COLBY COMMUNITY COLLEGE

Syllabus

Course Number/Title: AE 275 Introduction to Solar Photovoltaic **Year:** Fall 2012

Department: Business & Technology **Credit Hours: 2**

Required Text: NCCER Contren Learning Series
Introduction to Solar Photovoltaics, 1st Edition
Pearson Education, Inc.
Upper Saddle River, NewJersey 07458

Days/Time: Lecture Online
Boot Camp Required
TBA

Instructor: Derek Reilley **Room #:** Basement of T. Hall

Office Hours: 8:00 am to 5:00 pm Monday-Friday **Phone:** 785-460-5431 Office
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Course Placement: Freshman/Sophomore **Pre-requisite:** None

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Rationale: With growing concerns about the future and security of the world's energy supply, renewable resources such as solar power are becoming increasingly important. Photovoltaic (solar) is a rapidly growing sector of the energy market. This course is intended for students with little or no solar (photovoltaic) background.

Course Description: This course covers a broad range of information that is valuable to entry-level photovoltaic installers, including system components, design considerations, environmental effects, and site analysis. Introduction to Solar Photovoltaics is intended to provide students with the requisite knowledge to help pass the North American Board of Certified Energy Practitioners (NABCEP) PV Entry Level Exam.

Course Outline:

1. Chapter 1: Introduction
2. Chapter 2: Applications
3. Chapter 3: Ohm's Law and Power
4. Chapter 4: System Components
5. Chapter 5: Safety Considerations in PV Systems
6. Chapter 6: Site Assessment
7. Chapter 7: System Design
8. Chapter 8: Installation
9. Chapter 9: Maintenance
10. Chapter 10: Troubleshooting
11. Chapter 11: Codes and Standards
12. Chapter 12: Emerging Technologies

Course Learning Objectives Assessed:

Colby Community College (CCC) uses the North American Board of Certified Energy Practitioners (NABCEP) to help guide the college in learning outcomes. These outcomes are created for those individuals wanting to attain knowledge and application of solar photovoltaic system operations, CCC's technical track of courses is the perfect curriculum for students wanting to take the NABCEP PV Entry Level Exam. Below are the ten objectives contained in the North American Board of Certified Energy Practitioners' (NABCEP's) Entry Level Program:

1. PV Markets and Applications
2. Safety Basics
3. Electricity Basics
4. Solar Energy Fundamentals
5. PV Module Fundamentals
6. System Components
7. PV System Sizing Principles
8. PV System Electrical Design
9. PV System Mechanical Design
10. Performance Analysis, Maintenance and Troubleshooting

CCC Student Learning Outcomes (NABCEP) to be measured in This Course

1. PV Markets and Applications. (NABCEP 1.2) Identify common types of PV system applications for both stand-alone and utility interactive systems with and without energy storage.
2. Electricity Basics. (NABCEP 3.5) Demonstrate the ability to apply Ohm's Law in analyzing simple electrical circuits, and to calculate voltage, current, resistance or power given any other two parameters.
3. Solar Energy Fundamentals. (NABCEP 4.1) Define basic terminology, including solar radiation, solar irradiance, solar irradiation, solar insolation, solar constant, air mass, ecliptic plane, equatorial plane, pyranometer, solar declination, solstice, equinox, solar time, solar altitude angle, solar azimuth angle, solar window, array tilt angle, array azimuth angle, and solar incidence angle.
4. Solar Energy Fundamentals. (NABCEP 4.4) Differentiate between solar irradiance (power), solar irradiation (energy), and define the meaning of the terms peak sun, peak sun hours, and insolation.
5. Safety Basics (NABCEP 2.1) Identify the various safety hazards associated with both operating and non-operating PV systems and components.

Course Competencies

The overall objective of this course is to introduce the student to the components of photovoltaic systems in an interesting, accessible and understandable format for the entry level student.

Chapter 1 Introduction to Solar Photovoltaics

- Identify photovoltaic (PV) applications and advantages
- Identify system components and their functions
- Identify safety hazards associated with PV installations
- Trace a basic electrical circuit and perform calculations using Ohm's law
- List PV sizing considerations
- Identify PV electrical and mechanical system design considerations
- Describe the tasks required to complete a site analysis
- Identify the effects of the environment on panel output
- Describe how to install a simple grid-connected PV system
- Explain how to assess system operation and efficiency
- Recognize the tasks required when performing PV maintenance and troubleshooting

- Identify appropriate codes and standards concerning installation, operation, and maintenance of PV systems and equipment

Chapter 2 Applications

- Standalone Systems
- Grid-Connected Systems
- Grid-Interactive Systems
- Utility-Scale Solar Generating Systems

Chapter 3 Ohm's Law and Power

- Applying Ohm's Law to Series and Parallel Circuits
- Series Circuits
- Parallel Circuits
- Series-Parallel Circuits
- Ohm's Law and Power
- Series and Parallel Circuits in Solar PV systems
- Peak Sun and Power

Chapter 4 PV System Components

- PV Panels
- Monocrystalline
- Polycrystalline
- Thin Film
- Inverters
- Batteries
- FLA Batteries
- AGM Batteries
- Charge Controllers
- BOS Components
- Electrical System Components
- Footers and Support Structures

