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Northeast Wisconsin Technical College

Land Acknowledgement Statement

The region served by NWTC **occupies the ancestorial home** of the Menominee Nation, who have **persisted here** in Northeast Wisconsin from **before recorded history** to the present day. The College's Green Bay campus exists **upon lands ceded from the Menominee Tribe to the Oneida Nation.** We acknowledge this land we stand upon today as sacred, historical, and significant to the Menominee and Oneida Nations as are the **lands of all First Nations People.**

See more detail at https://tinyurl.com/244wh3xf

NORTHEAST WI Technical College

Class Syllabus

PHOTOVOLTAICS - ADVANCED

Catalog #10-482-133 & Class #81872
Starts: Aug 15th, 2023 Ends: Oct 5th, 2023

Instructor Information

Instructor:	John Hippensteel, PE
Office:	EE 101 G
Telephone:	920-498-7103 (Cell: 920-559-3337)
Email:	john.hippensteel@nwtc.edu
Instructor Availability:	By Appointment on Mondays 8:30 to 11 am Wednesdays 8:30 to 11 am And as mutually agreed upon, in person, phone or email

CLASS INFORMATION

Course Description: 10-482-133 PHOTOVOLTAICS-ADVANCED ...topics include batteries, wiring configurations, system diagramming, National Electrical code, component selection, wiring, safety and system maintenance.

Credits: 4

Class Schedule: This class meets on the following days/times:

M	Tuesday	W	Thursday	F	S	S
	12:30 PM – 5:15 PM		**12:30 PM – 5:15 PM**			

Class Delivery Mode: 8 week format in person.

Class Meeting Location: This class meets on the NWTC Green Bay campus in the Great Lakes Energy Education Center in room EE 116, unless otherwise notified.

Pre-requisites/Corequisites: 0-482-126 Intro to Solar; 10-660-104, DC 1: Intro; 10-660-105, DC 2: Circuits; 10-620-107, AC 1: Properties

Textbook: Photovoltaic Systems, 3rd Edition & 2017 National Electric Code
Supplies/Technology: Calculator and access to a computer for email, internet research and Blackboard.

Course Competencies: You have the opportunity to learn the following skills in this course:

COMPETENCIES

1. **Explore the basics of Grid tied and Stand alone Photovoltaic systems.**

   Learning Objectives

   1.a. Differentiate between interactive and stand alone systems.
   1.b. Explore the use of the Flat-plate collector for Photovoltaic applications over concentrating collectors.
   1.c. Identify remote applications for Photovoltaic systems.
   1.d. List the typical components required to complete a Photovoltaic installation.

2. **Explore the solar radiation data and measurements in our lab setting for sizing a Photovolatic system**.

   Learning Objectives

   2.a. Calculate maximum average daily solar radiation for given locations and month of the year.
   2.b. Analyze the radiation data to determine the average amount of energy for given Photovoltaic systems.
   2.c. Measure the radiation for our lab location.
   2.d. Compare your measured radiation to your calculated values.

3. **Analyze the OSHA safety requirements for typical Photovoltaic installations.**

   Learning Objectives

   3.a. Review OSHA CFR 1910 as is applies generally to PV installations
   3.b. Review OSHA CFR 1926 as it applies to construction safety

4. **Analyze the NFPA 70E requirements for typical Photovoltaic installations.**

   Learning Objectives

   4.a. List the hazards involved when working with electricity
   4.b. Differentiate between Arc blast and Arc Flash
   4.c. Apply NFPA 70E to the electrical installation in our lab setting
   4.d. List the OSHA requirements relating to NFPA 70E

5. **Design an interactive (Grid Tied) and stand alone Photovoltaic system.**

   Learning Objectives

   5.a. Determine the load(s) to be served by the Photovoltaic system.
   5.b. Calculate the hours of demand for the loads served by the Photovoltaic systems.
   5.c. Select the required inverter for your installation.
   5.d. Determine the required array output for your installation.

6. **Determine the typical procedures for mounting the Photovoltaic panels.**

Learning Objectives

- 6.a. List the construction considerations integrating arrays on buildings.
- 6.b. Identify the various types of mounting configurations available for Photovolatic arrays.
- 6.c. Identify the different types of attachments methods available for Photovolatic arrays.
- 6.d. Identify the structural loads that will be placed on a Photovoltaic array.

