AMERICAN RIVER COLLEGE

ELECTRONICS DEPARTMENT

ENERGY 141

Electrical & Mechanical Applications for Solar Installers

Fall 2012

Course Title: Electrical & Mechanical Applications for Solar Installers

Course #: **20276** **Course Units:** 4

Instructor: Steve Geiger
Office hours TBA
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Prerequisite: ENERGY 140 - Electrical Applications for Solar Installers with grades of "C" or better

Hours: 54 hours LEC; 54 hours LAB

Class Times:				
10/22 - 11/21	MTWTh	09:00AM	11:40AM	Lec – Classroom: Tech Ed 321
10/22 - 11/21	MTWTh	11:50AM	02:30PM	Lab – Classroom: Tech Ed 321

Course Description: This is an advanced course in Solar Photovoltaic (PV) energy. Topics include using hardware and software tools for shading and correctly orientating solar panels, the effect PV panel orientation has on system power output and efficiency, what effect optimum PV panel loading has on power produced, and how to perform load analysis on a specific residence. Additionally, it covers various manufacturers' software to calculate PV panel string sizing for optimum efficiency when working with grid tie inverters. National Electrical Code (NEC) and fire code wire sizing, fusing, and other safety instructions and procedures are stressed. The successful completion of this course and ENERGY 142 qualify students to take the NABCEP (North American Certified Energy Practitioner) certified solar photovoltaic installers and service technicians entry level certificate of knowledge of PV systems test. Field trips are required. This course may be taken two times for credit using different test equipment.

Required Textbook: **Photovoltaic Systems (Second Edition), by James P. Dunlop, PE and the National Joint Apprenticeship and Training Committee (NJATC),** American Technical Publishers, (ISBN # 978-0-8269-1308-1)

Required **Electrical and Mechanical Applications for Solar Installers - Lab Project Book**, Energy 141

Lab book: from University Press https://students.universityreaders.com/store/ or ARC Bookstore

RAD Requirement: Reading and retaining information in this course is a critical requirement for passing the NABCEP (North American Board of Certified Energy Practitioners) beginning installation test. Therefore, enrollment in RAD (Reading Across the Disciplines) to improve skills in reading studying, and retention is highly advised.

Required Materials: Safety Goggles/Safety Glasses are required to be worn at all times in the lab; and a scientific calculator. All other Course materials will be furnished by the instructor.

Recommended Materials: Notebook, binder for handouts

Student Learning Outcomes & Objectives:

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

- analyze and describe the advantages of obtaining the NABSEP Entry Level Certificate of Knowledge Certificate.
- construct a simulated roof system using industry standard building materials.
- calculate the amount of yearly solar radiance in relationship to shading using the Solmetrics SunEye predictor and software.
- calculate the correct gauge wire and number of wires in a metal raceway according to National Electrical Code standards.
- inspect and repair malfunctioning components in a functioning grid tie solar photovoltaic system.
- employ common hand tools such as saws, drills, and framing squares used in building a simulated roof structure.
- analyze test equipment data to determine the Voltage drop on low voltage, high current wires.
- attach solar PV panel mounting rails and associated hardware to a roof while retaining the ability of the roof to be watertight.
- evaluate the different types of solar grid tie inverters and determine which configurations would have the highest efficiency and most power output for a given situation.
- assess safety hazards in respect to fire, shock, and falls when installing or repairing photovoltaic systems.
- estimate the yearly power output (Wh/year) for a solar photovoltaic system using both the SunEye and the Pathfinder sun angle and shade predictor.
- evaluate, draft, and construct a simple solar panel one-line drawing using "Sketch Up" software.
- examine and classify different sizes of wire according to American Wire Gauge (AWG) tables.
- develop a solar PV panel string size using SMA string sizing software and then modify the design for one half of the power output.

Evaluation Procedure:

Course Attendance	50 Points
Homework	125 Points
Lab Projects	125 Points
Portfolio of Projects	50 Points
Midterm/Final Exam/Oral Report/Project	150 Points
TOTAL	500 Points

Grading: The Final class grade will be based on a percentage of the total points (500) earned in the Course. Because of the complexity of the material, it essential to attend every class. See attendance policy (ARC) for grade lowering due to absences. (After two absences your grade is dropped one letter grade.) If the there is a problem with you missing a class, please contact me (leave a message) before the class to make other arrangements. All assigned lab projects must be completed for the student to earn a passing grade.

