ENMA 412/612 and CHBE468J – (Advanced) Fundamentals of Photovoltaics
Instructor: Prof. Leite (MSE, IREAP, Physics)
Tue, Thurs 5:00pm – 6:15pm: AJC (bldg. #429), room 2119.
Office hours: Thurs 1-3pm: CHE (bldg. #090), room 2123.

Tentative schedule (29 lectures)

	Date	Lecture	Deadlines
1	Thurs 01/25	Intro to course. The need for renewable energy resources	
2	Tue 01/30	Properties of sunlight	
3	Thurs 02/01	p-n junction: basics, generation	
4	Tue 02/06	p-n junction: recombination, transport	Quiz #1
5	Thurs 02/08	p-n junctions, diode equation	
6	Tue 02/13	Solar cell operation: ideal solar cells, PV parameters	
7	Thurs 02/15	Solar cell operation: resistive and other effects	Quiz #2
8	Tue 02/20	Detailed balance	
9	Thurs 02/22	Design of a solar cell: fundamental concepts, cell structure	
10	Tue 02/27	Design of a solar cell: simulation with AFORS-Het	Quiz #3
11	Thurs 03/01	Modules and arrays	
12	Tue 03/06	PV market	
13	Thurs 03/08	Solar cell demo at UMD	
14	Tue 03/13	Solar cells' characterization	Quiz #4 + Project 1
15	Thurs 03/15	PV trial: Monocrystalline Si	
-	Tue 03/20	Spring break – no class	
-	Thurs 03/22	Spring break – no class	
16	Tue 03/27	PV trial: Multicrystalline Si	
17	Thurs 03/29	PV trial: CdTe	
18	Tue 04/03	Fundamental losses in photovoltaics	
19	Thurs 04/05	PV trial: CIGS, CZTS	
20	Tue 04/10	PV trial: Amorphous Si	
21	Thurs 04/12	PV trial: III-V, III-nitrides semiconductors	
22	Tue 04/17	PV trial: Wire solar cells	
23	Thurs 04/19	PV trial: Organic PV, Dye-sensitized solar cell	
24	Tue 04/24	PV trial: Perovskites	
25	Thurs 04/26	PV trial: Quantum dot solar cells	
26	Tue 05/01	PV trial: 3rd generation concepts (multijunction solar cells, intermediate band solar cells)	
27	Thurs 05/03	PV trial: 3rd generation concepts (multiple exciton generation, hot carrier solar cells)	
28	Tue 05/08	Advanced concepts in PV and characterization	
29	Thurs 05/10	Solar-Powered Home	Project 2*

Course Description: Overview of the fundamentals of photovoltaic devices, including principles of operation, with emphasis on the materials science aspects of the different technologies available.

Prerequisite: ENMA300 or consent of instructor.

Course Objectives:

At the end of this course, the student should be able to:

1. Understand how photovoltaic devices operate.
2. Identify and describe what materials' properties are relevant for PV applications.
3. Identify what are the materials currently used for PV.
4. Identify the limitations and opportunities provided by each material/technology.
5. Critically analyze the different PV materials, based on their structural, electrical, and optical properties.

References: (i) Lecture notes (provided by the instructor AFTER each class), (ii) Electronic book *www.pveducation.org*, (iii) Book: *The Physics of Solar cells* by Jenny Nelson, (iv) *Handbook of Photovoltaic Science and Engineering* by Antonio Luque and Steven Hegedus, (v) articles by experts in the field.

About office hours:

1. Whenever the instructor is out of town, the office hour will be rescheduled accordingly. Please keep track of the announcements posted in Canvas and during classes.
2. Please contact the instructor at least 48hs in advance in case you would like to meet at an additional time, different than the standard office hours.

About electronic devices: Cell phones and laptops (as well as any other type of electronic devices) are not allowed during the lectures and their use will result in zero points in participation (regardless of how many times the electronic device was used). Please use your notebook to take notes if you would like. Thank you for understanding.

About religious holidays: It is your responsibility to inform the instructor which religious holidays you are observing. If you will be absent on a certain day due to a religious holiday, please let the instructor know at least a week before you will be absent, so that arrangements can be done for you to make up the class. Informing after the fact will not be accepted. The same applies to professional meetings.

