

RC321
Solar Thermal Systems

3 Credits

Instructor: Robert Baron
780 853 8549

Original Developer: Tom Jackman

Current Developer: Robert Baron

Reviewer: James Woodhouse

Created: 07/02/2008

Revised: 23/05/2018

Approval: 24/09/2018

Alternate Delivery: Yes

The Implementation Date for this Outline is 27/08/2018

Copyright©LAKELAND COLLEGE. Email: admissions@lakelandcollege.ca
2602 - 59 Avenue, Lloydminster, Alberta, Canada T9V 3N7. Ph: 780 871 5700
5707 College Drive, Vermilion, Alberta, Canada T9X 1K5. Ph: 780 853 8400
Toll-free in Canada: 1 800 661 6490



RC321 Version: 3



Solar Thermal Systems

Calendar Description

RC321 examines the current types of residential (applicable to small commercial) solar thermal applications and components, their installation and maintenance, advanced details on thermal collector performance, sizing of components, integrating heating systems and system controls. Students review the solar heat opportunity of a building's overall energy patterns, evaluate existing solar installations, recommend improvements, and design and plan the installation of a new solar heating system for a building of their choice.

Rationale

This is a required course for the Renewable Energy and Conservation Diploma.

Our homes and buildings need heat and solar thermal can provide this energy without fossil fuels and the associated environmental and financial costs and infrastructure needs. However, as a society, we are not using solar thermal in a substantial manner. The largest reason for this is the lack of knowledge on solar thermal – collector performance, heating system design, integration with mechanical systems and architectural compatibility. Consequently the pioneering solar thermal projects that are done are sometimes not very well designed and/or implemented. The purpose of this course is to provide students with solar thermal knowledge and practical experience so they can design effective solar thermal systems that provide a meaningful contribution to a building's energy mix. Successful solar thermal projects will, in time, change societal understanding and expectation of solar thermal.

Prerequisites

[RC205](#)

Co-Requisites

None

Course Learning Outcomes

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

1. demonstrate a working knowledge of a building's energy systems, identifying potential applications for solar thermal in a building's energy mix.
 - review fundamentals of solar thermal systems.
 - tabulate energy consumption for a building to demonstrate competence in energy measurement.
 - interview building owners on their energy usage, heating systems, and discuss solar thermal opportunities
 - Infer energy literacy level, as well as environmental, financial, and social values of those interviewed.

2. demonstrate a high level of proficiency in reviewing solar thermal collectors by identifying the variables that affect solar thermal collector performance and the methods used to estimate the energy provided from solar thermal collectors.
 - locate information on solar thermal collector design and specifications.
 - identify the variables that affect solar thermal collector performance.
 - discover the SRCC performance specifications with the intent of using them to compare diverse collectors.
 - calculate collector efficiency for specified conditions.
 - recognize the influence of conditions on collector efficiency.
 - apply the collector specifications and the operating conditions tabulated in Assignment 2.2 to develop heat collection rate for a series of specified conditions.
 - estimate the monthly and annual heat that will be collected using different methods

3. evaluate components of solar thermal systems collectively, as well as individually, for the purpose of designing a system that will deliver all the heat collected to an application while optimizing costs.
 - read about solar thermal 'Balance of System' components.
 - specify the methods used for component selection as well as procedures for proper sizing of each component.

4. complete solar site assessments
 - recognize larger geographical influence on solar opportunity.
 - develop an awareness of site characteristics to check when planning a solar heater.
 - evaluate shading and other limitations on a specific site.
 - relate site characteristics to array geometry with consideration to azimuth and tilt.
 - use site factors such as thermal energy application, space requirements, piping access and integration with other heating systems.
 - practise assessing a site and recommending specifications for a solar heating project.

5. develop creative solutions to integrate solar thermal collectors with a building's architecture.

6. demonstrate an ability to recommend a location and mounting method for a solar thermal array.
 - discover different roof styles, structures, and weather protections.
 - locate different methods and hardware for mounting collectors to roofs or walls.

- identify racking methods and associated hardware.
 - compare different racking and mounting methods for flat plate and evacuated tube collectors in the context of desired tilt.
 - evaluate aesthetic influence of racking and mounting and consider the significance of conformity to the structure in the eyes of the building owner.
 - based on the site assessments from module 4, select one site, detailing the collector array which will be further developed during the remainder of the course.
 - research mounting and racking hardware to better specify the specific materials that will be used to install the array.
 - assess roof structure (or mounting location), determining needs to accommodate collector array.
 - demonstrate creativity in new-build structures to accommodate solar collectors, incorporating the use of aesthetic factors.
7. evaluate energy usage in homes in order to develop recommendations to change the energy consumption patterns and to apply solar energy.
8. using an energy supply-demand approach, select where the heat collected in your solar thermal array will be applied in the building.
- assess the energy consumption from a case study building, commenting on consumption patterns.
 - evaluate seasonal energy usage on a monthly basis, suggesting steps to reduce energy consumption.
 - for your project site, compile the energy consumption on a monthly basis and compare it to other average or typical values, identifying alternative applications where the energy collected from your array could be applied.
 - calculate the energy that can be expected from your array each month, comparing the solar heat to the energy demand each month, planning how a shortage of heat will be supplied, and deciding how excess heat will be dissipated.
 - with consideration to your site energy characteristics and balance of system requirements, recommend where the heat will be applied.
9. develop a complete specification for a solar heating system for your site.
- demonstrate a working knowledge of all the parts required for a solar heater.
 - prepare a detailed list of each component required for your solar heating system including performance specifications, quantity, and suggested make and model.
 - prepare a piping diagram of your solar heater showing the major components and noting the operating modes.
 - practice sourcing components to meet the specifications.
10. prepare a financial cost and benefit for your solar project.
11. calculate environmental benefits, but also identifying other considerations.
- develop a price for your solar heating form material, installation, and other costs plus a profit margin.
 - calculate the financial benefit of the energy provided by the solar heating system.