90%-100%	= A
80%-89%	= B
70%-79%	= C
60%-69%	= D
Below 60%	= F

Final: Wednesday, Nov 21, 2012 Time: 9:00 AM to 11:40 AM

Field trip: A field trip is required and may be done at any time during the semester depending on tour availability. It will be during class time to allow those with other commitments to attend.

Dropping Classes: It is your responsibility to drop this course if you quit attending class. I will not drop you. Because the grading system is computerized, instructors are required to assign a letter grade for all students. Therefore, it is EXTREMELY IMPORTANT that you drop the class before the drop date so you won't receive an "F" on your transcripts. The drop date can be found in the college schedule.

ENERGY 141 Course Rules and Requirements:

Attendance Requirements – 2012-2013 Catalog:

(a) Per LRCCD Policy P-2222, students are expected to attend all sessions of the class in which they are enrolled.

(b) A student may be dropped from any class when that student's absences exceed six percent (6%) of the total hours of class time.

(c) Any student who is a no show shall be dropped from a class (CA Code of Regs., Title 5, 58004).

Note: Instructors must state in the class syllabus what constitutes excessive absences for that course.

Tardiness Policy:
The college does not have an official tardy policy. If the instructor wishes to implement a tardiness policy, it needs to be clearly stated.

Conduct and Behavior: Every college class is a learning environment. The college promotes and nurtures a safe environment for the free exchange of ideas and open expression of individuality and diversity within the bounds of courtesy, sensitivity, civility and mutual respect. The college practices the fundamental belief that every student has the right to a safe and respectful learning environment. Students should behave appropriately in class and show respect for classmates and the instructor. Examples of unacceptable behavior are yelling, moving about the classroom, talking during lectures or students presentations. The college prohibits sexist or racist remarks, and harassment of any kind. Students must turn off cell phones and other electronic devices during class. Students should not use I-Pods during class. Students should not wear headphone devices during class. Food and drinks are not allowed in classrooms.
Inappropriate behavior of any kind will be reported to the ARC Student Discipline Officer. Disruptive students may be suspended from class and are subject to more severe college disciplinary action, up to and including dis-enrollment, and suspension from the college. Any days spent in suspension from class are unexcused absences.
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Plagiarism: Material submitted by the student shall be created by that student. Any plagiarized or copied material will not be counted for credit and receive 0 Points for that assignment.

Special Needs, Health and Safety: "Students with health issues or disabilities that may necessitate intervention, academic accommodations, or modification to the college educational or physical environment are encouraged to arrange an appointment to discuss these issues with the professor so that a plan for meeting these needs may be established (Heath Center, March 2004)". DSPS# 484-8545 (Disabled Students and Services) provide support services to students who are identified by them as needing accommodations. Latex products may be used. If a student has a health issue related to latex, the student should discuss with the instructor so that accommodation can be made.

Personal Protective Equipment and Clothing: Safety glasses will be worn during the lab portion of the class whenever performing dangerous activities such as soldering and cutting/ stripping wires.

Safety: All students must successfully complete a safety test with a passing grade before using lab equipment and tools, or working in the lab. All injuries must be reported to the instructor immediately. A safety review will be done prior to working in the lab.

Lab Clean-Up Policy: Students are responsible for cleaning up their work station and surrounding area and returning tools and supplies to the tool room at the end of each class session. Under no circumstances try to attempt to repair lab test equipment.

Field Trips: Students must sign the "Agreement to Participate and Waiver/Assumption of Risk" Form and submit to the instructor in order to participate in each field trip. The instructor will retain a signed copy of each form and submit a duplicate set of forms to the dean's office.

Homework is due one week from the day that it is assigned.

Tests and Quizzes: Quizzes that are missed must be made up prior to the next class meeting unless prior arrangements have been made.

