RENG 430 – Solar Photovoltaic Systems

2013 Fall Semester
3 Credits (2 50-minute lectures, 3-hour laboratory)
Pre-requisites: MATH 103, RENG 330

INSTRUCTOR:

Dr. Philip V. Hofmeyer, 108 Shannon Hall
On-campus mailbox: Marshall Hall
Office phone: 315-684-6515
E-mail: hofmeypv@morrisville.edu

OFFICE HOURS:

Monday 2-3:30 PM and Wednesday 11 AM to 1PM. If necessary, students are also encouraged to make appointments to see the instructor at other times.

Students with disabilities who require accommodations to fully-participate in the course activities are requested to contact the instructor within the first two weeks of the semester.

COURSE DESCRIPTION:

RENG 430 is a 3-credit hour class (2 hours of lecture and 3 hours of laboratory) that that builds on RENG 330. The focus is on siting solar PV systems, National Electrical Code Article 690, roof analysis, wind loading, weight loading, array withdrawal forces, sliding forces, 1- and 3-line electrical diagrams, system grounding, off-grid systems, optimizing system efficiency, and troubleshooting. Paperwork necessary for grant funding and New York State local ordinances are also covered. Fall semester.

EXPECTED COURSE OUTCOMES:

The overall objective of this course is to provide the student with a technical understanding of residential solar photovoltaic energy systems. The objectives for this course will be modeled after the NABCEP solar PV installer guidelines. Upon completion of this course, the student will be able to:

1. Collect and analyze solar data
2. Analyze a potential site and conduct a full site assessment
3. Create 1-line and 3-line solar system diagrams
4. Collect and analyze inverter data to optimize system efficiency
5. Critique various residential PV modules and inverters to select the proper equipment for a given site
6. Scrutinize technical journal articles through a process of identifying article strengths, insights, and areas for improvement (SII methodology)
7. Critique a PV system, perform a full system inspection, and troublehsoot components
8. Employ safe work habits at heights, with high voltage, and high electrical current

INSTRUCTIONAL METHODS:

1. Lecture/laboratory/problem solving sessions.
2. Reading assignments.
3. Homework and laboratory exercises.

4. A renewable energy system project shall be undertaken (group project).
5. Reading current literature related to energy systems.

REQUIRED TEXTS:

Dunlop, J.P. 2010. Photovoltaic Systems, 2nd Ed. American Technical Publishers, 469 p. (ISBN: 978-0-8269-1308-1).

National Fire Protection Agency. 2011. The National Electrical Code Handbook. 1497 p. ISBN: 978-0-877-65916-7

Other handouts and course material will be available on-line via Blackboard, accessible only by those students who are enrolled in the course.

REFERENCES:

Solar Energy International. 2004. Photovoltaics: Design and Installation Manual. New Society Publishers, 326 p. (ISBN: 978-0-86571-520-2).

Hart, G.V., and S. Hart. 2009. Ugly's Electrical References, Revised 2008 Edition. Jones and Bartlett Publishers. 186 p. (ISBN: 978-0-7637-7126-3).

STUDENT REQUIRED EQUIPMENT:

Notebook, texts, scientific calculator, laptop, work boots, and appropriate dress for scheduled laboratory operations and field trips.

CLASS POLICIES:

Student Behavior: *As students in a technical program are preparing for a professional career, all students are expected to conduct themselves, in both manner and dress, as professionals.*

Eating, drinking, or the consumption of *any* tobacco products is prohibited during class meetings (lecture hall, classroom, laboratory, or field). Doing so may result in the student's dismissal from that class period and will count as an unexcused absence.

Cell phones, pagers, and similar devices must be turned **off** during the instruction time. Use of or disruption of class by these devices **will** result in the confiscation of the device by the instructor, and may result in the student's dismissal from that class period which will count as an unexcused absence. The confiscated device may be retrieved at University Police.

Attendance: Students are required to attend scheduled lectures, labs, and field trips; and to work on class and lab/field assignments as scheduled by the professor. Students are required to attend their scheduled sections for labs, lectures, and examinations (unless authorized by the professor). Since class sessions start on the hour, students are expected to be punctual. *There will be no late entries once a class has begun.* In this case, student's absence will be counted as *unexcused* and will receive a zero for any assignments due.

If a student must leave class early during a regularly scheduled meeting, he/she must discuss reasons with the professor. If a student must miss a scheduled class meeting due to an acceptable, verifiable time conflict, he/she must resolve the time conflict *prior to* class.

If a student is unable to attend class because of an emergency, the professor or School of Agriculture and Natural Resources office must be contacted *prior to* the scheduled class meeting.

The telephone number is 684-6515 (Dr. Hofmeyer) or 684-6083 (School office). Use of e-mail (hofmeypv@morrisville.edu) is highly recommended.

Students failing to call ahead or discuss absences prior to the class will be unexcused. If a student accumulates four *unexcused* absences, he/she will be given the option of dropping the course or receiving a failing grade for the semester.

Honesty Policy & Discipline (Due Process): Honesty and integrity are major elements in professional behavior and are expected of each student. Any assignment (including those in electronic media) submitted by a student must be of the student's original authorship. Representation of another's work as his/her own shall constitute plagiarism. Cheating, in any form, is considered unacceptable behavior within all University courses. Students having academic problems should consult with their advisor or a college counselor. Instances of cheating will be dealt with in accordance to University policy. Standards of academic honesty and due process procedures for Morrisville College are located in the Rules, Regulations & Expectations section of the student handbook.

