Vocational Training Program

Electricity

5795

Training Sector

9

Electrotechnology

Québec

Vocational Training Program

5795

Electricity

Traning Sector

9

Electrotechnology

Formation professionnelle et technique
et formation continue

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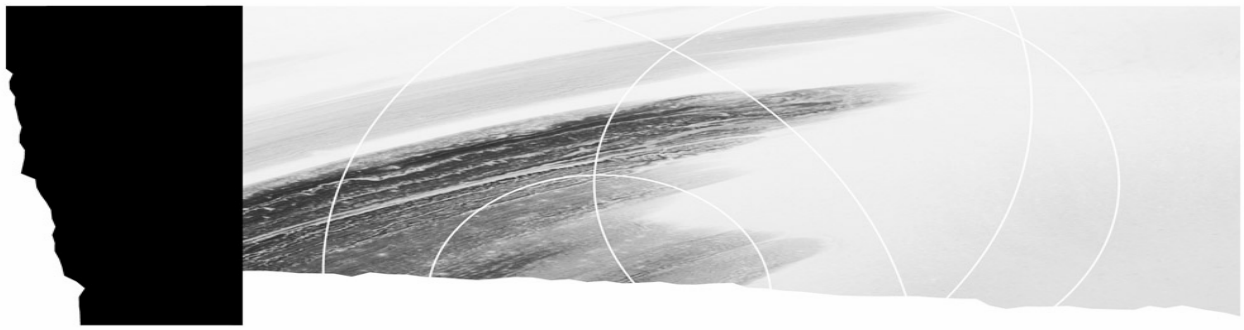


5795	**Electricity**

Year of approval: 2006

Certification:	Diploma of Vocational Studies
Number of credits:	120
Number of modules:	24
Total duration:	1 800 hours

- Persons holding a Secondary School Diploma or its recognized equivalent.

OR

- Persons who are at least 16 years of age on September 30 of the school year in which their training is to begin must meet the following additional requirement: to have earned the Secondary IV credits in language of instruction, second language and mathematics in the programs of study established by the Minister, or to have been granted recognition of equivalent learning.

OR

- Persons who are at least 18 years of age upon entry into the program must have the following functional prerequisites: the successful completion of the general development test and of the language of instruction examination SPR 3, 4, 5, 6 and the mathematics course MTH 4068-1, or recognition of equivalent learning.

OR

- Persons having earned Secondary III credits in language of instruction, second language and mathematics in the programs of study established by the Minister must continue their general education courses concurrently with their vocational training in order to obtain the credits they are missing in the following areas: Secondary IV credits in language of instruction, second language and mathematics in the programs of study established by the Minister.
-

Introduction to the Program

The vocational training curriculum, from which this program of study derives, is the responsibility of both the Ministère de l'Éducation, du Loisir et du Sport, which develops programs and their teaching guides, and the educational institutions, which implement the programs and the evaluation process. Programs of study include compulsory objectives and suggestions for competency-related knowledge, skills and attitudes.

Programs of study provide teachers with a frame of reference for planning teaching activities. They define the scope of teaching strategies by identifying the broad educational orientations to be favoured and the objectives to be attained. By successfully completing a program, students acquire not only the entry-level competencies required by the workplace in order to practise a trade or occupation, but also learning that provides students with a certain degree of versatility.

The duration of the program is 1 800 hours, which includes 1 005 hours spent on the specific competencies required to practise the trade and 795 hours on general, work-related competencies. The program of study is divided into 24 modules, which vary in length from 15 to 120 hours. The total hours allocated to the program include time devoted to evaluation for certification purposes and to remedial work.

Title of Module	Code	Module	Hours	Credits
The Trade and the Training Process	783401	1	15	1
Health and Safety	754992	2	30	2
Using Computers	783412	3	30	2
Electrical Circuits	783428	4	120	8
Sketches and Diagrams	783433	5	45	3
Tools	783445	6	75	5
Handling Materials	783453	7	45	3
Cables and Conduits	783466	8	90	6
Residential Branch Circuits	783477	9	105	7
Technical Drawings and Manuals	783484	10	60	4
Three-Phase Transformers	783494	11	60	4
Service Entrances	783506	12	90	6
Electronic Circuits	783517	13	105	7
Logic Circuits	783525	14	75	5
Lighting Systems	783537	15	105	7
Heating Systems	783546	16	90	6
Communications Wiring	783555	17	75	5
Fire Alarm Systems	783564	18	60	4
Home Automation and Telephone Systems	783578	19	120	8
DC and single-phase AC Rotating Machines	783586	20	90	6
Three-Phase AC Rotating Machines	783597	21	105	7
Programmable Controllers	783607	22	105	7
Electronic Instrumentation	783615	23	75	5
Preparation for the Job Market	783622	24	30	2

Glossary

Program

A vocational training program is a coherent set of competencies to be acquired. It is formulated in terms of objectives and divided up into modules for administrative purposes. It describes the learning expected of students in accordance with a given performance level. Published as an official pedagogical document, the program leads to the recognition of training qualifying students to practise a trade or occupation.

A vocational training program includes compulsory objectives and content. Although the educational institutions are responsible for learning and evaluation activities, the program presents suggestions for competency-related knowledge, skills, attitudes and perceptions that must be enriched or adapted according to the needs of students, and information regarding the certification of studies.[1]

Program Goals

Program goals consist of the expected outcome at the end of training as well as a general description of a given trade or occupation. They also include the four general goals of vocational training.

Educational Aims

Educational aims are broad orientations to be favoured during training in order to help students acquire intellectual and motor skills, work habits and attitudes. Educational aims usually address important aspects of personal and vocational development that have not been explicitly included in the program goals or competencies. They help guide educational institutions in implementing the program.

Competency

A competency is the ability to act successfully and evolve in order to adequately perform work-related tasks or activities, based on an organized body of knowledge and skills from a variety of fields, perceptions, attitudes, etc.

Objectives

Objectives refer to the operational aspect of a competency to be acquired. They are expressed in terms of specific requirements and serve as the practical basis for teaching, learning and evaluation. Objectives are either behavioural or situational.

Objectives also provide indicators for learning, related knowledge, skills, attitudes and perceptions, and associated guidelines. These indicators are grouped according to elements of the competency (in the case of behavioural objectives), and according to phases of the learning context (in the case of situational objectives).

1. Behavioural Objective

A behavioural objective is a relatively closed objective that describes the actions and results expected of the student. Behavioural objectives consist of the following components:

- The *statement of the competency,* which is the result of the job analysis, the general goals of the program and other determinants.

- The *elements of the competency,* which correspond to essential details that are necessary in order to understand the competency and are expressed in terms of specific behaviours. They refer to the major steps involved in performing a task or the main components of the competency.

1. Specifications regarding certification complement the program of study, but are presented in another document.

- The *achievement context,* which corresponds to the situation in which the competency is exercised at entry-level on the job market. The achievement context does not specify the context for learning or evaluation.

- The *performance criteria,* which define the requirements by which to judge the attainment of the competency. They may refer to each element of the competency, to several elements or to the competency as a whole. Those associated with a specific element correspond to the requirements for performing a task or activity; those associated with several elements indicate the expected level of performance or the overall quality of a product or service.

Evaluation is based on expected results.

2. Situational Objective

A situational objective is a relatively open-ended objective that outlines the major phases of a learning situation in which a student is placed. It allows for output and results to vary from one student to another. Situational objectives consist of the following five components:

- The *statement of the competency,* which is the result of the job analysis, the general goals of the program and other determinants.

- The *elements of the competency,* which outline the essential aspects of the competency and ensure a better understanding of the expected outcome.

- The *learning context,* which provides a broad outline of the learning situation designed to help the students develop the required competency. It is normally divided into three phases of learning:
  – information
  – participation
  – synthesis

- The *instructional guidelines,* which provide guidelines and means to ensure that learning takes place and that the context in which it occurs is always the same. These guidelines may include general principles or specific procedures.

- The *participation criteria,* which describe requirements the students must fulfill when participating in the learning activities. They focus on how the students take part in the activities rather than on the results obtained. Participation criteria are normally provided for each phase of the learning context.

Evaluation is based on the student's participation in the activities suggested in the learning context.

Competency-Related Knowledge, Skills, Attitudes and Perceptions

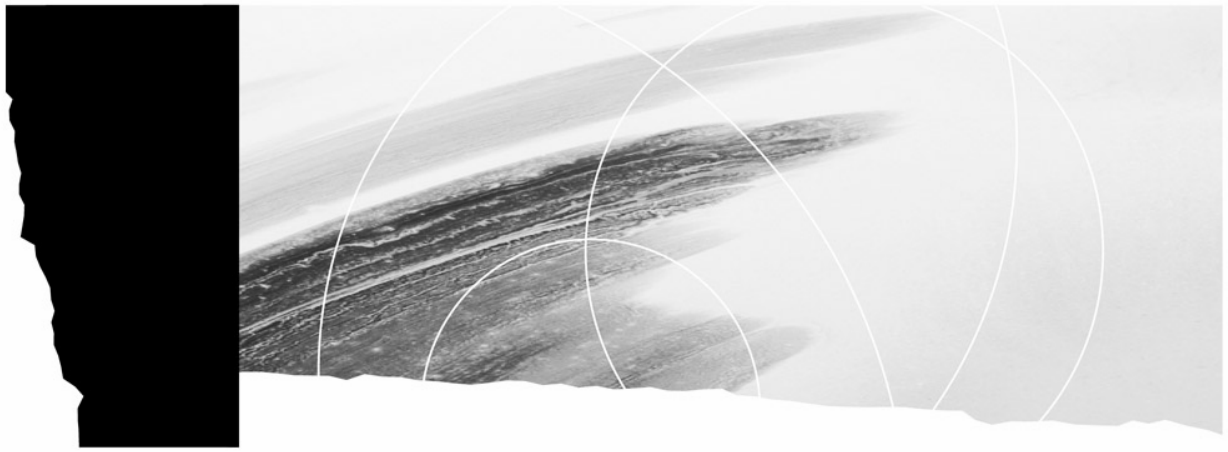
Competency-related knowledge, skills, attitudes and perceptions define the essential and important learning that the student must acquire in order to apply and continue to develop the competency. They correspond to activities in the job market and are accompanied by guidelines that provide information on the field of application, the level of complexity or content related to training. The knowledge, skills, attitudes and perceptions and the related guidelines are not prescriptive.

Module

A module is a component of a program of study comprising a prescriptive objective and suggestions for competency-related knowledge, skills, attitudes and perceptions.

Credit

A credit is a unit used for expressing quantitatively the value of the modules in a program of study. One credit corresponds to 15 hours of training. Students must accumulate a set number of credits to obtain a diploma or attestation.



Part I

Program Goals

Educational Aims

Program Competencies and Grid of Competencies

Harmonization

Program Goals

The *Electricity* program prepares students to practise the trade of electrician.

Electricians install electrical systems in the residential, commercial, institutional, industrial and public works sectors, and maintain building electrical systems in the manufacturing, institutional and industrial sectors. Installation activities take place primarily in the construction sector, where the apprenticeship scheme of the Commission de la construction du Québec applies. For other sectors, Emploi-Québec's apprenticeship scheme applies.

Electricians install, modify, maintain, repair and troubleshoot electrical lighting, heating and power systems, electronic instrumentation and programmable controllers. They must also adapt to new technologies related to home automation, alarm systems, electronic instrumentation and programmable controllers.

The securing and connection of electrical cables, conduits, service entrances, distribution panels, transformers and controls are the most important tasks that an electrician performs during installation activities.

Electricians generally work in pairs under the supervision of a master electrician or electrical contractor. The work can take place indoors, for example, when maintaining a heating system, or outdoors, when maintaining a road lighting system. The trade is physically demanding and often requires working at heights.

To perform their tasks, electricians use instruments to measure voltage, amperage and watts, as well as a variety of tools for securing and assembling. They must also possess in-depth knowledge of electricity and its characteristics.

The program goals of the *Electricity* program are based on the general goals of vocational training. These goals are:

- To help students develop effectiveness in the practice of a trade or occupation, that is:
  - to teach students to perform roles, functions, tasks and activities associated with the trade or occupation upon entry into the job market
  - to prepare students to progress satisfactorily on the job (which implies having the technical and technological knowledge and skills in such areas as communication, problem solving, decision making, ethics, health and safety)

- To help students integrate into the work force, that is:
  - to familiarize students with the job market in general and the context surrounding the trade or occupation they have chosen
  - to familiarize students with their rights and responsibilities as workers

- To foster students' personal development and acquisition of occupational knowledge, skills, perceptions and attitudes, that is:
  - to help students develop their autonomy and ability to learn, and acquire effective work methods
  - to help students understand the principles underlying the techniques and the technology used in the trade or occupation
  - to help students develop self-expression, creativity, initiative and entrepreneurial spirit
  - to help students adopt the attitudes required to successfully practise the trade or occupation, and instill in them a sense of responsibility and a concern for excellence

- To promote job mobility, that is:
  - to help students develop positive attitudes toward change
  - to help students develop the means to manage their careers by familiarizing them with entrepreneurship

Educational Aims

The aim of the *Electricity* program is to help students develop attitudes and behaviours that are deemed essential to the practice of the trade or occupation:

- To develop a constant concern for health and safety during installation and maintenance activities.
- To develop an awareness of the importance of performing safe installations for users.
- To promote an interest in keeping up with technological developments in the field of electricity.
- To develop a concern for the economical use of materials and energy.

Program Competencies and Grid of Competencies

List of Competencies

- To determine their suitability for the trade and the training process.
- To prevent risks related to health, safety and physical well-being on construction sites.
- To use a computer.
- To verify the voltage, current and power of electrical circuits.
- To draw an installation sketch and a circuit diagram.
- To use tools.
- To work at heights and handle materials.
- To install electrical conduits and cables.
- To install residential branch circuits and associated protective devices.
- To interpret drawings, specifications, technical manuals and maintenance procedures.
- To install and maintain three-phase transformers.
- To install and maintain a service entrance and emergency power supply.
- To verify that electronic circuits are working properly.
- To verify the relay and integrated circuit logic of electrical and electronic circuits.
- To install and maintain a lighting system.
- To install and maintain a heating system.
- To install copper and fibre optic communications cables.
- To install a fire alarm system.
- To install home automation and residential telephone systems.
- To install and maintain single-phase DC and AC rotating machines and associated controls.
- To install and maintain a three-phase AC rotating machine and associated controls.
- To install and maintain a programmable controller for building electrical systems.
- To install and maintain electronic instrumentation for building electrical systems.
- To prepare for the job market.

Grid of Competencies

The grid of competencies shows the relationship between general competencies (or work-related activities) and specific competencies (or those specific to the trade or occupation).

The general competencies appear on the horizontal axis and the specific competencies, on the vertical axis. The symbol (△) indicates a correlation between a specific competency and a step in the work process. The symbol (❍) indicates a correlation between a general and a specific competency. Shaded symbols indicate that these relationships have been taken into account in the formulation of objectives related to specific competencies.

The logic used in constructing the grid influences the course sequence. Generally speaking, this sequence follows a logical progression in terms of the complexity of the learning involved and the development of the students' autonomy. The vertical axis presents the specific competencies in the order in which they should be acquired. The modules on the horizontal axis should be taught in relation to those on the vertical axis. This means that some modules are prerequisite to others, while other modules are taught concurrently.

