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

1. **ENMA 482 – Introduction to Electron Microscopy**

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. John Cumings**

4. **Text book, title, author and year:** Egerton, R. F., *Physical Principles of Electron Microscopy*, Springer 2007.
   - **a.** Other supplemental materials: D. B. Williams and C. B. Carter, Transmission Electron Microscopy, Springer 2009; L. Reimer and H. Kohl, Transmission Electron Microscopy, Springer 2008; L. Reimer, Scanning Electron Microscopy, Springer 1998. (optional)

5. **Specific course information**
   - **a. Brief description of the content of the course (catalog description):** An introduction of the basic principles of operation for modern electron microscopes. Details will be given on the construction of microscopes, their basic operation, and the types of questions that can be addressed with an electron microscope. Emphasis will be placed on a conceptual understanding of the underlying theories. Where appropriate, mathematical descriptions will be utilized. Upon completion of this course, students will be excepted to have a basic understanding sufficient to give interpretations of microscopy images and to suggest the correct tool or approach for certain research studies.
   - **b. Pre-requisites or co-requisites:** PHYS142, PHYS122, or PHYS260
   - **c. Indicate whether a required, elective, or selected elective (as per Table 5-1) course in the program:** ENMA 482 is an elective course for Materials Science and Engineering majors.

6. **Specific goals for the course:**
   - **a. Specific outcomes of instruction:** The main objective of this course is to:
     1. Student learns Image formation and interpretation for a Transmission Electron Microscope.

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
ABET B: Ability to design and conduct experiments, analyze and interpret data.
ABET K: Ability to use the techniques, skills and modern engineering tools necessary for engineering practice

7. Brief list of topics to be covered:

1. Introduction to optics & Microscopy: XRM & TEM, SEM, STEM, & SPM
2. Images & Electron Lenses; Lens Defects & Resolution
3. TEM Overview & Electron Sources: Forming an Electron Beam; TEM Specimen & Objective Lens, TEM Projection, Camera, and Vacuum:
4. Electron Scattering from Materials: Image Contrast, Electron Diffraction & Phase Contrast, Lorentz Contrast & TEM Specimen Preparation, Advanced TEM imaging
5. SEM Basics & Detectors: SEM Modes & Parameters, SEM Specimens & Lithography,
6. X-Ray Spectroscopy: Quantitative Analysis, Auger & EELS
7. Recent Developments in Electron Microscopy: Special Topic: In-Situ Electron Microscopy