Late Work: All materials to be graded must be submitted on the date due unless prior arrangements have been made. Late assignments loose 10% per week after due date.

Reading Assignment(s): In addition to the handouts, there will be supplemental reading and web assignments required.

Outside Assignments: Homework assignments are required as part of your grade.

Health Issues or Disabilities: "Students with health issues or disabilities that may necessitate intervention or modification to the college educational or physical environment are encouraged to arrange an appointment to discuss these issues with the professor so that a plan for meeting these needs can be established. (Heath Center, March 2004)".

Supplemental Items: If you have an issue that requires special accommodations, let me know as soon as possible. There are many services on campus to assist students with their learning experience. It is recommended to seek help as early as possible when a problem arises. We can't help you if you don't ask.

Student Conduct Policies: Disruptive and inappropriate behavior will not be tolerated and may result in you being dropped from the class. Group learning is recommended; however, the lecture and lab tests are designed to test your individual knowledge of the material. So that means DON'T CHEAT!

Final and Progress Grades: Final grades will be available by ***zip-mail*** only. Grades will not be posted. Progress points will be available from the instructor and will be occasionally distributed.

Binders: It is a good idea to get a binder to keep the many handouts that you will be getting throughout the class. They are important and will be used as reference throughout your electronics career or can be sold at an exorbitant price on e-bay.

Methods of Instruction: The course material will be delivered by lecture, overheads, videos, textbook, supplemental reading and web-based assignments. Practical applications including programming will be explored during hands-on demonstrations.

Cell Phones & Pagers: Phones and pagers interrupt the class and annoy fellow students. Please be considerate of others or they will be banned from the lab and lecture.

Food & Drink: **Food and Drinks are NOT** allowed in the Lab. Under no circumstances bring any food or drink into Room 323 because of Fiber Optic contamination of your food/drink.

Injuries: Notify the Lab Instructor immediately in case of injury.

Attendance Cessation: If you stop attending, it is your responsibility to contact e-services and drop the class. That way, the class will not be reflected on your transcripts.

Other Important Information: If you stop attending, it is your responsibility to contact e-services and drop the class. That way, the class will not be reflected on your transcripts. Use of appropriate language and sense of community—if behavior is disruptive to the class or the learning environment it is inappropriate. Latex products may be used in certain classroom activities. If a student has a health issue related to latex, the student should discuss with the instructor so that accommodation can be made.

- College Emergency Number is College Police at X2221 and from a cell phone at 558-2221
- All injuries must be reported to the instructor immediately.
- Safety glasses must be worn at all times when in the Lab (This is school policy)
- No food or drinks are allowed in the 323 Lab because of safety reasons (Fiber in your Coffee??) This means leave your backpacks, drinks and food someplace else!
- No playing around in the lab because of the cost of the equipment and safety issues

Final Comments / My Objective:
This instructor is pleased to accept suggestions regarding ways the class, labs, lectures, etc. may be made more fun, interesting, meaningful, and/or useful. Even though the essential content and required effort of the course cannot be diminished, all such suggestions will be carefully considered.

As your instructor, it is my objective to teach you the material in a dynamic and positive environment, as well as from personal first-hand experience. I like to teach in a synergistic and solution-oriented style. Your own motivation will help you succeed and excel in this class. I wish you the best for this semester.

Electrical & Mechanical Applications for Solar Installers
ENERGY 141
Semester Topic Outline
(May be modified due to semester time constraints)

