ENSC M07L: APPLIED SOLAR TECHNOLOGY LAB

Originator
bswartz

Co-Contributor(s)

Name(s)
Putnam, Roger (rputnam)

College
Moorpark College

Discipline (CB01A)
ENSC - Environmental Science

Course Number (CB01B)
M07L

Course Title (CB02)
Applied Solar Technology Lab

Banner/Short Title
Applied Solar Technology Lab

Credit Type
Credit

Start Term
Fall 2023

Catalog Course Description
Provides hands-on learning of solar technology and photovoltaic systems. Emphasizes design, installation, and maintenance of residential and commercial projects.

Taxonomy of Programs (TOP) Code (CB03)
0303.00 - *Environmental Technology

Course Credit Status (CB04)
D (Credit - Degree Applicable)

Course Transfer Status (CB05) (select one only)
B (Transferable to CSU only)

Course Basic Skills Status (CB08)
N - The Course is Not a Basic Skills Course

SAM Priority Code (CB09)
C - Clearly Occupational

Course Cooperative Work Experience Education Status (CB10)
N - Is Not Part of a Cooperative Work Experience Education Program

Course Classification Status (CB11)
Y - Credit Course

Educational Assistance Class Instruction (Approved Special Class) (CB13)
N - The Course is Not an Approved Special Class

Course Prior to Transfer Level (CB21)
Y - Not Applicable

Course Noncredit Category (CB22)
Y - Credit Course

Funding Agency Category (CB23)
Y - Not Applicable (Funding Not Used)

Course Program Status (CB24)
1 - Program Applicable

General Education Status (CB25)
Y - Not Applicable

Support Course Status (CB26)
N - Course is not a support course

Field trips
Will be required

Faculty notes on field trips; include possible destinations or other pertinent information
Visits to local facilities such as Moorpark College's "solar village" to understand the physics, engineering, and installation of applied solar PV.

Grading method
(L) Letter Graded

Alternate grading methods
(O) Student Option- Letter/Pass
(P) Pass/No Pass Grading

Does this course require an instructional materials fee?
No

Repeatable for Credit
No

Is this course part of a family?
No

Units and Hours

Carnegie Unit Override
No

In-Class

Lecture

Activity

Laboratory
Minimum Contact/In-Class Laboratory Hours
52.5
Maximum Contact/In-Class Laboratory Hours
52.5

Total in-Class

Total in-Class
Total Minimum Contact/In-Class Hours
52.5
Total Maximum Contact/In-Class Hours
52.5

Outside-of-Class

Internship/Cooperative Work Experience

Paid

Unpaid

Total Outside-of-Class

Total Outside-of-Class

Total Student Learning

Total Student Learning
Total Minimum Student Learning Hours
52.5
Total Maximum Student Learning Hours
52.5

Minimum Units (CB07)
1
Maximum Units (CB06)
1

Prerequisites
ENSC M07 or concurrent enrollment

Entrance Skills

Entrance Skills
ENSC M07

Prerequisite Course Objectives
ENSC M07-define basic solar terms (e.g., irradiation, Langley, azimuth), describe solar movement and the effect of earth's tilt, predict solar position using a solar path diagram or sun chart, and determine true (solar) south from magnetic (compass) south given a declination map; examine, evaluate, and identify the potential implementation of solar technology and identify types of photovoltaic systems.
ENSC M07-explain the difference between energy and power and compare and contrast the power and energy consumption of common electrical appliances in the home and business; describe how a solar cell converts sunlight into electric power.
ENSC M07-outline the proper safety procedures, precautions, and protective equipment used to mitigate hazards in photovoltaic systems (both operational and non-operational) during installation and maintenance.
ENSC M07-diagnose electric services and distribution panels for sufficient capacity to add grid-connected and stand-alone photovoltaic systems per national electric code and local standards.
ENSC M07-analyze ground, roof, and pole constructions and their effects on photovoltaic system design and mounting.
ENSC M07-evaluate array, battery, and inverter size for grid-connected and stand-alone systems, calculate approximated peak power output (AC and DC), and estimate monthly and annual energy outputs.
ENSC M07-illustrate the effects of environmental conditions and series/parallel connections on current-voltage (IV) curves; solve simple series and parallel electrical circuit problems.
ENSC M07-assess photovoltaic system configuration options using web-based and stand-alone software sizing tools.
ENSC M07-describe the mechanical loads on a photovoltaic array (e.g., wind, snow, seismic, etc).
ENSC M07-list and describe the purpose and operation of main electrical balance of system (BOS) components.
ENSC M07-identify common adaptations to the electrical and mechanical design of photovoltaic systems for site-specific environmental constraints to satisfy local codes and standards.

