COLLEGE OF THE DESERT

Course Code ESYS-011

Course Outline of Record

1. Course Code: ESYS-011
2. a. Long Course Title: Residential Solar Fundamentals
   b. Short Course Title: Solar Fundamentals
3. a. Catalog Course Description:
   This course is for students engaged in a solar related field that have a need for a fundamental knowledge and skills of solar function and design of solar photovoltaics. The coordination between trades, design limitations, and workflow processes will be explained. The fundamental principles and functions of the photovoltaic industry will be introduced.
   b. Class Schedule Course Description:
   This course is for students interested in a career in the solar industry. The coordination between trades, design limitations, and workflow processes will be explained.
   c. Semester Cycle (*if applicable*): *N/A*
   d. Name of Approved Program(s):
   - ENERGY SYSTEMS TECHNOLOGY Certificate of Achievement
4. Total Units: 3.00 Total Semester Hrs: 72.00
   Lecture Units: 2.5 Semester Lecture Hrs: 45.00
   Lab Units: 0.5 Semester Lab Hrs: 27.00
   Class Size Maximum: 20 Allow Audit: No
   Repeatability No Repeats Allowed
   Justification 0
5. Prerequisite or Corequisite Courses or Advisories:
   Course with requisite(s) and/or advisory is required to complete Content Review Matrix (CCForm1-A)
   Advisory: ENG 070
   Advisory: ESYS 004
6. Textbooks, Required Reading or Software: *(List in APA or MLA format.)*
   a. Dunlop,J.,P. (2012). *Photovoltaic Systems* (3rd/e). American Tech Publishers. ISBN: 9781935941057
   College Level: Yes
   Flesch-Kincaid reading level: 11.2
7. Entrance Skills: *Before entering the course students must be able:*

a.
Demonstrate the ability to generate, develop and organize ideas into a cohesive essay using multiple paragraphs.

- ENG 070 - Demonstrate the ability to generate, develop and organize ideas into a cohesive essay using multiple paragraphs.

b.
Read and identify main ideas and supporting details.

- ENG 070 - Read and identify main ideas and supporting details.

c.
Recognize and explain patterns of idea development in readings.

- ENG 070 - Recognize and explain patterns of idea development in readings.

d.
Identify and employ transitions and connectors to show unity between ideas.

- ENG 070 - Identify and employ transitions and connectors to show unity between ideas.

e.
Compute using the four basic operations of addition, subtraction, multiplication, and division on the rational numbers.

- ESYS 004 - Compute using the four basic operations of addition, subtraction, multiplication, and division on the rational numbers.

f.
Apply the order of operations to simplify expressions involving several operations.

- ESYS 004 - Apply the order of operations to simplify expressions involving several operations.

g.
Comprehend the concept of a fraction as a part of a whole.

- ESYS 004 - Comprehend the concept of a fraction as a part of a whole.

h.
Use the concept of ratio to determine the solution to a proportion problem.

- ESYS 004 - Use the concept of ratio to determine the solution to a proportion problem.

i.
Apply the basic operations to solve application problems.

- ESYS 004 - Apply the basic operations to solve application problems.

8. Course Content and Scope:

Lecture:

1. PV Markets and Applications
1.1. Describe history of PV technology and industry
1.2. Describe markets and applications for PV (grid-tie, remote homes, telecom, ev charging.)
1.3. Identify types of PV systems (utility-interactive, standalone, direct-coupled, etc.)
1.4. Grid connection, utility-interactive, net metering
1.5. Be aware of current trends
2. Safety Basics
2.1. Identify safety hazards of PV systems
2.2. Identify safety hazards, practices, and protective equipment during PV system installation and maintenance (electricity, batteries, roof work)
3. Solar Energy Fundamentals
3.1. Define basic solar terms (e.g., irradiation, azimuth)
3.2. Explain magnetic declination
3.3. Understand basic celestial movements and their effects on photovoltaics
3.4. Recognize solar path diagrams & their usefulness
3.5. Identify factors that reduce/enhance solar irradiation
3.6. Understand the effects of shading
3.7. Have basic knowledge of average solar irradiation
3.8. Understand the effects of environmental conditions
3.9. Be cognizant of solar tools such as the Solar Pathfinder, Solmetric Sun-Eye, and sun charts
4. Solar Ready Roofs
4.1. Solar code requirements
4.2. Orientation and Pitch
4.3. Roof materials
4.4. Roofs design for solar maintenance
4.5. Roof flashing- material, tools and techniques
4.6. Identify roof construction methods- truss versus traditional framing
4.7. Calculate roof space requirements for photovoltaic