GRID OF COMPETENCIES

ELECTRICITY

SPECIFIC COMPETENCIES	Competency Number	Type of Objective	Duration (in hours)	GENERAL COMPETENCIES: To determine their suitability for the trade and the training process.	To prevent threats to health, safety and bolidy integrity on construction sites.	To use a computer.	To verify the voltage, current and power of electrical circuits.	To draw an installation sketch and a circuit diagram.	To use tools.	To work at heights and handle materials.	To install electrical conduits and cables.	To interpret drawings, specifications, technical manuals and maintenance procedures.	To verify that electronic circuits are working properly.	To verify the relay and integrated circuit logic of electrical and electronic circuits.	To install copper and fibre optic communication cables.	To prepare for the job market.
Competency Number				1	2	3	4	5	6	7	8	10	13	14	17	24
Type of Objective				S	S	B	B	B	B	B	B	B	B	B	B	B
Duration (in hours)				15	30	30	120	45	75	45	90	60	105	75	75	30
To install residential branch circuits and associated protective devices.	9	B	105	○	●	○	●	●	●	●	●	○	○			○
To install and maintain three-phase transformers.	11	B	60	○	●	○	●	●	●	●	●	●				○
To install and maintain a service entrance and emergency power supply.	12	B	90	○	●	○	●	●	●	●	●	●	○			○
To install and maintain a lighting system.	15	B	105	○	●	○	●	●	●	●	●	●	●	●	○	○
To install and maintain a heating system.	16	B	90	○	●	○	●	●	●	●	●	●	●	●	○	○
To install a fire alarm system.	18	B	60	○	●	○	●	●	●	●	●	●	○	○	●	○
To install home automation and residential telephone systems.	19	B	120	○	●	●	●	●	●	●	●	●	●	●	●	○
To install and maintain DC and single-phase AC rotating machines and associated controls.	20	B	90	○	●	○	●	●	●	●	●	●	●	●	○	○
To install and maintain a three-phase AC rotating machine and associated controls.	21	B	105	○	●	○	●	●	●	●	●	●	●	●	○	○
To install and maintain a programmable controller for building electrical systems.	22	B	105	○	●	●	●	●	●	●	●	●	●	●	●	○
To install and maintain electronic instrumentation for building electrical systems.	23	B	75	○	●	●	●	●	●	●	●	●	●	●	●	○

Harmonization

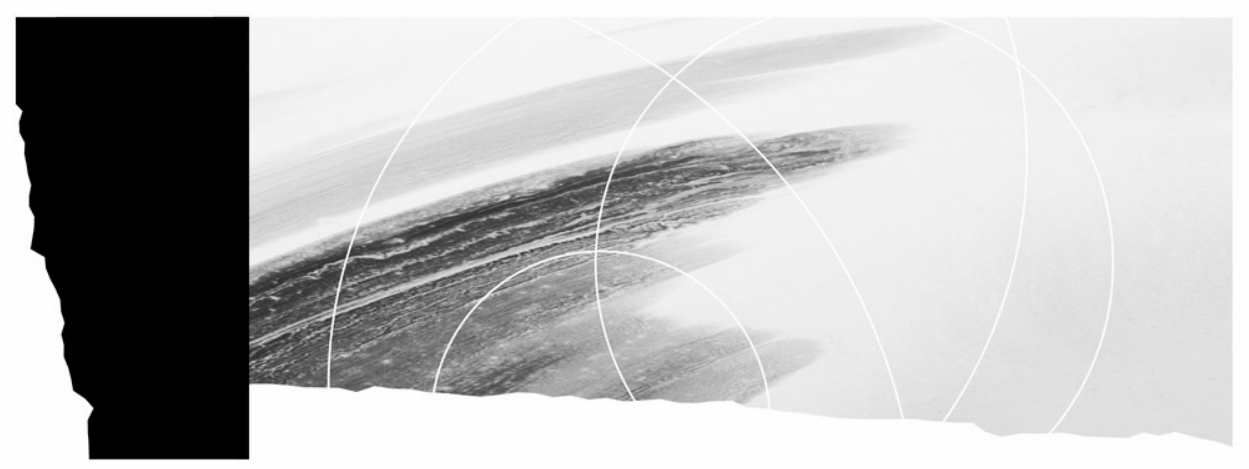
The Ministère de l'Éducation, du Loisir et du Sport harmonizes its vocational and technical programs by establishing similarities and continuity between secondary and college level programs within a particular sector or between sectors in order to avoid overlap in program offerings, to recognize prior learning and to optimize the students' progress.

Harmonization establishes consistency between training programs and is especially important in ensuring that the tasks of a trade or occupation are clearly identified and described. Harmonization makes it possible to identify tasks requiring competencies that are common to more than one program. Even if there are no common competencies, training programs are still harmonized.

Harmonization is said to be "inter-level" when it focuses on training programs at different levels, "intra-level" when it focuses on programs within the same educational level, and "inter-sector" when carried out between programs in various sectors.

An important aspect of harmonization is that it allows the common features of competencies to be identified and updated as needed. Common competencies are those that are shared by more than one program; once acquired in one program, they can be recognized as having been acquired in another. Competencies with exactly the same statement and elements are said to be identical. Common competencies that are not identical but have enough similarities to be of equal value are said to be equivalent.

Harmonization of the *Electricity* program has resulted in identifying competencies that are shared with other programs. Detailed information on the harmonization of this program and its results is presented in the document entitled *Tableaux d'harmonisation, Électricité*.



Part II

Objectives

The Trade and the Training Process	Code:	783401

Module 1 Duration 15 hours

Situational Objective

To determine their suitability for the trade and the training process.

Elements of the Competency

- Become familiar with the nature of the trade.
- Understand the training process.
- Confirm their career choice.

Learning Context

Information Phase

- Learning about the job market for electricians, job prospects, working conditions, remuneration and apprentice booklets.
- Learning about the nature and requirements of the job: types of tasks, rights and responsibilities in the construction sector and in other sectors, occupational health and safety risks, etc.
- Presenting the information gathered during a group discussion and sharing their perceptions of the trade: advantages, disadvantages and requirements.

Participation Phase

- Discussing the skills, attitudes, aptitudes and knowledge required to practise the trade.
- Learning about the program of study, evaluation methods, certification of studies, amount of individual work required, etc.
- Sharing their initial reactions to the trade and the training program.

Synthesis Phase

- Producing a report in which they:
  - state their preferences and interests related to practising the trade
  - evaluate their career choice by comparing various aspects and requirements of the trade with their preferences and interests

Instructional Guidelines

- Encourage all students to engage in discussions and express their opinions.
- Organize shop visits.
- Help students to arrive at an accurate perception of the trade.
- Provide students with the means to assess their career choice objectively.
- Make available to students a variety of relevant documentation.
- Motivate students to participate in the proposed activities.

Participation Criteria

Information Phase

- Gather relevant information on the job market, the different work environments and the nature and requirements of the trade.
- Appropriately express their views on the trade during a group discussion, relating these views to the information they have gathered.

Participation Phase

- Give their opinions on some of the requirements they will have to meet in order to practise the trade.
- Carefully review the documents provided.
- Listen attentively to the explanations given.
- Clearly express their reactions.

Synthesis Phase

- Produce a report in which they:
  - sum up the information gathered
  - list the advantages and disadvantages of the trade
  - explain why they choose to continue or withdraw from the training program

Suggestions for Competency-Related Knowledge, Skills, Attitudes and Perceptions

The following suggestions take into account the learning context, the elements of the competency related to each phase as well as the instructional guidelines.

Information Phase

• Learning about the job market for electricians, job prospects, working conditions, remuneration and apprentice booklets.	Construction and other sectors Job prospects and type of employment Working conditions Remuneration Apprentice booklet of Emploi-Québec and the Commission de la construction du Québec
• Learning about the nature and requirements of the job: types of tasks, rights and responsibilities in the construction sector and in other sectors, occupational health and safety risks, etc.	Types of tasks: installing, modifying and maintaining lighting, heating, surveillance and power systems Working conditions Rights and responsibilities of workers and employers Related jobs: contractor, appraiser, foreman, sales representative specializing in electricity Health and safety risks and summary presentation of the guide issued by the Association sectorielle paritaire
• Presenting the information gathered during a group discussion and sharing their perceptions of the trade: advantages, disadvantages and requirements.	Presentation methods: notes, summaries and talks Rules governing group discussions: participation, respect of a person's turn to speak, respect of others, etc.

Participation Phase	
• Discussing the skills, attitudes, aptitudes and knowledge required to practise the trade.	Physical skills (dexterity, endurance, working at heights) and cognitive skills (reading drawings, measuring and calculating electrical parameters) Attitudes and aptitudes: autonomy, sense of responsibility and organization
• Learning about the program of study, evaluation methods, certification of studies, amount of individual work required, etc.	Program of study and content of modules Training process Evaluation methods: formative and summative evaluation Certification of studies Calendar, schedule, lockers, rules
• Sharing their initial reactions to the trade and the training program.	Links between the competencies and requirements of the trade
Synthesis Phase	
Producing a report in which they:	
• state their preferences and interests related to practising the trade.	Summary of preferences and interests
• evaluate their career choice by comparing various aspects and requirements of the trade with their preferences and interests.	Summary of requirements for practising the trade Brief conclusion explaining their career choice

Health and Safety	Code:	754992

Module 2 Duration 30 hours

Situational Objective

Statement of the Competency

To prevent threats to health, safety and bodily integrity on construction sites.

Elements of the Competency

- Develop a responsible attitude toward health and safety.
- Understand why it is important to respect occupational health and safety standards and regulations.
- Identify dangerous situations or unsafe behaviour and applicable preventive measures.

Learning Context

Information Phase

- Learning about construction site hazards.
- Learning about the standards and regulations governing health and safety on construction sites.
- Learning about emergency measures.
- Reflecting on why it is important to develop competency in matters of occupational health and safety.

Participation Phase

- Experiencing situations in which it is necessary to prevent and eliminate hazards associated with the environment, installations, equipment, machinery, materials, tools, sources of energy, etc.
- Participating in activities that will enable them to identify the risks associated with carrying loads and working in awkward positions.
- Participating in activities that will enable them to identify hazard signs and symbols (e.g. hazardous substances, road work, transport of hazardous materials).
- Comparing unsafe behaviours on a construction site and identifying the basic principles underlying safe behaviour.

Synthesis Phase

- Presenting a report containing:
  – a summary of newly acquired knowledge and skills
  – an assessment of their own attitudes toward occupational health and safety
  – objectives and measures to adopt in order to improve

Instructional Guidelines

- Provide the required sources of information.
- Invite, as needed, resource persons specialized in certain areas of occupational health and safety to speak to the class.
- Use audiovisual materials to their full advantage.
- Make use often of learning situations that are representative of construction sites.
- Prevent unsafe movements that students might make during simulation exercises.
- Encourage all students to participate during discussions.
- Guide the students' evaluation by providing them with the necessary tools (such as a questionnaire) to help them analyze their experience and determine their objectives.

Participation Criteria

Information Phase

- Consult available sources of information.
- Describe the advantages of respecting health and safety standards and regulations.

Participation Phase

- Participate actively in the activities suggested.
- State the principles of safe behaviour.
- Draw up a list of construction site hazards and applicable preventive measures.

Synthesis Phase

- Present a report containing:
  - a summary of newly acquired knowledge and skills
  - an assessment of their own attitudes toward occupational health and safety
  - objectives and measures to adopt in order to protect their own health, safety and bodily integrity, as well as that of others on a construction site.

Suggestions for Competency-Related Knowledge, Skills, Attitudes and Perceptions

The following suggestions take into account the learning context, the elements of the competency related to each phase as well as the instructional guidelines.

Information Phase

- Be receptive to information on construction site health and safety.
- Identify the most common threats to health, safety and bodily integrity on construction sites.
- Identify sources of information on construction sites health and safety and find information.
- Determine the advantages of respecting health and safety standards and regulations.

Roles and responsibilities in matters of construction sites health and safety

Legislation governing health and safety

Prevention of accidents and diseases

Participation Phase

• Associate construction site and trade hazards with applicable preventive measures.	Hazards associated with construction sites and the trade Preventive measures to adopt depending on the hazard Identification systems for hazardous substances

Using Computers	Code:	783412

Module 3 Duration 30 hours

Behavioural Objective

Statement of the Competency	Achievement Context
To use a computer.	• Using a computer, common peripherals and user manuals

Elements of the Competency	Performance Criteria
1. Install peripherals on a computer workstation.	• Identification of workstation components • Proper connection of peripherals
2. Manage files.	• Proper creation of files • Appropriate organization of folders • Proper creation of backup copies • Appropriate use of the operating software's basic functions
3. Enter data.	• Appropriate use of the basic functions of word-processing and spreadsheet software • Proper backup and printing of documents
4. Browse the Internet.	• Appropriate choice of tools and search criteria • Appropriate use of browsers and e-mail software
	For the competency as a whole: • Appropriate use of user manuals • Careful handling of equipment • Observance of ergonomic rules

Suggestions for Competency-Related Knowledge, Skills, Attitudes and Perceptions

The following suggestions take into account the elements of the competency, the main components of these elements and the performance criteria related to the competency.

1. Install peripherals on a computer workstation.

• Identify the components of a computer.	Processing unit and components: microprocessor, memory, hard disk, cards, drives, etc. RAM and ROM Features and operation of keyboard, mouse, scanner, monitor, printer, diskette drive, CD-ROM drive, etc.

• Connect the peripherals.	Powering off the computer: risks to health (electrical shock) and to equipment (live components) Connection of external peripherals to the processing unit: serial and parallel, USB, monitor, S-video and RCA ports, etc. Ergonomic layout of workstation
2. Manage files.	
• Use operating software.	Basic commands: start-up, shutdown, save, file management, etc.
• Create folders and organize files in them.	Hierarchical filing structure: tree structure for drives, folders, subfolders and files Creation of drives, folders and subfolders Access mode, rename, move, copy, delete, etc.
• Create backup copies.	Importance of having backup copies Features and operation of backup devices: hard disk, diskettes, CD-ROM, etc. Procedures for making backup copies
3. Enter data.	
• Use word-processing and spreadsheet software.	Basic functions of word-processing software: fonts, paragraph attributes, text format and page layout Basic functions of spreadsheet software: cells, rows, columns, creating mathematical formulas (four basic operations) and page layout
• Save and print documents.	Save procedures: printer identification, properties, number of copies, selection of print options, etc.
4. Browse the Internet.	
• Visit a site.	Browser features Use of search commands Saving of search file
• Use e-mail.	E-mail program features Receiving messages: opening messages and attachments Sending messages: using the address book, recipient, carbon copy (CC), attaching files Deleting messages

Electrical Circuits	Code:	783428

Module 4 Duration 120 hours

Behavioural Objective

Statement of the Competency	Achievement Context
To verify the voltage, current and power of electrical circuits.	• For direct current (DC) and alternating current (AC) circuits, with a single power source, connected in series or parallel, with a resistive, inductive or capacitive load • Using a circuit diagram • Using measuring instruments: multimeter, clamp-on ammeter, wattmeter and oscilloscope

Elements of the Competency	Performance Criteria
1. Analyze a DC or AC circuit connected in series or parallel, with a resistive, inductive or capacitive load.	• Accurate interpretation of diagram • Accurate identification of the technical characteristics of circuit components • Recognition of the phenomena related to electrical loads and electrical and magnetic fields
2. Calculate the expected values for the voltage, current, resistance and power of the electrical circuit.	• Accurate interpretation of the significance of the units of measure • Appropriate choice and use of mathematical formulas • Appropriate use of Ohm's Law • Appropriate power factor correction • Correct algebraic manipulation • Accurate calculations
3. Take measurements on the circuit.	• Choice of appropriate measuring instruments • Appropriate choice of measuring points • Proper connection of measuring instruments • Appropriate use of a multimeter, clamp-on ammeter, wattmeter and oscilloscope • Observance of protective measures
4. Analyze the results.	• Identification of discrepancies between the values expected and the measurements • Relevant judgment concerning the performance of the circuit • Accurate assessment of the causes of poor performance

For the competency as a whole:

- Observance of health and safety rules
- Methodical, meticulous work

Suggestions for Competency-Related Knowledge, Skills, Attitudes and Perceptions

The following suggestions take into account the elements of the competency, the main components of these elements and the performance criteria related to the competency.

