Course Number and Title: NRG 202 Photovoltaic Systems II

Campus Location:
Georgetown, Dover, Stanton

Effective Date:
2018-51

Prerequisite:
ELC 125, NRG 109, NRG 111, NRG 201, NRG 205 or concurrent, ENG 102

Co-Requisites:
none

Course Credits and Hours:
4.00 credits
3.00 lecture hours/week
2.00 lab hours/week

Course Description:
This course covers the design of both the electrical and mechanical systems required in photovoltaic (PV) systems. Secondary components required in PV systems and how all parts are integrated into the overall system are explored. Troubleshooting typical problems that can occur when installing PV systems is also discussed.

Required Text(s):
Obtain current textbook information by viewing the campus bookstore - https://www.dtcc.edu/bookstores online or visit a campus bookstore. Check your course schedule for the course number and section.

Additional Materials:
None

Schedule Type:
Classroom Course

Disclaimer:
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Core Course Performance Objectives (CCPOs):

1. Engage in professional behavior. (CCC 1, 3, 4, 5)
2. Design and size PV systems for a variety of uses. (CCC 1, 2, 3, 4, 6; PGC 1, 2, 3, 5, 6, 7)
3. Design PV mechanical systems. (CCC 1, 2, 3, 4, 6; PGC 1, 2, 3, 4, 5)
4. Prepare a professional technical report based upon a site assessment for a given location. (CCC 1, 2, 3, 4, 6; PGC 4, 5, 6, 7)
5. Explain and determine the economic considerations related to solar energy systems, including state and federal policy mechanisms. (CCC 1, 2, 3, 4, 6; PGC 2, 5)

See Core Curriculum Competencies and Program Graduate Competencies at the end of the syllabus. CCPOs are linked to every competency they develop.

Measurable Performance Objectives (MPOs):
Upon completion of this course, the student will:

1. Engage in professional behavior.
    1. Demonstrate punctuality when attending class, participating in off-site projects, and submitting assignments.
    2. Communicate using industry-appropriate language in presentations, reports, and homework.
    3. Demonstrate appropriate professional behavior when working with others.
2. Design and size PV systems for a variety of uses.
    1. Explain the basic principles, rationale, and strategies for sizing stand-alone PV systems versus utility-interactive PV systems.

2. Determine the peak power demand and energy consumption over a given period of time, given the power usage and time-of-use for various electrical loads.
3. Determine the derating factors and other system losses as well as their typical values.
4. Calculate alternating current (AC) power and energy productions using simplified calculations, beginning with PV module direct current (DC) nameplate output.
5. Calculate AC power and energy production using online software tools, including PVWatts.
6. Determine the maximum and minimum number of modules that may be used in source circuits and the total number of source circuits that may be used with a specified inverter for a specified PV module and inverter in a simple utility-interactive system.
7. Determine array configurations that will fit within a given inverter's maximum power point tracker (MPPT) voltage window given site-specific range of operating temperatures.
8. Use both simple calculations and inverter manufacturer's online string sizing software tools to determine maximum and minimum number of modules, modules per string, and number of strings.
9. Calculate the size of the PV array and battery substation needed for a given task for a standalone operation.
10. Construct a components based model in software such as the system adviser model that includes shading considerations.
11. Determine the appropriate sizing of the battery, PV array, and diesel generator for a hybrid system using the hybrid optimization modeling of multiple energy resources (HOMER) or similar energy software.
12. Create one-line electrical schematics for interactive and standalone PV systems showing all major components and subsystems, and indicate the locations of the PV source and output circuits, inverter input and output circuits, charge controller and battery circuits, as applicable, and mark the directions of power flows through the system under various load conditions.
13. Explain the benefits and drawbacks of micro inverters.

