RC 326

Electrical Installation and Codes

3 Credits

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Reviewer: Rob Baron

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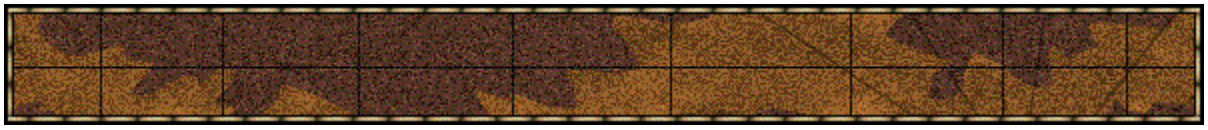

Electrical Installation and Codes

Calendar Description

This is an advanced course that details the codes and regulations which govern the installation of electrical renewable energy systems in residential and commercial buildings in Canada. Topics include the electrical code, building code and examples of regulations or bylaws that may pertain to grid-tie and off-grid solar electric and wind turbine installations.

Rationale

This is a required course for the Sustainable Energy Technology program. Sustainable Energy electrical generation systems pose the same fire and shock hazards as any other electrical system and personnel involved in the design and/or installation of those systems must be aware of the governing regulations and how to properly apply those regulations in order to ensure the safety of workers and the general public. In addition, installations of renewable energy electrical generation systems often have impacts on the structural loads of building and there may be bylaws that deal with ancillary impacts of renewable electrical generation systems. Awareness of the governing regulations is necessary to ensure safety of workers and the general public as well as to avoid unnecessary delays in the implementation of renewable energy projects. This course provides participants with the background to access the appropriate regulations, to evaluate the proper steps to secure licenses and permits for the installation of renewable electrical generation systems, and to apply the governing codes and regulations to the design of renewable electrical generation systems.

Prerequisites

RC 205

Co-Requisites

None

Course Learning Outcomes

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

Module One: Introduction to Electrical Installation and Regulation

(estimated time: 6 hours)

Learning Outcome:

- describe regulations that are applicable to PV (photovoltaic) and Wind Turbine installations.

Learning Objectives:

- identify the Codes and Regulations in your local jurisdiction.
- explain the purpose and organization of the Canadian Electrical Code.
- identify sections of the Canadian Electrical Code that apply to renewable energy systems.
- list who can legally install renewable energy equipment according to provincial laws, acts, and regulations.
- differentiate between various accreditation, certifications, and license categories used in the renewable energy industry.
- outline the applicable sections of the National/Alberta Building Code that may govern the installation of PV or Wind Turbine systems.

Module Two: PV Arrays and the Electrical Code

(estimated time: 6 hours)

Learning Outcome:

- document the design of a PV array that complies with the Canadian/Alberta Electrical Code with drawings and calculations.

Learning Objectives:

- apply PV system design principles to grid-interactive PV systems.
- select conductor types and wire gauges for PV source and output circuits.
- justify the ratings and location of protection and control devices for PV source and output circuits.
- propose valid conductor installation methods for PV source and output circuits.
- discuss valid bonding and grounding methods for PV source and output circuits.

Module Three: Inverter and Battery Wiring, and the Electrical Code

(estimated time: 5 hours)

Learning Outcome:

- document the design of a battery and/or inverter sub-system that meets the requirements of the Canadian/Alberta Electrical Code with drawings and calculations.

Learning Objectives:

- apply PV system design principles to off-grid battery storage.
- select conductor types and wire gauges for battery and inverter circuits.
- justify the ratings and location of protection and control devices for battery and inverter circuits.
- select conductor types and wire gauges for inverter circuits.

- justify the location and ratings of protection and control devices for inverter circuits.
- locate the labels and notices required for inverters.

Module Four: Bonding and Grounding of Inverter Systems

(estimated time: 5 hours)

Learning Outcome:

- document the design of a battery and/or inverter sub-system that meets the requirements of the Canadian/Alberta Electrical Code, with drawings and calculations.