- calculate the annual GHG (Green House Gasses) reduction from the solar heating project.
 - prepare a short report explaining the other benefits realized by proceeding with the solar heating project.
12. write a work plan to install your solar heater project
- prepare a plan to procure all components with consideration to lead time, payment method, shipment method, and delivery location.
 - list site preparation activities and consider timing and access.
 - identify preparation activities, specifying where they will be done.
 - prepare a work sequence for installation of the array and the balance of system.
 - estimate time requirement.
 - prepare a work sequence for system cleaning, commissioning, and final inspection.
 - write a checklist for the building owner orientation.
 - document system maintenance, performance evaluation, and troubleshooting.
 - review your project budget from module eight, commenting on any changes.
13. demonstrate ability to design and plan all the aspects of a solar heater for a residential or small commercial project.
- prepare a report on a solar heater project by reviewing, revising, and improving all the course work undertaken for your selected solar heating project.

Resource Materials

Required Text(s):

The German Solar Energy Society. 2010. Planning and installing solar thermal systems, a guide for installers, architects and engineers. James & James/Earthscan, London, UK.

NABCEP Solar Heating Resource Guide, May 2013, V.1.1 Available on-line at www.nabcep.org.

- Paper, etc to take field notes
- Access to a computer and the Internet
- Library
- D2L orientation and technical assistance

Optional Resources:

- Compass, protractor, grid-line paper

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 will be available on-line. A course facilitator will be available to guide the learner through the course, answer any questions, and grade assignments and exams. Assignments and projects will be submitted electronically through the learning manager program. Assignments and projects will be marked by the instructor and returned to the student with a grade and comments in the learning manager program. Students can monitor their progress through the course using utilities available in the learning manager program. In order to complete the course on time, deadlines for assignments and projects will be enforced.

Time allotment for each module:

• Module One:	4 hours
• Module Two:	6 hours
• Module Three:	6 hours
• Module Four:	5 hours
• Module Five:	5 hours
• Module Six:	5 hours
• Module Seven:	6 hours
• Module Eight:	5 hours
• Final Report:	<u>3 hours</u>
Course Total:	45 hours

Evaluation Procedures

Assessment, Expectations

Written exercises and assignments are required to complete each module. The student's final grade is an aggregate of the following components:

Exercises/Assignments	As detailed below	80%
Final Project	Final Project Report	20%
Module one:	Assignment 1.1 Building Energy Measurement	3%
	Assignment 1.2 Interviews	6%
Module two:	Assignment 2.1 Collector Operating Conditions	2%
	Assignment 2.2 Collector Efficiency	4%
	Exercise 2.3 and Assignment 2.3 Thermal Energy Estimates	4%
	Assignment 2.4 Collector Selection	2%

Module three:	Assignment 3.1 Solar Heater Improvements	9%
Module four:	Assignment 4.1 Site Assessments	9%
Module five:	Assignment 5.1 Collector Architecture	3%
	Assignment 5.2 Collector Mounting	6%
Module six:	Assignment 6.1 Heating Applications	4%
	Assignment 6.2 Project Site Energy Analysis	5%
Module seven:	Assignment 7.1 Solar Heater Specification	9%
	Assignment 7.2 Solar Heater Implementation Plan	3%
Module eight:	Assignment 8.1 Solar Heater Financial Cost and Benefit	5%
	Assignment 8.2 Solar Heating Environmental Benefits	3%
	Assignment 8.3 Solar Heater Other Considerations	3%

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 Renewable Energy and Conservation 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.

Learners will 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 or participation is considered vital to the learning process. Students are expected to keep up with the set course schedule. If a student is unable to participate for an extended period of time, marks will not be given for material missed. With prior notice, the facilitator may allow extensions for missed assignments at his/her discretion.

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 One: Solar Thermal Warm-Up

LA 1.1 Fundamentals

LA 1.2 Energy Measurement

LA 1.3 Interviews

Module Two: Collecting Heat

LA 2.1 Thermal Collectors Basics

LA 2.2 Collector Efficiency

LA 2.3 Thermal Energy Estimates

Module Three: Moving and Using Heat

LA 3.1 Balance of System

Module Four: Site Assessment

LA 4.1 Site Assessments

Module Five: Mounting and Racking

LA 5.1 Mounting and Racking

Module Six: Solar Thermal Applications

LA 6.1 Energy Usage Analysis

LA 6.2 Project Site Energy Supply - Demand

Module Seven: Solar Heater Specification

LA 7.1 Solar Heater Specification Development

LA 7.2 Solar Heater Implementation Plan

Module Eight: Solar Heating System Costs and Benefits

LA 8.1 Financial Costs and Benefits

LA 8.2 Environmental Benefits

LA 8.3 Additional Benefits

Final Assignment: Solar Heater Project Report



Copyright©LAKELAND COLLEGE.
2602 - 59 Avenue, Lloydminster, Alberta, Canada T9V 3N7. Ph: 780 871 5700
5707 College Drive, Vermilion, Alberta, Canada T9X 1K5. Ph: 780 853 8400
Toll-free in Canada: 1 800 661 6490 Email: admissions@lakelandcollege.ca