1. Analyze a DC or AC circuit connected in series or parallel, with a resistive, inductive or capacitive load.

• Recognize the nature of electricity.	The structure of matter: atoms (protons, neutrons, electrons) Groupings of components (conductors, insulators and semiconductors) Conversion of hydraulic, thermal, solar and wind energy into electrical energy Methods of storing electricity: batteries, accumulators, battery systems Static electricity: charge, electrification, attraction and repulsion, electrical discharge Current electricity: electrical generator, charge and current
• Distinguish between electrical currents and their effects.	Distinction between DC and AC Thermal and magnetic effects of electrical current Units of measure and symbols
• Analyze a resistive DC circuit connected in series or parallel.	Resistive circuits: baseboard heater, hot water heater, toaster, etc. Properties of resistance in an electrical circuit: types, symbols, power, tolerance, colour code and units of measure Ohm's Law Power: definition, formulas and units of measure

• Analyze an inductive AC circuit connected in series or parallel.	Inductive circuits: relays, inductive ballast, electric bell, etc. Properties of inductance in an electrical circuit: types, symbols, tolerance, colour code and units of measure Electromagnetism: magnetic effect of the electrical current, magnetic field and laws Magnets and characteristics of magnetic force: solenoid, electromagnet, permanent magnet, as well as their applications: relays, electromagnetic plunger, fixed electromagnetic core and magnetic poles of rotating machines Principles of electromagnetism, Ohm's Law Electromagnetic induction: generating action, motoring action, mutual inductance and time constant
• Analyze a capacitive DC circuit connected in series or parallel.	Capacitive circuits: timer, delays, etc. Properties of capacitance in an electrical circuit: types, symbols, tolerance, colour code and units of measure Coulomb's and Ohm's laws Time constant, charge and discharge of capacitor
• Recognize the characteristics of a sine wave.	Elementary alternator Forms of sine waves Terminology and symbols: period, frequency (and unit of measure), alternation and amplitude Characteristic values: instantaneous, peak, peak-to-peak, average and effective Mains voltage
• Analyze simple and combined reactive circuits (RL, RC, RLC).	Phase relation between two sine waves: definition and characteristics of phase difference Reactive circuits comprising a motor and heating element, with power factor correction using a capacitor Types of reactive circuits: inductive and capacitive Inductive and capacitive reactance: 1) phase difference between voltage and current 2) reactive power 3) power factor

2. Calculate the expected values for the voltage, current, resistance and power of the electrical circuit.

• Choose the mathematical formula and perform the algebraic manipulations required for the calculations.	Ohm's Law, Pythagorean Theorem, trigonometry formulas Isolating of the variable: current, resistance, voltage and power

• Calculate the expected values.	Application of formulas Use of graphs: sine waves, value (peak-to-peak, average, effective), period, frequency, etc. Use of vector diagram to determine the phase vectors Power factor correction
3. Take measurements on the circuit.	
• Recognize how over current control and protective devices work in an electrical circuit.	Control devices: switches and commutators (uses, types, properties, symbols) Protective devices: fuses and circuit breakers (uses, types, properties, symbols)
• Choose the measuring instrument.	Operation of a multimeter (ohm, ampere, volt), an oscilloscope (period, voltage, peak-to-peak), a wattmeter and a clamp-on ammeter Verification of the measuring instrument
• Measure the values at different points in the circuit.	Identification of measuring points according to the instrument being used Safe connection of instruments Choice of reading scales Oscilloscope insulation Taking and interpretation of measurements
4. Analyze the results.	
• Calculate the discrepancies.	Discrepancies between the values calculated and the values measured
• Determine the reasons for the discrepancies.	Possible sources of discrepancies: defective components, measuring errors, tolerance of components, etc. Application of a problem-solving method

Sketches and Diagrams	Code:	783433

Module 5 Duration 45 hours

Behavioural Objective

Statement of the Competency	Achievement Context
To draw an installation sketch and a circuit diagram.	• Given an object or an isometric projection • Using grid paper, a T-square, a ruler, a protractor and a square

Elements of the Competency	Performance Criteria
1. Draw front, top and side views.	• Appropriate choice of scale • Precise calculations of dimensions, areas and volumes • Accurate conversion of units of measure for dimensions, areas and volumes • Presence of all lines • Clear lines • Drawings accurately reflect the view
2. Draw a sectional view.	• Appropriate choice of scale • Precise calculations of dimensions and areas • Accurate conversion of units of measure for dimensions and surfaces • Presence of all lines • Clear lines • Drawing accurately reflects the view
3. Dimension the views and draw the title block.	• Appropriate choice of dimensions to be indicated • Proper positioning of dimensions • Accurate dimensions • Clear dimension lines • Correct information in the title block • Legible writing
4. Draw a circuit diagram.	• Appropriate choice of electrical symbols • Accurate representation of circuit components and connecting lines • Legible diagram
	For the competency as a whole: • Correct application of drawing techniques • Observance of drawing standards and conventions • Clean sketch and diagram

Suggestions for Competency-Related Knowledge, Skills, Attitudes and Perceptions

The following suggestions take into account the elements of the competency, the main components of these elements and the performance criteria related to the competency.

1. Draw front, top and side views and a sectional view, given an object or an isometric projection.

• Choose the scale and establish the projection.	Types of projections Scales in metric and imperial systems of measurement Reduction and enlargement scales for drawing the object Calculation of conversions, dimensions, surfaces and volumes
• Position the projections.	Centering of projections Use of the 45-degree line
• Draw the lines of the object.	Lines of the object, hidden contour lines, dimension lines, axis lines, hatched areas, etc. Representation of an object's interior using a cutting plane line Technique for making lines: methods for making vertical and horizontal lines, methods for making circles and arcs Use of pencils, grid paper, a T-square, a ruler, a protractor and a square

2. Dimension the views and draw the title block.

• Indicate the dimensions.	Purpose of dimensions Method of recording dimensions Positioning of dimensions and extension lines Method of drawing lines and arrows
• Indicate the information.	Purpose of annotation arrows Method of recording annotations Lettering method Elements in a title block: name of drawing, date, name of drawer, system of measurement, scale, etc.

3. Draw a circuit diagram.

• Choose the electrical symbols.	Representation of wiring Electrical symbols
• Draw various circuit diagrams.	Basic electrical diagrams (one-line) Connection diagram Wiring diagram Drawing techniques (see above)

Tools	Code:	783445

Module 6 Duration 75 hours

Behavioural Objective

Statement of the Competency	**Achievement Context**
To use tools.	• Given installation and assembly sketches for electrical materials • Using hand or power tools, fastening devices, personal protection equipment and technical manuals

Elements of the Competency	**Performance Criteria**
1. Take measurements using the metric and imperial systems.	• Appropriate choice of measuring instruments • Accuracy of measurements and marking
2. Cut wood, metal, concrete and dry wall.	• Appropriate choice of cutting tools • No chips • Precise cuts
3. Drill wood, metal, concrete and dry wall.	• Appropriate choice of drilling tools and bits • No chips • Precise drilling
4. Assemble components.	• Appropriate choice of assembly techniques • Appropriate choice of screws and bolts • Appropriate use of tapping and threading techniques • Solid assembly
5. Secure components.	• Accurate interpretation of technical information on fastenings • Appropriate choice of fastenings • Appropriate use of nail gun • Levelling of components • Solid assembly
6. Weld and unsolder electronic components.	• Appropriate choice of soldering iron and solder alloy • Correct preparation of components • Absence of cold welds and burrs • Cleanliness of unsoldered surfaces
7. Weld grounding conductors using thermit welding.	• Appropriate choice of moulds • Appropriate use of thermit welding

For the competency as a whole:

- Observance of health and safety rules
- Proper techniques for using tools
- Clean work area

Suggestions for Competency-Related Knowledge, Skills, Attitudes and Perceptions

The following suggestions take into account the elements of the competency, the main components of these elements and the performance criteria related to the competency.

1. Take measurements using the metric and imperial systems.

• Choose a measuring instrument.	Characteristics of equipment: steel tape, ruler, level, square, etc. Characteristics of elements to be measured
• Use instruments for taking measurements and marking.	Techniques for using measuring instruments Techniques for using a square and a chalk line Risk of injury associated with this activity

2. Cut wood, metal, concrete and dry wall.

• Cut wood.	Characteristics of wood Types of tools: circular saw, jigsaw, frame saw, wood chisel, etc. Adjustment, types of blades, direction of cut, techniques Risk of injury associated with this activity
• Cut metal.	Types of metals Types of saws: hacksaw, straight sheet metal shears, pipe cutter, power saw, armoured cable sheath knife, etc. Adjustment, types of blades, direction of cut, techniques Risk of injury associated with this activity
• Cut concrete.	Power saw carbide blade Techniques Risk of injury associated with this activity
• Cut dry wall.	Dry wall knife, keyhole saw Techniques Risk of injury associated with this activity

3. Drill wood, metal, concrete and dry wall.

• Use drills.	Types of drills: cordless and corded drills, hammer drill, etc. Characteristics of drills: amperage, chuck diameters, rotational speed Characteristics of drill bits: existing diameters, rotational speed, sharpening, etc. Wood drilling: metal and wood drill bits, electrician's bit, auger, cutter drill bit, etc. Metal drilling: metal drill bit, pilot hole, cutting fluid, etc. Concrete drilling: carbide-tipped twist drill bit, carbide-tipped concrete drill bit, etc. Dry wall drilling and cutter drill bit Techniques Risk of injury associated with this activity
• Use other tools for drilling.	Types of tools: hammer and punch, cold chisel, electrician's punch, hand compass saw for dry wall, etc. Techniques Risk of injury associated with this activity

4. Assemble components.

• Use pliers.	Types of pliers: electrician's pliers, adjustable pliers, crimping pliers, rivet pliers, etc. Techniques Risk of injury associated with this activity
• Use screwdrivers.	Types of screwdrivers: standard straight screwdriver, Robertson square-tipped screwdriver, Phillips and Frearson cross-slot screwdrivers, hex-tip (Allen) screwdriver, etc. Techniques Risk of injury associated with this activity
• Use wrenches.	Types of wrenches: adjustable wrench, ratchet wrench, torque wrench, pipe wrench, etc. Techniques Risk of injury associated with this activity
• Use threading machines.	Hand and power threaders for rigid metal conduits, revolving knife, fettling machine Techniques Risks associated with this activity
• Use dies and taps.	Types of threads (metric and imperial), die, die stock, taps (1, 2, 3), tap wrench, cutting fluid, tap extractor, screw extractor Techniques Risk of injury associated with this activity

• Use screws and nuts.	Threaded screws and bolts Diameters, lengths, screw heads, pitch of thread
5. Secure components.	
• Use fastenings.	Types of screws: wing screw, concrete screw, wood screw, machine screw, expansion sleeve screw, etc. Characteristics: diameter, length, maximum weight, screw heads, pitch of thread, uses Fastenings other than screws: plastic and lead anchors, sleeve nut, nail, PVC glue, bracket for metal structures, etc. Fastening accessories for electrical boxes: electrical boxes with dry wall bracket, accessories for wood and metal structures (“F” brackets), etc.
• Use a nail gun.	Dismantling, verification and maintenance of the gun Application to metal or concrete Techniques Risk of injury associated with this activity
6. Weld and unsolder electronic components.	
• Use a soldering iron.	Principles of soldering Types of irons and solder tails Welding and unsoldering techniques Risks associated with this activity
7. Weld grounding conductors using thermit welding.	
• Use a thermit welding mould.	Principles of thermit fusing Types of moulds and size of conductors Firing and verification Risk of injury associated with this activity

Handling Materials	Code:	783453

Module 7 Duration 45 hours

Behavioural Objective

Statement of the Competency	**Achievement Context**
To work at heights and handle materials.	• Given work situations • Using personal protection equipment, a scaffold, a ladder, a lift, slings, cables and lifting devices

Elements of the Competency	**Performance Criteria**
1. Use a scaffold.	• Observance of procedure for working close to power lines • Appropriate choice of type of scaffold • Observance of techniques for assembling and dismantling a scaffold • Solid, safe scaffold
2. Use a ladder.	• Appropriate choice of type of ladder • Safe positioning of ladder • Safe ascent and descent
3. Use a lift.	• Observance of procedure for working close to power lines • Solidity of the lift base • Lift operations in compliance with manufacturer's standards
4. Move materials.	• Correct estimate of weight of materials • Appropriate choice of slings and cables • Appropriate choice of lifting devices • Appropriate use of securing methods • Observance of lifting techniques • Accurate interpretation of the crane operator's signalling
	For the competency as a whole: • Observance of occupational health and safety rules • Establishment of a safety perimeter • Proper techniques for handling materials

Suggestions for Competency-Related Knowledge, Skills, Attitudes and Perceptions

The following suggestions take into account the elements of the competency, the main components of these elements and the performance criteria related to the competency.

1. Use a scaffold.

• Recognize the risks associated with assembling, dismantling and using a scaffold.	Risk of falls Procedures for working near power lines Preventive measures: hardhat, safety footwear, harness, gloves, safety cones, etc.
• Choose a scaffold.	Types of scaffolds: metal frame scaffold, tube and fitting scaffold, mobile scaffold, etc. Characteristics and uses
• Assemble and dismantle a scaffold.	Verification of components Positioning, assembling and dismantling techniques, and manufacturer's standards

2. Use a ladder.

• Recognize the risks associated with moving and using a ladder.	Risk of falls Procedures for working near power lines Preventive measures: hardhat, safety footwear, harness, gloves, safety cones, etc.
• Choose a ladder.	Types of ladders: single ladder, extension ladder, stepladder, etc. Characteristics and uses: height, manufacturing materials and accessories
• Set up the ladder, climb up and climb down.	Verification of ladder Positioning, techniques and manufacturer's standards

3. Use a lift.

• Recognize the risks associated with using a lift.	Risk of falls Procedures for working near power lines Preventive measures: hardhat, safety footwear, harness, gloves, safety cones, etc.
• Recognize the different types of lifts.	Lift with ladders Lift with hydraulic cylinder Characteristics and uses
• Position the lift and operate it.	Circle check: verification of hydraulic components, cables, etc. Range of motion Positioning, techniques and manufacturer's standards

4. Move materials.

• Recognize the risks associated with moving materials.	Backaches Risk of falls Preventive measures: hardhat, safety footwear, gloves, glasses, hearing protector, harness, safety cones, guardrail, lock-up procedure
• Estimate the weight of the materials.	Sources of information: technical manuals, nameplates, etc. Approximate calculations
• Prepare the materials for moving.	Choice and use of cables, chains and slings (support capacity, functions, safety factors) Main knots and determination of the load's centre of gravity
• Use moving and lifting equipment.	Moving equipment: trolley, dolly, rollers, manufacturer's standards, etc. Characteristics and uses of lifting equipment: hoist, winch, pulley, lever, hydraulic lever, manufacturer's standards, etc.
• Interpret the crane operator's signalling.	Common signals

Cables and Conduits	Code:	783466

Module 8 Duration 90 hours

Behavioural Objective

Statement of the Competency	Achievement Context
To install electrical conduits and cables.	• For residential, commercial, institutional and industrial installations • For new installations and those undergoing renovation • Using a wiring or conduit diagram, materials, the required tools, personal protection equipment and manufacturers' manuals

Elements of the Competency	Performance Criteria
1. Plan the installation.	• Accurate interpretation of the diagram • Accurate interpretation of technical information on the types of cables and conduits • Appropriate choice of cables, conduits, electrical boxes, connectors and conductors • Appropriate choice of tools
2. Prepare the conduits.	• Exact measurement of lengths • Appropriate use of cutting, boring and threading techniques • Appropriate use of bending techniques • Correct assembly of conduits
3. Secure cables, conduits and associated components.	• Correct placement of electrical boxes • Conduits solidly connected to connectors • Correct, solid installation of cables and conduits • Levelling of conduits • Appropriate choice and use of technique for pulling conductors through conduits • Appropriate use of fish wire inside walls, ceilings and floors
4. Strip cables and connect them.	• Appropriate use of crimping and splicing techniques • Solid crimps and splices • Cables solidly connected to connectors • Integrity of conductors • Correct identification of conductors
5. Complete the work.	• Appropriate storage of tools • Appropriate cleaning of work area

For the competency as a whole:

- Observance of health and safety rules
- Appropriate use of tools
- Installation in compliance with the *Québec Electrical Code*, the diagram and manufacturer's instructions

Suggestions for Competency-Related Knowledge, Skills, Attitudes and Perceptions

The following suggestions take into account the elements of the competency, the main components of these elements and the performance criteria related to the competency.

