**ENG ME 532/MS 532 Atomic Structure and Dislocations in Materials**

**2008-2009 Catalog Data:**

**ENG ME 532/MS 532 Atomic Structure and Dislocations in Materials** Prereq: ENG ME 305 and ENG ME 306 or graduate standing. Relates mechanical behavior of crystalline materials to processes occurring at microscopic and/or atomic levels. Topics covered include structure of materials and their determination by X-ray diffraction; dislocations and their relationship to plastic deformation and strength of materials; fracture and creep. 4 cr.

**Class/Lab Schedule:** 4 lecture hours per week

**Status in the Curriculum:** Elective

**Textbook(s) and/or Other Required Material:** *Elements of X-ray Diffraction*, 2nd Ed., B. D. Cullity, Addison Wesley Publishing Company, Inc., Reading, MA, 1978.
*Introduction to Dislocations*, 3rd Ed., D. Hull and D. J. Bacon, Pergamon Press, 1984.
*Mechanical Behavior of Materials*, T. H. Courtney, McGraw Hill Publishing Co., New York, NY, 1990.

**Coordinator:** Soumendra Basu, Professor, Mechanical Engineering

**Prerequisites by topic:**
1. Differential equations
2. Atomic bonding
3. Crystal structure
4. Interference between waves
5. Simple elasticity theory

**Goals:**
1. Graduate level understanding of the structure of crystalline materials their determination by X-ray diffraction; line defects in crystalline materials and their relationship to mechanical behavior. This course is aimed at graduate students involved in research in the area of materials.
2. Expose undergraduate students who might be contemplating graduate research in the materials area to more advanced topics in materials science and engineering.

**Course Learning Outcomes:** As an outcome of completing this course, students will:

i. Gain a graduate level understanding of the fundamental principles of structure and line defects in crystalline materials and their relation to the mechanical behavior.
ii. Gain the ability to apply the above principles to engineering materials.
iii. Gain an understanding of the utility of materials in industry.

**Course Learning Outcomes mapped on to Program Outcomes:**

| **Program**: | A | B | C | D | E | F | G | H | I | J | K | L | M | N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Course**: | i | | | | ii | | | | | | ii,iii | i-iii | iii | |
| **Emphasis**: | 5 | 1 | 1 | 1 | 4 | 1 | 1 | 1 | 1 | 1 | 2 | 3 | 1 | 1 |

**Topics (time spent in weeks):**

1) Structure and X-ray diffraction:
Bravais lattice, unit cell; Miller indices, stereographic projections; close packed structures; Paulings rules for ionic materials; structure of ceramic materials; Braggs law, structure factor; single crystal and powder diffraction patterns; determination of grain size, texture and lattice parameters.

2) Dislocations and plastic deformation:
Burgers vector, CRSS, Schmid factor; energy of dislocations; forces on dislocations; dislocation in FCC structure; dislocations in other structures; dislocation interactions; dislocation density, Frank Reed source.

3) Strengthening of crystalline materials:
Work hardening; solid solution hardening; precipitation hardening; dispersed phase strengthening.

4) Fracture: Griffith cracks; ductile fracture; brittle fracture; creep fracture.

5) Creep: Nabarro-Herring and Coble creep; Ashby deformation maps

**Contribution of Course to Meeting the Professional Component:**
Engineering topics: 100% Math:

**Status of Continuous Improvement Review of this Course:**
**Prepared by**: Soumendra Basu Date: March 22, 2009