Learning Objectives:

- describe the general requirements for system ground installations.
- illustrate valid bonding methods for battery and/or inverter sub-systems.
- support the configuration of system grounding in a PV system.
- specify the proper equipment for an ungrounded renewable energy power system.
- contrast the requirements for an ungrounded system versus a grounded system.

Module Five: Grid Interconnection and the Electrical Code

(estimated time: 5 hours)

Learning Outcome:

- plan the utility grid-interconnection of a renewable energy system, for residential and commercial buildings, that meets the requirements of the Canadian Electrical Code.

Learning Objectives:

- evaluate a building electrical service for utility grid-interconnection.
- document the design of supply side interconnection.
- document the design of load side interconnection.
- locate the labels and notices required for a utility grid interconnection.

Module Six: Photovoltaic Systems and the Building Code

(estimated time: 5 hours)

Learning Outcome:

- develop the design for a roof-mounted PV array that complies with the National/Alberta Building Code.

Learning Objectives:

- identify applicable National/Alberta Building Code regulations for PV systems.
- evaluate the suitability of a roof for installation of a photovoltaic array.
- select appropriate mechanical integration equipment for roof mounted PV arrays.
- describe acceptable methods of attaching solar photovoltaic mounting structures to pitched roofs.
- determine the hardware required to attach solar photovoltaic mounting structures to pitched roofs.
- describe acceptable methods of preventing water penetration into asphalt shingle roofs.

Module Seven: Wind Turbine Systems and the Electrical Code

(estimated time: 5 hours)

Learning Outcome:

- document the design of a small wind turbine installation that complies with the Canadian/Alberta Electrical Code, and incorporates drawings and calculations.

Learning Objectives:

- select conductor types and wire gauges for small wind turbine circuits.
- propose valid wiring installation methods for small wind turbine circuits.
- select disconnects and overcurrent devices for small wind turbine circuits.
- identify the location of disconnects and overcurrent devices in small wind turbine circuits.
- illustrate the bonding and grounding requirements for small wind turbine circuits.
- identify the location of surge protective devices in small wind turbine circuits.

Module Eight: Bylaws, Zoning, Licences, Permits and Renewable Energy

(estimated time: 8 hours)

Learning Outcome:

- contrast the bylaws of various jurisdictions, preparing forms necessary for the legal completion of a renewable energy system installation.

Learning Objectives:

- explain general bylaw requirements such as height restrictions, setbacks, and accessory or ancillary structures limitations.
- identify examples of bylaws that specifically deal with renewable energy such as sound, screening and location of renewable energy equipment.
- list the requirements of a development permit applications.
- prepare an electrical permit application for a renewable energy system.
- complete a grid-interconnection agreement.

Resource Materials

***Required Text(s)*:**

Warmke, Jay. 2021. Understanding Photovoltaics. BRS Press.

Construction Electrician Apprenticeship Program, Learning Guide H: Install Alternative Power Systems.

Canadian Standards Association. Pope, T. (Technical Editor). 2018. Canadian Electrical Code CSA22.1-18 (24th ed.). Canadian Standards Association, Mississauga, ON.

***Resources*:**

- Access to a computer and the Internet
- Library
- D2L orientation and technical assistance

- CSA *On Demand* account. Available for free at https://store.csagroup.org/ondemand/s/?language=en_US
- on-line Subscription to Solar Pro Magazine: http://solarprofessional.com/
- additional resources as noted in the individual modules

**Additional resources as noted in the individual modules are provided on an as needed basis by your instructor

Conduct of Course

This course consists of the equivalent of 45 hours of lecture delivered on-line using an online learning manager program. The course is delivered over a set 8-week period. Course content modules and links to assigned readings are available on-line. A course facilitator is available to guide the learner through the course, answer any questions, and grade assignments and exams. Learners are expected to participate in on-line asynchronous discussion forums with other classmates and the course facilitator as scheduled. Assignments are submitted electronically through the learning manager program. Open book unit exams are taken on-line. Exams and assignments are marked by the instructor and returned to the student with a grade and comments as required in the learning manager program. Students can monitor their progress though the course using utilities available in the learning manager program. In order to complete the course on time, deadlines for assignments, exam, and projects are enforced.

