I. CATALOG INFORMATION
   A. Discipline: ENVIRONMENTAL SCIENCE
   B. Subject Code and Number: ENSC M07
   C. Course Title: Applied Solar Technology
   D. Credit Course units:
      Units: 3
      Lecture Hours per week: 3
      Lab Hours per week: 0
      Variable Units: No
   E. Student Learning Hours:
      Lecture Hours:
      Classroom hours: 52.5 - 52.5
      Laboratory/Activity Hours:
      Laboratory/Activity Hours 0 - 0
      Total Combined Hours in a 17.5 week term: 52.5 - 52.5
   F. Non-Credit Course hours per week __________
   G. May be taken a total of: [X] 1 [ ] 2 [ ] 3 [ ] 4 time(s) for credit
   H. Is the course co-designated (same as) another course: No [X] Yes [ ]
      If YES, designate course Subject Code & Number: __________
   I. Course Description:
      Surveys the fundamentals of solar technology and photovoltaic systems with a
      focus on design, installation, and maintenance. Emphasizes mechanical and
      electrical integration, system sizing, array layout, mounting, related electric
      codes, workplace safety standards, and troubleshooting.
   J. Entrance Skills
      *Prerequisite: No [X] Yes [ ] Course(s)
      *Corequisite: No [X] Yes [ ] Course(s)
      Limitation on Enrollment: No [X] Yes [ ]
      Recommended Preparation: No [X] Yes [ ] Course(s)
      Other: No [X] Yes [ ]
### COURSE OBJECTIVES

Upon successful completion of the course, a student will be able to:

<table>
<thead>
<tr>
<th>Objective</th>
<th>Description</th>
<th>Methods of evaluation will be consistent with, but not limited by, the following types or examples.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>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.</td>
<td>Quizzes, examinations, and cumulative final exam.</td>
</tr>
<tr>
<td>2</td>
<td>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.</td>
<td>Quizzes, examinations, and cumulative final exam.</td>
</tr>
<tr>
<td>3</td>
<td>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.</td>
<td>Quizzes, examinations, and cumulative final exam.</td>
</tr>
<tr>
<td>4</td>
<td>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.</td>
<td>Quizzes, examinations, and cumulative final exam.</td>
</tr>
<tr>
<td>5</td>
<td>Analyze ground, roof, and pole constructions and their effects on photovoltaic system design and mounting.</td>
<td>Quizzes, examinations, and cumulative final exam.</td>
</tr>
<tr>
<td>6</td>
<td>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.</td>
<td>Quizzes, examinations, and cumulative final exam.</td>
</tr>
<tr>
<td>7</td>
<td>Illustrate the effects of environmental conditions and series/parallel connections on current-voltage (IV) curves; solve simple series and parallel electrical circuit problems.</td>
<td>Quizzes, examinations, and cumulative final exam.</td>
</tr>
<tr>
<td>8</td>
<td>Assess photovoltaic system configuration options using web-based and stand-alone software sizing tools.</td>
<td>Quizzes, examinations, and cumulative final exam.</td>
</tr>
<tr>
<td>9</td>
<td>Describe the mechanical loads on a photovoltaic array (e.g., wind, snow, seismic, etc.).</td>
<td>Quizzes, examinations, and cumulative final exam.</td>
</tr>
<tr>
<td>10</td>
<td>List and describe the purpose and operation of main electrical balance of system (BOS) components.</td>
<td>Quizzes, examinations, and cumulative final exam.</td>
</tr>
<tr>
<td>No.</td>
<td>Learning Outcomes</td>
<td></td>
</tr>
<tr>
<td>-----</td>
<td>----------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>identify common adaptations to the electrical and mechanical design of photovoltaic systems for site-specific environmental constraints to satisfy local codes and standards.</td>
<td>Quizzes, examinations, and cumulative final exam.</td>
</tr>
<tr>
<td>12</td>
<td>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.</td>
<td>Quizzes, examinations, and cumulative final exam.</td>
</tr>
<tr>
<td>13</td>
<td>evaluate key features, costs, and benefits associated with each step of photovoltaic systems with consideration of utility and government incentives.</td>
<td>Quizzes, examinations, and cumulative final exam.</td>
</tr>
</tbody>
</table>

