compare common applications and perform calculations using various differential pressure methods.
  - i. level measurement by differential pressure
  - ii. density measurement by differential pressure
  - iii. flow measurement by differential pressure
5. Describe pressure measurement procedures to verify proper operation within an acceptable tolerance of error.
  - i. test instruments for pressure measurement
  - ii. calibration principles

- iii. calibration procedures
6. Describe the mounting details of pressure and differential pressure instruments.
7. Explain the accepted terminology and concepts of theory for the measurement of temperature.
8. Describe the measuring of temperature in an industrial process.
  - i. thermometers
  - ii. thermocouples
  - iii. resistance thermometers - RTD's
  - iv. thermistors
  - v. pyrometer
9. Describe the considerations and limitations when 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 considerations, limitations and procedures when installing flow measuring devices in a process.
  - i. differential pressure flowmeters
  - ii. variable area rotameters
  - iii. open channel flowmeters
  - iv. positive displacement flowmeters
  - v. magnetic flowmeters
  - vi. mass flowmeters
  - vii. turbine flowmeters
12. Describe procedures used to calculate calibration points (curves) for flow measuring instruments.
13. Explain the theory for the measurement of level.
14. Describe the various methods of measuring levels in an industrial process.
  - i. direct measurement methods
  - ii. constant displacement devices
  - iii. hydrostatic head level measurement
  - iv. electronic level measuring systems
  - v. ultrasonic

- vi. weighing
  - vii. radioactive
  - viii. granular solids
  - ix. level measurements
15. Describe the configuration of smart transmitters and their applications.
- i. HART protocol
  - ii. foundation field bus
  - iii. configuring transmitters
16. Describe the maintenance and calibration of recorders and indicators.
17. Describe calibration standards.
18. Describe the importance of record keeping procedures.

**Practical:**

Practical skills enhance the apprentices' ability to meet the objectives of this course. The learning objectives outlined below are **mandatory** in Newfoundland, but are provided as suggestions for Nova Scotia, Prince Edward Island and New Brunswick.

1. Install various measurement instruments.
2. Calibrate various measurement instruments and record calibration data.
3. Perform calculations that relate to pressure measurement and the properties of fluid.

## **ER2215 Pneumatic Systems (Instrument Air Supply)**

### **Outcomes:**

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

- install instrument air supply systems and equipment
- maintain instrument air supply systems and equipment
- troubleshoot instrument air supply systems and equipment

**Pre-Requisites:** None

### **Objectives and Content:**

1. Identify and interpret pneumatic drawings and sketches.
2. Describe the parts and characteristics of various types of compressors and associated equipment.
  - i. instrument air requirements
  - ii. pressure
  - iii. estimation of air requirements
  - iv. types of compressors
  - v. principles of operation
  - vi. location of air intake and filters
  - vii. compressor operation
3. Describe the procedures used to install conditioning devices in instrument air supply systems.
  - i. moisture removal
    - dehydrators
    - traps
    - separators
    - air coolers
    - air dryers
  - ii. absolute and relative humidity of air
  - iii. dew point
  - iv. use of psychometric chart
  - v. desiccant dehydrators
  - vi. oil removal



4. Describe the procedures used to select and install tubing and fittings.
  - i. main branch lines
  - ii. piping size and sizing
  - iii. piping materials
  - iv. pipe cutting; deburring and threading
  - v. copper (PVC) covered
  - vi. brass
  - vii. steel
  - viii. aluminum
  - ix. plastic
  - x. other types used in instrumentation
  - xi. selection of tubing; size and type
  - xii. selection of tubing fittings
  - xiii. tubing run
  - xiv. cut, ream and assemble copper and brass pipe
  - xv. solder fittings and tubing
  - xvi. flare tubing
  
5. Describe the procedure used to install pressure instruments.
  - i. pressure taps
  - ii. position
  - iii. types of connections
  - iv. methods of installing taps
  - v. working pressure of unit
  
6. Describe the procedure used to install special applications.
  - i. process fluids in leads
  - ii. methods of sealing out process
  - iii. choice of suitable sealing liquid
  - iv. protection of instruments
  - v. corrosive vapours
  - vi. weather
  - vii. dust
  - viii. vibration
  
7. Describe the procedures used to detect leaks in tubing runs.
  - i. pressure test
  - ii. lighted candle
  - iii. odoriferous air
  - iv. soap test

**Practical:**

Practical skills enhance the apprentices' ability to meet the objectives of this course. The learning objectives outlined below are **mandatory** in Newfoundland, but are provided as suggestions for Nova Scotia, Prince Edward Island and New Brunswick.

1. Install instrument air supply systems and equipment.
2. Maintain instrument air supply systems and equipment.
3. Troubleshoot instrument air supply systems and equipment.

