MAE 160 (4 units)
Mechanical Behavior of Materials

Class/Laboratory Schedule: four hours of lecture, eight hours outside preparation.
12 hours/week total

Course Coordinator(s): Joanna McKittrick

Textbooks/Materials:

1. M. A. Meyers and K. K. Chawla, Mechanical Behavior of Materials, Cambridge University Press, 2009

Catalog Description: Elasticity and anelasticity, dislocations and plasticity of crystals, creep, and strengthening mechanisms. Mechanical behavior of ceramics, composites, and polymers. Fracture: mechanical and microstructural aspects. Fatigue. Laboratory demonstrations of selected topics.

Prerequisites: MAE 20, 130A (or SE 101A), and MAE 131A

- ■ Required Course
- ☐ Technical Elective Course
- ☐ Other: _____

Performance Criteria:

Objective 1
1.1 Students will demonstrate an understanding of the structure-deformation behavior correlation in engineering materials.

Objective 2
2.1 Students will demonstrate the ability to identify the deformation mechanisms operative in various engineering materials.
2.2 Students will demonstrate an ability to qualitatively predict the mechanical properties of materials using a variety of strengthening theories.

Objective 3
3.1 Students will demonstrate an understanding of the dependency of the yield strength and flow stress of materials on both test temperature and strain rate.
3.2 Students will demonstrate an understanding of several material models, their limitations, and applications .

Objective 4
4.1 Students will demonstrate the ability to determine stress intensity factors for a variety of flawed component configurations.
4.2 Students will demonstrate the ability to design using a fracture mechanics approach.

Objective 5
5.1 Students will demonstrate knowledge of temperature transition effects in engineering materials and how various microstructures influence the fracture behavior.

Objective 6
6.1 Students will demonstrate knowledge of fatigue crack growth and its correlation using fracture mechanics theory.
6.2 Students will demonstrate an understanding of designing for fatigue applications, and for predicting fatigue lifetimes of engineering components using fracture mechanics.

Course Objectives:
(Numbers in parentheses refer to the specific MAE Program Outcomes)

Objective 1: To teach students the deformation behavior of engineering materials as a function of various external factors, such as temperature, strain rate, stress state, and internal microstructural features such as anisotropy and plasticity (1a, 3c, 5e).

Objective 2: To teach students the micromechanisms of deformation and the various methods of strengthening materials. (1a, 3c, 5e).

Objective 3: To teach students the concept of linear elastic fracture mechanics, its limitation and application in real engineering situations. (1a, 3c, 5e).

Objective 5: To teach students the role of microstructure and test conditions on the fracture behavior of materials. (1a, 3c, 5e)

Objective 6: To teach students the concept of fatigue fractures, and methods of predicting fatigue lifetimes of components (5e,1a, 3c).

Course Topics:
1. Elastic constants; anisotropy and symmetries.
2. Yield and Failure Criteria
3. Dislocations and Slip
4. Twinning
5. Strengthening Mechanisms
6. High Temperature Response: Creep
7. Deformation Response of Polymers
8. Fracture :Mechanical Aspects
9. Fracture: Microstructural Aspects
10. Fatigue Crack Propagation
11. Fatigue Life Predictions
12. Mechanical Response of Ceramics; Weibull statistics
13. Mechanical Behavior of Composites

Prepared By: K. Vecchio, March 2000
Revised: Prab bandaru & Joanna McKittrick, April 2008, via Teaching Work Group Meeting
Reviewed and Revised: TWG, June 2010; June 2011
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