Chapter 5 Safety Considerations in PV Systems

- Fall Protection
- Battery Hazards
- Electrical Hazards
- Meter Safety

Chapter 6 Site Assessment

- Customer Interview
- Power Consumption
- Roof Evaluation
- Array Orientation
- Equipment Location

Chapter 7 System Design

- Panel Nameplate Data
- Solar Array Sizing
- Inverter Selection
- Battery Bank Sizing
- Selecting a Charge Controller
- Adjusting PV Conductors
- Temperature adjustment

- Continuous Duty
- Conduit Fill
- Voltage Drop

Chapter 8 Installation

- Forces Exerted on the Panels/Support System
- Expansion and Contraction
- Drag
- Wind
- Roof-Mounted Installations
- Ground-Mounted Installation
- Electrical System Installation
- Assessing System Output Power

Chapter 9 Maintenance

Chapter 10 Troubleshooting

- Loose or Corroded System Connections
- Inverter Losses
- Heat Fade
- Burnt Terminals
- Bypass Diode Failure

Chapter 11 Codes and Standards

Chapter 12 Emerging Technologies

Method of Instruction:

Lectures, including Power Point presentations and/or video, assigned reading, class discussions either in the physical classroom or online format, individual assignments. Student questions are an important part of the learning process. Students will be expected to participate in open class discussions and assignments. Be prepared for questions on given topics.

Method of Evaluation:

The student's evaluation whether in the classroom or online, will be based upon discussion and review questions, quizzes and a final exam. The following will be how the course will be weighted:

1. Discussion Questions 25%
2. Boot camp 25%
3. Quiz 25%
4. Final Exam 25%

Grading Scale

Letter grades are assigned as follows:

90-100	A
80-89	B
70-79	C
60-69	D
Under 60	F

Course Requirements:

Understanding comes from interacting and you cannot interact if you do not participate in class. Be sure to take notes on what you see in Power Point presentations, assigned reading, or during lectures. Important objectives are presented in each class

meeting or in each online unit. Communicating your thoughts in the physical classroom or within the online threaded discussion is an important component of learning and participation is an important part of the course.

Assignment Policy:
All assignments must be completed and handed in at the designated times assigned by the instructor. No late work will be accepted. (Usually, assignments will be requested at the beginning of class; any attempt to turn in later will be considered late and not accepted.)

Test Policy:
Instructor reserves the right to schedule proctored exams.

Attendance Policy:
For the physical classroom, attendance is required and roll will be taken daily. Class interaction is important, and material covered in lecture may appear on the test. For online instruction of this course, your attendance is noted by your interaction on the discussion thread and through online assessments.

Assessment
Colby Community College assesses student learning at several levels: general education, program, and course. The goal of these assessment activities is to improve student learning. As a student in this course, you will participate in various assessment activities. An example of your work, a paper, some test questions, a presentation, or other work may be selected for assessment. This process will not affect your grade, will not require you do additional work and your evaluation will be confidentially handled. Results of these activities will be used to improve teaching and learning at Colby Community College.

Syllabus Information Disclaimer I reserve the right to change any information contained in this document, when necessary, with adequate notice given to the student. Notice shall be given in the classroom during class (or online). No other notice is required. It is the students' responsibility to stay current with any changes, modifications, adjustments or amendments that are made to this document."

Accommodations for Students With Disabilities According to the Americans with Disabilities Act, it is the responsibility of each student with a disability to notify the college of his/her disability and to request accommodation. If a member of the class has a documented learning disability or a physical disability and needs special accommodations, he/she should contact Student Support Services, which is located in the Student Union."

Equipment:
Solar Stik (Hybrid off-grid solar photovoltaic and wind turbine power plant that can support both AC and DC loads). Photovoltaic Modules, Charge Controllers, Inverters, Batteries, Solar Pathfinder, Multi-meter, angle/pitch finder, Balance of System Components, Racking sSysems, and Pyranometer.

Bibliography:
NCCER Contren Learning Series (2010). Introduction to Solar Photovoltaics (1st ed.). Upper Saddle River, NewJersey Pearson Education, Inc.

Recommended Resources:
1. Photovoltaic Systems, 2nd Edition, by James P. Dunlop, ISBN 978-0-8269-1287-9 ©July 2009 National Joint Apprenticeship and Training Committee and American Technical Publishers: www.jimdunlopsolar.com
2. Code of Federal Regulations, Chapter 29 Part 1926 – Safety and Health Regulations for Construction, Occupational Safety and Health Administration: www.osha.gov
3. 2008 National Electrical Code ®, NFPA 70 or 2008 National Electrical Code® Handbook, National Fire Protection Association®: www.nfpa.org
4. Study Guide for Photovoltaic System Installers, North American Board of Certified Energy Practitioners, Version 4.2, April 2009: www.nabcep.org
5. Photovoltaics Design and Installation Manual, ISBN 978-0-86571-520-2. ©2007 Solar Energy International, New Society Publishers (available in both English and Spanish): www.solarenergy.org

Revised & Approved May 2003
Revised 08/04
Revised 08/11