1. Plan the installation.

• Plan the work.	Electrical symbols specific to electrical conduits and cables Interpretation of installation sketch
• Choose the conduits and cables for a residential, commercial, institutional or industrial installation.	Types of conduits: electrical metal tubing, rigid metal conduit, rigid PVC conduit, flexible metal conduit, cable tray, etc. Characteristics of conduits: installation and assembly techniques, uses, etc. Types of electrical cables and associated connectors: nonmetallic sheathed cable, armoured cable, TECK cable, busbar, etc. Characteristics of electrical cables: installation and connection techniques, uses, etc. Types of electrical boxes: junction boxes for electrical equipment, pull box, splitter box, control cabinet, etc.
• Consult the *Québec Electrical Code*.	Introduction to the Code and search method Provisions related to wiring Provisions related to the selection of conduits, conductors, boxes and protective devices, etc.
• Choose the electrical materials, tools and equipment required to install conduits and cables.	Tools and equipment for working at heights and handling materials (see Modules 6 and 7)

2. Prepare the conduits.

• Cut and ream the conduits and thread them as needed.	Use of tools (see Module 6)
• Bend the conduits.	Measure the conduits for the size and curve Techniques for using manual and hydraulic benders (electrical metal tubing and rigid metal conduit) Techniques for using ovens and heat guns for rigid PVC conduits

3. Secure cables, conduits and associated components.

• Secure the conduits and components.	Placement of boxes depending on their use Safe work techniques (see Module 2) Method of securing conduits: clips, "U" channels, threaded rods, etc. Methods of securing and assembling boxes and conduit connectors (see Module 6)
• Use pulling techniques.	Techniques for pulling cables and conductors: conductors inside a conduit, cables inside a wall, ceiling and floor Pulling accessories: baskets, fish wire, pulleys, lubricant, electrical winch, etc.

4. Strip cables and connect them.

• Make the connections.	Method of removing the different protective jackets of cables Method of removing insulation from conductors Methods of crimping and splicing conductors and use of electrician's knife
• Label conductors.	Technique for identifying conductors

5. Complete the work.
   - Store tools and materials, and clean the work area.

Residential Branch Circuits	Code:	783477

Module 9 Duration 105 hours

Behavioural Objective

Statement of the Competency	Achievement Context
To install residential branch circuits and associated protective devices.	• Using a wiring diagram, nonmetallic cables, materials, measuring instruments, the required tools and personal protection equipment

Elements of the Competency	Performance Criteria
1. Plan the installation.	• Accurate interpretation of wiring diagram • Appropriate choice of protective devices, wiring, switches, boxes and receptacles • Appropriate choice of tools • Relevant sketches
2. Secure the components and make the connections.	• Correct placement of boxes for receptacles, switches and outlets • Proper securing technique • Correct installation of nonmetallic cables • Appropriate connection of conductors
3. Verify that the circuits are working properly.	• Proper performance of a continuity check • Proper method of powering on • Appropriate use of measuring instruments • Appropriate verification of the voltage, current and power • Correct determination of operating problems and their causes • Relevant corrections made
4. Complete the work.	• Appropriate storage of tools • Appropriate cleaning of work area
	For the competency as a whole: • Observance of health and safety rules • Appropriate use of tools • Installation in compliance with the *Québec Electrical Code*, the diagram and manufacturer's instructions • Circuit working properly

Suggestions for Competency-Related Knowledge, Skills, Attitudes and Perceptions

The following suggestions take into account the elements of the competency, the main components of these elements and the performance criteria related to the competency.

1. Plan the installation.

• Recognize the operation of a branch circuit in a wiring diagram.	Types of conductors: power source, return (neutral), control, bonding, grounding Current outlet control with three- and four-way switches Tripping of the over current protective device by means of the grounding conductor
• Plan the work.	Electrical symbols specific to switches, light outlets and receptacles Location of receptacles, switches and light outlets according to the installation sketches (see Module 5)
• Consult the *Québec Electrical Code*.	Provisions related to grounding and bonding Provisions related to protection and controls Provisions related to the installation of equipment Provisions related to the selection of conductors, boxes and protective devices, etc.
• Choose the wiring, switches, boxes, receptacles and protective devices for the installation of the residential branch circuit.	Types of cables: NMD 90, flexible cable, etc. Characteristics of cables: number of conductors, voltage, amperage, uses and colours Types of switches: two, three and four terminals Characteristics of switches: operating principles, voltage, amperage, uses Types of boxes: box #1104, octagon box, 4 11/16" box, waterproof box, etc. Types of receptacles: standard, for range, clothes dryer, GFI, etc. Characteristics of receptacles: voltage, amperage, uses Types of circuit breakers: thermal, magnetic, thermomagnetic, differential Characteristics of circuit breakers: single pole, 2-pole, 3-pole, voltage, amperage, uses Types of fuses: plug screw-in, cartridge, time delay, renewable, etc. Characteristics of fuses: voltage, amperage, fusion point, uses Protective devices against arcing faults and ground faults Electrical panels: busbar with power source conductor terminals, neutral and grounded branch conductor terminals, circuit breaker terminals, etc.

• Choose the electrical materials, tools and equipment required to install the residential branch circuit.	Fastening devices, boxes, cables, conductors or conduits (see Module 8) Tools and equipment for working at heights and handling materials (see Modules 6 and 7)

2. Secure the components and make the connections.

• Secure the components.	Placement of components depending on use Safe work techniques (see Modules 2 and 7) Methods of securing and assembling components (see Module 6) Method of pulling conductors (see Module 8)
• Make the connections.	Removal of cable jacket, conductor insulation and connection (see Module 8)

3. Verify that the circuit is working properly.

• Take measurements on the branch circuit.	Ground continuity check of power conductors and control conductors Powering on of circuits in stages Verification of the operation of receptacles, switches and outlets Verification of the voltage, current and power (see Module 4) Use of a multimeter and clamp-on ammeter
• Solve problems related to installing the branch circuit.	Main problems encountered: conductor colours not respected, reverse polarity of receptacles, interrupted power source, etc. Application of a troubleshooting method: test, diagnosis, correction and verification

4. Complete the work.

• Store tools and materials, and clean the work area.	
• Write the installation report.	Standards for writing an installation report Description of the work done List of materials used Calculation of hours worked

Technical Drawings and Manuals	Code:	783484

Module 10 Duration 60 hours

Behavioural Objective

Statement of the Competency	Achievement Context
To interpret drawings, specifications, technical manuals and maintenance procedures.	• Using residential, commercial, institutional and industrial drawings and specifications, technical manuals and maintenance procedures

Elements of the Competency	Performance Criteria
1. Locate elements in architectural, plumbing, heating and ventilation drawings.	• Accurate interpretation of information contained in the legends and title block • Accurate interpretation of imperial and metric systems of measurement • Precise location of elements
2. Locate elements related to electrical systems.	• Accurate interpretation of information contained in the legends and title block • Accurate interpretation of imperial and metric scales • Precise location of elements
3. Find information in specifications.	• Appropriate use of index and sections • Precise location of information
4. Find information in technical manuals.	• Appropriate use of index and sections • Precise location of information
5. Consult maintenance procedures.	• Accurate distinction between the different characteristics of preventive, corrective and predictive maintenance procedures • Precise location of information in manuals
	For the competency as a whole: • Appropriate use of drawings, specifications, technical manuals and maintenance procedures

Suggestions for Competency-Related Knowledge, Skills, Attitudes and Perceptions

The following suggestions take into account the elements of the competency, the main components of these elements and the performance criteria related to the competency.

1. Locate elements in architectural, plumbing, heating and ventilation drawings.

• Interpret the information contained in the legends and title block.	Project, architect, location, content, trades concerned, etc.

• Interpret the scale.	Function and principles of scale Units of measure in the imperial and metric systems
• Locate the main components of the drawing.	Representations related to architecture: structure, foundation, envelope, roof, etc. Representations related to ventilation, heating and plumbing: systems, piping, air ducts, etc. Symbols used
2. Locate elements related to electrical systems.	
• Recognize the different sections of an electrical drawing.	Lighting Heating Motors Other systems
• Locate electrical systems and associated components.	Representation of service supply, distribution, lighting, heating, home automation, rotating machine and alarm systems Electrical symbols used
• Interpret wiring diagrams.	Terminal connection, wiring and control diagrams, etc.
3. Find information in specifications.	
• Use the table of contents and index.	Search method Identification of different parts and sections Section related to electricity
• Interpret information.	Differences in the type of information found in specifications (legal aspect and specific requirements) and in drawings (location of elements) Specific requirements regarding certain materials, identification standards, etc. Legal aspects: delivery date, work completion stages, penalties, etc.
4. Find information in technical manuals.	
• Make connections between the information sought and the technical manual.	Types of technical manuals and their characteristics: installation, programming, operating and maintenance
• Use the table of contents and index.	Method of searching for and locating information related to safety, parts (part number, description, manufacturer's number, data sheet number), etc.

5. Consult maintenance procedures.

• Recognize the different types of maintenance.	Types of maintenance: corrective or curative maintenance, preventive or systematic maintenance (performed at regular intervals), predictive maintenance (performed based on the equipment's condition)
• Recognize the roles and responsibilities of the various persons concerned.	Categories of tasks included in the maintenance process: technical tasks, administrative tasks Various trades involved
• Search for information.	Use of maintenance software Interpretation of maintenance schedule, data sheets, costs, etc. Main features of maintaining a lighting system, a motor control system, etc.

Three-Phase Transformers	Code:	783494

Module 11 Duration 60 hours

Behavioural Objective

Statement of the Competency	Achievement Context
To install and maintain three-phase transformers.	• For commercial, institutional and industrial installations • Using a drawing and specifications, materials, measuring instruments, the required tools, personal protection equipment and manufacturers' manuals

Elements of the Competency	Performance Criteria
1. Plan the installation.	• Accurate interpretation of the drawing and specifications • Accurate interpretation of technical information on the types of transformers • Correct determination of voltage and power requirements • Appropriate choice of transformer • Appropriate choice of protective devices, conductors, cables and conduits • Appropriate choice of tools • Relevant sketches
2. Secure the transformer and associated components, and make the connections.	• Proper securing technique • Correct installation of cables and conduits • Correct installation of ground • Proper connection of conductors
3. Verify that the transformer is working properly.	• Proper performance of a continuity check • Proper method of powering on • Appropriate use of measuring instruments • Appropriate verification of the voltage, current and power • Correct determination of operating problems and their causes • Relevant corrections made • Precise load balancing between phases

4. Maintain the transformer.	• Accurate interpretation of the maintenance procedure • Appropriate verification of the transformer's condition • Appropriate verification of power source and connections • Correct determination of operating problems and their causes • Thorough cleaning of fittings and windings
5. Complete the work.	• Appropriate storage of tools • Appropriate cleaning of work area • Proper completion of an installation report or maintenance sheet
	For the competency as a whole:
	• Observance of health and safety rules • Appropriate use of measuring instruments and tools • Installation in compliance with the *Québec Electrical Code*, the drawing, the specifications and manufacturer's instructions • Transformer working properly

Suggestions for Competency-Related Knowledge, Skills, Attitudes and Perceptions

The following suggestions take into account the elements of the competency, the main components of these elements and the performance criteria related to the competency.

1. Plan the installation.

• Plan the work.	Electrical symbols specific to transformers and other electrical components Location of transformers and components in drawings and specifications (see Module 10) Drawing standards for installation sketches and wiring diagrams (see Module 5)
• Determine voltage and power requirements.	Basic principles, basic components, transformation ratio for voltage and current Calculation of the various loads to supply

Three-Phase Transformers	Code:	783494

• Choose a transformer for a commercial, institutional or industrial installation.	Types of transformers: single-phase, three-phase, control, instrument, autotransformer, etc. Characteristics of transformers: primary and secondary voltage, power range, power factor, construction, polarity, dry- or liquid-cooled, uses, etc. Single-phase parallel connection Three-phase transformer: triangle-star connection, star-triangle connection, triangle connection, etc. Use of three single-phase transformers to produce three-phase voltage Load balancing
• Consult the *Québec Electrical Code*.	Provisions related to the installation of electrical equipment Provisions related to the selection of conduits, conductors, boxes and protective devices, etc.
• Choose the electrical materials, tools and equipment required to install the transformer.	Fastening devices, boxes, cables, conductors and conduits (see Module 8) Tools and equipment for working at heights and handling materials (see Modules 6 and 7)

2. Secure the transformer and associated components, and make the connections.

• Secure the components.	Safe work techniques (see Modules 2 and 7) Methods of securing and assembling components (see Module 6) Method of pulling conductors (see Module 8)
• Make the connections.	Removal of cable jacket, conductor insulation and connection (see Module 8) Connection to the ground

3. Verify that the transformer is working properly.

• Take measurements on the transformer.	Ground continuity check of the primary and secondary power supply conductors Powering on of system in stages Verification of the voltage, current and power with and without load (see Module 4) Use of a multimeter, megohmmeter and clamp-on ammeter
• Solve problems related to installing a transformer.	Main problems encountered: overheating of transformer, burnt protection fuses, phase inversion, etc. Application of a troubleshooting method: test, diagnosis, correction and verification

4. Maintain the transformer.

• Plan the work.	Verification and replacement schedule Interpretation of maintenance sheet (see Module 10)
• Verify the power source, connections and physical condition of the transformer.	Application of padlocking lockout procedure Use of measuring instruments (see Module 4) Visual and tactile inspection
• Determine the causes of operating problems related to the transformer.	Main signs of problems and their causes: wear, overheating, noise, loosening of clamping bolts, deterioration of winding insulation, etc. Application of a troubleshooting method: test, diagnosis, correction and verification
• Perform the maintenance.	Corrective and preventive maintenance: tightening of bolts, cleaning of windings, etc.