ENSC M07-troubleshoot for common issues that lead to typical photovoltaic system performance problems; demonstrate an awareness of potential electrical and mechanical failures and propose alternative remedies.
ENSC M07-evaluate key features, costs, and benefits associated with each step of photovoltaic systems with consideration of utility and government incentives.

Requisite Justification

Requisite Type

Prerequisite

Requisite

ENSC M07 or concurrent enrollment

Requisite Description

Course in a sequence

Level of Scrutiny/Justification

Closely related lecture/laboratory course

Student Learning Outcomes (CSLOs)

	Upon satisfactory completion of the course, students will be able to:
1	demonstrate an understanding of the proper installment of a photovoltaic system on a residential home.

Course Objectives

	Upon satisfactory completion of the course, students will be able to:
1	evaluate the maximum power and average daily energy consumption of a plug-in appliance.
2	demonstrate proper safety practices and use required protective equipment for the installation and maintenance of photovoltaic (PV) systems; follow safety procedures when working with ladders and fall-protection equipment.
3	assess annual solar path and the effect of earth's tilt.
4	properly use a digital multimeter and other equipment necessary to test and work with electric circuits.
5	evaluate optimal photovoltaic array locations based on shading analysis results; create a shading analysis report for a site.
6	design, construct, and document series and parallel circuit sizes given module, inverter, and temperature range specifications.
7	outline and follow procedures for a single-phase grid interconnection and rooftop (commercial and residential) photovoltaic array installation; construct and maintain a simple photovoltaic system.
8	compare and contrast both the features and benefits of different solar mounting techniques.
9	evaluate key specifications of main electrical balance of system (BOS) components.
10	formulate and construct array circuit wiring, grounding, and over-current protection according to national electric code requirements.
11	list and utilize diagnostic equipment for testing field performance upon completion of photovoltaic system installation.

Course Content

Lecture/Course Content

NA

Laboratory or Activity Content

- 10.00% Overview of photovoltaics, electric principles, and applications
- 10.00% Solar energy fundamentals
- 10.00% Load analysis
- 10.00% Modules
- 5.00% Batteries

- 10.00% PV controllers
- 10.00% Inverters
- 10.00% Wiring
- 10.00% Sizing stand-along and grid-tied photovoltaic systems
- 10.00% Mounting and installation
- 5.00% Maintenance, troubleshooting, and safety

Methods of Evaluation

Which of these methods will students use to demonstrate proficiency in the subject matter of this course? (Check all that apply):

Problem solving exercises
Skills demonstrations

Methods of Evaluation may include, but are not limited to, the following typical classroom assessment techniques/required assignments (check as many as are deemed appropriate):

Essay exams
Objective exams
Problem-solving exams
Problem-solving homework
Quizzes
Research papers
Skills demonstrations
Classroom Discussion
Projects
Participation
Reports/Papers/Journals

Instructional Methodology

Specify the methods of instruction that may be employed in this course

Audio-visual presentations
Case studies
Class activities
Class discussions
Collaborative group work
Demonstrations
Field trips
Instructor-guided interpretation and analysis
Instructor-guided use of technology
Laboratory activities
Observation
Small group activities
Other (specify)

Specify other method of instruction

1. Through hands-on based instruction, the instructor demonstrates the topic of ground protection of photovoltaic arrays. From this instruction, students are able to design and construct photovoltaic array grounding that meets national electric code standards.
2. Assign primary source materials for students to read prior to
class. Instructor holds a quiz on the assigned topic followed by in-class discussion with students.
3. Instructor demonstrates roof mounting techniques on mock-up
structures with various roof constructions. From this instruction, students
document detailed procedures for these installation processes in their lab journal.

