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

1. **ENMA 441 – Characterization of Materials**

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 (lecture)

3. **Instructor's or course coordinator's name: Profs. Raymond Phaneuf and Lourdes Salamanca-Riba**

4. **Text book, title, author and year:** Materials Characterization: Introduction to Microscopic and Spectroscopic Methods; Author - Yang Leng, Wiley, ISBN 0470822988.
   a. **Other supplemental materials:** "Scanning Probe Microscopy and Spectroscopy: Theory Techniques and Applications", 2nd ed., ed. Dawn Bonnell (Wiley-VCH, New York, 2001)
5. **Specific course information**
   a. **Brief description of the content of the course (catalog description):** Techniques to characterize the properties of materials whose characteristic dimensions range from nanometers to macroscopic. These include conventional crystalline and noncrystalline materials, with a special attention to materials of current technological interest. The course will include recent results from the scientific literature.
   b. **Pre-requisites or co-requisites:** ENMA 300 and permission of the department and senior standing.
   c. **Indicate whether a required, elective, or selected elective (as per Table 5-1) course in the program:** ENMA 441 is a required course for Materials Science and Engineering majors.

6. **Specific goals for the course:**
   a. Specific outcomes of instruction: This course is intended to introduce a number of the techniques used to characterize materials including structure at length scales from atoms to macroscopic dimensions, composition, electronic structure, as well optical, electric, magnetic and transport properties. The

emphasis is on what each technique measures, how the measurements can be interpreted, and what the limits are to the information which can be obtained. Students taking this course learn:
1. Elements of quantum mechanical confinement and tunneling, and how these are used in scanning tunneling microscopy and spectroscopy.
2. About surface forces and potentials, and how these are used in scanning force microscopy and force curve interpretation.
3. About scattering phenomena and their application to characterizing nanostructured materials.
4. To analyze current research results critically, and to communicate a critique in both written and oral formats

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
ABET G: Ability to communicate effectively.
ABET I: Recognition of the need for and an ability to engage in life-long learning
ABET J: Knowledge of contemporary issues.
ABET K: Ability to use the techniques, skills and modern engineering tools necessary for engineering practice.

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

Lectures:
1. Light Microscopy
2. Diffraction/Scattering
3. Transmission Electron Microscopy
4. Scanning Electron Microscopy
5. Scanned Probe Microscopies
6. Scanning Tunneling Microscopy
7. Atomic Force Microscopy (Lab Component)
8. X-Ray Spectroscopy
9. Electron Spectroscopy
10. Secondary Ion Mass Spectroscopy
11. Optical spectroscopy & Ellipsometry

Lab Demos:
Atomic Force Microscopy (AFM)
TEM/TED
SEM/EDS
Small Angle Xray Scattering
XRD(Powder Patterns)
Ellipsometry