5. Complete the work.

• Store tools and materials, and clean the work area.	
• Write the installation report or maintenance sheet.	Standards for writing an installation report or maintenance sheet Description of work done List of materials used Calculation of hours worked

Service Entrances	Code:	783506

Module 12 Duration 90 hours

Behavioural Objective

Statement of the Competency	Achievement Context
To install and maintain a service entrance and emergency power supply.	• For residential, commercial and institutional installations • For an emergency power supply from a generator • Using a drawing and specifications, materials, measuring instruments, the required tools, personal protection equipment and manufacturers' manuals

Elements of the Competency	Performance Criteria
1. Plan the installation.	• Accurate interpretation of the drawing and specifications • Accurate interpretation of technical information on the types of service entrances and emergency power supplies • Correct determination of the load of the service entrance and emergency power supply • Appropriate choice of type of service entrance • Appropriate choice of protective devices, conductors and cables or conduits • Appropriate choice of tools • Relevant sketches
2. Secure the components and make the connections.	• Correct placement of mast, service box, meter base, emergency switch, distribution panel and ground • Proper securing technique • Proper installation of conduits and cables • Proper connection of conductors
3. Verify that the service entrance and emergency power supply are working properly.	• Proper performance of a continuity check • Proper method of powering on • Appropriate use of measuring instruments • Appropriate verification of the voltage, current and power • Correct determination of operating problems and their causes • Relevant corrections made

4. Maintain the service entrance and emergency power supply.	• Accurate interpretation of the maintenance procedure • Appropriate verification of the condition of equipment and components • Appropriate verification of power source and connections • Correct determination of operating problems and their causes • Replacement of defective parts • Thorough cleaning of the service entrance and emergency power supply components
5. Complete the work.	• Appropriate storage of tools • Appropriate cleaning of work area • Proper completion of an installation report or maintenance sheet
	For the competency as a whole: • Observance of health and safety rules • Appropriate use of measuring instruments and tools • Installation in compliance with the *Québec Electrical Code*, the Hydro-Québec standard, the drawing, the specifications and manufacturers' manuals • Service entrance and emergency power supply working properly

Suggestions for Competency-Related Knowledge, Skills, Attitudes and Perceptions

The following suggestions take into account the elements of the competency, the main components of these elements and the performance criteria related to the competency.

1. Plan the installation.

• Plan the work.	Electrical symbols specific to service entrances Location of connection points, master switch box, other service entrance and emergency power supply system components in the drawings and specifications (see Module 10) Drawing standards for installation sketches and wiring diagrams (see Module 5)
• Consult the Hydro-Québec standard concerning low-voltage service entrances.	Responsibilities of the master electrician Connection conditions Overhead, underground and temporary service entrances

Service Entrances	Code:	783506

• Consult the *Québec Electrical Code*.	Calculation of a service entrance load Provisions related to service entrances and service equipment Provisions related to circuit load and demand factors Provisions related to the selection of conduits, conductors, boxes and protective devices, etc.
• Choose a service entrance for a residential, commercial or institutional installation.	Types of service entrances: single-phase or three-phase, residential, multidwelling, commercial, temporary, underground, etc. Components: service box, meter base, disconnect switch, distribution panel and ground Distinction among the service entrance, distribution and branches, distribution components
• Choose an emergency power supply system.	Establishment of emergency power supply requirements: required power, permanent or temporary power supply, etc. Transfer switch, emergency panel, emergency power supply: generator or accumulator, etc.
• Choose the electrical materials, tools and equipment required to install the service entrance and emergency power supply.	Fastening devices, boxes, cables, conductors or conduits (see Module 8) Tools and equipment for working at heights and handling materials (see Modules 6 and 7)

2. Secure the components and make the connections.

• Secure the components.	Placement of components according to the type of service entrance Safe work techniques (see Modules 2 and 7) Methods of securing and assembling components (see Module 6) Method of pulling conductors (see Module 8)
• Make the connections.	Removal of the cable jacket, conductor insulation and connection (see Module 8) Connection to the ground

3. Verify that the service entrance and emergency power supply are working properly.

• Take measurements on the service entrance and emergency power supply.	Ground continuity check of the distributor and emergency power supply conductors Powering on of system in stages Verification of the voltage, current and power (see Module 4) Use of a multimeter and clamp-on ammeter

• Solve problems related to installing the service entrance and emergency power supply.	Main problems encountered: defective fuse or circuit breaker, mislabelled conductors, defective transfer switch, etc. Application of a troubleshooting method: test, diagnosis, correction and verification

4. Maintain the service entrance and emergency power supply.

• Plan the work.	Verification and replacement schedule Interpretation of maintenance sheet (see Module 10)
• Verify the power source, connections and condition of the service entrance and emergency power supply.	Application of padlocking lockout procedure Use of measuring instruments (see Module 4) Visual inspection
• Determine the causes of operating problems related to the service entrance and emergency power supply.	Main signs of problems and their causes: wear, overheating of components, loosening of conductor clamping bolts, defective generator, etc. Application of a troubleshooting method: test, diagnosis, correction and verification
• Perform the maintenance.	Corrective and preventive maintenance (see Module 10) Cleaning of contacts, verification of generator, tightening of bolts, etc.

5. Complete the work.

• Store tools and materials, and clean the work area.	
• Write the installation report or maintenance sheet.	Standards for writing an installation report or maintenance sheet Description of work done List of materials used Calculation of hours worked

Electronic Circuits	Code:	783517

Module 13 Duration 105 hours

Behavioural Objective

Statement of the Competency	Achievement Context
To verify that electronic circuits are working properly.	• For electronic circuits with a power supply, amplifier, oscillator and signal processing • For electronic power circuits • Using a circuit diagram • Using measuring instruments: multimeter, wattmeter and oscilloscope • Using manufacturers' manuals

Elements of the Competency	Performance Criteria
1. Analyze the electronic circuit.	• Accurate interpretation of circuit diagram • Recognition of the type of integrated circuit • Recognition of the type of power supply, amplifier, oscillator and power control • Exact location of components • Accurate distinction of the technical characteristics of components • Accurate interpretation of the manufacturer's specifications concerning waveforms, voltage, current and power
2. Take measurements on the circuit.	• Choice of appropriate measuring instruments • Appropriate choice of measuring points • Proper connection of measuring instruments • Appropriate use of multimeter, wattmeter and oscilloscope • Proper protective measures
3. Analyze the results.	• Detection of the reasons for discrepancies between the manufacturer's specifications and the measurements • Relevant assessment of how the circuit is working • Correct assessment of the causes of malfunction
	For the competency as a whole: • Observance of health and safety rules • Methodical, meticulous work

Suggestions for Competency-Related Knowledge, Skills, Attitudes and Perceptions

The following suggestions take into account the elements of the competency, the main components of these elements and the performance criteria related to the competency.

1. Analyze the electronic circuit.

• Identify the electronic components.	Identification of electrical or electronic symbols for components Operation of diodes: Zener diodes, light-emitting diodes, data sheets, etc. Operation of bipolar transistors: type, polarization, data sheets, etc. Operation of a linear integrated circuit: comparator, operational amplifier, data sheets, etc. Operation of thyristors: type, gate polarization, holding current, data sheets, etc. Operation of optocouplers: type, polarization, data sheets, etc.
• Analyze a power supply circuit.	Power supply transformer Operation of a rectifier circuit (no-load or under load): type, average voltage and current, waveforms, efficiency and regulation factor Operation of a filter circuit (no-load or under load): type (capacitor or inductance), minimum value, time constant, voltage, waveforms, ripple factor, regulation factor and maximum power Operation of a regulating circuit: type (Zener diode or voltage regulator), waveforms, regulation voltage, power, minimum and maximum currents, and data sheets Operation of a voltage regulator: type (positive or negative voltage), power supply, input and output voltage, waveforms, differential voltage, maximum current and power, and data sheets
• Analyze an amplifying circuit.	Operation of an amplifying circuit with a transistor: polarization, coupling capacitor, and voltage, current and power gain Operation of an amplifying circuit with an operational amplifier: reference voltage, and voltage, current and power gain
• Analyze an oscillating circuit.	Operation of an oscillating circuit with a transistor: type (phase-shift or Armstrong oscillator), polarization, value of the resistance, capacitor or inductance to determine the frequency Operation of an oscillating circuit with a time-delay integrated circuit: value of the resistance and capacitor to determine the frequency

• Analyze a power circuit.	Operation of an SCR and TRIAC power circuit: gate polarization, holding current, maximum power, etc. Operation of optocoupler in a power circuit: maximum input and output voltage, current and power
2. Take measurements on the circuit.	
• Choose the measuring instrument.	Operation of a multimeter (ohm, ampere, volt), oscilloscope (period, voltage, peak-to-peak, waveforms) and wattmeter Verification of measuring instrument
• Measure the values at different points of the electronic circuit.	Identification of measuring points according to the instrument being used Safe connection of instruments Choice of reading scales Oscilloscope insulation Taking and interpretation of measurements on the power supply, amplifying, oscillating and power circuits
3. Analyze the results.	
• Interpret the discrepancies.	Simulation of circuit operation using software Discrepancies between calculated values and measured values
• Determine the cause of the discrepancies.	Possible sources of discrepancies: defective components, measurement errors, tolerance of components, transistor gain, operational amplifiers, time constant, etc. Application of a problem-solving method

Logic Circuits	Code:	783525

Module 14 Duration 75 hours

Behavioural Objective

Statement of the Competency

To verify the relay and integrated circuit logic of electrical and electronic circuits.

Achievement Context

- Using a circuit diagram
- Using a multimeter and logic probe
- Using manufacturers' manuals

Elements of the Competency	Performance Criteria
1. Analyze the combinational or sequential functions of the circuit.	• Accurate interpretation of the diagram and manufacturer's specifications • Exact location of components • Accurate distinction between relay contacts and integrated circuit pins • Accurate interpretation of the operation of logic gates, latches and relays
2. Determine the expected signal at the circuit output or outputs.	• Appropriate use and accurate interpretation of truth table • Correct application of rules of combinational and sequential logic • Accurate analysis of the logic sequence or ladder diagram
3. Take measurements on the circuit.	• Choice of appropriate measuring instruments • Appropriate choice of measuring points • Proper connection of measuring instruments • Appropriate use of multimeter and logic probe • Proper protective measures
4. Analyze the results.	• Relevant assessment of how the circuit is working • Correct assessment of causes of malfunction
	For the competency as a whole: • Observance of health and safety rules • Methodical, meticulous work

Suggestions for Competency-Related Knowledge, Skills, Attitudes and Perceptions

The following suggestions take into account the elements of the competency, the main components of these elements and the performance criteria related to the competency.

1. Analyze the combinational or sequential functions of the circuit.

• Recognize logic functions.	Binary system: derivatives (binary, octal and hexadecimal bases) and codes (BCD and GRAY) Combinational logic functions: YES, OR, AND, EXOR, NOT, NOR, NAND, EXNOR Sequential logic functions: latches, counters-timers, registers, etc. Drawing of logic functions in integrated circuits: standards of the American National Standards Institute (ANSI) and the International Organization for Standardization (ISO)
• Analyze the operation of relays and combinational integrated circuits.	Relay structure: bobbin and types of contacts, start and stop timers, symbols, etc. Types of relays: control, power and electronic relays, data sheets, etc. Families of integrated circuits (TTL, CMOS, etc.) and types of logic functions, data sheets, etc. Input and output pins Power supply voltage, logic level 0 and logic level 1 Truth tables for logic gates
• Analyze the operation of sequential integrated circuits.	Families of integrated circuits (TTL, CMOS, etc.) and types of logic functions, data sheets, etc. Types of latches (RS, D, JK, etc.) and combinations (counter-timer and register) Truth tables for latches

2. Determine the expected signal at the circuit output or outputs.

• Analyze the logic sequence or ladder diagram.	Structure of function diagram: steps/action, transitions, arrows Relationship between the function diagram and a latch Conversion of diagrams
• Determine the output signal or signals.	Rules of combinational and sequential logic Truth tables: writing of logic equations Simplification of equations through Boolean algebra or Karnaugh maps Types of actuator signals according to Karnaugh maps and the function diagram

3. Take measurements on the circuit.

• Choose the measuring instrument.	Operation of a multimeter (ohm, ampere, volt) and logic probe (logic levels) Verification of measuring instrument
• Measure the presence of signals.	Identification of measuring points according to the measuring instrument Safe connection of instruments Choice of reading scales Taking and interpretation of measurements

4. Analyze the results.

• Determine the cause of the discrepancies.	Simulation of circuit operation using software Possible causes of inconsistencies: inappropriate circuit voltage, defective gate, defective latch and defective printed circuit, etc. Application of a problem-solving method

Lighting Systems	Code:	783537

Module 15 Duration 105 hours

Behavioural Objective

Statement of the Competency	Achievement Context
To install and maintain a lighting system.	• For lighting systems using different bulbs: incandescent, fluorescent, halogen and various vapours • For residential, commercial, institutional and industrial installations • Using a drawing and specifications, materials, measuring instruments, the required tools, personal protection equipment and manufacturers' manuals

Elements of the Competency	Performance Criteria
1. Plan the installation.	• Accurate interpretation of the drawing and specifications • Accurate interpretation of technical information on the types of lighting systems • Accurate interpretation of customer's needs • Appropriate choice of lighting system, bulbs, light fixtures and controls • Correct determination of the illumination level • Appropriate choice of protective devices, boxes, conductors and cables or conduits • Appropriate choice of tools • Relevant sketches
2. Secure the components and make the connections.	• Correct placement of light fixtures and controls • Proper securing technique • Proper installation of cables or conduits • Proper connection of conductors
3. Verify that the lighting system is working properly.	• Proper performance of a continuity check • Proper method of powering on • Appropriate use of measuring instruments • Appropriate verification of the voltage, current and power • Appropriate verification of the operation of controls, control relays or electronic controls • Correct determination of operating problems and their causes • Relevant corrections made

4. Maintain the lighting system.	• Accurate interpretation of the maintenance procedure • Appropriate verification of the condition of equipment and components • Appropriate verification of power source, connections and control circuits • Correct determination of operating problems and their causes • Replacement of defective parts • Thorough cleaning of lighting system components
5. Complete the work.	• Appropriate storage of tools • Appropriate cleaning of work area • Proper completion of an installation report or maintenance sheet
	For the competency as a whole:
	• Observance of health and safety rules • Appropriate use of measuring instruments and tools • Installation in compliance with the *Québec Electrical Code*, the drawing, specifications and manufacturer's instructions • Lighting system working properly

Suggestions for Competency-Related Knowledge, Skills, Attitudes and Perceptions

The following suggestions take into account the elements of the competency, the main components of these elements and the performance criteria related to the competency.

1. Plan the installation.

• Plan the work.	Electrical symbols specific to light fixtures, controls and other electrical components Location of light fixtures and controls in drawings and specifications (see Module 10) Drawing standards for installation sketches and wiring diagrams (see Module 5)

• Choose a lighting system, bulbs, light fixtures and controls for a residential, commercial, institutional or industrial installation.	Types of bulbs: incandescent, fluorescent, sodium, multi-vapour, etc. Characteristics of bulbs: operating principle, type of use, life expectancy, etc. Characteristics of light fixtures: recessed, surface, hanging, pedestal, interior or exterior, waterproof, vibrations, explosions, etc. Power supply voltage, type of reflector, etc. Types of controls: very low voltage two- and three-way relays and switches, photoelectric cell, timer, X10 electronic module, etc. Characteristics of controls: operating principles, components and uses
• Establish the illumination levels and determine the number of light fixtures according to the customer's needs.	Photometric units: candela, lumen, lux Luminance and reflection Colour rendering index (CRI) Illumination level depending on the use of the premises Illumination calculation using the point method and the lumen/watt/metre^2 method Rule for the spacing of light fixtures
• Consult the *Québec Electrical Code*.	Provisions related to the installation of lighting equipment Provisions related to an emergency lighting system, stand-alone light fixtures and exit lighting Provisions related to the selection of conduits, conductors, boxes and protective devices, etc.
• Choose the electrical materials, tools and equipment required to install the lighting system.	Fastening devices, boxes, cables, conductors or conduits (see Module 8) Tools and equipment for working at heights and handling materials (see Modules 6 and 7)

2. Secure the components and make the connections.

• Secure the components.	Placement depending on the type of lighting system Safe work techniques (see Modules 2 and 7) Methods of securing and assembling components (see Module 6) Method of pulling conductors (see Module 8)
• Make the connections.	Removal of cable jacket, conductor insulation and connection (see Module 8)

3. Verify that the lighting system is working properly.

• Take measurements on the lighting system.	Ground continuity check of power source and control conductors Powering on of system in stages Verification of the voltage, current and power (see Module 4) Verification of the operation of lighting circuits, controls, control relays or electronic controls (see Modules 13 and 14) Use of a multimeter and luxmeter
• Solve problems related to installing the lighting system.	Main problems encountered: defective control, burnt bulb, interrupted power source, etc. Application of a troubleshooting method: test, diagnosis, correction and verification

4. Maintain the lighting system.

• Plan the work.	Verification and replacement schedule Interpretation of maintenance sheet (see Module 10)
• Verify the power source, connections, control circuits and the physical condition of the lighting system.	Application of padlocking lockout procedure Use of measuring instruments (see Modules 4, 13 and 14) Visual inspection
• Determine the causes of operating problems related to the system.	Main signs of problems and their causes: wear, flickering, drop in light intensity, noise, etc. Application of a troubleshooting method: test, diagnosis, correction and verification
• Perform the maintenance.	Corrective and preventive maintenance: replacement of ballast and bulb, cleaning of reflectors, etc.