Describe specific examples of the methods the instructor will use:

- Through hands-on based instruction, the instructor demonstrates the topic of ground protection of photovoltaic arrays. From this instruction, students are able to design and construct photovoltaic array grounding that meets national electric code standards.
- Assign primary source materials for students to read prior to class. Instructor holds a quiz on the assigned topic followed by in-class discussion with students.
- Instructor demonstrates roof mounting techniques on mock-up structures with various roof constructions. From this instruction, students document detailed procedures for these installation processes in their lab journal.

Representative Course Assignments

Writing Assignments

- Demonstrate problem solving of exam questions.
- Reflect on readings from the newspaper, journal articles, and/or Internet sources about solar PV.
- Describe observations and answer questions from site evaluations of solar PV.
- Design series and parallel circuit sizes given module, inverter, and temperature range specifications.

Critical Thinking Assignments

- Troubleshoot, identify, and document photovoltaic system performance issues from field work.
- Complete essay exam questions about how to engineer and install PV systems.

Reading Assignments

- Read technical manuals on equipment and methods used for photovoltaic systems installation.
- Read articles from online and print sources about current events relating to photovoltaic public policy.

Skills Demonstrations

- Demonstrate technical proficiency understanding individual pieces of equipment used in photovoltaic systems.
- Demonstrate technical proficiency installing and monitoring photovoltaic systems.

Outside Assignments

Representative Outside Assignments

- Read articles from the newspaper, journal articles, and/or Internet sources about solar PV.
- Solve additional problem sets provided by the instructor about PV systems.
- Complete homework problems about PV physics and engineering selected from the textbook or other relevant resource.
- Read material from textbook on solar PV.

Articulation

Equivalent Courses at 4 year institutions

University	Course ID	Course Title	Units
			2
			2

Equivalent Courses at other CCCs

College	Course ID	Course Title	Units
De Anza College	ESCI 63	Photovoltaic (PV) Technology Field Project	2
Diablo Valley College	ENSYS 130	Photovoltaic Systems Design and Installation	2
College of the Redwoods	CT 32	Photovoltaic Design and Installation	1

District General Education

A. Natural Sciences

B. Social and Behavioral Sciences

C. Humanities

D. Language and Rationality

E. Health and Physical Education/Kinesiology

F. Ethnic Studies/Gender Studies

Course is CSU transferable
Yes

CSU Baccalaureate List effective term:
S2010

CSU GE-Breadth

Area A: English Language Communication and Critical Thinking

Area B: Scientific Inquiry and Quantitative Reasoning

Area C: Arts and Humanities

Area D: Social Sciences

Area E: Lifelong Learning and Self-Development

Area F: Ethnic Studies

CSU Graduation Requirement in U.S. History, Constitution and American Ideals:

IGETC

Area 1: English Communication

Area 2A: Mathematical Concepts & Quantitative Reasoning

Area 3: Arts and Humanities

Area 4: Social and Behavioral Sciences

Area 5: Physical and Biological Sciences

Area 6: Languages Other than English (LOTE)

Textbooks and Lab Manuals

Resource Type
Textbook

Description
Parrish, Peter. *Photovoltaic Laboratory: Safety, Code-Compliance, and Commercial Off-the-Shelf Equipment*. CRC Press, 2018.

Resource Type
Manual

Description

Brooks, William, and James Dunlop. *North American Board of Certified Energy Practitioners (NABCEP) Photovoltaic (PV) Installation Professional Resource Guide.* NAVCEP, 2016.

Library Resources

Assignments requiring library resources

Research on appropriate applied solar technology topics using journal articles and other sources from the Library's print and online resources.

Sufficient Library Resources exist

Yes

Example of Assignments Requiring Library Resources

Read articles from online and print sources about current events relating to photovoltaic public policy.

Primary Minimum Qualification

EARTH SCIENCE

Review and Approval Dates

Department Chair

02/08/2022

Dean

02/08/2022

Technical Review

02/17/2022

Curriculum Committee

03/01/2022

DTRW-I

04/21/2022

Curriculum Committee

MM/DD/YYYY

Board

05/11/2022

CCCCO

MM/DD/YYYY

Control Number

CCC000515925

DOE/accreditation approval date

MM/DD/YYYY