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

1. **ENMA 411 – Materials for Energy II**

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. Liangbing Hu**

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

   a. **Other supplemental materials:**
   Fundamentals of Materials for Energy and Environmental Sustainability
   Edited by David Ginley and David Cahen, Cambridge University Press:
   Additional reading and lecture materials will be distributed

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 410 is an elective course for Materials Science and Engineering majors.

6. **Specific goals for the course:** Demonstrates the role of materials in solving one of the most critical socio-economic issues of our time, affordable and sustainable energy. Materials for Energy is a two-part course based on material functionality; however, they are independent and neither is a prerequisite for the other. Materials for Energy II will focus on electrical, optical, thermal, and mechanically functional materials for energy devices. Solar cells, solar fuel, solar thermal, energy efficient lighting, building energy, thermoelectric and wind energy will be covered.

   a. **Specific outcomes of instruction**: Students will learn about electrical, optical, thermal and mechanical materials for energy devices.

   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**.

Semiconductor Physics and Solar Cells-Semiconductor, metal and insulator; p-n junction and solar cell fundamentals; Transparent electrode; Optics and plasmonics in solar cells, and materials; Si (device and new materials);CZTS, CIGS (device and new materials);Polymer solar cells; III-V solar cells;

Solar fuel (Water Splitting): materials, devices and recent development - Principles; Materials development

Thermoelectrics: materials, devices and recent development - Thermoelectric fundamental; Nanotechnology and new materials

Energy Efficient Lighting: materials, devices (LED and OLED) and recent development - LED principles; OLED principles and materials; Recent development, nanomorphology with conductive AFM

Energy Efficient Building: materials, devices and recent development - Building energy consumption and window; Small window, optics and electrochromic devices

Wind Energy: materials, devices and recent development- Wind turbine and blade materials;New materials development, nanocomposite

Energy from wastewater: materials, devices and recent development- Device principle; Recent electrode development, bacterial-electrode interface

Special topics, energy for Special Applications (Space, DOD and flexible, etc.): materials, devices and recent development- Flexible energy storage and solar cell; Wearable energy system; Lightweight energy device and system for NASA and air force applications; Material Genome and computational materials; Nanomanufacturing; roll-to-roll manufacturing.