## **AP1100 Introduction to Apprenticeship**

### **Description:**

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

### **Course Outcomes:**

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

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

**Pre-Requisites:** None

### **Objective and Content:**

1. Define apprenticeship.
  - i. define Apprenticeship and Red Seal Certification
  - ii. discuss the definition of Apprenticeship and Red Seal Certification
  - iii. distinguish between Red Seal and Provincial Certification
2. Explore how apprenticeship is governed and administered.
  - i. explain who is responsible for administrating apprenticeship
    - Department of Education
    - Provincial Apprenticeship and Certification Board
3. Explore the roles and responsibilities of those involved in the apprenticeship process.
  - i. apprentice
  - ii. employer/journeyperson
  - iii. Industrial Training Division

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

6. Explain Plans of Training.
  - i. identify what is included in the Plan of Training
    - entrance requirements
    - duration of in-school and on-the-job training
    - course content
    - entry level or advanced level
  - ii. explain how a Journeyperson Certificate is achieved
    - discuss Certificate of Qualification.
    - discuss Certificate of Apprenticeship.
    - discuss Red Seal endorsement
  
7. Discuss the Red Seal Program.
  - i. define designated trade
  - ii. explore the National Occupational Analysis for your trade
  - iii. explain Interprovincial Standards Red Seal Program and how it works.
    - labor mobility
    - qualification recognition
  - iv. discuss the range of careers possible in your chosen trade
  
8. Explain apprenticeship progression schedule and wage rates.
  - i. review a Record of Occupational Progress (Log Book)
  - ii. hours per program
  - iii. requirements for progression
  - iv. wage rates per year of apprenticeship
  
9. Identify the examinations and evaluation process used in Apprenticeship.
  - i. discuss occupational tests and examinations as directed by the Provincial Apprenticeship and Certification Board
    - theory
    - practical
  - ii. explain formal assessment and the pass mark of 70%
  
10. Examine some of the financial incentives available to apprentices.
  - i. Employment Insurance (E.I.) Benefits
  - ii. government sponsored student loans
  - iii. apprenticeship incentive Federal and Provincial
  - iv. scholarships
  
11. Continuing training outside the Province of Newfoundland Labrador.

- i. training in other provinces and territories
    - procedure for registration and recognition of hours and skills in other provinces
  - ii. options for dual certification
    - transfer of credits
12. Review and define the following terms:
- i. Apprenticeship Program Accreditation
  - ii. Cancellation of Apprenticeship
  - iii. Certificate of Apprenticeship
  - iv. Certificate of Qualification
  - v. Certification Renewal
  - vi. Criteria for Eligibility
  - vii. Journeyperson
  - viii. Practical Examination
  - ix. Prior Learning
  - x. Record of Occupational Progress (Logbook)
  - xi. Red Seal Certification
  - xii. Registered Apprentice
  - xiii. Theoretical Examination
  - xiv. National Occupational Analysis (NOA)
  - xv. Class Call
  - xvi. Dual certification

**Practical:**

1. Review the Provincial Apprenticeship web site: [www.gov.nl.ca/app](http://www.gov.nl.ca/app).
  - i. identify the requirements for registering as an apprentice and the registration process
  - ii. explain the steps to complete an apprenticeship program
  - iii. identify who is responsible for tracking and signing-off on trade skills
  - iv. identify the nearest Industrial Training Office to your community
  - v. identify the current incentives available to apprentices
2. Review a plan of training on the Provincial Apprenticeship web site.
  - i. identify the hours for your trade (in-school and on-the-job)
  - ii. explain the roles and responsibilities of the following stakeholders in the apprenticeship process: employer, apprentice, training institution and the Industrial Training Division

3. Visit the Red Seal Web site <http://www.red-seal.ca>, review the National Occupational Analyses for your trade.
  - i. review the scope of work for your occupation and identify the industry sectors and job types requiring your trade
  - ii. identify the trends of your trade
  - iii. provide a list of personal protective equipment required for your trade

## **CM2150 Workplace Communications**

### **Description:**

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

### **Course Outcomes:**

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

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

**Pre-Requisites:** None

### **Objectives and Content:**

1. Apply rules and principles for writing clear, concise, complete sentences which adhere to the conventions of grammar, punctuation, and mechanics.
2. Explain the rules of subject-verb agreement.
3. Define and describe the major characteristics of an effective paragraph.



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

**Practical:**

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

## **MR1220 Customer Service**

### **Description:**

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

### **Course Outcomes:**

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

- define customer service
- explain why service is important
- describe the relationship between “service” and “sales”
- demonstrate an understanding of the importance of a positive attitude
- demonstrate methods of resolving customer complaints

**Pre-Requisites:** None

### **Objectives and Content:**

1. Define quality service.
  - i. identify and discuss elements of customer service
  - ii. explain the difference between service vs. sales or selling
  - iii. explain why quality service is important
  - iv. identify the various types of customers and challenges they may present
  - v. describe customer loyalty
  - vi. examine barriers to quality customer service
2. Explain how to determine customer’s wants and needs.
  - i. identify customer needs
  - ii. explain the difference between customer wants and needs

- iii. identify ways to ensure repeat business
3. Demonstrate an understanding of the importance of having a positive attitude.
  - i. identify & discuss the characteristics of a positive attitude
  - ii. explain why it is important to have a positive attitude
  - iii. explain how a positive attitude can improve a customer's satisfaction
  - iv. define perception and explain how perception can alter us and customers
  - v. describe methods of dealing with perception
4. Communicating effectively with customers.
  - i. describe the main elements in the communication process
  - ii. identify some barriers to effective communication
  - iii. explain why body language is important
  - iv. define active listening and state why it is important
  - v. identify and discuss the steps of the listening process
  - vi. identify and discuss questioning techniques
5. Demonstrate using the telephone effectively.
  - i. explain why telephone skills are important
  - ii. describe the qualities of a professional telephone interaction
6. Demonstrate an understanding of the importance of asserting oneself.
  - i. define assertiveness
  - ii. discuss assertive techniques
  - iii. explain the use of assertiveness when dealing with multiple customers
7. Demonstrate techniques for interacting with challenging customers in addressing complaints and resolving conflict.
  - i. examine and discuss ways to control feelings
  - ii. examine and discuss ways to interact with an upset customer
  - iii. examine and discuss ways to resolve conflict/customer criticism
  - iv. examine and discuss ways to prevent unnecessary conflict with customers