7. **Access the electrical and building requirements and codes pertaining to typical Photovoltaic installations.**

Learning Objectives

- 7.a. Select the conductors for Photovoltaic systems.
- 7.b. Select the overcurrent device for Photovoltaic systems.
- 7.c. Identify the applicable articles of the National Electrical Code that apply to Photovoltaic installations.
- 7.d. Review the requirements for the grounding of Photovoltaic systems.
- 7.e. List the locations and size of the required disconnecting means for Photovoltaic systems.
- 7.f. Detail the requirements for installers of the electrical components for Photovoltaic systems.

8. **Determine the typical maintenance, troubleshooting, and installation concerns for typical Photovoltaic installations.**

Learning Objectives

- 8.a. Analyze the steps necessary for inspection of the entire installation.
- 8.b. Discuss installations on asphalt roofing when the ambient temperatures are high and low
- 8.c. List the tasks involved with the typical maintenance of the Photovoltaic array.
- 8.d. Determine the required electrical test equipment necessary to troubleshoot a Photovoltaic system.
- 8.e. Detail the steps to systematically troubleshoot an Photovoltaic installation.

9. **Install a typical photovoltaic system in the lab or out in the field.**

Learning Objectives

- 9.a. Construct a Photovoltaic system that meets all applicable codes and standards.
- 9.b. Verify the operation of your Photovoltaic installation by connecting it to the grid.

10. **Determine correct wire type and size for PV systems.**

Learning Objectives

- 10.a. Select correct wire types for various aspects of PV applications.
- 10.b. Determine the current / amp flow requirements for both DC and AC PV wiring applications.
- 10.c. Determine the correct wire size based on current requirements, voltage drop, temperature, conduit fill, and NEC requirements for PV applications, including rooftop applications.

11. **Interpret & understand Section 690, and other applicable sections, in the current National Electric Code**

Learning Objectives

- 11.a. Describe the purpose of the National Electric Code, NEC.
- 11.b. Articulate the requirements of being "Code Compliant".
- 11.c. Explain the major components of NEC Section 690, Solar Photovoltaic (PV) Systems.
- 11.d. Elaborate on the requirements of NEC Section 250, Grounding and Bonding.
- 11.e. Apply the guidelines and tables of NEC Section 310, Conductors for General Wiring
- 11.f. Determine required locations and correctly size all disconnecting means required on PV systems.
- 11.g. Ascertain need, correct type and size of overcurrent protection devices.
- 11.h. Diagram correct bonding and grounding for all parts of a PV system.

12. **Apply correct code compliant labeling for PV systems.**

Learning Objectives

- 12.a. Describe the labeling requirements per NEC for PV system installations
- 12.b. Explain equipment and PV module required labeling per NEC.
- 12.c. Describe PV AC & DC disconnect means labeling requirements.
- 12.d. Explain color coding requirement for the various categories of required labels.

Employability Skills: In addition to specific job-related training, NWTC has identified transferrable employability skills reaching beyond the context of a specific course. These are:

NWTC's TRANSFERABLE EMPLOYABILITY SKILLS
1. Communicate Effectively
2. Work Cooperatively and Professionally
3. Think Critically and Creatively
4. Solve Problems Effectively
5. Value Individual Differences and Abilities
6. Demonstrate Personal Accountability
7. Demonstrate Community and Global Accountability

Instructor Responsibilities:
As a NWTC instructor, I am expected to:

- Maintain a professional, safe learning environment while adhering to the policies of the college.
- Provide open and frequent communication with students regarding their progress in this class.
- Reply to communications within 48 business hours.
- Grade assignments and post scores in Blackboard regularly.
- Provide feedback to guide learners toward improvement of their coursework.
- Post information about assignments in Blackboard Class Materials and Grade Center.

(In the event of a college level cancellation) Communicate with students within 24-hours a detailed plan regarding expectations for responding to the cancellation.

Student Responsibilities:

As a NWTC student, you are expected to:

- Follow the policies of the College as outlined by the Student Handbook (noted above in Rights & Responsibilities section) and of the Instructor as outlined in the course syllabus.
- Monitor and use your NWTC Student Email account. Email is the official mode of communication at NWTC.
- Make an honest attempt to use correct English grammar and punctuation in all written communications.
- Utilize Starfish to monitor your course success, to communicate with instructors, and to connect with college services.
- Follow the due dates established in the Course Calendar (found at the end of this document) and posted in the electronic calendar in Blackboard.
- Keep your contact information up to date in RAVE to ensure that you receive prompt notification in the event of a college closure.
- Communicate questions, comments or concerns to your instructor via email, voicemail, or in-person.

