RC 321

Solar Thermal Systems

3 Credits

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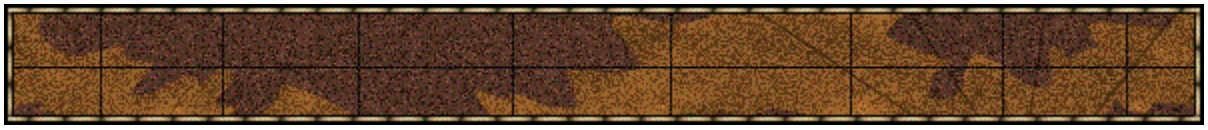

Solar Thermal Systems

Calendar Description

RC 321 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 Sustainable Energy Technology 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

RC 205

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 texts required for this course are available on-line or through the Lakeland College on-line library resources. Instructions to access these is given in the learning manager instructions.

Marken, C., Vaughan Woodruff. 2016. NABCEP Solar Heating Installer Resource Guide. V1.0. Clifton Park, New York: Retrieved November 27, 2020 from https://www.nabcep.org/wp-content/uploads/2008/11/SH-Resource-Guide-v.1-Web-5-10-12.pdf

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

Students are required to use spreadsheets and word processors for assignments. All assignments are to be submitted in Microsoft™ Word or Excel format.

A computer drawing software program is useful to create diagrams and wiring diagrams.

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, offer synchronous web conference review sessions and grade assignments and exams. Assignments and projects are submitted electronically through the learning manager program. Assignments and projects are marked by the instructor and returned to the student with a grade and comments 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 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:	3 hours
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	The number and weight of each assignment in each module may vary however, the assignment weighting for each module is given below and make up 80% of the course mark.	80%
Final Project	Final Project Report – draws on work from the module assignments	20%
	Total:	100%

Module one:	Solar Thermal Warm-up	9%
Module two:	Collecting Heat	12%
Module three:	Moving and Using Heat	9%
Module four:	Site Assessment	9%
Module five:	Mounting and Racking	9%
Module six:	Solar Thermal Applications	9%
Module seven:	Solar Heater Specifications	12%
Module eight:	Solar Heating System Cost and Benefits	11%

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.

Learners are 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

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