ELEC 156 Course Outline as of Summer 2011

CATALOG INFORMATION

Dept and Nbr: ELEC 156 Title: PHOTOVOLTAIC SYSTEMS
Full Title: Photovoltaic Systems Design and Installation
Last Reviewed: 1/28/2019

Units		Course Hours per Week		Nbr of Weeks	Course Hours Total	
Maximum	3.00	Lecture Scheduled	2.00	17.5	Lecture Scheduled	35.00
Minimum	3.00	Lab Scheduled	3.00	8	Lab Scheduled	52.50
		Contact DHR	0		Contact DHR	0
		Contact Total	5.00		Contact Total	87.50
		Non-contact DHR	0		Non-contact DHR	0

Total Out of Class Hours: 70.00 Total Student Learning Hours: 157.50

Title 5 Category:	AA Degree Applicable
Grading:	Grade Only
Repeatability:	00 - Two Repeats if Grade was D, F, NC, or NP
Also Listed As:	
Formerly:	

Catalog Description:
Introduction to photovoltaic technology and its practical application. Focus is on residential and small commercial photovoltaic systems; how they work, the equipment required, and maximizing energy harvest in both utility interactive and off-grid applications. Provides the basic understanding required to size, site, design, and install code-compliant solar energy systems. Course is registered provider of the NABCEP Entry Level Certificate of Knowledge Exam (optional at end of semester).

Prerequisites/Corequisites:
Course Completion or Current Enrollment in ELEC 51A OR Course Completion or Current Enrollment in ELEC 60A

Recommended Preparation:
Course Completion of MATH 150A

Limits on Enrollment:

Schedule of Classes Information:
Description: Introduction to photovoltaic technology and its practical application. Focus is on residential and small commercial photovoltaic systems; how they work, the equipment required,

and maximizing energy harvest in both utility interactive and off-grid applications. Provides the basic understanding required to size, site, design, and install code-compliant solar energy systems. Course is registered provider of the NABCEP Entry Level Certificate of Knowledge Exam (optional at end of semester). (Grade Only)
Prerequisites/Corequisites: Course Completion or Current Enrollment in ELEC 51A OR Course Completion or Current Enrollment in ELEC 60A
Recommended: Course Completion of MATH 150A
Limits on Enrollment:
Transfer Credit:
Repeatability: Two Repeats if Grade was D, F, NC, or NP

ARTICULATION, MAJOR, and CERTIFICATION INFORMATION:

AS Degree:	**Area**	Effective:	Inactive:
CSU GE:	**Transfer Area**	Effective:	Inactive:
IGETC:	**Transfer Area**	Effective:	Inactive:

CSU Transfer:	Effective:	Inactive:
UC Transfer:	Effective:	Inactive:

CID:

Certificate/Major Applicable:
Certificate Applicable Course

COURSE CONTENT

Outcomes and Objectives:
Upon completion of this course, students will be able to:
1. Discuss the history of photovoltaic technology.
2. Use current--voltage curves (IV curves) to interpret photovoltaic response to Sun and temperature.
3. Read a Sun chart and understand the Earth's movements around the Sun.
4. Chose appropriate personal protection equipment when working with PV.
5. Use standard industry tools to determine a site's shading and to measure the total solar resource fraction available.
6. Perform a load analysis for both utility interactive and off-grid system sizing.
7. Match PV modules to inverter by using both manual string sizing calculations and manufacturer's string sizing tools.
8. Select appropriate racking and balance of system components for roof and ground mounted arrays.

Topics and Scope:

Lectures and labs will cover the following topics:
I. Energy Overview
 a. Production
 b. Uses
 c. Conservation

II. Photovoltaic History, Applications, Types of Systems
 a. Photovoltaics cell development: 1839--Today
 b. Early Applications
 c. Technology uses today
III. Photovoltaics Economics and Political Environment
 a. Net-Metering vs. Feed-in-Tariffs
 b. Federal incentives
 c. State incentives
IV. Electricity and PV
 a. Voltage, Current, Resistance
 b. Ohms Law
 c. Alternating current (AC) & direct current (DC)
 d. Power vs. Energy
 e. Digital Multimeter Use
V. Photovoltaic Safety
 a. Electricity Physiology
 b. Lock out/tag out procedures
 c. Fall safety
 d. Personal protection equipment
 e. Battery safety
 f. NEC Code
VI. Photovoltaic Modules
 a. Mono & Poly Crystalline
 b. Amorphous & Thin Film
 c. IV Curve Irradiance Response
 d. IV Curve Temperature Response
 e. Test Conditions: STC (factory standard test conditions) & PTC (PV USA test conditions)
VII. Solar Resource
 a. Peak Sun Hours
 b. Units of Irradiation & Insolation
 c. Azimuth, Tilt, and Latitude
 d. Sun Charts
 e. Seasons
VIII. Load Analysis
 a. Rate Schedule Tiers
 b. Time-Of-Use
 c. Energy requirements (kWhrs)
 d. Critical loads
IX. System Sizing
 a. DC vs. AC kWhrs
 b. De-rate factors
X. Site Review
 a. Compass declination
 b. Shade Evaluation Tools: PathFinder, SunEye, Protractor
 c. Mounting Azimuth & Tilt
 d. Utility Service Panel
XI. Equipment Selection
 a. Modules
 b. Inverters
 c. Racking
XII. Design
 a. Layout

b. Row Spacing
c. Roof vs. Ground
XIII. Permitting
a. Site Plans
b. Layouts
c. Line Diagrams
XIV. Installation
a. Structural requirements
b. Mounting
c. Roof Types
d. Wire Runs
XV. Off-Grid System Design
a. Load Analysis - Amp Hours & Watts
b. System Voltages
c. Batteries
d. Charge Controllers
e. Array Sizing
XVI. Performance Analysis and Troubleshooting
a. Expected Output
b. Diagnostic Measurements
c. Failure Modes & Causes

Assignment:

1. Read approximately one textbook chapter per week
2. Weekly problem sets
3. Weekly lab activities
4. 5-10 quizzes
5. Midterm
6. PV system design project
7. Final exam

Methods of Evaluation/Basis of Grade:

Writing: Assessment tools that demonstrate writing skills and/or require students to select, organize and explain ideas in writing.

None, This is a degree applicable course but assessment tools based on writing are not included because problem solving assessments are more appropriate for this course.	Writing 0 - 0%

Problem Solving: Assessment tools, other than exams, that demonstrate competence in computational or non-computational problem solving skills.

Problem sets	Problem solving 10 - 40%

Skill Demonstrations: All skill-based and physical demonstrations used for assessment purposes including skill performance exams.

Lab assignments; PV system design project	Skill Demonstrations 20 - 50%

Exams: All forms of formal testing, other than skill performance exams.

Quizzes, final exam: multiple choice, completion, true-false	Exams 20 - 40%

Other: Includes any assessment tools that do not logically fit into the above categories.

None	Other Category 0 - 0%

Representative Textbooks and Materials:
Dunlop, Jim: Photovoltaic Systems, American Technical Publishers 2nd Edition
Homewood, Illinois: 2009

Solar Energy International: Photovoltaics Design and Installation Manual, New Society Publishers
Gabriola Island, BC, Canada: 2004

Instructor prepared materials