**Practical:**

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

## **SP2330 Quality Assurance/Quality Control**

### **Description:**

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

### **Course Outcomes:**

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

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

**Pre-Requisites:** None

### **Objectives and Content:**

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

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

**Practical:**

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

## **MC1050 Introduction to Computers**

### **Description:**

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

### **Course Outcomes:**

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

- computer systems and their operation
- popular software packages, their applications
- security issues of computers

**Pre-Requisites:** None

### **Objectives & Content:**

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



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

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

19. Describe use ranges.
  - i. typing a range for a function
  - ii. pointing to a range for a function
  - iii. selecting a range for toolbar and menu commands
  
20. Describe how to print a worksheet.
  - i. printing to the screen
  - ii. printing to the printer
  - iii. printing a selected range
  
21. Describe how to edit a worksheet.
  - i. replacing cell contents
  - ii. inserting & deleting rows and columns
  - iii. changing cell formats
  - iv. changing cell alignments
  - v. changing column width
  - vi. copying and moving cells
  
22. State major security issues in using computers.
  - i. pass words
  - ii. accessing accounts
  - iii. viruses and how they can be avoided
  - iv. identity theft and ways to protect personal information
  - v. demonstrate how to view directory structure and folder content
  - vi. organize files and folders
  - vii. copy, delete, and move files and folders
  
23. Describe how to use electronic mail.
  - i. e-mail etiquette
  - ii. e-mail accounts
  - iii. e-mail messages
  - iv. e-mail message with attachments
  - v. e-mail attachments
  - vi. print e-mail messages
  - vii. deleting e-mail messages
  
24. Explain the internet and its uses.
  - i. the world wide web(www)
  - ii. accessing web sites
  - iii. internet web browsers

- iv. internet search engines
- v. searching techniques
- vi. posting documents on-line

**Practical:**

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

## **SD1700 Workplace Skills**

### **Description:**

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

### **Course Outcomes:**

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

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

**Pre-Requisites:** None

### **Objectives & Content:**

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

- ii. give a concise description of the history of Canadian labour
  - iii. explain how unions function
  - iv. explain labour's structure
  - v. describe labour's social objectives
  - vi. describe the relationship between Canadian labour and the workers
  - vii. describe the involvement of women in unions
3. Worker's Compensation.
- i. describe the aims, objectives, benefits and regulations of the Workplace Health, Safety and Compensation Commission
  - ii. explain the internal review process
4. Employment Insurance.
- i. explain employment insurance regulations
  - ii. describe how to apply for employment insurance
  - iii. explain the appeal process
  - iv. identify the components of a letter of appeal
5. Worker's Rights.
- i. define labour standards
  - ii. explain the purpose of the Labour Standards Act
  - iii. identify regulations pertaining to:
    - hours of work
    - minimum wages
    - employment of children
    - vacation pay
  - iv. explain the purpose of the Occupational Health & Safety Act as it refers to workers' rights
6. Human Rights.
- i. describe what information cannot be included on an employment application
  - ii. describe what information cannot be included in an interview
  - iii. examine the Human Rights Code and explain the role of the Human Rights Commission
  - iv. define harassment in various forms and identify strategies for prevention

7. Workplace diversity.
  - i. define and explore basic concepts and terms related to workplace inclusively including age, race, culture, religion, socio-economic, sexual orientation with an emphasis on gender issues and gender stereotyping.
8. Gender sensitivity.
  - i. explore gender and stereotyping issues in the workplace by identifying strategies for eliminating gender bias

**Practical:**

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

## **SD1710 Job Search Techniques**

### **Description:**

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

### **Course Outcomes:**

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

- demonstrate effective use of job search techniques

**Pre-Requisites:** None

### **Objectives and Content:**

1. Identify and examine employment trends and opportunities.
2. Identify sources that can lead to employment.
3. Access and review information on the Newfoundland and Labrador Apprenticeship and Certification Web site and the Apprenticeship Employment Gateway.
4. Analyze job ads and discuss the importance of fitting qualifications to job requirements.
5. Identify and discuss employability skills as outlined by the Conference Board of Canada.
6. Discuss the necessity of fully completing application forms.
7. Establish the aim/purpose of a resume.
8. Explore characteristics of effective resumes, types of resumes, and principles of resume format.



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

**Practical:**

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

## **SD1720 Entrepreneurial Awareness**

### **Description:**

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

### **Course Outcomes:**

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

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

**Pre-Requisites:** None

### **Objectives and Content:**

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

- iii. identify and summarize the role of various agencies that support business development
4. Review the entrepreneurial process.
- i. explain the entrepreneurial process
  - ii. describe the purpose of a business plan

## **Block 2**

### **ER1740 On-Off Control**

#### **Outcomes:**

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

- demonstrate knowledge of the installation and maintenance of discrete control devices.
- demonstrate knowledge of the installation and maintenance of on-off control systems.
- demonstrate knowledge of the installation and maintenance of annunciator panels.