Safety Guidelines: Certain class assignments may require the student to be absent from the professor's immediate supervision. Whether the student is under immediate supervision or not, safe conduct and safe use of equipment shall be the ultimate rule. Failure to comply with prudent safety practice and/or willful disregard for class participants and/or equipment may be cause for immediate dismissal from that particular class session by the professor. Subsequent similar activity may be cause for dismissal from the course by the School Dean.

GRADING/EVALUATION OF THE STUDENT:

Evaluation is a shared responsibility between the teacher and the student. The purpose of the evaluation is to demonstrate how well the professor has taught and the student has learned specific course materials, the principles, concepts and terms relevant to the renewable energy field, and to determine the students' ability to apply that knowledge to specific situations.

Grade Method: Many class and laboratory periods will have a graded component or exercise. These may be written assignments, in-lab assignments, homework, or the evaluation of the student's participation and attitude. These components will total sixty percent (60%) of the total course score. It is important that students complete their assignments accurately, neatly, and submit them on time. Assignments received past the due date will be devalued 50% for each day that the item is late. No class assignment of any student will be graded (for credit) once the same assignment is corrected and returned to the class.

A final written exam will follow the North American Board of Certified Energy Practitioners (NABCEP) PV Installer Exam guidelines (worth 30% of final grade). This will prepare students to take the exam once they graduate. This exam will be multiple choice, just as the NABCEP exam is. No make-up examination will be given without a written medical excuse, family emergency, or prior permission from the instructor. Students are responsible for all material covered in the class whether presented orally during the lectures and labratory or assigned (homework and reading).

The breakdown of grading is as follows:

Homework/laboratory assignments	60%
Final Exam	30%
Class participation	10%
TOTAL	100%

Grading Scale:

100 - 94% = A	89 - 87% = B+	79 - 77% = C+	69 - 65% = D+
93 - 90% = A-	86 - 83% = B	76 - 73% = C	64 - 60% = D
	82 - 80% = B-	72 - 70% = C-	Below 60% = F

TENTATIVE OUTLINE OF TOPICS*:

Week	Topics (Lecture and Lab)	Homework
1	Intro, Safety, NABCEP	
	Course introduction and expectations	
	Review of NREL data	Assignment #1: Solar energy
lab	Lab overview, Safety, NABCEP, I-V curves and measurement	
2	System sizing	
	Cell temp correction	Assignment #2: Cell temps
	Review of string sizing	Assignment #3: Series Strings
lab	Move and redo solar roof	
3	Wiring review	
	Review of voltage drop, Ampacity, power loss	Assignment #4: Vd and Ampacity
	Review of basic wiring diagrams	Assignment #5: Wiring diagram
lab	Move and redo solar roof	
4	Mounting and Racking Review	
	Roof analysis and racking systems, thermal expansion	Assignment #6: Racking layout
	Mounting BOS components	Assignment #7: Article 90
lab	Solar Roof setup (flashing, racking, disconnects)	Solar roof install
5	NEC 2011 Introduction	
	Article 90 - Introduction to *The Code*	Assignment #8: Article 100, 110
	Article 100 – Selected definitions, Article 110 - Requirements	
lab	Wiring the Solar Roof, modules	Solar roof install
6	PV code	
	Article 690.2 – Definitions for PV systems	Assignment #9: Article 690.4
	Article 690.7 – circuits	Assignment #10: Article 690.7, 690.8
lab	AutoCAD Electrical – Basic use and functions for wiring diagrams	Lab 6: AutoCAD PV components
7	PV Code II	
	Article 690.82 ampacity	Assignment #11: Article 690.9
	Article 690.9 – Overcurrent Protection	Assignment #12: Article 690.13
lab	AutoCAD Electrical – Simple PV system	Lab 7: AutoCAD basic wiring diagram
8	In class system design	
	No classes (October Break)	

	Disconnects	
Lab	PV design part 1	AutoCAD PV 1
9	PV Code III	
	Article 690.13 – Switches and disconnects	Assignment #13: Article 690.31
	Article 690.31 – Wiring methods	Assignment #14: Article 250
Lab	AutoCAD electrical – Complex PV system I	Lab 9: Complex wiring diagram
10	In-class group project	
	In-class group project	
Lab	AutoCAD structural	Lab 10: Roof layout
11	Grounding!!	
	Sizing grounding conductors, continuity	Assignment #15: Article 690.5
	Article 690.5 - PV Grounding (EGC and GEC)	Assignment #16: Article 690.5
Lab	Commercial systems	Lab 11: commercial system I
12	PV Code IV	
	Article 690.5 - Marking	Assignment #17: Article 705
	Article 690.6 and Article 705 – Interconnected power sources	Assignment #18: Article 310.104
Lab	Site view and disconnect plan	Lab 12: Site plan and disconnect
13	Conductors and ampacity	
	Conduit and wire ways (Articles 348, 350, 352, 358, 376)	Assignment #19: Article 310.15
	Off-grid system overview	
lab	Off-grid load analysis	Lab 13: Final project introduction
14	Off-Grid Systems	
	Load Analysis (power and energy)	Assignment #21: Load analysis
	No Class (Thanksgiving Break)	
lab	**No Lab (Thanksgiving Break)**	
15	Off-Grid Systems	
	Battery Bank Sizing	Assignment #22: Battery bank sizing
	Array Sizing and off-grid modules	Assignment #23: O-G array
lab	AutoCAD AC coupled system	AC-coupled systems
16	Off-Grid Systems	
	Off-grid controllers	Assignment: Selecting controllers
	Off-grid inverters	Assignment #24: Selecting inverters
	Final project (system design)	Final project

**The topics and corresponding schedule listed in the table above are tentative and may be subject to change during the semester.*