### III. COURSE CONTENT

<table>
<thead>
<tr>
<th>Estimated %</th>
<th>Topic</th>
<th>Learning Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture (must total 100%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.00%</td>
<td>Energy and photovoltaic principles</td>
<td>2</td>
</tr>
<tr>
<td>10.00%</td>
<td>Safety requirements and procedures</td>
<td>3</td>
</tr>
<tr>
<td>12.00%</td>
<td>Electrical principles and residential wiring basics</td>
<td>4, 6</td>
</tr>
<tr>
<td>12.00%</td>
<td>Residential construction basics</td>
<td>5, 9</td>
</tr>
<tr>
<td>12.00%</td>
<td>System components and configurations; system sizing and site assessment</td>
<td>1</td>
</tr>
<tr>
<td>15.00%</td>
<td>Selecting and adapting system design: mechanical and electrical</td>
<td>7, 8, 9</td>
</tr>
<tr>
<td>12.00%</td>
<td>Installing subsystems and components</td>
<td>10, 11</td>
</tr>
<tr>
<td>10.00%</td>
<td>Performance, maintenance, and troubleshooting</td>
<td>12</td>
</tr>
<tr>
<td>5.00%</td>
<td>Economic analysis and rebates</td>
<td>13</td>
</tr>
</tbody>
</table>

### IV. TYPICAL ASSIGNMENTS

**A. Writing assignments**

Writing assignments are required. Possible assignments may include, but are not limited to:

1. accurately predict the solar position given a position on Earth, a date, and a time.
2. given a set of power consumption data, site data, and current electricity pricing, be able to analyze the pay-off time of a photovoltaic (PV) analog.
3. given a mock set of site conditions, describe what modifications would be needed to create a system that meets local and national codes.
4. explain how trends in large scale electrical production from PV and solar-thermal plants will affect the smaller scale rooftop solar industry.

**B. Appropriate outside assignments**

Appropriate outside assignments are required. Possible assignments may include, but are not limited to:

1. read material from textbook.
2. complete homework problems selected from the textbook or other relevant resource.
<table>
<thead>
<tr>
<th>3</th>
<th>solve additional problem sets provided by the instructor.</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>read articles from the newspaper, journal articles, and/or Internet sources.</td>
</tr>
</tbody>
</table>

C. Critical thinking assignments

Critical thinking assignments are required. Possible assignments may include, but are not limited to:

| 1 | troubleshoot, identify, and document a photovoltaic system performance issue staged by the instructor on a demonstration system. |
| 2 | perform site analysis and system design to meet the power needs of an assigned project. |

V. METHODS OF INSTRUCTION

Methods of instruction may include, but are not limited to:

- [x] Distance Education – When any portion of class contact hours is replaced by distance education delivery mode (Complete DE Addendum, Section XV)
- [x] Lecture/Discussion
- [ ] Laboratory/Activity
- [x] Other (Specify)

1. 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 chapter covering photovoltaic modules followed by in-class discussion with students regarding the effects of environmental conditions and series/parallel connections on the current-voltage (IV) curve.

- [x] Optional Field Trips
- [ ] Required Field Trips

VI. METHODS OF EVALUATION

Methods of evaluation may include, but are not limited to:

- [x] Essay Exam
- [x] Problem Solving Exam
- [x] Objective Exams
- [x] Classroom Discussion
- [x] Reports/Papers/ Journals Projects
- [x] Skill Demonstration
- [ ] Participation
- [x] Other (specify)

Suggested assessment information may include:
1. quiz and/or exam on selected readings about solar radiation and average irradiance.
2. a student presentation which researches photovoltaic module and grid-interactive inverter specifications as well as discussing how equipment selection affects circuit sizing options.
3. a student presentation which researches roof mounting system specification, discussing the applicability of different mounting systems with different roof capabilities, and preparing a report outlining the various findings.
4. quiz and/or exam on mechanical integration, structural loads, and their impact on photovoltaic array design.
5. preparing a report on the proposed configuration, expected performance, estimated cost, and potential incentives for a grid-interactive photovoltaic system.