5. PV Module Fundamentals

5.1. Explain how a solar cell converts sunlight into electric power
5.2. Have basic knowledge of solar module construction
5.3. Identify output values of solar modules by exploring manufacturing availability
5.4. Define measurement conditions for solar cells and modules (STC, NOCT, PTC)
5.5. Compare the performance and characteristics of various cell materials
5.6. Understand efficiency of solar modules

6. System Components

6.1. Describe common solar module mounting techniques (ground, roof, pole)
6.2. Identify system components (inverter, charge controller, combiner, batteries, etc.)
6.3. Describe purpose and operation of system components

7. PV System Sizing

7.1. Explain DC system output versus AC production
7.2. Analyze load demand calculation methodologies
7.3. Identify de-rating factors
7.4. Usage of NREL's PV-Watts
7.5. Sizing grid-tied versus standalone systems
7.6. Explain string inverters versus micro-inverters
7.8. Calculate PV Design
7.9. Calculate battery storage needs for electrical (EV)

8. PV System Mechanical Design

8.1. Describe various roof attachment methods
8.2. Describe the mechanical loads on a PV array (e.g., wind, snow, seismic)

9. Performance Analysis and Troubleshooting

9.1. Describe typical system design errors
9.2. Describe typical system performance problems
9.3. Associate performance problems with typical causes
9.4. Compare actual system power output to expected

Lab: *(if the "Lab Hours" is greater than zero this is required)*

1. Develop a power and energy curve using mini panels and solar analysis software.
2. Find maximum power output versus set angle.
3. Test effects of loads on solar panels.
4. Visit multiple buildings and perform energy surveying.
5. Explored variables affecting solar collectors.
6. Design solar equipment layout using cad software.

9. Course Student Learning Outcomes:
   1. Explain the design clearances required for maintenance access for a PV array and other components including inverter and batteries of a stand-alone system.
   2. Describe the coordination process between trades involve to properly design a residential solar system.
   3. Design and draw a typical utility-interactive photovoltaic (PV) system and explain how each component operates.
   4. Define and use solar terminology appropriately when discussing photovoltaics.

10. Course Objectives: *Upon completion of this course, students will be able to:*
    a. Describe history of PV technology and industry
    b. Describe markets and applications for PV (grid-tie, remote homes, telecom, etc.)
    c. Identify types of PV systems (utility-interactive, standalone, direct-coupled, etc.)
    d. Identify safety hazards of PV systems
    e. Define basic electrical units and terms
    f. Explain fundamentals of the NEC Article 690
    g. Recognize solar path diagrams & their usefulness.
    h. Identify factors that reduce/enhance solar irradiation.
    i. Understand the effects of environmental conditions in the solar the industry.
    j. Explain how a solar cell converts sunlight into electric.
    k. Compare the performance and characteristics of various cell materials.
    l. Basic knowledge of solar module construction.
    m. Describe efficiency of solar modules.
    n. Describe common solar module mounting techniques (ground, roof, pole)
    o. Identify system components (inverter, charge controller, combiner, batteries, etc.)
    p. Explain DC system output versus AC production
    q. Explain string inverters versus micro-inverters

11. Methods of Instruction: *(Integration: Elements should validate parallel course outline elements)*
    a. Activity
    b. Collaborative/Team
    c. Discussion
    d. Laboratory
    e. Participation
    f. Supplemental/External Activity
    g. Technology-based instruction

12. Assignments: *(List samples of specific activities/assignments students are expected to complete both in and outside of class.)*
    In Class Hours: 72.00
    Outside Class Hours: 90.00
    a. In-class Assignments