Student Services to Support You:

Being in college is an exciting time to develop skills, further your career path, and build community. We don't want financial challenges to get in your way! Our team is ready to support basic needs such as groceries, housing assistance, transportation assistance, and more. Our goal is to keep you on track with your studies and educational goals. If you are experiencing a financial emergency or an unexpected event in your life, let us help. Support services are available at all NWTC locations. Our main office is located on the Green Bay campus in SC133. We can be reached by phone (920) 498-6258, email supportservices@nwtc.edu or in-person. For more information, please visit us at www.nwtc.edu/student-experience/student-support-services.

Additionally, NWTC provides many services and support networks to assist our students. Descriptions of these services can be found in the NWTC Student Handbook or at www.nwtc.edu/students. We encourage you to learn about the resources available to you, ranging from student involvement and personal counseling to academic, financial aid, or career advising. When you are looking for services, please contact your instructor or academic advisor via Starfish, or by calling (920) 498-5444.

Academic Coaching (Tutoring) at NWTC:
Academic Coaching provides an additional layer of support to ensure students achieve their academic goals. Academic Coaching is committed to serving all students as an academic resource to

promote student growth and success. Students who use Academic Coaching receive content help, but also gain study skills, organization skills, time management, and confidence. We understand that school can be challenging; let us help you reach your academic goals at **www.nwtc.edu/academiccoaching**

NWTC ALL-COLLEGE POLICIES

These policies are in effect for all classes at NWTC.

This syllabus is a learning contract between you and your instructor. In addition to your syllabus, there are policies and procedures listed in the NWTC Student Handbook that all students must uphold. Please refer to the NWTC Student Handbook to raise your awareness and understanding of the College's expectations.
NWTC Student Handbook

- Academic Integrity (includes Plagiarism, cheating and collusion)
- Drop from a Class or Program
- Student Academic Grievance
- **Discrimination and Harassment Prevention:** NWTC is committed to embracing the worth of every individual and promoting a respectful environment. Discrimination and harassment of protected categories in its employment and educational programs is prohibited. For questions or concerns, contact Mohammed Bey, Chief Diversity Officer, by email at mohammed.bey@nwtc.edu or by phone at (920) 498-6826.
- **Disability Act Statement:** NWTC is committed to creating a learning environment that meets the needs of its diverse student body. NWTC complies with all provisions of the Americans with Disabilities Act and makes reasonable accommodations upon request. If you have a disability, please call Disability Services at (920) 498-6904 to begin a conversation regarding the support services available to you or to request an official accommodation.
    - Accessibility & Data Privacy

Student Academic Calendar: Visit Academic Calendar page for important College dates you should add to your personal calendar.

CLASS SPECIFIC & DEPARTMENT POLICIES

In addition to the college policies referenced above, the following department & instructor policies also apply.

Appropriate Use of Technology:
The use of Social Media, cell phones, and other electronic devices are encouraged, and expected for specific class topics and class research only. Students are expected to respect others' views and display common courtesy when posting their views to online discussions, as well as in classroom discussions. It is important that everyone understands how to use online course tools and etiquette in a way where ALL students feel safe and supported.

Technology Skills & Assistance:

Technology Help

Get technical assistance by calling the Student Help Desk at (920) 498-6900 or 1-866-235-5037.

Learn more about the technology skills needed to be successful at NWTC (such as sending email, using software for assignments, submitting online work, and using test monitors) by watching the Technology 101 video series or visiting the Ask a Librarian FAQ site.

Find out how to Download Office 365 for Free and access Off-Campus Software. Learn how to borrow equipment from NWTC.

Campus Closure Day(s) Procedure:
In the event of a campus closure, NWTC and or instructors will provide detailed information regarding expectations for students, should the need arise.

Class Cancellation: Class cancellations will be posted as early as possible at:
http://www.nwtc.edu/Lists/CancelClasses/WebView.aspx

Syllabus Changes:
Instructors retain the right to make changes based on the timeline of the class, feedback from learners and/or logistical issues. Students will be informed as soon as a change is made. A current copy of the course syllabus will be maintained by the division office

Attendance and Participation:
You will receive a Participation Grade for each class period. In a face-to-face class, we learn from each other in an interactive, real-time format, and we need to make the most of this opportunity. Active participation includes:

- Attending class,
- Arriving on time,
- Being prepared to participate in class activities by completing the assignment(s),
- Focusing on the lesson during class time,
- Making a positive contribution to the lesson by paying attention and participating in discussions,
- Treating each person and opinion with respect
- Using electronic devices for classroom purposes only.