3. Design PV mechanical systems.
    1. Differentiate among the common ways PV arrays are mechanically secured and installed on the ground, to building rooftops or other structures, including rack mounts, ballasted systems, pole mounts, integral, direct and stand-off roof mounts, sun tracking mounts, and for other building-integrated applications.
    2. Compare and contrast the features and benefits of different PV array mounting systems and practices, including their design and materials, standardization and appearance, applications and installation requirements, thermal and energy performance, safety and reliability, accessibility and maintenance, costs, and other factors.
    3. Describe the effects on PV cell operation from environmental conditions, including incident solar radiation levels, ambient temperature, wind speed, and direction for various PV array mounting methods.
    4. Compare and contrast the features and benefits of various building-integrated PV (BIPV) applications with conventional PV array designs.
    5. Select desirable material properties that have the appropriate longevity consistent with the operating life expectancies and weather applicable to a given system.
    6. Examine the requirements for roofing systems expertise, and identify the preferred structural attachments and weather-sealing methods for PV arrays affixed to different types of roof compositions and coverings.
4. Prepare a professional technical report based upon a site assessment for a given location.
    1. Demonstrate good customer service skills when communicating with the customer on the phone and in person.
    2. Qualify the customer by performing a remote site assessment using various online tools.
    3. Complete an onsite site assessment of the property, including the identification of energy conservation measures (ECMs) that will reduce electricity consumption on the property.
    4. Calculate the estimated energy savings by implementing these ECMs.
    5. Identify suitable locations for a PV installation; select the most promising location, and defend why it should be used for PV installation.
    6. Perform shading analysis of solar site chosen.
    7. Propose and justify the size of a solar system.
    8. Calculate the electricity that can be produced at the chosen site.
    9. Design the layout of PV system.
    10. Create an equipment list for all materials needed.
    11. Size the additional components necessary for installation, including inverters, racking, wiring, and other items based on customer requests.
    12. Calculate the installation cost for the customer.
    13. Calculate the upfront cost to the customer after incentives and rebates are identified.
    14. Calculate the simple and discounted payback on this investment.
    15. Perform a utility analysis of the property.
    16. Prepare the requirements for plan review, permitting, inspections, construction contracts, and other matters associated with approvals and code-compliance for PV systems.
5. Explain and determine the economic considerations related to solar energy systems, including state and federal policy mechanisms.
    1. Describe federal and state policy mechanisms related to solar energy, including solar renewable energy credits (SREC), renewable portfolio standards, investment tax credit, accelerated depreciation, and feed-in tariffs.
    2. Calculate the impact of state and federal policy mechanism on solar energy costs, including payback.
    3. Explain the principles and benefits of net metering.
    4. Perform lifecycle cash flow analysis of a solar PV installation, including panel depreciation, panel life expectancy, inverter life expectancy, and operations and maintenance (O&M) costs.
    5. Determine discounted payback, net present value (NPV), and levelized cost of energy (LCOE) of a solar array.
    6. Describe power purchase agreements (PPAs) and how they can be used for residential and commercial solar systems.
    7. Calculate the impact that special SREC auctions have on payback.

Evaluation Criteria/Policies:
Students must demonstrate proficiency on all CCPOs at a minimal 75 percent level to successfully complete the course. The grade will be determined using the Delaware Tech grading system:

92	–	100	=	A
83	–	91	=	B
75	–	82	=	C
0	–	74	=	F

Students should refer to the Student Handbook - https://www.dtcc.edu/handbook for information on the Academic Standing Policy, the Academic Integrity Policy, Student Rights and Responsibilities, and other policies relevant to their academic progress.

Core Curriculum Competencies (CCCs are the competencies every graduate will develop):

1. Apply clear and effective communication skills.
2. Use critical thinking to solve problems.
3. Collaborate to achieve a common goal.
4. Demonstrate professional and ethical conduct.
5. Use information literacy for effective vocational and/or academic research.
6. Apply quantitative reasoning and/or scientific inquiry to solve practical problems.

Program Graduate Competencies (PGCs are the competencies every graduate will develop specific to his or her major):

1. Utilize building system and energy technology hardware and software to gather data on building lighting systems operation and energy consumption.
2. Calculate, analyze, and verify the energy use of buildings based upon the interaction of energy consuming building systems.
3. Evaluate residential buildings and make recommendations for optimized building performance and occupant comfort.
4. Prepare and present technical reports.
5. Analyze the economic, environmental, and business implications of potential energy measures.
6. Perform preliminary and in depth site and customer suitability evaluation of potential applications for solar use.
7. Design and calculate the output of an optimal site specific array by deriving panel configuration and specifying components.

Disabilities Support Statement:
The College is committed to providing reasonable accommodations for students with disabilities. Students are encouraged to schedule an appointment with the campus Disabilities Support Counselor to request an accommodation needed due to a disability. A listing of campus Disabilities Support Counselors and contact information can be found at the disabilities services - https://www.dtcc.edu/disabilitysupport web page or visit the campus Advising Center.