MtSE 719 "Physical Principles of Characterization of Solids" Fall 2004

SYLLABUS

The course emphasizes fundamental, rather than technical aspects of characterization of solids. Topics and activities include:

1. Introduction
2. Basic science (overview) and selected applications
   (a) Electromagnetic radiation (classical). Optical microscopy.
   (b) Quantum aspects of radiation. Planck radiation law. Photons and Compton scattering. Electromagnetic spectrum.
   (c) Motion of charged particles. Lorentz force. Electron energy analyzers.
   (d) Elements of quantum mechanics. Wave properties of matter. Tunneling.
   (e) Atomic energy levels. Multidimensional Schrödinger equation and selection rules for electronic transitions.
   (f) Interaction of atoms with radiation. Basic scattering concepts. Types of spectroscopy.
   (g) Molecular energy levels. Infrared and Raman spectroscopy.
   (h) Elements of solid-state physics: Elastic waves; energy levels of electrons; defects. Spectra of solids.
   (i) Particle interaction in solids. Basic scattering concepts. Rutherford Backscattering Spectroscopy (RBS).
   (j) Elements of crystallography.
3. **Mid-term exam**.
4. Methods of characterization:
   (a) X-ray diffraction analysis (XRD).
   (b) X-ray Photoelectron Spectroscopy (XPS) and Auger Electron Spectroscopy (AES).
   (c) Scanning Electron Microscopy (SEM).
   (d) Transmission electron microscopy (TEM) and Scanning Transmission Electron Microscopy (STEM).
   (e) Scanning Tunneling Microscopy and Atomic Force Microscopy (AFM).
5. **Final exam**.

Pre-requisit: Graduate standing

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TIME: TBA
(office hours will be published by the second week of classes)

RECOMMENDED READING: The following books will be held on reserve at the NJIT library:
Encyclopedia of Materials Characterization by C.R. Brundle, C.A. Evans, S. Wilson, eds. Butterworth-Heinemann, 1992.
C.J. Chen, *Introduction to Scanning Tunneling Microscopy*. Oxford University Press. 1993.
L. Reimer, *Scanning Electron Microscopy*. Springer, 1997.
L. Reimer, *Transmission Electron Microscopy*. Springer, 1998.

Additional reading:
J.B. Wachtman, *Characterization of Materials*. Butterworth-Heinemann, 1993.

GRADING: The final grade will be determined by accumulated points obtained on homework, mid-term and final exams.

Extra credit may be given occasionally for solutions of additional problems (to be announced during lectures), for an active participation in the class, etc.

Mid-term exam will cover basic science and selected applications (see syllabus next page).

A comprehensive examination will be given during the Finals week at the end of the semester.