    1. Draw a control diagrams for solar systems and battery systems.

    2. Prepare a synopsis, in writing, of the differences between AC and DC control systems.

    3. Reading assigned chapters.

    4. Class discussion.

    5. Group interaction and presentation.

    6. Evaluate industry.

    7. Evaluate industry tools.

    b. Out-of-class Assignments

    1. Read assigned text.

    2. Industry journal entry.

    3. Assigned worksheets.

4. Evaluate energy bill.

5. Evaluate energy rebates and incentives.

6. Prepare for in-class discussions on specific energy topics.

7. Case studies.

13. Methods of Evaluating Student Progress: *The student will demonstrate proficiency by:*
    - Group activity participation/observation
    - True/false/multiple choice examinations
    - Mid-term and final evaluations
    - Student participation/contribution
    - Student preparation
    - Organizational/timelines assessment

14. Methods of Evaluating: Additional Assessment Information:

15. Need/Purpose/Rationale -- *All courses must meet one or more CCC missions.*
    PO - Career and Technical Education
    Fulfill the requirements for an entry- level position in their field.
    Apply critical thinking skills to execute daily duties in their area of employment.
    Display the skills and aptitude necessary to pass certification exams in their field.
    PO-BS Problem Solving
    Use a variety of solution methods and techniques, for example, making a sketch, systematic listing, using the solution of a simpler (but related) problem.
    Recognize the importance of checking a proposed solution to verify that it satisfies the requirements of a problem.
    Recognize that a solution may not be possible, given limits of time, money, or other finite resources.

16. Comparable Transfer Course

University System	Campus	Course Number	Course Title	Catalog Year

17. Special Materials and/or Equipment Required of Students:

18. Materials Fees: ☐ Required Material?

Material or Item	Cost Per Unit	Total Cost

19. Provide Reasons for the Substantial Modifications or New Course:

This course is developed to meet the goals of the California Energy Efficiency Strategic Plan (CEESP) which mandates that 100 percent of all new homes in California will be Zero Net Energy starting in 2020 and 50 percent of commercial buildings by 2030. Solar technology is the leading technology used to offset electrical demand from the power grid. California has acknowledged the shortage of qualified and available work force to meet these new mandates. Residential solar 1, the course is designed to develop the highly trained technical workforce necessary to meet the goals of the California Energy Efficiency Strategic Plan (CEESP).

20. a. Cross-Listed Course *(Enter Course Code)*: *N/A*

b. Replacement Course *(Enter original Course Code)*: *N/A*

21. Grading Method *(choose one)*: Letter Grade Only

22. MIS Course Data Elements
    a. Course Control Number [CB00]: *N/A*
    b. T.O.P. Code [CB03]: 0000.00 -
    c. Credit Status [CB04]: *N/A*
    d. Course Transfer Status [CB05]: *N/A*
    e. Basic Skills Status [CB08]: *N/A*
    f. Vocational Status [CB09]: *N/A*
    g. Course Classification [CB11]: *N/A*
    h. Special Class Status [CB13]: *N/A*
    i. Course CAN Code [CB14]: *N/A*
    j. Course Prior to College Level [CB21]: *N/A*
    k. Course Noncredit Category [CB22]: *N/A*
    l. Funding Agency Category [CB23]: *N/A*
    m. Program Status [CB24]: *N/A*

    Name of Approved Program *(if program-applicable)*: ENERGY SYSTEMS TECHNOLOGY
    Attach listings of Degree and/or Certificate Programs showing this course as a required or a restricted elective.)

23. Enrollment - Estimate Enrollment
    First Year: 20
    Third Year: 40

24. Resources - Faculty - Discipline and Other Qualifications:
    a. Sufficient Faculty Resources: Yes
    b. If No, list number of FTE needed to offer this course: *N/A*

25. Additional Equipment and/or Supplies Needed and Source of Funding.
    N/A

26. Additional Construction or Modification of Existing Classroom Space Needed. *(Explain:)*
    N/A

27. FOR NEW OR SUBSTANTIALLY MODIFIED COURSES
    Library and/or Learning Resources Present in the Collection are Sufficient to Meet the Need of the Students Enrolled in the Course: Yes

28. Originator Ramiro Galicia Origination Date 09/17/16