

JCL 208: Characterization of Materials (300)

Course Instructor: Bivas Saha

Objective of the Course: To develop an in-depth theoretical understanding of various structural, spectroscopic, microscopic and device characterization techniques. Successful completion of this course will enable students to develop general skills for the characterization of materials.

Syllabus:

1. Spectroscopic Characterization:

Basics of light-matter interaction, Dielectric function, Drude theory, Interband and Intraband transitions, Joint densities of states, Absorption of light in solids, Frequency dependence of optical properties, Impurities and Excitons, Luminescence and Photoconductivity, Optical study of lattice vibration, Thermal emission, Emitters and Absorbers.

2. Electron Spectroscopy:

Photoemission and photo-absorption spectroscopy, angle resolved photoelectron spectroscopy, Electron diffraction and electron energy loss spectroscopy, Auger Electron Spectroscopy.

3. Structural Characterization:

X-ray diffraction - symmetric vs. asymmetric scan in thin films, Reciprocal space map (RSM), X-ray reflectivity (XRR). Inelastic X-ray and Neutron scattering. Basics of materials characterization with atom-probe techniques.

4. Electronic Properties and Device Characterization:

Basic measurement techniques on electrical, optical and thermal properties in materials. Hall measurement, Seebeck and thermal transport measurements.

LEDs and Lasers, Photodetectors and Solar Cells.

Reference Materials

1. Solid State Physics, Part II, Optical Properties of Solids. M. S. Dresselhaus.
2. Physics of Semiconductor Devices, S. M. Sze and K. K. Ng.

Office Hours: Bivas Saha (Friday 4:30 PM - 5:30 PM).

Grade Formula (Tentative)

Homework - 20%

Midterm Exam- 20%

Term Paper- 25%

Final Exam- 35%

Term Paper: As a graduate level course, the objective of the term paper is to stimulate and foster independent thinking. Depending on the number of students availing this course, groups of two to three students will be assigned an advanced characterization technique. The group will study the topic critically, identify the most important challenge(s) that researchers are encountering, and will conceptually suggest possible solution(s) for the problem. The group will write a brief (4 page maximum) paper on their finding(s) and present a seminar for 30 mins (25 min +5 min Q/A).