**Pre-Requisites:** ER1760

#### **Objectives and Content:**

1. Describe the construction and operation of pushbuttons.
2. Describe the construction and operation of selector switches.
3. Describe the construction and operation of centrifugal switches.
4. Describe the construction and operation of limit switches.
5. Describe the operation/limitations and installation procedures of proximity switches.
  - i. inductive proximity sensors
  - ii. installation techniques
  - iii. ultrasonic proximity sensors
  - iv. detection and accuracy
  - v. capacity proximity sensors
  - vi. wiring proximity sensors
6. Describe the operation and installation procedures of photo sensors and switches.
  - i. photo tubes (photo missive cells)

- ii. solar cells (photo voltaic cells)
  - iii. photo resistive cells (photo conductive)
  - iv. photo diodes/photo transistors
  - v. installation of photo switches
7. Describe the operation of temperature-operated switches.
- i. purpose of temperature-operated switches
  - ii. definitions and terms
  - iii. input devices
8. Describe the methods of determining liquid levels.
- i. sight glass
  - ii. float switches/controls
  - iii. photo-type level detectors
  - iv. pressure switches
9. Describe the methods of determining liquid levels.
- i. types of pressure switches
10. Describe the methods used to determine the movement of air or liquids.
11. Describe the basic operation of general purpose relays.
12. Interpret wiring and schematic diagrams.
- i. standard electrical symbols
  - ii. diagrams and interpretation
  - iii. wiring diagrams
  - iv. schematic diagram
  - v. tracing control circuit current flow
  - vi. tracing power circuit current flow
13. Describe the purpose and operation of common magnetic starters and controllers.
- i. magnetic contractor
  - ii. electromagnet operation
  - iii. control-circuit transformers
  - iv. magnetic motor starter sizes
  - v. power contacts
  - vi. overload relay

14. Describe the construction and operation of overload devices.
  - i. thermal overload relay
  - ii. solid state overload unit
  
15. Describe control circuits used with starters.
  - i. two-wire control
  - ii. three-wire control
  - iii. control circuit transformer
  - iv. pushbutton connections
  
16. Describe the installation and troubleshooting procedures for annunciator panels.
  - i. annunciator types and features

**Practical:**

Practical skills enhance the apprentices' ability to meet the objectives of this course. The learning objectives outlined below are mandatory in Newfoundland, but are provided as suggestions for Nova Scotia, Prince Edward Island and New Brunswick.

1. Install discrete control devices.
2. Install and troubleshoot an annunciator panel.
3. Install a motor control system.
4. Interpret wiring schematic diagram.

## ER2196 Process Control

### Outcomes:

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

- understand the basic concept of automatic process control
- inspect and calibrate control equipment
- perform tuning procedures in control systems
- troubleshoot control systems

**Pre-Requisites:** ER2156

### Objectives and Content:

1. Describe the basic control concepts.
  - i. control loop variables
  - ii. typical manual control
  - iii. feedback control
  - iv. manual feed forward control
  - v. automatic feed forward control
  - vi. process control and process management
2. Describe the functional structure of feedback control.
  - i. single feedback control loop
  - ii. block diagrams
  - iii. functional layout of a feedback loop
  - iv. dynamic components
  - v. mathematical model of a loop
3. Describe the setup and calibration of controls
  - i. controllers
  - ii. on-off control
  - iii. proportional control action
  - iv. reset control action
  - v. rate control action
  - vi. PID control
4. Describe process dynamics.

- i. dead time
  - ii. closed-loop response vs. open-loop response
  - iii. transfer lag
5. Describe tuning on control systems.
  - i. closed-loop tuning methods
  - ii. simple open-loop method
6. Describe the set-up and troubleshooting of cascade, ratio control and dead time control.
7. Describe feed forward control.
8. Describe adaptive control.
9. Interpret instrumentation blue prints.
  - i. ISA symbols
  - ii. SAMA symbols
  - iii. P&ID diagrams
  - iv. control logic diagrams

**Practical:**

Practical skills enhance the apprentices' ability to meet the objectives of this course. The learning objectives outlined below are **mandatory** in Newfoundland, but are provided as suggestions for Nova Scotia, Prince Edward Island and New Brunswick.

1. Set-up and calibrate controllers.
2. Tune control systems.



## **Block 3**

### **ER2160 Solid State Drives**

#### **Outcomes:**

Upon the successful completion of this unit the apprentice will be able to install and troubleshoot solid state controls for motors.

**Pre-Requisites:** ER1732

#### **Objectives and Content:**

1. Describe the operation of solid state DC motor controllers.
  - i. power converters
  - ii. field voltage control
  - iii. armature voltage control
  - iv. protection
  - v. speed control
  - vi. reversing
2. Describe the procedures used to install, maintain and troubleshoot solid state DC motor controllers.
3. Describe the procedures used to install, maintain and troubleshoot variable frequency AC drives.
  - i. DC power section
  - ii. AC power section
  - iii. control section
    - filtering
    - size and ratings
4. Describe the operation of the frequency converter (inverter).
  - i. variable voltage inverter (VVI)
  - ii. pulse width modulated inverter (PMW)
  - iii. current source inverter (CSI)
5. Describe the operation of motors used with variable frequency AC drives.