Lec Hrs	Lab Hrs	Topic
4	4	Lecture: Overview of ENERGY 140, topics to be covered, NABSEP Entry Level Certificate of Knowledge of PV Systems Test certification and why it is important, safety test and safety overview for PV solar equipment. Lab: Build solar panel trainers including power load and test equipment, troubleshoot and ensure all PV panels and test equipment is working properly.
3	3	Lecture: Review solar power systems; how seasons and time of the year affect the sun angle, how time of day affects the sun angle and location, demonstration of SunEye shadow predictor, demonstration of Solarmetrics shadow predictor. Lab: Operate both the SunEye shadow predictor and the Solarmetrics shadow predictor.
4	3	Lecture: Review operation of SunEye and Solarmetrics shadow predictors, review the different software programs for calculating sun angle and exposure, demonstrate software drawing program, explain blueprint drawings and symbols. Lab: Use software program to design and draw a simple one line solar PV system, use SunEye and Solarmetrics shadow predictors to obtain shadow readings at 4 locations around campus.
3	4	Lecture: Review IV curves, explain what happens when clouds block the sun on bright days (knife edge effect, explain what happens to the IV power curves when clouds come over, typical solar PV panel installation mistakes and how to avoid them. Lab: Plot IV power curves for various panels, determine the effect on the IV curve when clouds pass over the panels (simulate cloud cover), calculate and track the “sweet spot” for a PV panel.
4	4	Lecture: Energy saving technology and applications, major components of a grid tie systems and their function, demonstrate SMA panel and grid tie inverter sizing software, perform load analysis of home photovoltaic systems, major power consumption devices in the home, major power consumption devices in the office. Lab: Use SMA software to estimate string size of solar panels, calculate load analysis for a specific residence, calculate load analysis for the student’s own home after applying energy saving technology.
3	5	Lecture: Show actual power load analysis using a sample residence, design a complete grid tie system for my home, use the SMA string sizing software to design a system and calculate payback years for my PV system. Lab:

		Do a load analysis for their home, design a grid tie system for their home, use SMA string sizing software to design a PV system and calculate years until payback for their home.
2	4	Lecture: Review load sizing software, typical problems and errors in PV installations and how to avoid them. Lab: Draft a working one-line drawing showing panel installation for a specific home, complete a load analysis for the home, and locate and fill out the paperwork for state and federal incentive offers for the home.
4	3	Lecture: Voltage drops in high and low Voltage wires, proper wire sizing for various PV systems, inverter drop out problems. Lab: Make long wire runs and measure resistance, calculate Voltage drop on long wire run and then measure the Voltage drop to compare theoretical to actual values, design a PV system for their home.
4	3	Lecture: Demonstrate Sharp Electronics solar panel estimator. Lab: Use the Sharp Electronics solar panel estimator to design a solar panel array for a given home.
4	4	Lecture: Construction, framing, and PV panel installation hazards, framing a roof using standard methods, designing and drawing the plans for framing a roof, drawing one line PV panel installation plans, how to deal with building departments and inspectors. Lab: Build roof structure.
2	2	Lecture: SMUD field trip (Hedge, Rancho Seco, Turkey Ranch Solar Farm) or guest lecture. Lab: SMUD field trip (Hedge, Rancho Seco, Turkey Ranch Solar farm) or guest lecture.
4	3	Lecture: Compare the types of PV panel mounting hardware; Pole mount PV panels, tracking PV panels, fixed ground PV panels, pitched roof mounts, NEC and fire code restrictions on placement of solar panels on roof structures. Lab: Mount PV panel rack hardware to roof and mount PV panels to rack, wire panels to each other and to the grid tie inverter.
4	4	Lecture: Electrical characteristics and parameters of grid tie inverters, phasing and hot connection of grid tie inverters, fusing and safety procedures when using grid tie inverters. Lab: Correctly fusing the grid tie inverter, phasing the AC signal from a grid tie inverter, measure input and output power and compare grid feed to use ratio.
2	2	Lecture: Calculating temperature of wires in conduit for various locations, proper sizing of wires and maximum number of wires per raceway, NEC codes for wire sizes, fire codes for wiring location and placement of PV panels.

		Lab: Continue working on roof grid tie systems, use rails and various PV grounding and securing hardware to mount the PV panels to the roof Insert problems in working PV system to give students troubleshooting practice.
3	4	Lecture: Typical design errors when installing PV systems, proof of performance testing and verification, testing of systems and types of equipment needed. Lab: Demonstrate advanced troubleshooting procedures, disassemble entire roof assembly, disassemble all PV trainers, review of semester lab projects.
2	2	Lecture: NABSEP Entry Level Certificate of Knowledge of PV Systems Test Lab: NABSEP Entry Level Certificate of Knowledge of PV Systems Test
2	0	Lecture: Final exam
54	**54**	**Total Hours**