VII. REPRESENTATIVE TEXTS AND OTHER COURSE MATERIALS


VIII. STUDENT MATERIALS FEES

☐ No  ☑ Yes

IX. PARALLEL COURSES

<table>
<thead>
<tr>
<th>College</th>
<th>Course Number</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>De Anza College</td>
<td>ESCI 61</td>
<td>Introduction to Photovoltaic (PV) Technology</td>
<td>3</td>
</tr>
<tr>
<td>Diablo Valley College</td>
<td>ENSYS 130</td>
<td>Photovoltaic Systems Design and Installation</td>
<td>2</td>
</tr>
</tbody>
</table>

X. MINIMUM QUALIFICATIONS

Courses in Disciplines in which Masters Degrees are not expected:
Any bachelor's degree and two years of relevant experience, or any associate's degree and six years of relevant experience, or equivalent.

XI. ARTICULATION INFORMATION

A. Title V Course Classification:
1. This course is designed to be taken either:
   ☑ Pass/No Pass only (no letter grade possible); or
   ☑ Letter grade (P/NP possible at student option)

2. Degree status:
   Either ☑ Associate Degree Applicable; or ☐ Non-associate Degree Applicable

B. Moorpark College General Education:
1. Do you recommend this course for inclusion on the Associate Degree General Education list?
   Yes: ☐ No: ☑ If YES, what section(s)?
A1 - Natural Sciences - Biological Science
A2 - Natural Sciences - Physical Science
B1 - Social and Behavioral Sciences - American History/Institutions
B2 - Social and Behavioral Sciences - Other Social Behavioral Science
C1 - Humanities - Fine or Performing Arts
C2 - Humanities - Other Humanities
D1 - Language and Rationality - English Composition
D2 - Language and Rationality - Communication and Analytical Thinking
E1 - Health/Physical Education
E2 - PE or Dance
F - Ethnic/Gender Studies

C. California State University (CSU) Articulation:

1. Do you recommend this course for transfer credit to CSU? Yes: X No:

2. If YES do you recommend this course for inclusion on the CSU General Education list? Yes: X No: If YES, which area(s)?
   A1 □ A2 □ A3 □ B1 □ B2 □ B3 □ B4 □
   C1 □ C2 □ D1 □ D2 □ D3 □ D4 □ D5 □
   D6 □ D7 □ D8 □ D9 □ D10 □ E □

D. University of California (UC) Articulation:

1. Do you recommend this course for transfer to the UC? Yes: □ No: X

2. If YES do you recommend this course for the Intersegmental General Education Transfer Curriculum (IGETC)? Yes: □ No: X

IGETC Area 1: English Communication
   English Composition
   Critical Thinking-English Composition
   Oral Communication

IGETC Area 2: Mathematical Concepts and Quantitative Reasoning
   Mathematical Concepts

IGETC Area 3: Arts and Humanities
   Arts
   Humanities

IGETC Area 4: Social and Behavioral Sciences
   Anthropology and Archaeology
II. REVIEW OF LIBRARY RESOURCES

A. What planned assignment(s) will require library resources and use?

The following assignments require library resources:
Research on appropriate applied solar technology topics using journal articles and other sources from the Library's print and online resources.

B. Are the currently held library resources sufficient to support the course assignment?

YES: [X] NO: [ ]

If NO, please list additional library resources needed to support this course.

XIII. PREREQUISITE AND/OR COREQUISITE JUSTIFICATION
ENSC M07: Not Applicable

XIV. WORKPLACE PREPARATION

Required for career technical courses only. A career technical course/program is one with the primary goal to prepare students for employment immediately upon course/program completion, and/or upgrading employment skills.