- i. speed characteristics
  - ii. torque characteristics
  - iii. braking
  - iv. reversing
  - v. protection
  
6. Describe the procedures used to test and troubleshoot variable frequency AC drives.
  - i. start-up and adjustments
  - ii. voltage readings
  - iii. oscilloscope readings
  - iv. harmonics
  
7. Identify types of drives and describe their operation.

**Practical Projects:**

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

Practical Projects include:

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

## ER2170 PLC Fundamentals

### Outcomes:

Upon the successful completion of this unit the apprentice will be able to install, maintain and troubleshoot PLC's as well as identify basic programming instructions.

**Pre-Requisites:** ER1732; ER1740

### Objectives and Content:

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

- internal control bit (sealing contact)
  - iii. inserting and closing rungs
  - iv. inserting branches
  - v. file manipulating
    - saving
    - opening
    - copying
  - vi. program testing
    - downloading to PLC
    - uploading from PLC
    - online monitoring
- 5. Describe the procedures used to install, maintain and troubleshoot a programmable logic controller.
  - i. safety considerations
  - ii. system layout
  - iii. proper grounding techniques
  - iv. source of electrical interference
  - v. input/output connection
  - vi. field checkout of PLC's
  - vii. PLC maintenance
  - viii. PLC troubleshooting
- 6. Describe the physical characteristics and applications of programmable relays.

**Practical Projects:**

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

Practical Projects include:

1. Connect, commission, and troubleshoot a PLC control system.

## ER2180 Programming PLC'S

### Outcomes:

Upon the successful completion of this unit the apprentice will be able to program a PLC and work with PLC's connected to a network.

**Pre-Requisites:** ER2170

### Objectives and Content:

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

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

7. Describe the procedures used to install and maintain a PLC data highway system.
  - i. system layout
  - ii. connect PLC's to a network interface devices
  - iii. program a PLC controlling other PLC's on a network system

**Practical Projects:**

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

Practical Projects include:

1. Program a PLC using ladder logic or 'instruction set' type language.

## ER2226 Control Valves

### Outcomes:

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

- demonstrate knowledge of installation and maintenance of control valves
- demonstrate knowledge of installation and maintenance of pneumatic, hydraulic and electric actuators

**Pre-Requisites:** ER2156

### Objectives and Content:

1. Define control element terminology.
  - i. control valve nomenclature
  - ii. rotary-shaft valve nomenclature
2. Describe the different types and application/function of final control elements found in an industrial process.
  - i. control valve functions and characteristics
  - ii. control valve actuators
    - diaphragm actuators
    - piston actuators
    - electro-hydraulic actuators
    - manual actuators
    - electric actuators
  - iii. control valve bodies
    - pinch valves
    - 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 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
  - iv. control valve packing
    - TFE V-ring
    - TFE-impregnated asbestos
    - graphite asbestos
    - laminated and filament graphite
    - semi-metallic
  - v. valve stem packing lubrication
    - conventional characterized valve plugs
    - characterization of cage-guided valve bodies
    - valve plug guiding
    - restricted capacity control valve trim
  - vi. special control
    - high pressure control valves
    - high temperature control valves
    - small flow control valves
    - large flow control valves
3. Describe the accessories used with control valves.
- i. valve positioners
  - ii. hand wheels and manual operations
  - iii. hydraulic snubber
  - iv. limit/proximity switches
  - v. solenoid valve manifold
  - vi. supply pressure regulator
  - vii. pneumatic lock-up systems
  - viii. fail-safe systems for pistons
  - ix. electro-pneumatic transducers
4. Describe the procedures for installing and maintaining control valves.
- i. piping arrangements
  - ii. pipeline cleanliness
  - iii. inspection before installation
  - iv. good piping practice

- v. control valve maintenance
  - replacing actuator diaphragm
  - replacing stem packing
  - replacing threaded seat rings
  - grinded metal seats
  - lubricating control valve packing
  - adjusting travel and connecting stem
- 5. Describe the calibration of smart valves and positioners.
  - i. intelligent systems for control valves
  - ii. digital positions
- 6. Describe ANSI and ASTM standards as they apply to control valves.

**Practical:**

Practical skills enhance the apprentices' ability to meet the objectives of this course. The learning objectives outlined below are **mandatory** in Newfoundland, but are provided as suggestions for Nova Scotia, Prince Edward Island and New Brunswick.

- 1. Install and maintain various control valves and accessories.

## ER2235 Hydraulic Systems

### Outcomes:

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

- demonstrate knowledge of hydraulic systems, their components and applications
- demonstrate knowledge of the procedure used to troubleshoot and maintain hydraulic systems

**Pre-Requisites:** None

### Objectives and Content:

1. Use hydraulic formulas to solve problems.
  - i. pascal's law
  - ii. bernoulli's principle
  - iii. pressure drop and flow
  - iv. horsepower and torque
2. Identify the components needed to make up a basic hydraulic system.
  - i. pumps
  - ii. actuators
  - iii. hydraulic fluid
  - iv. piping and sealing
  - v. motors
3. Describe the operation of various plumbing components used in hydraulic systems.
  - i. filters
  - ii. accumulators
  - iii. intensifiers
  - iv. pressure switches
  - v. gauges and flowmeters
4. Describe the operation and purpose of various valves used in hydraulic systems.
  - i. directional control valves
  - ii. pressure control valves
  - iii. volume control valves

5. Describe the use of schematic diagrams in troubleshooting systems.
6. Describe preventative maintenance procedures.
  - i. seals
  - ii. motor vanes
  - iii. checking for leaks
  - iv. cavitating pumps
7. Describe fluid maintenance procedures.
  - i. assessing fluid conditionreplace fluids  
replace filters

**Practical:**

Practical skills enhance the apprentices' ability to meet the objectives of this course. The learning objectives outlined below are **mandatory** in Newfoundland, but are provided as suggestions for Nova Scotia, Prince Edward Island and New Brunswick.

