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

1. **ENMA 410 – Materials for Energy I**

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. Eric Wachsman**

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:
   Advanced Batteries, Materials Science Aspects, Robert A Huggins, Springer
   Fuel Cell Fundamentals. Ryan O'Hare, Suk-Won Cha, Whitney Colella, and Fritz Prinz, Wiley. Additional reading and lecture materials will be distributed.

5. **Specific course information**
   a. **Brief description of the content of the course (catalog description:** The goal is to demonstrate the role of materials in solving one of the most critical socio-economic issues of our time, affordable and sustainable energy. There will be a discussion of U.S. and global energy and related environmental issues. Topics covered include: fuel cells and batteries (electrochemical energy conversion and storage); catalysts and membrane separations (fossil fuel and biomass energy conversion); and nuclear fuels.
   b. **Pre-requisites or co-requisites:** ENMA 300 and permission of the department.
   c. **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:**
   a. **Specific outcomes of instruction**: Student learns about role of materials in energy conversion and storage technologies

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.

1. Introduction to Energy: Resources; Efficiency and demand.
2. Environmental impacts: Climate change and air pollution; the energy-water nexus.
3. Electrochemical energy storage: Introduction to batteries and capacitors; Ionic transport; Electrolytes; Anodes; Cathodes.
4. Electrochemical energy conversion: Introduction to fuel cells; SOFC electrolytes; SOFC anodes and cathodes; SOFC interconnects and seals;
PEMFC electrolytes; PEMFC anodes and cathodes.
5. Membrane separations: Introduction to membranes; Porous membranes;
Dense membranes.
6. Catalytic conversion: Introduction to catalysis; Oxide catalysts; Nobel metal catalysts; Membrane reactors.
7. Nuclear fuels.