ME/MSE 413: Mechanics of Solids

Course description: Elasticity, elastic stress distributions; plastic deformation of single and polycrystals; introduction to dislocation theory and its applications; creep, fracture, and fatigue.

Number of credits: 3. This course is required for MSE.

Course Coordinator: Scott Beckman

Prerequisites by course: MSE 201, CE 215

Prerequisites by topic:

1. Newtonian mechanics
2. Elementary stress analysis
3. Crystal structures
4. Introductory concepts of dislocations
5. Polycrystalline nature of engineering alloys

Postrequisites: MSE 513 (recommended)
ME/MSE 537 (recommended)

Textbooks/other required materials: R.W. Hertzberg, R.P. Vinci, and J.L. Hertzberg. *Deformation and Fracture Mechanics of Engineering Materials.* Wiley and Sons, Hoboken, NJ.

Course objectives:

1. To analyze the stresses and strains that exist within a body subjected to non-uniaxial loading.
2. To be able to determine yielding under multiaxial loading.
3. To understand the fundamental processes involved in deformation, fracture, and fatigue under ambient conditions.
4. To compute fracture stresses and fatigue lives of engineering components.
5. To be able to match applications with the appropriate material based on an understanding of both the mechanics and fundamental material behavior.
6. To use numerical techniques in the solution of complex problems

Topics covered:

1. Stress and Strain
2. Mohr's Circle
3. Tensor Notation
4. Linear Elasticity and Hooke's Law
5. Principles of Stress Analysis
6. Continuum Plasticity
7. Flow Curves and Constitutive Relations
8. Yield Criteria and Flow Under Multiaxial Stress
9. Crystal Plasticity and Dislocation Theory
10. Strengthening Mechanisms in Metals
11. Fracture and Fracture Mechanics-Toughness, Fatigue and Stress Corrosion Cracking
12. Applications of LEFM to Design and Ethical Implications
13. High Temperature Deformation

Expected learning outcomes:

1. Ability to calculate the state-of-stress at a point for complex loads using transformation equations and graphical techniques such as Mohr's Circle.
2. Ability to determine if yield will occur using Tresca and von Mises yield theories.
3. Ability to describe deformation, fracture, and fatigue in terms of dislocation motion and arrangements.
4. Use fracture mechanics concepts to compute fracture stress and fatigue lives given materials data and loading conditions.
5. Ability to select an appropriate material from a number of possible choices given the operating conditions.
6. Calculate the high temperature life of a component using engineering data and the Larson-Miller parameter.
7. Ability to appreciate ethical implications of engineering decisions related to fracture and fatigue.

Class schedule: Three 50-minute lecture sessions per week, for one semester.

Laboratory schedule: None.

Contribution to meeting the professional component: Engineering Topics

Relationship of course to student outcomes for ME:
3 strongly supported; 2 supported; 1 minimally supported

Student Outcomes Pre-Fall 2018 (ABET EC2000)

a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
3							1	1	1	3

Student Outcomes Fall 2018 forward (ABET EC2019)

1	**2**	**3**	**4**	**5**	**6**	**7**
3	2	1		1		1

Relationship of course to student outcomes for MSE:
3 strongly supported; 2 supported; 1 minimally supported

Student Outcomes Pre-Fall 2018 (ABET EC2000)

a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**m**	**n**	**o**
3							1	1	1	3	2	3	3	1

Student Outcomes Fall 2018 forward (ABET EC2019)

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
3	2	1		1		1	2	3	3	1

Prepared by: Andrea Butcherite and Dr. Scott Beckman *Date:* May 30, 2018