1. Troubleshoot a hydraulic system using a schematic diagram.

## **ER2325 Boiler Control**

### **Outcomes:**

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

- interpret boiler control Process & Instrument Diagram (P&ID) drawings
- interpret boiler control Scientific American Manufacturers Association . (SAMA) control drawings

**Pre-Requisites:** ER2196

### **Objectives and Content:**

1. Describe boiler basics and the steaming process.
2. Describe combustion of fuels, excess air and products of combustion.
3. Describe the steam supply system.
4. Describe the firing rate demand for utility and industrial boilers.
5. Describe main steam and reheat steam temperature control.
6. Describe boiler interlocks.
7. Describe feedwater supply and boiler water circulation systems.
8. Describe feedwater control systems.
9. Describe boiler draft systems.
10. Describe the measurement and control of boiler draft.
11. Describe the measurement and control of combustion air flow.
12. Describe flue gas analysis trimming of combustion control systems.
13. Describe fluid and solid fuel burners.

14. Describe burner management and flame safety interlocks.
15. Describe combustion control systems.

**Practical:**

Practical skills enhance the apprentices' ability to meet the objectives of this course. The learning objectives outlined below are **mandatory** in Newfoundland, but are provided as suggestions for Nova Scotia, Prince Edward Island and New Brunswick.

1. Interpret boiler control P&ID and SAMA control drawings.

## **Block 4**

### **ER1770 Process Analyzers**

#### **Outcomes:**

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

- describe the selection, operation and application of different types of process analyzers
- describe the maintenance and installation procedures applicable to process analyzers
- demonstrate how process analyzers are calibrated

**Pre-Requisites:** ER2156

#### **Objectives and Content:**

1. Describe pH system operations and their maintenance.
  - i. theory of disassociation, ionization and pH
  - ii. application of pH in industrial processes
  - iii. use of dyes to measure pH
  - iv. use of buffers as a standard for calibration of pH analyzers
  - v. operation and service maintenance of reference electrodes in a pH measuring system
  - vi. operation and service maintenance of glass electrodes in a pH measuring system
  - vii. operation and application of dual electrodes and differential electrode systems
  - viii. effects of temperature on:
    - pH
    - measuring electrodes
    - reference electrodes
  - ix. methods of thermo-compensation
    - manual
    - automatic
  - x. electrode assembly holders and flow chambers used pH measuring systems
  - xi. methods of automatic electrode cleaning

- ultrasonic
  - fluid jet
  - mechanical brush
  - hydrodynamic
  - xii. effects of electrode errors
    - grounding
    - shielding
    - moisture
  - xiii. calibration of analyzers/transmitters
2. Describe ORP systems and their operation and maintenance.
- i. theory and units for ORP measurement
  - ii. industrial process applications for ORP measurement
    - bleach production
    - bleaching reaction
    - water treatment
    - mineral waste treatment
  - iii. types of ORP measuring electrodes
  - iv. electrodes assembly holders and flow chambers used in ORP measuring systems
  - v. service maintenance procedures for ORP electrodes
  - vi. sources of electrode errors, common to ORP measuring systems
  - vii. use of specialized buffers to standardize an ORP electrode system
  - viii. calibration of ORP analyzers
3. Describe specific ion measurement systems and their operations and maintenance.
- i. theory units of specific ion measurement
  - ii. common specific ions measured
  - iii. specific ion electrode systems
  - iv. use of specialized buffers to standardize a specific ion electrode system
  - v. application of some common specific ion measuring systems
    - water treatment
    - demineralization
  - vi. operation and service maintenance of specific ion measuring electrodes
  - vii. calibration of monovalent or divalent cation or anion specific analyzers



4. Describe conductivity measurement systems and their operations and maintenance.
  - i. theory and units for conductivity measurement
  - ii. industrial applications using conductivity measurement
  - iii. how temperature affects conductivity measurement
  - iv. methods of temperature compensation
    - manual
    - automatic
  - v. types of conductivity cells
  - vi. proper location for conductivity cells in a process
  - vii. conductivity cell maintenance procedures
  - viii. operation and calibration of conductivity analyzers
  
5. Describe dissolved oxygen (D.O.) analysis systems and their operations and maintenance.
  - i. theory of dissolved oxygen analysis
  - ii. industrial process applications using dissolved oxygen analysis
  - iii. D.O. cells and their related maintenance procedures
  - iv. operation and calibration of D.O. analyzers
    - hydrogen difference of D.O. analyzers
    - polarographic cell type
  
6. Describe gas chromatography systems and their operations and maintenance.
  - i. theory and principle of operation of a gas chromatography
  - ii. theory and principles of operation analyzer components
    - columns
      - temperature control
      - detectors
      - thermal conductivity
      - flame ionization
    - gas density balance
    - injection and function valves
    - temperature and carrier gas
    - flow control
    - programmers
      - optical readers
      - magnetic tapes
      - micro processor
  - iii. operation and calibration of a gas chromatography

7. Describe the operation and uses for X-ray analyzers.
  - i. X-ray sources
  - ii. X-ray detectors
  - iii. readout
  - iv. types of processes analyzed
  
