If we consider about two weeks for each **bold topic** listed below we will run out of time and have no fun with new advances. Some topics can be shorter -- others will be longer. It is my intention to have all structures discussed in lectures and then to be related to measured structures obtained using the x-ray diffraction and electron diffraction equipment available within the University.

**Crystal Structure** is a very broad subject. However, this year I will include an extensive section on reciprocal lattices so Bragg's law for x-ray diffraction can derived and diffraction theories introduced. There is software to control and use the x-ray diffraction equipment noted above. I will also try to obtain use of the electron microscope. It will be introduced in this first section. There is also software for analyses of the x-ray diffraction results. Selected crystal structures will be analyzed using x-ray diffraction. **Amorphous, Semi-Crystalline** and fine **Grain Size** materials can all be measured and observed using the x-ray diffraction equipment.

**Point Defects** can change lattice spacings which in-turn can be measured using x-ray diffraction equipment. This is part of the x-ray-analysis objective. First it is important to understand just what point defects are and their relationship to mechanical properties. Hopefully, understanding and establishing key concepts in mechanical properties using point defects, as an example will be establish property structure relations for the students. **Line Defects** are very important for understanding mechanical properties. Their role in **Textures and Residual Stresses in Thin Films** are examples of applications.

**Planar Defects** have been recently very active especially in modern electronic materials. In the literature x-ray work is especially important for **Thin Films and Surfaces**. Epitaxial films and multi-layered structures typically on Silicon single crystals give unique electronic properties. Special topics from the class are especially important and will form part of the term papers in this class. Also, we may want to change direction in mid-course especially if we find a topic of great or particular interest.

**Crystal Structures**

1. Space lattices, translational and rotational symmetries, Bravais lattices.
2. Three-dimensional crystal point groups.
4. Miller's indices, atomic structures and simple crystals, reciprocal lattices.
5. Bragg's law for kinematical diffraction by crystals.

**Point Defects**
1. Vacancies, equilibrium concentration of vacancies.
2. Diffusion in crystals.
3. Interstitial atoms.
4. Substitution atoms, clusters, precipitates and second phases.

**Line Defects**
1. Dislocations, Burger's circuit, plastic deformation and slip surfaces.
2. Elasticity; stresses and strains around screw and edge dislocations.
3. Dislocations on interfaces.
4. Tensile test and stability; energy balances.
5. Residual stresses from dislocations.
6. Dislocations arrays; pile-ups of dislocations; Hall-Petch equation.

**Planar Defects**
1. Stacking faults, partial dislocations.
2. Grain boundaries, dislocation models of strain energy in grain boundaries.
3. Coincidence boundaries and interfaces in materials.
5. Brittle fracture; ductile fracture.
7. Dislocation emission from crack tips.
8. Crack tip dislocations and their shields.
Nano-Structures and Precipates
1. Guinier-Preston zones and precipitates.
2. Twins.

Thin Films
1. Film thickness, grain structures, thermal stresses and internal stresses.
2. Epitaxed films.
5. Film adhesion and surface chemistry.
6. Friction.

Textures
1. Tensile test textures, rolling textures, pole figures.
2. Preferred orientation.
3. Evaporated columnar and cellular films; sputtered films.

Grain Size and Distributions
1. Micro-crystalline materials.
2. Coherent domains and internal strains.
3. Spherulites.

Advanced Microstructures
1. Single crystals; dynamical diffraction theory; Pendellösung fringes.
2. Order-disorder interfaces.
3. Buckminsterfullerene, C\textsubscript{60}, Buckyball; nanotubes, Graphine.

4. Polymers.

5. Liquid crystals.

6. Amorphous metals.

**Special Topics**

1. Set by class interests.

2. Special outside speakers.

The textbook for this class is given below.

*Elements of X-Ray Diffraction* 2\textsuperscript{nd} edition only by B. D. Cullity. There are lots of copies for sale on-line but **do not order the 3\textsuperscript{rd} edition** with Stock as it has just too many mistakes.

Additional reference texts are listed here all four books may be obtained for under $40:

*X-Ray Diffraction: In Crystals, Imperfect Crystals, and Amorphous Bodies* by Andre Guinier, a classical text, Dover.

*Vectors and Tensors in Crystallography* by Donald E. Sands, Dover; also *Introduction to Crystallography* by Donald E. Sands also by Dover.