ME 3228 – Introduction to Fatigue in Mechanical Design

Credits and Contact Hours: 3 Credits. Three 50 minute or two 75 minute lectures per week.

Instructors: Hanchen Huang, Eric Jordan


Specific Course Information:
  a. Catalog Description: Design calculation methods for fatigue life of engineering components. Crack initiation and crack propagation fatigue lives; introduction to current literature in the field. Emphasis on finite life prediction by strain life methods.
  
b. Prerequisites: CE 3110. Not open to students that have passed ME 5431.
  
c. Required, Elective or Selected Elective: Elective

Specific Goals:
  a. Course Outcomes:
After completing ME 3228 students should be able to:
1. Determine what models best describe a materials system - brittle or ductile - under cyclic loading.
2. Understand brittle fracture and crack growth criteria.
3. Have the knowledge of elastic-plastic constitutive relationships in general.
4. Have the knowledge of establishing elastic-plastic relationships for simple bending and torsion.
5. Have the knowledge of elastic-plastic models under cyclic loading.
7. Develop and use (uni-axial) stress-lifetime and strain-life time relationships.
8. Analyze effects of mean stress to stress/strain - lifetime relationships.
9. Analyze effects of three-dimensional loading to stress/strain - lifetime relationships.

b. Relationship of Course Outcomes to Criterion 3 Student Outcomes:
  a) an ability to apply knowledge of mathematics, science, and engineering:
     Students are required to apply fundamental concepts of vectors and tensors, transformations, solutions of eigenvalue problems and integral calculus. Newton's laws and fundamental energy and work concepts are used to explain various engineering phenomena, ranging from plastic deformation to fracture.
  b) an ability to design and conduct experiments, as well as analyze and interpret data:
     Lectures on elastic-plastic fracture mechanics are focused on providing the students with an understanding of when elastic fracture tests are not feasible and plastic fracture tests should be adopted. As part of this, students are required to analyze and interpret fracture tests to determine appropriate fracture toughness values.
c) an ability to design a system, component, or process to meet desired needs:

*The primary focus is to determine the maximum allowable stress, crack length or stress amplitude that will result in the desired component performance. Homework problems are assigned that require the student to determine specimen dimensions to achieve a desired life. Open-ended design problems are required such that the student identifies various strategies to improve material properties or designs to increase life.*

d) an ability to function on multi-disciplinary teams: *not applicable*

e) an ability to identify, formulate, and solve engineering problems:

*Through assignments, students are required to determine the probable cause of failure, given various conditions and material properties. Students also are required to predict component life by identifying failure mechanisms, formulating the correct life-prediction methodology and identifying changes in system parameters that will prolong life.*

f) an understanding of professional and ethical responsibility: *not applicable*

g) an ability to communicate effectively: *not applicable*

h) the broad education necessary to understand the impact of engineering solutions in a global and societal context: *not applicable*

i) a recognition of the need for, and an ability to engage in life-long learning:

*Students gain a recognition of the need for life-long learning through exposure to new developments in failure prediction and ongoing generation of material microstructures designed to prevent failure.*

j) a knowledge of contemporary issues:

*Students gain a recognition of contemporary issues through exposure to new developments in failure prediction and the generation of material microstructures designed to prevent failure.*

k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice:

*Students are exposed to modern computational techniques used to calculate fracture mechanics quantities.*

**Topics Covered:**

- Fatigue analysis based on elastic behavior characteristic of high cycle fatigue
- Strain based methods of analysis useful in low cycle fatigue
- Cracked bodies with respect to monotonic fracture and fatigue