8. Describe the ultraviolet absorption process analyzer.
  - i. absorption spectrum
  - ii. analyzers components
  - iii. analyzers applications
  - iv. analyzers calibration
  
9. Describe infrared process analyzers.
  - i. absorption spectrum
  - ii. analyzer detectors
  - iii. analyzer applications
  - iv. analyzer calibration
  
10. Describe oxygen analyzers.
  - i. types of O<sub>2</sub> analyzers
  - ii. uses of O<sub>2</sub> analyzers
  - iii. calibration
  
11. Describe thermal conductivity gas analyzers.
  - i. operating principles
  - ii. gas selection
  - iii. calibration
  - iv. applications
  
12. Describe density analyzers.
  - i. types
  - ii. applications
  - iii. calibrations
  
13. Describe viscosity measuring system.
  - i. types of measuring devices
  - ii. applications
  - iii. calibration

14. Describe consistency measuring system.

- i. types
- ii. applications
- iii. calibration

15. Describe nuclear radiation analytical instrumentation.
  - i. nuclear principle
  - ii. beta and gamma uses
  - iii. nuclear radiation detectors
  - iv. safety (Atomic Energy of Canada Regulations)
  - v. applications
  - vi. calibration
  
16. Describe refractive index analyzers.
  - i. operation (critical angle)
  - ii. application
  - iii. calibration
  
17. Describe moisture/dew point analyzers.
  - i. principle
  - ii. measuring systems
  - iii. applications
  - iv. calibration
  
18. Describe the sample conditioning systems for process analyzers.
  - i. take offs
  - ii. drying samples
  - iii. filtering samples
  - iv. multiple stream switching
  - v. calibration samples
  - vi. transport time considerations
  
19. Describe the installation procedures for process analyzers.
  - i. liquid
  - ii. gas

**Practical:**

Practical skills enhance the apprentices' ability to meet the objectives of this course. The learning objectives outlined below are **mandatory** in Newfoundland, but are provided as suggestions for Nova Scotia, Prince Edward Island and New Brunswick.

1. Calibrate and install various process analyzers.

## ER1780 DCS Process Applications

### Outcomes:

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

- configure control loops.
- tune control loops.
- interpret DCS programs.
- troubleshoot system problems.
- describe fibre optic applications.

**Pre-Requisites:** ER1770

### Objectives and Content:

1. Describe the procedures used to interpret DCS programs
  - i. SAMA control systems
  - ii. function block programming
  - iii. digital control symbols
2. Describe the procedures used to configure a DCS system.
  - i. basic PID loop
  - ii. cascade control
  - iii. ratio control
  - iv. feed forward control
  - v. override control
3. Describe the procedures used to employ advanced programming features.
  - i. signal characterization
  - ii. gain characterization
  - iii. feed forward
  - iv. multiple valve manipulation
  - v. open-loop backup
  - vi. rate of change control
  - vii. failure protection
4. Describe the procedures used to interpret boiler control application drawings.
  - i. combustion control

- ii. drum level control
  - iii. steam temperature control
  - iv. furnace pressure control
5. Describe the features of fibre optic cables.
- i. fibre type
    - step-index multi-mode
    - graded-index multi-mode
    - single mode
  - ii. fibre fabrication methods
    - modified chemical vapor deposition
    - outside vapor deposition
    - axial vapor deposition
  - iii. fibre cable design and construction
    - TubeStar
    - LiteTube
    - LiteStar
6. Describe the components and operation of a fibre optic communication system.
- i. optical sources
    - LED's
    - semiconductor lasers
  - ii. optical detectors
    - PIN diodes
    - avalanche photo diodes
  - iii. light propagation through core
    - monochromatic
    - coherent
  - iv. signal
    - digital
    - analog
7. Describe the procedures for troubleshooting DCS network.
- i. remote I/O
  - ii. data highway
  - iii. devicenet

**Practical:**

Practical skills enhance the apprentices' ability to meet the objectives of this course. The learning objectives outlined below are **mandatory** in Newfoundland, but are provided as suggestions for Nova Scotia, Prince Edward Island and New Brunswick.

1. Configure a loop and DCS system.
2. Configure a control application on a DCS system.
3. Troubleshoot a DCS network.

## ER1790 PLC Process Applications

### Outcomes:

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

- configure analog modules
- configure PID loops
- troubleshoot process applications
- interface a PLC with an HMI system
- troubleshoot PLC networks

**Pre-Requisites:** ER2180

### Objectives and Content:

1. Describe procedures used to calculate input/output relationships.
  - i. analog to digital conversion
  - ii. digital to analog conversion
2. Describe the procedures used to configure analog modules.
  - i. voltage/current input modules
  - ii. voltage/current output modules
  - iii. TC and RTD input modules
3. Describe procedures for troubleshooting analog modules.
  - i. fault bits
  - ii. validity bits
4. Describe the procedure for troubleshooting PID control loops.
  - i. PID loop setup
  - ii. PID loop tuning
5. Describe the procedure for interfacing a PLC with and HMI system.
  - i. industrial panels
  - ii. HMI software
6. Describe the procedures for troubleshooting PLC networks.
  - i. remote I/O



- ii. data highway
- iii. device net

**Practical:**

Practical skills enhance the apprentices' ability to meet the objectives of this course. The learning objectives outlined below are **mandatory** in Newfoundland, but are provided as suggestions for Nova Scotia, Prince Edward Island and New Brunswick.

