November Characterization of Materials

EXAM 2 will cover:

1) **Terminology from crystallography**: Point and plane descriptions, miller indices, unit cells, bravais lattices, meaning of symmetry elements and use in crystal class, atoms in unit cell, lattice points in unit cell of crystals given in Cullity (ch 2).

2) **X-ray generation**: How x-rays are produced, role of energy levels of electrons in atoms, equations in ch 1, various spectra, labels of x-rays (Kα, etc.) and emitted electrons, relation of this info regarding interactions of electrons or photons with atoms in the characterization techniques that we have discussed. See IN GENERAL below for importance of photons, electrons, in analysis and Bohr model.

3) **Absorption**: Equations, mechanisms of absorption, graphs, problem-solving.

4) **Diffraction**: Bragg's law, peak broadening, equations.

5) **Intensity** of XRD peaks, factors in the I_{INT} equation, effects of these factors in I_{INT} on intensity of specific (hkl) lines in 2θ, especially form factor and the Structure Factor and their importance. Know how to solve for F_{hkl}.

6) **Fluorescence and EXAFS:** Mechanisms, information gained, advantage of EXAFS.

7) **Counters** (general characteristics)

8) **Surface spectroscopies** Electron spectroscopies: XPS, AES; Ion spectroscopies: ISS, RBS, SIMS. Know mechanisms and information that can be obtained. Depth of analysis, lateral resolution, advantages and disadvantages of each.
9) **Electron microscopies**: Limit of resolution, SEM vs TEM, use of fluorescence attachments and WDS (and EDS, but we covered WDS in more detail in section on fluorescence spectroscopy), info that can be obtained. HAADF-STEM, EELS (Similarity of EELS to spectroscopies and use of Bohr model).
10) **Scanning probe microscopies**: STM, AFM, mechanisms of each, benefits, resolution, etc.

IN GENERAL:
1. Know 'particles in' and 'particles out' for each technique (and the underlying similarities of a particle in creating several particles out).
2. Know which technique uses the specific 'particles out' for analysis.
3. For all techniques, know info gained, depth probed, lateral resolution, bulk or surface usage (Table of Techniques).

Of course, anything discussed in class should be understood and much of it is also available in the chapters in Brundel and Cullity, as well as the additional items on website that are provided to help clarify the ideas presented in class. The homework and answers covered in class will help.