Communications

Most communications between the instructor and students take place through email. If required zoom calls can be set up by an on-request basis. Please note that emails may take up to 48 hours for responses from your instructor. You are responsible for logging in to D2L on a regular basis (daily is highly suggested). Important course announcements on assignments, etc. are posted on D2L and not always directly emailed to students. It is highly recommended that you set your phone to alert you when an announcement is made.

Course Policies

This course follows all policies laid out in the HOOT & HOPE School of Energy Handbook.

- Academic Integrity: Any student who does not adhere to Lakeland College's Academic Integrity (cheating on an exam or assignment) is awarded a zero for that assessment. Any student who does not adhere to this is placed on probation from the Department Chair and/or College Registrar.
- Aiding and Abetting Academic Dishonesty is held to the same standards stated in the above bullet.
- Any student who fails to do the D2L assignment receives a zero for that quiz after the closing date (which is before each unit test)

Evaluation Procedures

Discussion Activity Assignments	15%
Quizzes	20%
Assignments	30%
Final Exam	35%

Grade Equivalents and Course Pass Requirements

A minimum grade of D (50%) (1.00) is required to pass this course.

Letter	F	D	D+	C-	C	C+	B-	B	B+	A-	A	A+
Percent Range	0-49	50-52	53-56	57-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-100
Points	0.00	1.00	1.30	1.70	2.00	2.30	2.70	3.00	3.30	3.70	4.00	4.00

Students must maintain a cumulative grade of C (GPA - Grade Point Average of 2.00) in order to qualify to graduate.

Attendance

Active participation is required in all courses within the Sustainable Energy Technology certificate and diploma programs. Each facilitator designates these requirements through the use of tools within the management system and personal contact with learners.

These expectations can be given marks as part of the assessment process. Each course outlines these expectations within the course structure.

For example, learners can be asked to demonstrate their participation/attendance through discussion forums, sharing research results, contributing relevant information, submitting assignments, communicating with colleagues and the facilitator, and participating in synchronous meetings or asynchronous activities.

Attendance is considered vital to the learning process. Absenteeism is recorded. For example, if a discussion forum is organized; the learner is expected to attend as per the guidelines set by the facilitator.

Students can request for an excused absence. An excused absence is one that is verified with your facilitator.

NOTE: Any exceptions to the above attendance policy (e.g. family or work-related issues) **must** be approved in writing by the Department Chair **prior** to the beginning of the course.

It is the student's responsibility to know their own absentee record.

Course Units/Topics

Module 1: Introduction to Electrical Installation and Regulation

- LA 1.1: Introduction
- LA 1.2: The Electrical Code
- LA 1.3: Electrical Workers
- LA 1.4: Building Code

Module 2: PV Arrays and the Electrical Code

- LA 2.1: PV Array Design Review
- LA 2.2: PV Array Conductors
- LA 2.3: PV Wire Management
- LA 2.4: Grounding and Bonding

Module 3: Inverter and Battery Wiring, and the Electrical Code

- LA 3.1: Battery Sizing
- LA 3.2: Battery Installation
- LA 3.3: Inverter Installation

Module 4: Bonding and Grounding of Inverter Systems

- LA 4.1: System Grounding Principles
- LA 4.2: System Grounding and Equipment Bonding of Inverter Systems
- LA 4.3: Ungrounded PV Arrays

Module 5: Grid Interconnection and the Electrical Code

- LA 5.1: Building Services
- LA 5.2: Supply Side Connection
- LA 5.3: Load Side Connection
- LA 5.4: Labels, Notices, and Diagrams

Module 6: Photovoltaic Systems and the Building Code

- LA 6.1: Roof Evaluation
- LA 6.2: Loading
- LA 6.3: Attachment

Module 7: Wind Turbine Systems and the Electrical Code

- LA 7.1: Wind Turbine Conductors
- LA 7.2: Wind Turbine Protection and Control
- LA 7.3: Wind Turbine Grounding and Bonding

Module 8:

- LA 8.1: Bylaws
- LA 8.2 Zoning, Licenses, and Permits

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