DEPT.  SOLR  COURSE NUMBER:  2020

NUMBER OF CREDITS:  3 (Lecture)

COURSE TITLE:  ADVANCED PHOTOVOLTAIC SYSTEMS

CATALOG DESCRIPTION:
Course/Catalog Description (must begin with an action verb/contains only class content):
This course will provide an introduction to photovoltaic (PV) systems design, installation, operation, and maintenance for residential and commercial applications. Students will collect and interpret data. They will apply this data to the design and configuration of grid-tied and standalone system designs.

AUDIENCE:  Solar Technicians

PREREQUISITES OR NECESSARY ENTRY SKILLS/KNOWLEDGE:
MN West Prerequisites: ELCO 1110 or ELCO 1100 (Minimum grade: 2.0 GPA equivalent) or above

LENGTH OF COURSE:
One Semester

THIS COURSE IS USUALLY OFFERED:
Every other year  fall  spring  summer  undetermined

Four goals are emphasized in course at Minnesota West Community & Technical College:

1) ACADEMIC CONTENT:  The academic objectives of this course are:
   a. Design a solar system  
   b. Manage a solar project  
   c. Install electrical components  
   d. Install mechanical components  
   e. Completing installation and system commissioning  
   f. Conducting maintenance and troubleshooting activities

2) THINKING SKILLS:  This course will help students improve the effectiveness of their thinking skills through:
   a. Completing homework (reading, reports, and worksheets).  
   b. Participating in classroom discussions  
   c. Taking quizzes and tests
3) COMMUNICATIONS SKILLS: This course will help students improve their oral and written communication skills through:
   a. Participating in classroom discussions and reports
   b. Participating in assignments, worksheets
   c. Communicating with other students on solar projects

4) HUMAN DIVERSITY: This course will help students recognize, understand, and appreciate human diversity through:
   a. Working with other students from other cultures
   b. Working with other students from different colleges
   c. Working on effective communication to complete assigned task given to them

TOPICS TO BE COVERED:
1. Introduction to Photovoltaic (PV) Systems
2. Solar Radiation
3. Site Surveys and Preplanning PV Specific
4. PV System Components & Configurations
5. PV Cells, Modules and Arrays
6. Battery Systems
7. Charge Controllers
8. Inverters
9. PV Systems Sizing
10. PV Integration and Mounting Systems
11. Electrical Integration
12. Utility Interconnection
13. PV System Permitting and Inspection
14. PV System Commissioning

Course Learning Outcomes:
- Understand how remote system monitoring and control are installed and operate.
- Know where to find pertinent information in the NEC code book.
- Create a safety plan for a solar project.
- Demonstrate project management skills for a solar project.
- Apply for and obtain an “unlicensed individual” card from DOLI
- Know how to use an I-V curve PV system analyzer.
- Select specific equipment for a design based on design requirements.
- Select and size wiring and other BOS components.
- Bend conduit as required.
- Demonstrate how to determine a solar modules expected output, measure actual output, and compare the two in order to evaluate the panel.
- Understand the pace at which employers expect work to be completed.
- Draw one line electrical diagrams.
- Contact the utility to determine the order of equipment in a one line diagram.
- Understand how to determine the metering requirements of a utility before designing a solar system.
- Demonstrate installation skills.
STUDENT LEARNING OUTCOMES (SPECIFIC):
1. compare the advantages, disadvantages to evaluate the design priorities of installing a PV system
2. describe the purposes of the major components in PV systems.
3. identify the common types of energy storage systems.
4. compare the functions of various power conditioning devices.
5. compare the features and requirements of various system configurations.
6. identify the relationships between PV cells, modules, and arrays.
7. describe the photovoltaic effect and the fundamentals of PV cells.
8. describe the construction and features of modules.
9. differentiate between flat-plate collectors and concentrating collectors.
10. differentiate between solar irradiance (power) and solar irradiation (energy).
11. describe how array orientations can maximize the solar energy gain on modules.
12. demonstrate how solar radiation and climate data are used in sizing and estimating performance for PV systems.
13. explain the purposes of data monitoring and discuss options for collecting system data.
14. describe the various performance rating conditions for modules.
15. describe the operation of batteries and their discharging and charging characteristics.
16. describe major principles and considerations for designing battery banks.
17. identify the principal functions and features of charge controllers.
18. define charge regulation and load control set points.
19. identify basic waveform types and properties.
20. compare applications for static inverters.
21. explain the basic types of inverters used in PV systems and describe their operation.
22. understand inverter specifications and ratings.
23. describe the primary factors that affect system sizing.
24. determine the system energy and power requirements from a load analysis.
25. calculate the size and configuration of the battery bank based on system requirements.
26. calculate the size and configuration of the array based on system requirements.
27. identify the key considerations for integrating arrays on buildings and other structures.
28. identify the electrical codes, regulations, and recommendations applicable to PV systems.
29. calculate the voltage and current limits for various circuits of a PV system.
30. identify the appropriate types of conductors for PV system circuits based on application and environment.
31. describe the required types of disconnects and their installation.
32. differentiate between acceptable PV system grounding methods.
33. describe the functions and requirements of electrical balance-of-system (BOS) components.
34. identify the applicable codes and standards for utility interconnection.
35. differentiate between load-side and supply-side interconnections and identify the requirements for each type.
36. describe the common requirements for permit applications.
37. describe the labeling requirements for PV system components and configurations.
38. describe the steps involved with commissioning a new PV system.
39. Identify the maintenance tasks involved with maximizing array output, battery health, and other equipment operation.

**LEARNING/TEACHING TECHNIQUES** used in the course are:
- Collaborative Learning
- Problem Solving
- Student Presentations
- Interactive Lectures
- Creative Projects
- Individual Coaching
- Lecture
- Films/Videos/Slides
- Demonstrations
- Other (describe below)
- Lab

**ASSIGNMENTS AND ASSESSMENTS FOR THIS CLASS INCLUDE:**
- Reading
- Tests
- Individual Projects
- Oral Presentations
- Worksheets
- Collaborative Projects
- Textbook Problems
- Papers
- Portfolio
- Group Problems
- Term Paper
- Other (describe below)

**Veteran Services:** Minnesota West is dedicated to assisting veterans and eligible family members in achieving their educational goals efficiently. Active duty and reserve/guard military members should advise their instructor of all regularly scheduled military appointments and duties that conflict with scheduled course requirements. Instructors will make every effort to work with the student to identify adjusted timelines. If you are a veteran, please contact the Minnesota West Veterans Service Office.

The information in this course outline is subject to revision

To receive reasonable accommodations for a documented disability, please contact the campus Student Services Advisor or campus Disability Coordinator as arrangements must be made in advance. In addition, students are encouraged to notify their instructor.

This document is available in alternative formats to individuals with disabilities by contacting the Student Services Advisor or by calling 800-658-2330 or via your preferred Telecommunications Relay Service.

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