COLLEGE OF THE DESERT

Course Code ESYS-012

Course Outline of Record

1. Course Code: ESYS-012
2. a. Long Course Title: Residential Solar Installation
   b. Short Course Title: Solar Installation
3. a. Catalog Course Description:
   This course is for students interested in advancing their knowledge in photovoltaics, take the NABCEP industry recognized test and furthering their career in the solar industry. The fundamental principles and functions of the photovoltaic industry begun in solar fundamentals and will be expanded along with the planning, installation and maintenance of all necessary components for a photovoltaic system. Understanding NEC guidelines and performing calculations required for de-rating using the 120% rule, the 125% rule, etc. will be covered.
   b. Class Schedule Course Description:
   Expanded fundamentals of solar energy & photovoltaic principles and systems including NEC guidelines, design factors, required calculations, etc.
   c. Semester Cycle (*if applicable*): *N/A*
   d. Name of Approved Program(s):
   - ENERGY SYSTEMS TECHNOLOGY Certificate of Achievement
4. Total Units: 4.00 Total Semester Hrs: 108.00
   Lecture Units: 3 Semester Lecture Hrs: 54.00
   Lab Units: 1 Semester Lab Hrs: 54.00
   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)
   Prerequisite: ESYS 004 with a minimum grade of C
   Advisory: ENG 070
   Advisory: ESYS 011
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.

   b.
   Read and identify main ideas and supporting details.

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

   d.
   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.

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

g.
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.

i.
Apply the basic operations to solve application problems.

j.
Explain the typical maintenance requirements for a PV array and other components including inverter and batteries of a stand-alone system.

k.
Describe the dangers and safety considerations of electricity and working with solar components.

l.
Design and draw a typical utility-interactive photovoltaic (PV) system and explain how each component operates.

m.
Define and use solar terminology appropriately when discussing photovoltaics.

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, etc.)
1.3. Identify types of PV systems (utility-interactive, standalone, direct-coupled, etc.)
1.4. 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. Electricity Basics

3.1. Define basic electrical units and terms

3.2. Use digital multi-meters to take various measurements
3.3. Use ampclamps to measure solar module current
3.4. Understand series, parallel, and series-parallel circuits
3.5. Understand overcurrent protection devices

4. Solar Energy Fundamentals

4.1. Define basic solar terms (e.g., irradiation, Langley, azimuth)
4.2. Determine true (solar) south from magnetic (compass) south given a declination map
4.3. Analyze celestial movements and calculate effects on PV systems
4.4. Predict solar position using solar path diagrams
4.5. Describe angular effects on the irradiance of array
4.6. Identify factors that reduce/enhance solar irradiation
4.7. Determine average solar irradiation
4.8. Calculate environmental effects on solar module output
4.10. Review the use of Solar Pathfinder, Solmetric Sun-Eye, and sun charts

5. PV Module Fundamentals

5.1. Explain how a solar cell converts sunlight into electric power

5.2. Label key points on a typical IV curve
5.3. Identify key output values of solar modules using manufacturer literature
5.4. Illustrate effect of environmental conditions on IV curve
5.5. Illustrate effect of series/parallel connections on IV curve
5.6. Define measurement conditions for solar cells and modules (STC, NOCT, PTC)
5.7. Compute expected output values of solar module under variety of environmental conditions
5.8. Compare the construction of solar cells of various manufacturing technologies
5.9. Compare the performance and characteristics of various cell technologies
5.10. Describe the components and construction of a typical flat plate solar module
5.11. Calculate efficiency of solar module
5.12. Explain purpose and operation of bypass diode
5.13. Describe typical deterioration/failure modes of solar modules

6. System Components

6.1. Describe most common solar module mounting techniques (ground, roof, pole)
6.2. Compare features and benefits of different solar mounting techniques
6.3. Explain the relationship between solar module cell temperature and environmental conditions, given mounting method
6.4. Describe purpose and operation of main electrical BOS components (inverter, charge controller, combiner, ground fault protection, battery banks, generator)
6.5. Identify types and key specifications of main electrical BOS components (inverter, charge controller, combiner, battery banks)