5. Complete the work.

• Store tools and materials, and clean the work area.	
• Write the installation report or maintenance sheet.	Standards for writing an installation report and maintenance sheet Description of work done List of materials used Calculation of hours worked

Heating Systems	Code:	783546

Module 16 Duration 90 hours

Behavioural Objective

Statement of the Competency	Achievement Context
To install and maintain a heating system.	• For heating systems using baseboards, convectors, infrared lamps, radiant heating panels, or a warm-air or hot-water electrical central heating system with a hot water storage tank • For residential, commercial, institutional and industrial installations • Using a drawing and specifications, materials, measuring instruments, the required tools, personal protection equipment and manufacturers' manuals

Elements of the Competency	Performance Criteria
1. Plan the installation.	• Accurate interpretation of drawing and specifications • Accurate interpretation of technical information on the types of heating systems • Accurate interpretation of customer's needs • Correct determination of heating requirements • Appropriate choice of heating system, equipment and controls • Appropriate choice of protective devices, boxes, conductors and cables or conduits • Appropriate choice of tools • Relevant sketches
2. Secure the components and make the connections.	• Correct placement of equipment and controls • Proper securing technique • Proper installation of cables or conduits • Proper connection of conductors
3. Verify that the heating system is working properly.	• Proper performance of a continuity check • Proper method of powering on • Appropriate use of measuring instruments • Appropriate verification of the voltage, current and power • Appropriate verification of the operation of controls, control relays or electronic controls • Correct determination of operating problems and their causes • Relevant corrections made

4. Maintain the heating system.	• Accurate interpretation of the maintenance procedure • Appropriate verification of the condition of equipment and components • Appropriate verification of power source, connections and control circuits • Correct determination of operating problems and their causes • Replacement of defective parts • Thorough cleaning of the heating system components
5. Complete the work.	• Appropriate storage of tools • Appropriate cleaning of work area • Proper completion of an installation report or maintenance sheet
	For the competency as a whole:
	• Observance of health and safety rules • Appropriate use of measuring instruments and tools • Installation in compliance with the *Québec Electrical Code*, the drawing, specifications and manufacturer's instructions • Heating system working properly

Suggestions for Competency-Related Knowledge, Skills, Attitudes and Perceptions

The following suggestions take into account the elements of the competency, the main components of these elements and the performance criteria related to the competency.

1. Plan the installation.

• Plan the work.	Electrical symbols specific to heating systems, thermostats and other electrical components Location of heating equipment and thermostats in drawings and specifications (see Module 10) Drawing standards for installation sketches and wiring diagrams (see Module 5)
• Determine heating requirements according to the customer's requests.	Evaluation of heating requirements: simplified calculation method based on square meters and calculation method based on insulation

• Choose a heating system and associated controls for a residential, commercial, institutional or industrial installation.	Methods of heat transfer: convection, conduction and radiation Types and operating principles of electrical central heating systems: warm air, hot water, dual energy, radiant, etc. Types of heating equipment: electrical furnace, baseboards, convectors, infrared lamps, radiant heating panels, warm-air or hot-water electrical central heating system with hot water storage tank, etc. Characteristics of equipment: electrical operation, power supply and control voltage, components, uses, etc. Types of thermostats: line, very low voltage, electronic, combined with air conditioning, etc. Types of controls: magnetic relay, thermal relay, motorized valve, etc. Characteristics of controls: operating principle, voltage, components, uses, etc.
• Determine the number of heating units required.	Rules regarding the spacing of units Standardized power of units
• Consult the *Québec Electrical Code*.	Provisions related to fixed electrical space and surface-heating systems Provisions related to the selection of conduits, conductors, boxes and protective devices, etc.
• Choose the electrical materials, tools and equipment required to install the heating system.	Fastening devices, boxes, cables, conductors or conduits (see Module 8) Tools and equipment for working at heights and handling materials (see Modules 6 and 7)

2. Secure the components and make the connections.

• Secure the components.	Placement depending on type of equipment Safe work techniques (see Modules 2 and 7) Methods of securing and assembling components (see Module 6) Method of pulling conductors (see Module 8)
• Make the connections.	Removal of cable jacket, conductor insulation and connection (see Module 8)

3. Verify that the heating system is working properly.

• Take measurements on the heating system.	Ground continuity check of power source and control conductors Powering on of system in stages Verification of the voltage, current and power (see Module 4) Verification of the operation of heating circuits, thermostats, control relays or electronic controls (see Modules 13 and 14) Use of a multimeter and clamp-on ammeter
• Solve problems related to installing the heating system.	Main problems encountered: defective or poorly calibrated thermostat, burned-out element, tripped thermal protection, interrupted power source, etc. Application of a troubleshooting method: test, diagnosis, correction and verification

4. Maintain the heating system.

• Plan the work.	Verification and replacement schedule Interpretation of maintenance sheet (see Module 10)
• Verify the power source, connections, control circuits and the physical condition of the heating system.	Application of padlocking lockout procedure Use of measuring instruments (see Modules 4, 13 and 14) Tactile inspection
• Determine the causes of operating problems related to the system.	Main signs of problems and their causes: wear, defective thermostat or relay, burned-out element, dirty filter, motor noise, etc. Application of a troubleshooting method: test, diagnosis, correction and verification
• Perform the maintenance.	Corrective and preventive maintenance: replacement of thermostats, cleaning of contacts, elements and filters, etc.

5. Complete the work.

• Store tools and materials, and clean the work area.	
• Write the installation report or maintenance sheet.	Standards for writing an installation report and maintenance sheet Description of work done List of materials used Calculation of hours worked

Communications Wiring	Code:	783555

Module 17 Duration 75 hours

Behavioural Objective

Statement of the Competency	Achievement Context
To install copper and fibre optic communications cables.	• For the installation of home automation, telephone, video surveillance and intercommunications systems • Using a wiring diagram, materials, measuring instruments, the required tools, personal protection equipment and manufacturers' manuals

Elements of the Competency	Performance Criteria
1. Plan the installation.	• Accurate interpretation of the diagram • Accurate interpretation of technical information on the types of communications cables • Appropriate choice of cables, cable trays, connectors and interconnection boxes • Appropriate choice of tools
2. Secure the interconnection boxes, cable trays and cables.	• Correct placement of interconnection boxes • Levelling of cable trays and interconnection boxes • Correct, solid installation of cable trays and cables • Appropriate choice and use of cable-pulling technique • Appropriate use of fish wire inside walls, ceilings and floors
3. Install the connectors.	• Appropriate use of crimping and splicing techniques • Solid crimps and splices • Integrity of conductors and fibres • Correct identification of conductors and fibres • Compliance with colour codes • Precise verification of signal loss
4. Complete the work.	• Appropriate storage of tools • Appropriate cleaning of work area

For the competency as a whole:

- Observance of health and safety rules, including those related to handling fibre optics
- Appropriate use of measuring instruments and tools
- Installation in compliance with the diagram and manufacturer's instructions

Suggestions for Competency-Related Knowledge, Skills, Attitudes and Perceptions

The following suggestions take into account the elements of the competency, the main components of these elements and the performance criteria related to the competency.

1. Plan the installation.

• Plan the work.	Electrical symbols specific to communications cables Interpretation of installation sketch
• Choose cables, cable trays and interconnection boxes for a residential, commercial, institutional or industrial installation.	Types of communications cables: copper cables (categories 3, 4, 5), fibre optic cables (bare, jacketed, special, interconnection), coaxial cables (impedance of 50 or 75 ohms) Characteristics of cables: installation and connection techniques, uses, etc. Types of cable trays: open, closed, trunking, manufacturing materials, etc. Characteristics of cable trays: installation and assembly techniques, uses, etc. Interconnection boxes for telephone, home automation, video surveillance and intercommunications systems
• Consult the *Québec Electrical Code*.	Provisions related to wiring Provisions related to fibre optic cables Provisions related to the selection of conduits, conductors, boxes and protective devices, etc.
• Choose the tools and equipment required to install cable trays and cables.	Tools and equipment for working at heights and handling materials (see Modules 6 and 7)

2. Secure the interconnection boxes, cable trays and cables.

• Secure the interconnection boxes and cable trays.	Placement of interconnection boxes according to use Safe work techniques (see Module 2) Method of assembling components (see Module 6)
• Use pulling techniques.	Techniques for pulling cables and conductors: conductors inside a conduit, cables inside a wall, ceiling and floor Pulling accessories: baskets, fish wire, pulleys, lubricant, electrical winch, etc.

3. Install the connectors.

• Recognize the connectors corresponding to communications cables.	Types of fibre optic connectors: single- or multi-mode connectors, ST/P, FC/CP, etc. Types of connectors for copper cable: RJ-11, RJ-45, etc. Connectors for coaxial cables: BNC, F type, etc.
• Secure the connectors.	Method of removing different protective jackets from cable Method of removing conductor insulation Methods of crimping and splicing conductors and use of electrician's knife for copper and coaxial cables Methods of crimping fibre optics: fusion and mechanical Method of splicing connectors for fibre optics Safety measures to observe when handling fibre optics
• Verify signal losses.	Types of measuring instruments for fibre optics: optical reflectometer, optical wattmeter Types of measuring instruments for copper cables: tone generator, testing handset and inductive sensor Types of measuring instruments for coaxial cables: tone generator, coaxial cable tester (short-circuit and impedance), etc.
• Label the fibre optic conductors.	Technique for identifying communications cables Cable register

4. Complete the work.

- Store tools and materials, and clean the work area.

Fire Alarm Systems	Code:	783564

Module 18 Duration 60 hours

Behavioural Objective

Statement of the Competency	Achievement Context
To install a fire alarm system.	• For residential, commercial, institutional and industrial installations • Using a drawing and specifications, materials, measuring instruments and the required tools, personal protection equipment and manufacturers' manuals

Elements of the Competency	Performance Criteria
1. Plan the installation.	• Accurate interpretation of the drawing and specifications • Accurate interpretation of technical information on the types of fire alarm systems • Appropriate choice of type of fire alarm system • Appropriate choice of protective devices, boxes, conductors and cables or conduits • Appropriate choice of tools • Relevant sketches
2. Secure the components and make the connections.	• Correct placement of detectors, alarms, control panel or optional components • Proper securing technique • Proper installation of conduits and electrical and communications cables • Appropriate connection of conductors
3. Verify that the fire alarm system is working properly.	• Proper performance of a continuity check • Proper method of powering on • Appropriate use of measuring instruments • Appropriate verification of voltage • Appropriate verification of warning and alarm signals • Correct determination of operating problems and their causes • Relevant corrections made
4. Complete the work.	• Appropriate storage of tools • Appropriate cleaning of work area • Proper completion of installation report

For the competency as a whole:

- Observance of health and safety rules
- Appropriate use of measuring instruments and tools
- Installation in compliance with the *Québec Electrical Code*, standards published by the Underwriters' Laboratories of Canada (ULC), the drawing, specifications and manufacturer's instructions
- Fire alarm system working properly

Suggestions for Competency-Related Knowledge, Skills, Attitudes and Perceptions

The following suggestions take into account the elements of the competency, the main components of these elements and the performance criteria related to the competency.

1. Plan the installation.

• Plan the work.	Electrical symbols specific to a fire alarm system Location of detectors and alarms in the drawings and specifications (see Module 10) Drawing standards for installation sketches and wiring diagrams (see Module 5)
• Choose a fire alarm system for a residential, commercial, institutional or industrial installation.	Types of fires: A, B, C Types of systems: single signal, dual signal, addressable, etc. Characteristics of systems: zoning principles, class A or B circuits, operating principle, test voltage, uses, etc. Types of detectors: smoke, heat, manual pull station, etc. Characteristics of detectors: operating principle, test and supply voltage, uses, etc. Types of alarms: bell, visual signal, speakers, etc. Characteristics of alarms: operating principle, test and supply voltage, uses, etc. Types of control panels: one or more zones, intelligent, etc. Characteristics of control panels: configuration process, operation (normal, alarm, power outage and reset mode), emergency power supply, etc. Optional components: annunciation panel, door holder, telephone module, etc.

• Consult the *National Building Code*, ULC standards and the *Québec Electrical Code*.	*National Building Code* Installation standard Standard for the placement of smoke alarms *Québec Electrical Code*: provisions related to fire alarm systems and fire suppression systems; provisions related to the selection of conduits, conductors, boxes and protective devices, etc.
• Choose the electrical materials, tools and equipment required to install the fire alarm system.	Fastening devices, boxes, cables, conductors, conduits and communications cables (see Modules 8 and 17) Tools and equipment for working at heights and handling materials (see Modules 6 and 7)

2. Secure the components and make the connections.

• Secure the components.	Placement according to standards Safe work techniques (see Modules 2 and 7) Methods of securing and assembling components (see Module 6) Method of pulling conductors and communications cables (see Modules 8 and 17)
• Make the connections.	Removal of cable jacket, insulation from conductor and communications cable, and connection (see Modules 8 and 17)

3. Verify that the fire alarm system is working properly.

• Take measurements on the fire alarm system.	Ground continuity check of power source conductors, detection system conductors and alarm system conductors Powering on of system in stages Verification of detection and alarm signals in each zone, the annunciation panel and other components (see Modules 4, 13 and 14) Use of a multimeter
• Solve problems related to installing the fire alarm system.	Main problems encountered: defective detector, reverse polarity of component terminals, interrupted power source, etc. Application of a troubleshooting method: test, diagnosis, correction and verification

4. Complete the work.

• Store tools and materials, and clean the work area.	
• Write the installation report.	Standards for writing an installation report Description of work done List of materials used Calculation of hours worked

Home Automation and Telephone Systems	Code:	783578

Module 19 Duration 120 hours

Behavioural Objective

Statement of the Competency	Achievement Context
To install home automation and residential telephone systems.	• For home automation systems controlling heating, lighting, intrusion alarm, fire alarm, intercommunications, doorbell and video surveillance systems that have already been installed • Using a drawing and specifications, materials, measuring instruments, the required tools, personal protection equipment and manufacturers' manuals

Elements of the Competency	Performance Criteria
1. Plan the installation.	• Accurate interpretation of the drawing and specifications • Accurate interpretation of technical information on the types of home automation and telephone systems • Accurate interpretation of customer's needs • Appropriate choice of home automation and telephone systems • Appropriate choice of protective devices, boxes, conductors and cables or conduits • Appropriate choice of tools • Relevant sketches
2. Secure the components and make the connections.	• Correct placement of detectors, controlled modules, the control panel and telephone jacks • Proper securing technique • Proper installation of conduits, electrical cables and communications cables • Proper connection of conductors

3. Verify that the home automation and telephone systems are working properly.	• Proper performance of a continuity check • Proper method of powering on • Configuration of the control panel according to the customer's needs • Appropriate use of measuring instruments • Appropriate verification of the voltage, current and power • Appropriate verification of the operation of controls, control relays or electronic controls • Correct determination of operating problems and their causes • Relevant corrections made
4. Complete the work.	• Appropriate storage of tools • Appropriate cleaning of work area • Proper completion of an installation report
	For the competency as a whole:
	• Observance of health and safety rules • Appropriate use of measuring instruments and tools • Installation in compliance with the *Québec Electrical Code*, the drawing, specifications and manufacturer's instructions • Home automation and telephone systems working properly

Suggestions for Competency-Related Knowledge, Skills, Attitudes and Perceptions

The following suggestions take into account the elements of the competency, the main components of these elements and the performance criteria related to the competency.

