SYLLABUS
MTSE-3020: Microstructure and Characterization of Materials
Department of Materials Science and Engineering *Fall 2015*

Introduce the principal methods for characterizing materials at all scales (from nano to micro) in terms of atomic composition, atomic structure and chemical bonding. During this course, Students are presented with the basic operation and capabilities of the principal characterization methods used in materials science. This course applies basic science concepts to develop a fundamental understanding of materials characterization methods that are fundamental for graduate research and employment in the area of materials design.

Professor: El Bouanani
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Office Hours: Tuesday 9 AM – 11 AM
Class Hours: M/W 12:30-1:50 PM Class Location: B157

Textbook: The Instructor will supply handouts and references.
Course notes for each class (PPT files) will be e-mailed to students

Suggested text books:

- Materials Characterization, Y. Leng, Wiley (2010) ISBN 978-0-470-82298-2
- Microstructural Characterization of Materials, David Brandon and Wayne Kaplan, Wiley
- J.B. Wachtman, Characterization of Materials, Butterworth-Heinemann, ISBN 0-7506-9215-4 (1992).
- C.R. Brundle, C. A. Evans, Jr., and S. Wilson, Encyclopedia of Materials Characterization, Butterworth-Heinemann, ISBN 0-7506-9168-9 (1992).

Homework: Five homework sets will be assigned and graded. The purpose of the homework is to aid in learning the material. Although some collaboration among students in preparing the homework is acceptable, the main work should be primarily yours.
Late homework will not be accepted.

Exams: There will be tree examinations and one student project:
Midterm-I: October 5th
Midterm-II: November 9th
Comprehensive final Exam: December 7th
Student's projects are assigned on November 2ed and are due on November 23ed
Project presentations are scheduled to start on November 23ed.

Grading:

(1) Homework (5 total)	20%
(2) Quizzes	10%
(3) Student project	10%
(4) Midterm Exam-I + Midterm Exam-II	30%
(5) Comprehensive Final Exam	30%

1. Quizzes are closed-book. Pop-up quizzes will not be announced.
2. Final exam will cover all chapters
3. Attendance of the class is required. If you are going to miss class, notify me.
4. Unethical conduct on quizzes or exams will automatically lead to failure of the course.
5. Use of laptops, iPads and cell phones is not allowed during class.

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Course Topics (*Subject to Change*)

- Syllabus overview/General Introduction to Characterization
- Brief overview of Materials depositions and vacuum Technology

- Overview of X-ray, electron and ion sources

- **Spectroscopies Using Photon and Ion Probes**
  - Photon interactions with matter
  - X-Ray Fluorescence
    - X-ray absorption in materials
    - Instrumentation
    - Elemental identification and quantification
    - Basic principles
    - Instrumentations
    - Chemical identification and quantification
    - Examples and applications

  - X-ray Photoelectron Spectroscopy/UV Photoelectron Spectroscopy
    - Basic principles
    - Instrumentations
    - Chemical identification and quantification
    - Examples and applications

  - Fourier Transform Infra-Red and Raman
    - Basic principles
    - Examples and applications

  - Ion interactions with matter
  - Rutherford Backscattering Spectroscopy
    - Basic principles
    - Instrumentations
    - Atomic Collisions and Backscattering
    - Energy Loss and Backscattering Profiles
    - Examples and applications

  - Secondary Ion Mass Spectroscopy
    - Basic principles
    - Instrumentations
    - Sputtering processes

- Examples and applications

- *Examples and comparison of various spectroscopies in applications*

- **Topics on Optical microscopy**
  Metallographic Preparation Techniques
  Resolution (Rayleigh criterion, pixel counts)
  Contrast Formation
  Digital Imaging
  Image Quantification – Stereology
  Examples of optical microscopy in applications

- **Topics on Electron microscopy**
  Basics of electron sources and vacuum
  Signal types (SE, BSE)
  Energy Dispersive Spectroscopy (EDS)
  How TEM fundamentally differs
  Examples of electron microscopy in applications
- **Topics on X-ray diffraction**
  Bragg's Law
  Structure Factor
  Powder diffraction
  Textured diffraction
  Examples of X-Ray diffraction in applications

Course Goal:
The emphasis of this course will be on techniques utilizing X-ray, electron and ion probes.

Relationship to program Objectives:
(a) An ability to apply knowledge of mathematics, science, and engineering.
(e) An ability to identify, formulate, and solve engineering problems.
(k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Prepared by: El Bouanani Date: August 24, 2015