7. PV System Sizing

7.1. Use of NREL's PV-Watts
7.2. Analyze load demand for stand-alone and grid interactive service
7.3. Identify typical system electrical output de-rating factors
7.4. Calculate estimated peak power output (dc and ac)
7.5. Calculate array and inverter size for grid-connected system
7.6. Calculate estimated monthly and annual energy output of grid-connected system
7.7. Explain relationship between array and battery size for stand-alone systems
7.8. Calculate array, battery and inverter size for stand-alone system
7.9. Explain DC system output versus AC production

8. PV System Electrical Design

8.1. Determine series/parallel PV array arrangement based on module and inverter specifications
8.2. Select BOS components appropriate for specific system requirements
8.3. Determine voltage drop between major components
8.4. Perform design calculations using the 120% rule, the 125% rule, etc.
8.5. Perform calculations on conductor ampacity and conductor derating factors
8.6. Understand source circuits and output circuits
8.7. Understand usage of blocking diodes and bypass diodes

9. PV System Mechanical Design

9.1. Describe the relationship between row spacing of tilted modules and sun angle
9.2. Describe the mechanical loads on a PV array (e.g., wind, snow, seismic)
9.3. Describe various mounting methodologies

10. Performance Analysis and Troubleshooting

10.1. Describe typical system design errors
10.2. Describe typical system performance problems
10.3. Associate performance problems with typical causes
10.4. List equipment needed for typical system performance analysis
10.5. Compare actual system power output to expected
10.6. Identify typical locations for electrical/mechanical failure

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

1. Review power tool safety and safety gear.
2. Develop a power and energy curve using mini panels and solar analysis software.
3. Find maximum power output versus solar panels set angle.
4. Test effects of loads on solar panels.
5. Design solar roof layouts.
6. Used google earth and apply to solar design.

7. Explore google sketch and its application to solar design.
7. Compare multiple design alternatives.
8. Develop a proposal for the client.

9. Course Student Learning Outcomes:
   1. Obtain a passing score on the North American Board of Certified Energy Practitioners (NABCEP) Entry Level exam.
   2. Understand the dangers and safety considerations.
   3. Describe various roof attachment methods.
   4. Describe the mechanical loads on a PV array (e.g., wind, snow, seismic).
   5. Compare actual system power output to expected.

10. Course Objectives: *Upon completion of this course, students will be able to:*
    a. Obtain a passing score on the NABCEP Entry Level exam.
    b. Describe typical system design errors.
    c. Associate performance problems with typical causes.
    d. List equipment needed for typical system performance analysis.
    e. Describe the relationship between row spacing of tilted modules and sun angle.
    f. Describe the mechanical loads on a PV array (e.g., wind, snow, seismic).
    g. Describe various mounting methodologies.
    h. Determine series/parallel PV array arrangement based on module and inverter specifications.
    i. Select BOS components appropriate for specific system requirements.
    j. Perform calculations on conductor ampacity and conductor derating factors.

11. Methods of Instruction: *(Integration: Elements should validate parallel course outline elements)*
    a. Activity
    b. Collaborative/Team
    c. Discussion
    d. Laboratory
    e. Lecture
    f. Participation
    g. Supplemental/External Activity
    h. 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: 108.00
    Outside Class Hours: 216.00
    a. In-class Assignments

1. Draw advance control diagrams for Solar systems and Batties 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. Present discuss current industry events.

7. Used industry tools.

8. Calculate electrical load for a common house in group settings.

    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. Visit and interview a local solar provider.

13. Methods of Evaluating Student Progress: *The student will demonstrate proficiency by:*
    - 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.
    Apply critical thinking skills to research, evaluate, analyze, and synthesize information.
    Display the skills and aptitude necessary to pass certification exams in their field.
    PO-BS Problem Solving
    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.
    Identify what isn't known, but needs to be known in order to solve a problem (depending on the problem domain, reading and/or mathematical skills are helpful).

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 Installation, 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: 35

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 06/25/16