1. Plan the installation.

• Plan the work.	Electrical symbols specific to home automation and telephone systems, controls and other electrical and electronic components Location of home automation and telephone systems and controls in the drawings and specifications (see Module 10) Drawing standards for installation sketches and wiring diagrams (see Module 5)

• Choose the home automation and residential telephone systems according to the customer's requests.	Types of home automation systems: independent systems and those combined with other systems (intrusion alarm, fire alarm, intercommunications, heating, lighting and telephone) Signals via carrier current (bus), addressable modules (X10), etc. Types of detectors and uses Types of control panels Types of telephone systems: single and multiple lines Telephone wiring (series or star method) Distribution block Types of cables (containing 2, 4, 6 or 8 twisted pairs) Outlets and plugs
• Consult the *Québec Electrical Code*.	Provisions related to the selection of conduits, conductors, boxes and protective devices, etc.
• Choose home automation and telephone system materials as well as the tools and equipment required to install a home automation or telephone system.	Fastening devices, boxes, cables, conductors or conduits (see Modules 8 and 17) Tools and equipment for working at heights and handling materials (see Modules 6 and 7)

2. Secure the components and make the connections.

• Secure the components.	Placement of detectors, controlled modules, the control panel and telephone jacks according to uses Safe work techniques (see Modules 2 and 7) Methods of securing and assembling components (see Module 6) Method of pulling conductors and communications cables (see Modules 8 and 17)
• Make the connections.	Removal of cable jacket, insulation from conductor and communications cable, and connection (see Modules 8 and 17) Connection to the ground

3. Verify that the home automation and telephone systems are working properly.

• Configure the control panel for the home automation and telephone systems according to the customer's needs.	Configuration procedures based on the manufacturer's manual and customer's requests Verification with the central station, if necessary

• Take measurements on the home automation and telephone systems.	Ground continuity check of power source and control conductors Powering on of system in stages Verification of the voltage, current and power (see Module 4) Verification of the operation of controls, control relays or electronic controls (see Modules 13 and 14) Impact of harmonics on the system's operation Use of a multimeter and oscilloscope
• Solve problems related to installing the home automation and telephone systems.	Main problems encountered: defective control, incorrect addressing, noise, interrupted power source, defective wiring, etc. Application of a troubleshooting method: test, diagnosis, correction and verification

4. Complete the work.

• Store tools and materials, and clean the work area.	
• Write the installation report.	Standards for writing an installation report Description of work done List of materials used Calculation of hours worked

DC and single-phase AC Rotating Machines	Code:	783586

Module 20 Duration 90 hours

Behavioural Objective

Statement of the Competency	Achievement Context
To install and maintain DC and single-phase AC rotating machines and associated controls.	• For a motor with a maximum of 3 HP and a generator with a maximum of 5 kW • Using a drawing and specifications, materials, measuring instruments, the required tools, personal protection equipment and manufacturers' manuals

Elements of the Competency	Performance Criteria
1. Plan the installation.	• Accurate interpretation of the drawing and specifications • Accurate interpretation of technical information on the type of motor, generator and controls • Appropriate choice of controls • Appropriate choice of protective devices, control cabinet, boxes, conductors, cables and conduits • Appropriate choice of tools • Relevant sketches
2. Secure the rotating machine and associated components, and make the connections.	• Correct placement of the rotating machine, control cabinet, boxes and controls • Proper securing technique • Correct installation of cables and conduits • Correct identification of conductors • Proper connection of conductors
3. Verify that the rotating machine is working properly.	• Proper performance of continuity checks • Proper method of powering on • Proper start-up procedure • Appropriate use of measuring instruments • Appropriate verification of the voltage, current and power • Appropriate verification of the operation of controls, control relays or electronic controls • Correct determination of operating problems and their causes • Relevant corrections made

4. Maintain the rotating machine.	• Accurate interpretation of the maintenance procedure • Appropriate verification of the condition of the rotating machine and mechanical components • Appropriate verification of winding resistance and ground resistance • Appropriate verification of power source, connections and control circuits • Correct determination of operating problems and their causes • Replacement of defective parts • Thorough cleaning of the rotating machine's components
5. Complete the work.	• Appropriate storage of tools • Appropriate cleaning of work area • Proper completion of an installation report or maintenance sheet
	For the competency as a whole: • Observance of health and safety rules • Appropriate use of measuring instruments and tools • Installation in compliance with the *Québec Electrical Code*, the drawing, specifications and manufacturer's instructions • Rotating machine and associated controls working properly

Suggestions for Competency-Related Knowledge, Skills, Attitudes and Perceptions

The following suggestions take into account the elements of the competency, the main components of these elements and the performance criteria related to the competency.

1. Plan the installation.

• Plan the work.	Electrical symbols specific to single-phase DC and AC rotating machines, controls and other electrical components Location of controls in the drawings and specifications (see Module 10) Drawing standards for installation sketches and wiring diagrams (see Module 5)

• Choose the controls for a rotating machine.	DC and AC generator: operating principle, power, voltage, uses, etc. DC motors: permanent magnet motors, shunt, series and compound, operating principle, reverse rotation, operating voltage, power, uses, etc. Single-phase AC motors: auxiliary phase, capacitor, series (universal), operating principle, reverse rotation, operating voltage, power, uses, etc. Manual controls: switch with overload contact, drum switch, operating principle and uses Electrical controls: relay, contactor, time-delay relay, push button, operating principle and uses Automatic controls: limit switch, programmable controller, operating principle and uses Electronic controls: DC variable-voltage regulator, AC frequency inverter, operating principle and uses Types of starters: full-voltage starter, reduced-voltage starter, reversing starter, electronic starter, operating principle and uses Types of protective devices: time-delay fuses, thermal relay, thermostatic sensor, operating principle and uses Reading of motor and generator nameplates
• Consult the *Québec Electrical Code*.	Provisions related to motors and generators Provisions related to the selection of conduits, conductors, boxes and protective devices, etc.
• Choose the electrical materials, tools and equipment required to install the rotating machine.	Fastening devices, control cabinets, boxes, conductors, cables and conduits (see Module 8) Tools and equipment for working at heights and handling materials (see Modules 6 and 7)

2. Secure the rotating machine and associated components, and make the connections.

• Secure the motor or generator and associated components.	Placement depending on the use of the rotating machine Safe work techniques (see Modules 2 and 7) Methods of securing and assembling components (see Module 6) Method of pulling conductors (see Module 8)
• Make the connections.	Removal of cable jacket, conductor insulation and connection (see Module 8) Connection to the ground

3. Verify that the rotating machine is working properly.

• Take measurements on the motor or generator and associated controls.	Ground continuity check of power source and control conductors Powering on of system in stages Verification of the voltage, current and power (see Module 4) Verification of the operation of controls, control relays or electronic controls (see Modules 13 and 14) Use of a multimeter, megohmmeter, clamp-on ammeter, wattmeter and tachometer
• Solve problems related to installing the motor or generator.	Main problems encountered: defective control, overheating of motor or generator, interrupted power source, burnt fuse, tripped overload relay, etc. Application of a troubleshooting method: test, diagnosis, correction and verification

4. Maintain the rotating machine.

• Plan the work.	Verification and replacement schedule Interpretation of maintenance sheet (see Module 10)
• Verify the power source, connections, control circuits, winding resistance, ground resistance as well as the physical condition of the rotating machine and associated mechanical components.	Application of padlocking lockout procedure Use of measuring instruments (see Modules 4, 13 and 14) Visual and tactile inspection, and use of measuring instruments
• Determine the causes of operating problems related to the motor or generator and associated controls.	Main signs of problems and their causes: wear of brushes and ball bearings, power drop, noise, abnormal overheating, bluish or blackened power contacts on the controls, etc. Application of a troubleshooting method: test, diagnosis, correction and verification
• Perform the maintenance.	Corrective and preventive maintenance: replacement of push buttons and electrical, thermal or electronic relays, replacement of brushes, cleaning of fans, etc.

5. Complete the work.

• Store tools and materials, and clean the work area.	
• Write the installation report or maintenance sheet.	Standards for writing an installation report and maintenance sheet Description of work done List of materials used Calculation of hours worked

Three-Phase AC Rotating Machines	Code:	783597

Module 21 Duration 105 hours

Behavioural Objective

Statement of the Competency	Achievement Context
To install and maintain a three-phase AC rotating machine and associated controls.	• For a motor with a maximum of 3 HP and a generator with a maximum of 5 kW • Using a drawing and specifications, materials, measuring instruments, the required tools, personal protection equipment and manufacturers' manuals

Elements of the Competency	Performance Criteria
1. Plan the installation.	• Accurate interpretation of the drawing and specifications • Accurate interpretation of technical information on the type of motor, generator and controls • Appropriate choice of controls • Appropriate choice of protective devices, control cabinet, boxes, conductors, cables and conduits • Appropriate choice of tools • Relevant sketches
2. Secure the rotating machine and associated components, and make the connections.	• Correct placement of rotating machine, control cabinet, boxes and controls • Proper securing technique • Proper installation of cables and conduits • Correct identification of conductors • Proper connection of conductors
3. Verify that the rotating machine is working properly.	• Proper performance of continuity checks • Proper method of powering on • Proper start-up procedure • Appropriate use of measuring instruments • Appropriate verification of the voltage, current and power • Appropriate verification of the operation of controls, control relays or electronic controls • Correct determination of operating problems and their causes • Relevant corrections made

4. Maintain the rotating machine.	• Accurate interpretation of the maintenance procedure • Appropriate verification of the condition of the rotating machine and mechanical components • Appropriate verification of winding resistance and ground resistance • Appropriate verification of power source, connections and control circuits • Correct determination of operating problems and their causes • Replacement of defective parts • Thorough cleaning of the rotating machine's components
5. Complete the work.	• Appropriate storage of tools • Appropriate cleaning of work area • Proper completion of an installation report or maintenance sheet
	For the competency as a whole:
	• Observance of health and safety rules • Appropriate use of measuring instruments and tools • Installation in compliance with the *Québec Electrical Code*, the drawing, specifications and manufacturer's instructions • Rotating machine and associated controls working properly

Suggestions for Competency-Related Knowledge, Skills, Attitudes and Perceptions

The following suggestions take into account the elements of the competency, the main components of these elements and the performance criteria related to the competency.

1. Plan the installation.

• Plan the work.	Electrical symbols specific to three-phase AC motors and generators, controls and other electrical components Location of controls in the drawings and specifications (see Module 10) Drawing standards for installation sketches and wiring diagrams (see Module 5)

• Choose the controls for a rotating machine.	Three-phase AC generator: operating principle, power, voltage, uses, etc. Three-phase AC motors: induction squirrel-cage, multispeed, asynchronous, wound rotor synchronous, operating principle, reverse rotation, operating voltage, power, uses, etc. Manual controls: switch with overload contact, drum switch, operating principle, power, voltage, uses, etc. Electrical controls: relay, contactor, time-delay relay, push button, operating principle, power, voltage, uses, etc. Automatic controls: limit switch, programmable controller, operating principle, power, voltage, uses, etc. Electronic controls: AC variable speed drive, operating principle, power, voltage, uses, etc. Types of starters: full-voltage starter, reduced-voltage starter, reversing starter, electronic starter, operating principle and uses Types of protective devices: time-delay fuses, thermal relay, thermostatic sensor, operating principle and uses Reading of motor and generator nameplates
• Consult the *Québec Electrical Code*.	Provisions related to motors and generators Provisions related to the selection of conduits, conductors, boxes and protective devices, etc.
• Choose the electrical materials, tools and equipment required to install rotating machines.	Fastening devices, control cabinets, boxes, conductors, cables and conduits (see Module 8) Tools and equipment for working at heights and handling materials (see Modules 6 and 7)

2. Secure the rotating machine and associated components, and make the connections.

• Secure the motor or generator and associated components.	Placement depending on the use of the rotating machine Safe work techniques (see Modules 2 and 7) Methods of securing and assembling components (see Module 6) Method of pulling conductors (see Module 8)
• Make the connections.	Removal of cable jacket, conductor insulation and connection (see Module 8) Connection to the ground

3. Verify that the rotating machine is working properly.

• Take measurements on the motor or generator and associated controls.	Ground continuity check of power source and control conductors Powering on of system in stages Verification of the voltage, current and power (see Module 4) Verification of the operation of controls, control relays or electronic controls (see Modules 13 and 14) Use of a multimeter, megohmmeter, clamp-on ammeter, wattmeter and tachometer
• Solve problems related to installing the motor or generator.	Main problems encountered: defective control, overheating of motor or generator, interrupted power source, burnt fuse, tripped overload relay, etc. Application of a troubleshooting method: test, diagnosis, correction and verification

4. Maintain the rotating machine.

• Plan the work.	Verification and replacement schedule Interpretation of maintenance sheet (see Module 10)
• Verify the power source, connections, control circuits, winding resistance, ground resistance as well as the physical condition of the rotating machine and associated mechanical components.	Application of padlocking lockout procedure Use of measuring instruments (see Modules 4, 13 and 14) Visual and tactile inspection, and use of measuring instruments
• Determine the causes of operating problems related to the motor or generator and associated controls.	Main signs of problems and their causes: wear of brushes and ball bearings, power drop, noise, abnormal overheating, bluish or blackened power contacts on the controls, etc. Application of a troubleshooting method: test, diagnosis, correction and verification
• Perform the maintenance.	Corrective and preventive maintenance: replacement of push buttons and electrical, thermal or electronic relays, replacement of brushes, cleaning of fans, etc.

5. Complete the work.

• Store tools and materials, and clean the work area.	
• Write the installation report or maintenance sheet.	Standards for writing an installation report and maintenance sheet Description of work done List of materials used Calculation of hours worked

Programmable Controllers	Code:	783607

Module 22 Duration 105 hours

Behavioural Objective

Statement of the Competency	Achievement Context
To install and maintain a programmable controller for building electrical systems.	• For a controller comprising a maximum of 16 inputs and outputs • Using a drawing, specifications, materials, measuring instruments, the required tools, personal protection equipment, configuration software and manufacturers' manuals

Elements of the Competency	Performance Criteria
1. Plan the installation.	• Accurate interpretation of the drawing and specifications • Accurate interpretation of technical information on the controller • Appropriate choice of controller and input and output components • Appropriate choice of protective devices, control cabinet, boxes, conductors, cables and conduits • Appropriate choice of tools • Relevant sketches
2. Secure the control cabinet and associated components, and make the connections.	• Correct placement of the control cabinet and input and output components • Proper securing technique • Proper installation of conduits and electrical and communications cables • Proper connection of conductors
3. Verify that the controller is working properly.	• Proper performance of a continuity check • Proper method of powering on • Proper start-up procedure • Appropriate use of configuration software • Correct configuration of controller • Appropriate verification of voltage • Appropriate verification of the operation of electrical or electronic relays • Correct determination of operating problems and their causes • Relevant corrections made

4. Maintain the input and output components of the controller.	• Accurate interpretation of the maintenance procedure • Appropriate verification of the condition of components • Appropriate verification of power source and input and output connections • Correct determination of operating problems and their causes • Replacement of defective parts • Thorough cleaning of components
5. Complete the work.	• Appropriate storage of tools • Appropriate cleaning of work area • Proper completion of an installation report or maintenance sheet
	For the competency as a whole:
	• Observance of health and safety rules • Appropriate use of measuring instruments and tools • Installation in compliance with the *Québec Electrical Code*, the drawing, specifications and manufacturer's instructions • Controller working properly

Suggestions for Competency-Related Knowledge, Skills, Attitudes and Perceptions

The following suggestions take into account the elements of the competency, the main components of these elements and the performance criteria related to the competency.