Submitting Assignments: (Be sure to save a copy of every assignment before you submit it so that you don't lose any work.)

Each assignment in the Class Materials has a link at the bottom that allows you to submit your work through Blackboard. The file name of the document that you submit should include the ASSIGNMENT NAME & NUMBER and YOUR FULL NAME. For example:

Barb Johnson LP 10 Wind Energy.pptx.

The body of your submittals should include The COURSE NAME, ASSIGNMENT NAME & NUMBER, YOUR FULL NAME, and DATE. For example:

Renewable Energy & Sustainability
LP 1 Assignment A, What Kind of Transportation Energy Did You Use Today?
Barb Johnson
8/27/18

You can submit your work in .doc, .docx, .xls, .xlsx, .pdf, .rtf, .ppt, .pptx or other MS Office formats ONLY. (Open Office documents must be saved and submitted in MS Office or .pdf formats ONLY.

Grading Policy:
You can earn up to full credit for an assignment by submitting it in Blackboard by the assigned due date. Expect one letter grade deduction for every day of late submittal. For special situations make-up work is allowed with approval from instructor. Extra credit projects may be available.

Grading Scale:

Percentage	Grade
91-100	A
81-90	B
71-80	C*
51-70	D
0-50	F

***** C is the minimum passing grade for this class for Energy Management & Solar Energy program students.

Safety Policy: Safety is paramount, and you will be expected to dress and act suitably for the situation, especially during any lab work and or field trips. Dress accordingly and always come prepared for all weather conditions.

Course Calendar:
Due Dates & Competency Map
Photovoltaics – Advanced, 10-482-133
Fall 1, 2022, #81872

WK	LP	Topic/Competency	Due Dates	Possible Points	COMPETENCIES ASSESSED	EMPLOYABILITY SKILLS ASSESSED
1	Begin Here, Syllabus	Syllabus email Plan for Success Class Participation	Tue 8/15	0 10 5		1-7
1	LP 1A	Utility Intertie PV Systems Class Participation	Thu 8/17	10 5	1,5	1-7
1	LP 1B	Off Grid & Battery Based PV Systems Class Participation	Tue 8/22	10 5	1,5	1-7
2	LP 2A	Available Energy from the Sun Class Participation	Thu 8/24	10 5	2	1-7
2	LP 2B	PV System Sizing Class Participation	Tue 8/29	10 5	2	1-7
3	LP 3A	OSHA Class Participation	Thu 8/31	10 5	3	1-7
3	LP 3B	NEC Class Participation	Tue 9/5	10 5	4,11	1-7
4	LP 4A	NEC & System Commissioning, Inspection & Wiring Diagrams Class Participation	Thu 9/7	10 5	5,7,11	1-7
4	LP 4B	NEC & PV Design Class Participation	Tue 9/13	10 5	5,6,7,11	1-7
5	LP 5A	Utility Intertie PV System Sizing Class Participation	Thu 9/14	10 5	5,6,7,10	1-7
5	LP 5B	Battery Based PV System Sizing Class Participation	Tue 9/19	10 5	5,6,7,10	1-7
6	LP 6A	PV System Labelling Class Participation	Thu 9/21	10 5	12	1-7
6	LP 6B	PV System Monitoring Class Participation	Tue 9/26	10 5	5	1-7
7	LP 7A	PV System Design, Installation, Maintenance & Troubleshooting Class Participation	Thu 9/28	10 5	5,6,7,10	1-7
7	LP 7B	Solar Energy Marketing & the National Tour of Solar Homes Class Participation	Tue 10/3	10 5	5	1-7
8	LP 8A	Term Project Class Participation	Thu 10/5	100 5	1-12	1-7
8	LP 8B	Employability Evaluations	Thu 10/5	10	1-12	1-7
			TOTAL	**340 points possible**		

NOTES: All Assignments are due before the start of class on the Due Dates shown above.

Special Events: You may have the opportunity to attend optional conferences and events during this semester. (Attending these events is a great learning opportunity, but attendance is not required.) NOTE: Other field trips may be available and will be posted in the Announcements section of Blackboard.

Energy and Conservation Club (#405)
is a great way to get involved with many school projects in this subject area.

https://www.nwtc.edu/student-experience/student-involvement/clubs-and-organizations/energy-conservation-club

Advisor: John Hippensteel
John.Hippensteel@NWTC.edu

Student Agreement: After you have read the syllabus, please send me an e-mail with the following statement: ***I confirm that I have read the course syllabus and agree to the class policies, procedures, due dates, and all the other information communicated in the syllabus.***