Characterization of Materials
EXAM 3 will cover:

I) **Terminology from crystallography:** ***OK – not for this exam, but remember terms for the future.***
II) **X-ray generation**: How x-rays are produced, role of energy levels of electrons in atoms (Bohr model), equations in C 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.
III) **Absorption**: Equations, mechanisms of absorption, graphs, problem-solving.
IV) **Diffraction**: Bragg's law, peak broadening, equations.
V) **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}.
VI) **Counters** (general characteristics) **(Not needed for this exam)**
VII) **Surface spectroscopies** Electron spectroscopies: XPS, AES; Ion spectroscopies: ISS, MEIS, RBS, SIMS. Know mechanisms and information that can be obtained. Depth of analysis, lateral resolution.
VIII) **Vibrational spectroscopies**: general features, info gained, differences between IR and Raman, stokes vs. anti-stokes lines in Raman.
IX) **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).
X) **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 – ***although you'll notice I removed 'Detection limits'*** here).
4. Know strengths of each technique (why use one vs another - for example, SEM vs TEM, or XPS vs AES, etc.)
5. Remember what figures of output data look like for specific techniques; use labels of the axes as an aid. The additional reading on the website can help with figures if you don't recall those in class.

Which technique do you use if you need:
to determine elements present in sample;
good lateral resolution to determine elements present in a surface;
good depth resolution;
the microstructure;
the structure around specific species in a sample;
the phases present;
the phases present within particular regions in a sample;
the chemistry of the surface-(chemistry means both elements and bonding);
the chemistry of a material
etc.
Of course, anything discussed in class should be understood; you can clarify if necessary reading the chapters in Cullity, FW, and IMA and the added reading that is for those who want additional clarification or more in-depth info. The homework and answers covered in class will help.