Department of Materials Science and Engineering
University of Maryland, College Park, Maryland

1. **ENMA 412 – Fundamentals of Photovoltaics**

2. **Credits and contact hours – 3 credits.** The University of Maryland follows the Maryland Higher Education Commission's policies on "contact hours;" specifically, one semester hour of credit will be awarded for a minimum of 15 hours, of 50 minutes each of actual class time, exclusive of registration, study days, and holidays.

   Schedule: meets two 75 minute periods per week

3. **Instructor's or course coordinator's name: Prof. Marina Leite**

4. **Text book, title, author and year:** no required textbook

5. **Specific course information**
   a. **Brief description of the content of the course (catalog description: Pre-requisites or co-requisites:** ENMA 300 and permission of the department.
   b. **Indicate whether a required, elective, or selected elective (as per Table 5-1) course in the program:** ENMA 412 is an elective course for Materials Science and Engineering majors.

6. **Specific goals for the course:** Overview of the fundamentals of photovoltaic devices, including principles of operation, with emphasis on the materials science aspects of the different technologies available.

   a. **Specific outcomes of instruction**: 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 technology.
   5. Critically analyze the different PV materials, based on their structural, electrical, and optical properties.

   b. Explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed in this course.

   ABET A: Ability to apply mathematics, science and engineering principles. to design a system, component, or process to meet desired needs.
   ABET E: Ability to identify, formulate and solve engineering problems.
   ABET J: Knowledge of contemporary issues.

7. **Brief list of topics to be covered**.

The need for renewable energy resources
Characteristics of a photovoltaic cell
Sunlight properties
Photon in, electrons out: basic principles of PV
Electrons and holes in semiconductors
Carriers' generation and recombination
Junctions
Analysis of p-n junction
Solar cell characterization Project 1
Design of a solar cell: Si
Design of a solar cell: Si – cont.
Solar cell design - simulation
Monocrystalline Si Project 2
Multicrystalline Si
CdTe
CIGS, CZTS
Amorphous Si
III-V, III-nitrides semiconductors
Wire solar cells
Organic PV, Dye-sensitized solar cell
Perovskites
Quantum dot solar cells
Third generation concepts (multijunction solar cells, intermediate band solar cells, multiple exciton generation, hot carrier solar cells)
Solar cell demo