1. Troubleshoot analog applications
2. Troubleshoot PID loop
3. Interface a PLC with HMI
4. Troubleshoot a PLC network

## ER2116 Troubleshooting Techniques

### Outcomes:

Upon the successful completion of this unit the apprentice will be able to apply diagnostic and troubleshooting techniques.

**Pre-Requisites:** None

### Objectives and Content:

1. Describe personal and equipment safety practices.
  - i. energy isolation
    - lockout / tagout
    - OSHA requirements
  - ii. personal protective equipment
  - iii. “insulated” mats
  - iv. quality of workmanship
  
2. Describe conventional troubleshooting methods.
  - i. interview operator (owner)
  - ii. verify “facts”
  - iii. get to know the operating sequences of the machine
  - iv. use machine manuals, schematics, etc.
  - v. operator or record check for change to machine or environmental changes
  - vi. determine symptoms
    - “dead” machine
    - marginal
    - intermittent
  - vii. isolate problem
    - dividing method
  - viii. set up and following logical troubleshooting sequence
  - ix. use manufacturer’s troubleshooting guide
  - x. think beyond the “fix”
  - xi. substitution troubleshooting
  - xii. comparison troubleshooting
  - xiii. record work done

**Practical Projects:**

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

Practical Projects include:

Classroom exercise as determined by the instructor.

## **ER2200 Distributed Control Systems**

### **Outcomes:**

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

- demonstrate knowledge of the procedures to configure and install DCS systems and their peripheral devices

**Pre-Requisites:** ER2180

### **Objectives and Content:**

1. Describe a typical DCS (Distributed Control System).
  - i. definition of DCS
  - ii. basic DCS functions
  - iii. role of the computer in DCS
  - iv. DCS and expert systems overview
  - v. overall structure
  - vi. I/O modules
  - vii. local I/O bus
  - viii. controller modules
  - ix. communications modules
  - x. real time data highway
  - xi. host computer interfaces and PLC gateways
  - xii. power distributions systems
  - xiii. expanding and upgrading a DCS
2. Describe procedures used to program a DCS.
  - i. write program
  - ii. programming concepts
  - iii. executive software
  - iv. system support software
  - v. application software
  - vi. communication software
3. Describe procedures used to install field equipment, run data highways, and make connections to the DCS system.
  - i. physical location
  - ii. environmental conditioning

- iii. power source
  - iv. wiring
  - v. intrinsically safe barriers
  - vi. system checkout and site power up
  - vii. typical system layouts
  - viii. start up services
  - ix. system documentation
4. Describe procedures used to analyze video displays, use a system keyboard, and troubleshoot DCS control systems.
- i. historical trending
  - ii. operator interface hardware
  - iii. CRT display monitors
  - iv. alphanumeric keyboard
  - v. operator keyboard
  - vi. hard copy devices
  - vii. displays
  - viii. engineering workstations
  - ix. levels of support programs
  - x. categories of maintenance
  - xi. enhancement maintenance
  - xii. preventative maintenance
  - xiii. corrective maintenance
  - xiv. service contracts
5. Describe the typical UPS (Uninterruptible power supply) system used to supply a distributed control system.
- i. purpose and applications
  - ii. power line problems
  - iii. UPS system configurations

**Practical:**

Practical skills enhance the apprentices' ability to meet the objectives of this course. The learning objectives outlined below are **mandatory** in Newfoundland, but are provided as suggestions for Nova Scotia, Prince Edward Island and New Brunswick.

1. Program a DCS.
2. Install equipment, run data highways, and make connections to the DCS.
3. Analyse a video display.

## ER2380 Vibration

### Outcomes:

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

- install and calibrate vibration measurement devices

**Pre-Requisites:** None

### Objectives and Content:

1. Describe vibration and its causes.
  - i. motion
  - ii. unbalance
  - iii. misalignment
  - iv. bent shafts
  - v. gears
  - vi. belts and chains
  - vii. bearings
  - viii. torque variations
  - ix. electromagnetic forces
  - x. aerodynamic forces
  - xi. hydraulic forces
  - xii. looseness
  - xiii. rubbing
  - xiv. resonance
  
2. Describe the characteristics and significance of vibration.
  - i. frequency
  - ii. displacement
  - iii. velocity
  - iv. acceleration
  - v. phase
  
3. Describe the measurement of vibration amplitude and its effect on machine operation.
  - i. displacement
  - ii. velocity

- iii. acceleration
  - iv. severity charts
  - v. complex vibrations
4. Describe the methods of measuring machinery vibration.
- i. meter
  - ii. monitors
  - iii. analyzers
  - iv. transducers
  - v. seismic pickups
  - vi. accelerometer pickups
5. Describe the basic operation and mounting requirements of pickups.
- i. seismic
  - ii. accelerometer
  - iii. stud mounting
  - iv. hand held
  - v. probe
  - vi. magnetic pickup holders
  - vii. shaft stick
  - viii. non-contact pickups
6. Describe the procedures used to measure the following machine vibration.
- i. horizontal direction
  - ii. vertical direction
  - iii. axial direction

**Practical:**

Practical skills enhance the apprentices' ability to meet the objectives of this course. The learning objectives outlined below are **mandatory** in Newfoundland, but are provided as suggestions for Nova Scotia, Prince Edward Island and New Brunswick.

- 1. Measure machinery vibration.
- 2. Set-up and calibrate a vibration measuring monitoring device.