

**RENRG 157 Course Outline as of Fall 2019****CATALOG INFORMATION**

Dept and Nbr: RENRG 157 Title: ADVANCED PV SYSTEMS

Full Title: Advanced Photovoltaic Systems

Last Reviewed: 2/11/2019

Units		Course Hours per Week		Nbr of Weeks	Course Hours Total	
Maximum	2.00	Lecture Scheduled	2.00	17.5	Lecture Scheduled	35.00
Minimum	2.00	Lab Scheduled	0	6	Lab Scheduled	0
		Contact DHR	0		Contact DHR	0
		Contact Total	2.00		Contact Total	35.00
		Non-contact DHR	0		Non-contact DHR	0

Total Out of Class Hours: 70.00

Total Student Learning Hours: 105.00

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: ELEC 157

**Catalog Description:**

Advanced topics in applied photovoltaic technology. Includes applying the National Electrical Code (NEC) and California Electrical Code (CEC) to photovoltaic installations, OSHA safety requirements, commercial applications, off-grid and direct coupled systems, and emerging thin-film technologies.

**Prerequisites/Corequisites:**

Course Completion of ELEC 156

**Recommended Preparation:****Limits on Enrollment:****Schedule of Classes Information:**

Description: Advanced topics in applied photovoltaic technology. Includes applying the National Electrical Code (NEC) and California Electrical Code (CEC) to photovoltaic installations, OSHA safety requirements, commercial applications, off-grid and direct coupled systems, and emerging thin-film technologies. (Grade Only)

Prerequisites/Corequisites: Course Completion of ELEC 156

Recommended:

Limits on Enrollment:

Transfer Credit:

Repeatability: Two Repeats if Grade was D, F, NC, or NP

## **ARTICULATION, MAJOR, and CERTIFICATION INFORMATION:**

<b>AS Degree:</b>	<b>Area</b>	Effective:	Inactive:
<b>CSU GE:</b>	<b>Transfer Area</b>	Effective:	Inactive:

<b>IGETC:</b>	<b>Transfer Area</b>	Effective:	Inactive:
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<b>CSU Transfer:</b>	Effective:	Inactive:
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<b>UC Transfer:</b>	Effective:	Inactive:
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**CID:**

**Certificate/Major Applicable:**

Certificate Applicable Course

## **COURSE CONTENT**

### **Student Learning Outcomes:**

At the conclusion of this course, the student should be able to:

1. Apply National Electrical Code (NEC) and California Electrical Code (CEC) to photovoltaic (PV) system installations.
2. Work safely with photovoltaics.
3. Design and create line diagrams for small to moderate sized photovoltaic systems.
4. Apply photovoltaics to off-grid and direct-coupled water pumping applications.

### **Objectives:**

At the conclusion of this course, the student should be able to:

1. Interpret Article 690 of the NEC and its application to photovoltaic installations.
2. Calculate system voltage drops and select correct wire types/sizes per the NEC.
3. Create a photovoltaic single line diagram to meet building permit requirements.
4. Understand sub-parts of Occupational Safety and Health Administration (OSHA) 29 Code of Federal Regulations (CFR) Part 1926 Safety and Health Regulations relevant to photovoltaic installations.
5. Select appropriate personal protection equipment for photovoltaic installations.
6. Apply photovoltaics to commercial power situations.
7. Select appropriate equipment for battery based off-grid photovoltaic systems.
8. Size a solar direct water pumping system.
9. Describe alternative (non-crystalline) photovoltaic technologies.

### **Topics and Scope:**

- I. NEC Article 690
  - A. Terminology
  - B. Conductor ampacity
  - C. Fusing

- D. System and equipment grounding
- II. Voltage Drop Calculations
- III. Equipment Characteristics and Selection
  - A. Modules
  - B. Inverters
  - C. Charge controllers
  - D. Batteries
  - E. Balance of system
- IV. PV System Permitting Requirements
- V. Photovoltaic Line Diagrams
- VI. OSHA Regulations and Safety
  - A. Electrical safety
  - B. Fall protections
  - C. Stairways and ladders
  - D. Personal protective equipment
- VII. 3-Phase Power and Commercial Applications
- VIII. Off-Grid System Sizing
  - A. Load analysis
  - B. Battery sizing
  - C. Array sizing
  - D. Maximum power point tracking (MPPT) and pulse width modulation (PWM) charge controllers
  - E. Wiring requirements
- IX. Direct-Coupled Water Pumping Systems
  - A. System sizing
  - B. Pump selection
  - C. Array sizing
- X. Current Topics in Photovoltaic Technology
  - A. Amorphous and thin film photovoltaics
  - B. Concentrated photovoltaics

### **Assignment:**

1. Weekly readings
2. Weekly problem sets
3. Quizzes (5-10)
4. Midterm
5. PV system design project(s)
6. 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 and skill demonstrations 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.

PV system design project(s)

Skill Demonstrations  
20 - 50%

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

Quizzes, midterm, and final

Exams  
30 - 50%

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

None

Other Category  
0 - 0%

### **Representative Textbooks and Materials:**

NFPA 70: National Electrical Code. National Fire Protection Association. 2017

Photovoltaic Systems Engineering. 3rd ed. Messenger, Roger and Abtahi, Amir. CRC Press. 2017

Study Guide for Photovoltaic System Installers Version 4.2. North American Board of Certified Energy Practitioners. 2009 (classic)

Instructor prepared materials