About Academic Accommodations: If you have a documented disability, you should contact Disability Support Services 0126 Shoemaker Hall. Each semester students with documented disabilities should apply to DSS for accommodation request forms, which you can provide to your professors as proof of your eligibility for accommodations. The rules for eligibility and the types of accommodations a student may request can be reviewed on the DSS web site at http://www.counseling.umd.edu/DSS/receiving_serv.html.

About missing evaluations: To ensure that all students have the same opportunity when being evaluated during the semester, please keep in mind that if you miss an evaluation no points will be assigned toward your final grade. Exceptions may be made for sick leave demonstrated by a Doctor's notice or another

out-of-the-ordinary event. In this case, the student should contact the instructor as soon as possible to address the absence.

Grading:
No curve will be used on the grading.
The students will be evaluated according to the following guidelines:
Quizzes (40%) + Projects (30%) + Presentation (25%) + Participation (5%).

1) QUIZZES - Quizzes will encompass all subjects that were covered in class from the beginning of the semester until the class before the quiz. Paper will be provided with the question(s) and your answer(s) should fit within the indicated space (for your answers: pen only). All quizzes will take place at the end of class (10 min), according to our calendar in page 1.
2) PROJECTS - All projects must be completed by the deadline (5pm, see calendar in page 1 for dates). A printed (legible and neat) copy of Project #1 should be given to the instructor by the deadline (just before class) or should be passed under the instructor's door (CHE, room 2123). *A printed copy of Project #2 should be passed under the instructor's door. E-mailed homework will NOT be accepted (please plan ahead in order to print your projects because no exceptions will be made). Each day of delay will result in a penalty of 14.28/100. This means that after 7 days the project is worthy "zero" points. Note that the day 1 after the deadline starts counting at 5:01pm of the day indicated in our calendar as the deadline.
3) PRESENTATION - The presentation guidelines for the "PV trial" will be provided soon (as soon as the total number of students in this course is defined). An announcement will be made trough Canvas and a file containing detailed explanation of all requirements will be uploaded in Canvas as well.
4) PARTICIPATION - The participation grade includes: (i) attendance to all classes, (ii) participation in the instructor's evaluation at the middle and at the end of the semester, and (iii) no use of electronic devices during the lectures (valid for the entire semester).

* After you receive your grade you have one full week to request a review. No reviews will be granted at the end of the semester. Thus, please take a moment and check all corrected quizzes and projects. Keep in mind that a review of a correction could result in: (i) same grade, (ii) higher grade, or (iii) lower grade.

See http://www.faculty.umd.edu/teach/gradevalue.html for complete policy on plus/minus grading system adopted by UMD in 2012.

Letter	Quality Points	Numerical Grades	
A+	4.0	97-100	denotes excellent mastery of the subject and outstanding scholarship.
A	4.0	93-96	
A-	3.7	90-92	
B+	3.3	87-89	denotes good mastery of the subject and good scholarship.
B	3.0	83-86	
B-	2.7	80-82	
C+	2.3	77-79	denotes acceptable mastery of the subject and the usual achievement expected.
C	2.0	73-76	
C-	1.7	70-72	
D+	1.3	67-69	denotes borderline understanding of the subject. These grades denote marginal performance, and they do not represent satisfactory progress toward a degree.
D	1.0	65-66	
D-	0.7	60-65	
F	0		denotes failure to understand the subject and unsatisfactory performance.

Honor Code: The University of Maryland, College Park has a nationally recognized Code of Academic Integrity, administered by the Student Honor Council. This Code sets standards for academic integrity at Maryland for all undergraduate and graduate students. As a student you are responsible for upholding these standards for this course. It is very important for you to be aware of the consequences of cheating, fabrication, facilitation, and plagiarism. For more information on the Code of Academic Integrity or the Student Honor Council, please visit http://www.shc.umd.edu.
In this course, if you cheat (including plagiarism) your grade will be automatically 'zero' on the assignment and no second chance will be provided.

To further exhibit your commitment to academic integrity, remember to sign the Honor Pledge on all examinations and assignments: "I pledge on my honor that I have not given or received any unauthorized assistance on this examination (assignment)."