AAE 55400: Fatigue of Structures & Materials

Credit Hours	3
Offered	Fall
Pre-requisites	AAE 204 or equivalent
Co-requisites	None
Instructional Method	3 hours of lecture per week
Required	No

1. Course Description

Development and application of methods for predicting the fatigue life of structural components. Characterization and response of materials to cyclic loading. Fatigue resistant design of structures. Both fatigue crack initiation and crack propagation concepts are discussed.

2. Instructor Information

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3. Topics Covered

1. Introduction, History, Motivation for Fatigue, Syllabus
2. Design for Fatigue
3. Stress - Life Approach
    - Overview of stress-life
    - Mean Stress Effect

    - Notch Effect
    - Factors Influencing stress-life
    - Residual Stresses
    - Surfaces Effects and Shot Peening
    - Variability in Fatigue / Scatter
4. Strain - Life Approach
    - Bauschinger Effect and Hysteresis Loops
    - Overview of Strain-Life
    - Mean Stress Effect
    - Shakedown / Ratcheting
    - Energy Methods
    - Notches and Neuber's Rule
5. Physics of Fatigue
    - Slip Bands – Crack Initiation
    - Microstructure Effect
6. Multiaxial Fatigue
    - Multiaxial Stress States
    - Critical Plane Approach
7. Fatigue Crack Growth
    - Intro to Fracture
    - Crack Tip Plasticity
    - Fracture Toughness
    - Fatigue Crack Growth
    - Mean Stress and Crack Closure
    - Small Cracks
8. Environmental Effects
    - Corrosion and Local Chemistry
    - Thermo-mechanical fatigue
    - Dwell Loading Effects
9. Variable Amplitude
    - Linear/ Non-linear Approaches
    - Cycle Counting - Rainflow Method

4. Intended Learning Outcomes

On completing this course, the student shall be able to:

- Develop methods for characterizing fatigue resistance of materials and predicting cyclic lives of structural components
- Discuss approaches for preventing fatigue failures through materials selection, fatigue resistant design, and "fleet management" concepts.
- Both crack initiation (stress and strain based) and crack propagation (fracture mechanics) approaches are developed and compared.
- While general class concepts compare to a variety of structures, emphasis throughout is on aerospace applications.

5. Assessment Method

Weekly homework, midterm exam and final exam.

6. Relation to ABET Outcomes

	Program Learning Outcomes	Included?
1.	An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.	Yes
2.	An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.	Yes
3.	An ability to communicate effectively with a range of audiences.	No
4.	An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.	Yes

5.	An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.	Yes
6.	An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.	Yes
7.	An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.	Yes