1. Plan the installation.

• Plan the work.	Electrical symbols specific to controllers, controls and other electrical components Location of controllers and controls in the drawings and specifications (see Module 10) Drawing standards for installation sketches and wiring diagrams (see Module 5)
• Choose a controller and associated input and output components for a building electrical system.	Characteristics and operation of controller components: power supply, input and output modules, special modules, communications module, etc. Choice of equipment: push buttons, limit switch, sensors, probe, fan, motor, relay, contactor, etc.
• Consult the *Québec Electrical Code*.	Provisions related to the selection of conduits, conductors, boxes and protective devices, etc.

• Choose the electrical materials, tools and equipment required to install a controller.	Fastening devices, control cabinets, boxes, conductors, cables and conduits (see Modules 8 and 17) Tools and equipment for working at heights and handling materials (see Modules 6 and 7)

2. Secure the control cabinet and associated components, and make the connections.

• Secure the control cabinet and associated components.	Placement of control cabinet and associated components according to the electrical system being controlled Safe work techniques (see Modules 2 and 7) Methods of securing and assembling components (see Module 6) Method of pulling conductors and communications cables (see Modules 8 and 17)
• Make the connections.	Removal of cable jacket, insulation from conductor and communications cable, and connection (see Modules 8 and 17) Connection of external peripherals to the cabinet

3. Verify that the controller is working properly.

• Take measurements on the controller and electrical system.	Ground continuity check of power source and control conductors Powering on of system in stages Verification of the voltage, current and power (see Module 4) Verification of the operation of controls, control relays or electronic controls (see Modules 13 and 14) Use of a multimeter and clamp-on ammeter
• Configure the controller.	Use of a computer (see Module 3) Use of configuration software: equation in ladder diagram, Boolean or GRAFCET, operation simulation, etc. Communication protocol: Modbus, Ethernet, RS232, RS485, etc.
• Solve problems related to installing the controller.	Main problems encountered: defective control, defective actuator, interrupted power source, etc. Application of a troubleshooting method: test, diagnosis, correction and verification

4. Maintain the input and output components of the controller.

• Plan the work.	Verification and replacement schedule Interpretation of maintenance sheet (see Module 10)

• Verify the power source, connections and physical condition of the input and output components.	Application of padlocking lockout procedure Use of measuring instruments (see Modules 4, 13 and 14) Visual and tactile inspection
• Determine the causes of operating problems related to the controller.	Main signs of problems and their causes: wear, loosening of terminal blocks, overheating, humming, etc. Application of a troubleshooting method: test, diagnosis, correction and verification
• Perform the maintenance.	Corrective and preventive maintenance: replacement of actuators, cleaning of terminal blocks, etc.

5. Complete the work.

• Store tools and materials, and clean the work area.	
• Write the installation report or maintenance sheet.	Standards for writing an installation report and maintenance sheet Description of work done List of materials used Calculation of hours worked

Electronic Instrumentation	Code:	783615

Module 23 Duration 75 hours

Behavioural Objective

Statement of the Competency	Achievement Context
To install and maintain electronic instrumentation for building electrical systems.	• Using a drawing, specifications, flowcharts and instrumentation diagrams, materials, measuring instruments and the required tools, personal protection equipment and manufacturers' manuals

Elements of the Competency	Performance Criteria
1. Plan the installation.	• Accurate interpretation of the drawing, specifications, flowcharts and diagrams • Accurate interpretation of technical information on the types of electronic instrumentation • Accurate interpretation of customer's needs • Appropriate choice of type of instrumentation control module • Appropriate choice of protective devices, control cabinet, boxes, conductors, cables and conduits • Appropriate choice of tools • Relevant sketches
2. Secure the control cabinet and associated components, and make the connections.	• Correct placement of the control cabinet, sensors and converters • Proper securing technique • Proper installation of electrical and communications cables as well as conduits • Proper connection of conductors
3. Verify that the electronic instrumentation is working properly.	• Proper performance of a continuity check • Appropriate verification of the voltage and current • Appropriate verification of the operation of electronic relays • Configuration of instrumentation control module according to customer's needs • Proper calibration of converters and instrumentation control module • Compliance with manufacturer's standards • Correct determination of operating problems and their causes • Relevant corrections made

4. Maintain the electronic instrumentation.	• Accurate interpretation of the maintenance procedure • Appropriate verification of the condition of sensors, converters and the instrumentation control module • Appropriate verification of the calibration of converters and the instrumentation control module • Appropriate verification of communication signals • Correct determination of operating problems and their causes • Replacement of defective parts • Thorough cleaning of components
5. Complete the work.	• Appropriate storage of tools • Appropriate cleaning of work area • Proper completion of an installation report or maintenance sheet
	For the competency as a whole: • Observance of health and safety rules • Appropriate use of measuring instruments and tools • Installation in compliance with the drawing, specifications, flowchart and instrumentation diagrams and manufacturer's instructions • Instrumentation system working properly

Suggestions for Competency-Related Knowledge, Skills, Attitudes and Perceptions

The following suggestions take into account the elements of the competency, the main components of these elements and the performance criteria related to the competency.

1. Plan the installation.

• Plan the work.	Flowchart and process and instrumentation diagram (PID) Location of instrumentation in the drawings and specifications (see Module 10) Drawing standards for installation sketches and wiring diagrams (see Module 5)

• Choose the instrumentation control module in accordance with the customer's needs.	Analog and digital measuring assemblies Type of control and characteristics: open loop and closed loop Control modules for temperature, flow, heat, speed, level, etc. Types of components and their characteristics: sensors, converters, display, recorder, etc. Control module communication protocol: Modbus, Ethernet, RS232, RS485, etc. Type of communications cables (see Module 17)
• Consult the *Québec Electrical Code*.	Provisions related to fibre optic cables Provisions related to the selection of conduits, conductors, boxes and protective devices, etc.
• Choose the electrical materials, tools and equipment required to install electronic instrumentation.	Fastening devices, control cabinets, boxes, conductors, cables and conduits (see Modules 8 and 17) Tools and equipment for working at heights and handling materials (see Modules 6 and 7)

2. Secure the control cabinet and associated components, and make the connections.

• Secure the control cabinet and associated components.	Placement of control cabinet and associated components according to the electrical system being controlled Safe work techniques (see Modules 2 and 7) Methods of securing and assembling components (see Module 6) Method of pulling conductors and communications cables (see Modules 8 and 17)
• Make the connections.	Removal of cable jacket, insulation from conductor and communications cable, and connection (see Modules 8 and 17) Connection of external peripherals to the cabinet

3. Verify that the electronic instrumentation is working properly.

• Take measurements on the instrumentation system.	Ground continuity check of conductors Verification of the voltage and current (see Module 4) Verification of the operation of controls, control relays or electronic controls (see Modules 13 and 14) Use of a multimeter, oscilloscope, ammeter and signal generator
• Configure the instrumentation control module according to the customer's needs.	Communication and language procedures Use of configuration software and addressing of inputs and outputs

• Calibrate converters and the instrumentation control module.	Manufacturer's calibration procedures Use of a multimeter, oscilloscope, ammeter and signal generator
• Solve problems related to installing the electronic instrumentation.	Main problems encountered: defective control, measurement error, incorrect addressing, interrupted power source, etc. Application of a troubleshooting method: test, diagnosis, correction and verification
4. Maintain the electronic instrumentation.	
• Plan the work.	Verification and replacement schedule Interpretation of maintenance sheet (see Module 10)
• Verify the operation and physical condition of the electronic instrumentation.	Use of measuring instruments for sensors, converters and the instrumentation control module Presence of communication signals Visual and tactile inspection
• Determine the causes of operating problems related to the electronic instrumentation.	Main signs of problems and their causes: wear, heat, no display, etc. Application of a troubleshooting method: test, diagnosis, correction and verification
• Perform the maintenance.	Corrective and preventive maintenance: replacement of converters, adjustment of sensors, cleaning of connections, calibration, etc.
5. Complete the work.	
• Store tools and materials, and clean the work area.	
• Write the installation report or maintenance sheet.	Standards for writing an installation report and maintenance sheet Description of work done List of materials used Calculation of hours worked

Preparation for the Job Market	Code:	783622

Module 24 Duration 30 hours

Behavioural Objective

Statement of the Competency

To prepare for the job market.

Achievement Context

- Using the appropriate documentation

Elements of the Competency	Performance Criteria
1. Learn about the legal requirements for practising the trade as well as organizations in the construction industry.	• Accurate identification of companies working in the construction sector, other sectors, or in both the construction and other sectors • Accurate identification of rules related to practising the trade in the construction sector and other sectors • Accurate identification of the roles and responsibilities of organizations and employer and employee associations
2. Identify potential employers.	• Correct preparation of a list of potential employers • Appropriate use of employment information sources
3. Write a job application letter.	• Clarity of the letter with respect to the job sought • Observance of presentation standards
4. Prepare for and undergo a selection interview.	• Appropriate dress and appearance • Demonstration of attitudes and behaviours indicative of active listening and focus • Clear statements
	For the competency as a whole: • Relevant information gathered and transmitted

Suggestions for Competency-Related Knowledge, Skills, Attitudes and Perceptions

The following suggestions take into account the elements of the competency, the main components of these elements and the performance criteria related to the competency.

1. Learn about the legal requirements for practising the trade as well as organizations in the construction industry.

• Identify the companies working in the construction sector, other sectors, or in both the construction and other sectors.	Legal definition of the construction sector and the work governed by this sector Electrical contractors for the construction sector Companies hiring electricians in sectors other than construction: industrial or primary processing company, institutional sector, etc.
• Identify the rules related to practising the trade as well as the roles and responsibilities of organizations and employer and employee associations in the construction sector and other sectors.	Trade apprenticeship schemes: Emploi-Québec and the Commission de la construction du Québec Roles and responsibilities of organizations in the construction sector: Commission de la construction du Québec, unions representing electricians Roles and responsibilities of organizations in sectors other than construction: Emploi-Québec, Association des constructeurs-propriétaires en électricité et des électriciens d'entretien du Québec (AcpééeQ) Characteristics of collective agreements for the following sectors: residential, commercial and institutional, industrial, civil and public works

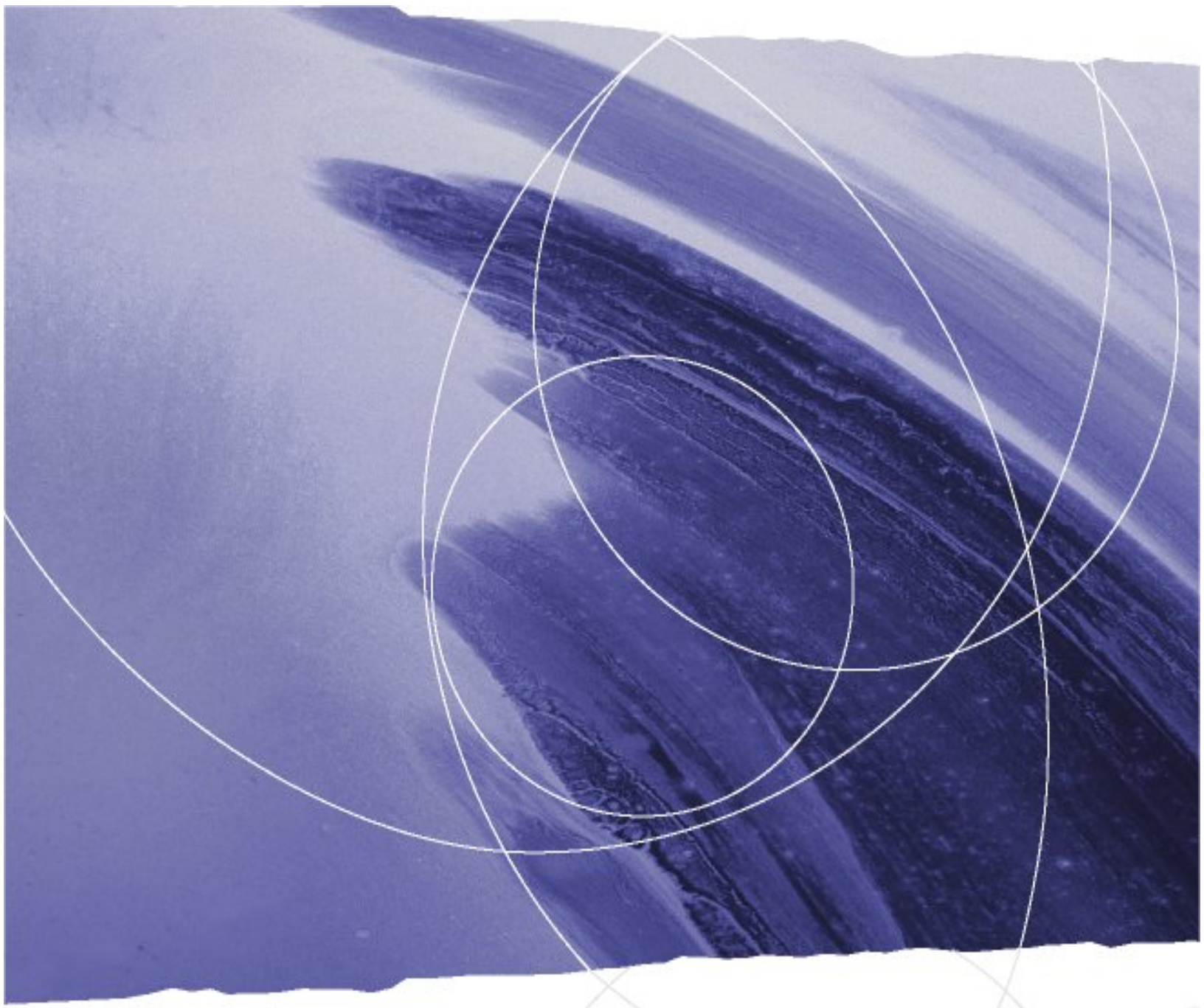
2. Identify potential employers.

• Consult information sources on employers.	Sources: placement agencies, Commission de la construction du Québec, Human Resources Centre (Canada), Local Employment Centre (Québec), list of contractors, etc.
• Make a list of potential employers.	Information to include on the list: company name, address and telephone and fax numbers, name of the person in charge of hiring, region in which company operates, types of activities, size of the company, etc.

3. Write a job application letter.

• Draft a job application letter.	Different parts of a job application letter General principles of presentation: engaging style, short sentences and paragraphs, etc. Elements likely to interest a potential employer: type of job sought, number of years of work experience, education, availability, etc. Documents to attach to the letter: photocopies of diplomas, qualification certificate, letter of recommendation, etc.

• Revise the letter.	Correction of errors
4. Prepare for and undergo a selection interview.	
• Prepare for the interview.	Types of interviews Preparation for the interview: gathering of detailed information on the company, compiling of personal documents, etc. Clothing appropriate for the circumstances
• Undergo an interview.	Behaviour and attitudes: introduction, greeting, politeness, questions asked at appropriate times, enthusiasm, etc. Questions to ask: description of the job, duration of employment, salary, etc.



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