Detail how the course meets the Secretary of Labors Commission on the Achievement of Necessary Skills (SCANS) areas. (For a description of the competencies and skills with a listing of what students should be able to do, go to: http://www.ncrel.org/sdrs/areas/issues/methods/assessment/as7scans.htm)

The course will address the SCANS competency areas:

1. Resources: the students will learn to optimize the allocation of materials and resources in the design and development of a photovoltaic (PV) system.

2. Interpersonal: the students will learn the importance of discussion, presentation, critique, and team work in order to effectively communicate ideas related to PV design, installation, and maintenance.

3. Information: the students will gather, assimilate, and communicate essential information in order to properly design and develop a PV system.

4. Systems: the students will demonstrate an awareness of potential system failures and propose alternative solutions for better design, installation, and maintenance.

5. Technology: the students will continue to gather contemporary working knowledge of developments in equipment and technology design in order to troubleshoot and maintain a PV system.

The course also addresses the SCANS skills and personal qualities:

1. Basic Skills: the students will prepare a report on the proposed configuration, expected performance, estimated cost, and potential incentives for a single-phase grid-interactive photovoltaic system.

2. Thinking Skills: the students will critically evaluate PV system designs for enhancement value and skills development.

3. Personal Qualities: the students will demonstrate competencies through oral and written presentations that will be shared with the class.

XV. DISTANCE LEARNING COURSE OUTLINE ADDENDUM

1. Mode of Delivery

☐ Online (course will be delivered 100% online)

☒ Online with onsite examinations (100% of the instruction will occur online, but examinations and an orientation will be scheduled onsite)

☒ Online/Hybrid (a percentage of instruction will be held online and the remaining percentage of instruction will be held onsite)

☐ Lab activities will be conducted onsite

☐ Televideo (Examinations and an orientation will be held onsite)

☐ Teleconference
2. Need/Justification

Improve general student access.

3. Describe how instructors teaching this course will ensure regular, effective contact with and among students.

Students may require online orientation and introduction to the course. Lectures may be delivered via live classroom, and learning will also be fostered via discussion boards, email, chat rooms, and digital drop-boxes.

4. Describe how instructors teaching this course will involve students in active learning.

As noted above, students may engage in active learning through chatroom participation, discussion board forums, email interactions, file exchanges, and/or online information searches.

5. Explain how instructors teaching this course will provide multiple methods of content representation.

The online interface is designed to meet the CCC Chancellor's Office guidelines for website accessibility. All course materials will be fully accessible to students who require assistive technology (i.e., all computer functions can be performed via keyboard, and all course materials will be provided in text format that can be accessed by a screen reader).

6. Describe how instructors teaching this course will evaluate student performance.

Students will be evaluated similar to a traditionally taught course, where the instructor will have the option of conducting the course online with on-site testing. Discussion, reports/papers, and group projects will generally be (although not limited to) conducted and submitted online.

VI. GENERAL EDUCATION COURSE OUTLINE ADDENDUM
ENSC M07: Not Applicable

VII. STUDENT MATERIALS FEE ADDENDUM
ENSC M07: Not Applicable

VIII. REPEATABILITY JUSTIFICATION TITLE 5, SECTION 55041
ENSC M07: Not Applicable

X. CURRICULUM APPROVAL
Course Information:
Discipline: ENVIRONMENTAL SCIENCE

Discipline Code and Number: ENSC M07

Course Revision Category: Outline Update

Course Proposed By:
Originating Faculty Brian Swartz 03/06/2016
Faculty Peer: Michael Walegur 03/07/2016
Curriculum Rep: Robert Keil 03/08/2016
Department Chair: Robert Keil 03/06/2016
Division Dean: Howard Davis 03/07/2016

Approved By:
   Curriculum Chair: Jerry Mansfield 04/11/2016
   Executive Vice President: Lori Bennett 04/11/2016
   Articulation Officer: Letrisha Mai 03/16/2016
   Librarian: Mary LaBarge 03/16/2016

Implementation Term and Year: Fall 2016

Approval Dates:
   Approved by Moorpark College Curriculum Committee: 04/05/2016
   Approved by Board of Trustees (if applicable): 04/12/2016
   Approved by State (if applicable): 04/12/2016