4 November 2015

AAE 554 FATIGUE OF STRUCTURES & MATERIALS: Spring 2016

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Class email:  please use for all class related matters:  AAE554@ecn.purdue.edu
Class webpage (blackboard):  http://www.itap.purdue.edu/learning/tools/blackboard/


Additional handouts will be posted on blackboard as needed.

Course Objectives:
1. Develop methods for characterizing fatigue resistance of materials and for predicting cyclic lives of structural components.
2. 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 apply to a variety of structures, emphasis throughout is on aerospace applications.

Grading:  Final course grade will be based on the following factors:

- 25%  Homework
- 25%  Exam 1 (tentative  Session 19 – Wednesday, 24 February 2016)
- 25%  Exam 2 (tentative  Session 37 – Wednesday, 13 April 2016)
- 25%  Final Exam (comprehensive – date TBD by university)

100%  Total

Comments:
1. Homework must be turned by the close of business on the day that it is due. Unless prior arrangements are made, late homework will not be accepted for credit, but will be graded if student desires his/her approach to be checked. Additional instructions for submitting homework by off-campus students will be provided at a later date.
2. The purpose of homework assignments is for students to gain further understanding of classroom principles through application to practical problems. Although discussion of assignments between students is permitted, the solution should represent your own efforts and understanding of the problem. Blatant copies of the solutions will not be accepted, and repeated evidence of copying will lead to failure of the course.
3. The instructor encourages all students to feel free to discuss class related problems with him. Although an open door policy will be maintained, students are encouraged to make appointments in order to ensure instructor availability.
4. Instructor reserves the right to raise the final grade of any student by one letter.
5. The plus/minus grading system will not be used for AAE 554 this semester.
6. In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructor’s control. Such changes will be posted on the course web page. Please contact the instructor by email or phone if any questions in this regard.
Tentative Outline for AAE 554 -- Fatigue of Structures and Materials

- **Introduction** (Text: Chapters 1 and 2)
  - Course objectives
  - Review failure modes
  - Characteristics of fatigue failure mode
  - Fatigue design criteria
  - Examples of service failures

- **Fatigue Crack Growth**
  - Overview of linear elastic fracture mechanics concepts (Chapter 3)
    - Crack tip stress intensity factors
    - Crack induced fracture
    - \( da/dN \) versus \( \Delta K \) and stress corrosion cracking
    - Crack growth life calculations
  - Crack tip plasticity (Chapter 5)
  - Fracture toughness considerations
    - 3-D aspects of fracture (Section 6.5)
    - leak-before break (Section 6.6)
    - proof testing (Section 4.3)
  - More fatigue crack growth (start Chapter 7)
    - Stress ratio effects and crack growth models (Sections 7.1-7.3)
    - Load interaction effects and crack retardation models (Sections 7.4 and 7.5)
    - Thickness and material effects (Section 7.6)
    - Variable amplitude fatigue crack growth analysis (Section 7.9)

- **Exam #1** (Closed-book, one-page review sheet)

- **Fatigue Crack Formation** (Portions of Chapter 9 plus handouts)
  - Overview and fatigue testing (Section 9.1 – 9.2.1)
  - Stress-life concepts (Section 9.2.2)
    - S-N curves
    - Mean stress models and “correction factors”
  - Strain-life concepts (Section 9.2.3)
    - Monotonic and cyclic stress-strain behavior
    - Cyclic strain versus life
    - Mean stress models
  - Notch fatigue (Section 9.2.4)
  - Variable amplitude loading (Section 9.2.5)
  - Cycle counting (Section 9.2.6)

- **Exam #2** (Closed-book, one-page review sheet)

- **Misc Fatigue Topics/Applications**
  - Finish chapter 7
    - Small crack, and environmental effects (Section 7.7-7.8)
    - Multi-degree-of freedom analysis (Section 7.10)
    - Fatigue crack thresholds (Section 7.11)
    - Fatigue crack closure (Section 7.12)
  - Total fatigue life and Equilivant Initial Crack Size concepts (Sections 9.4 and 9.5)
  - Variability in fatigue behavior
  - Design considerations (Portions of Chapter 16)
  - Aging Structure and Life Extension Issues (Chapter 17)
  - Stress Intensity Factor Analysis (Chapter 8)
  - Introduction to Nondestructive evaluation (Chapter 4)
  - Fatigue research topics

- **Final Exam** (Comprehensive, closed-book, two-page review sheet – date to be set by University)
As professor and students in this class, we have shared responsibility to maintain high standards of ethical conduct. The following guidelines are adopted from a statement of faculty ethics prepared by the AAUP. You are asked to join me in upholding these high standards this semester. Specifically, our ethical obligations are to:

1) **Engage in the free pursuit of learning by:**
   - Seeking help and clarification when needed.
   - Respecting fellow students’, professors’, and guests’ opinions without disparaging and dismissing them.
   - Seeing beyond “personality issues” with others to appreciate their contributions to the learning environment.

2) **Model ethical scholarly standards by:**
   - Avoiding plagiarizing and all other breaches of academic honesty.
   - Avoiding any seeming approval, acceptance, or encouragement of fellow students’ academic dishonesty and bringing any such instances to the attention of the professor and/or university officials.
   - Engaging in discussions with other students and professors about ethical issues in academics.

3) **Acknowledge, accept, and expect just assessment of your learning by:**
   - Understanding the professor’s methods and rationale for your assessment and asking for clarification if you don’t understand.
   - Engaging in accurate, just, objective self-assessments of your own work.
   - Engaging in constructive, value-neutral discussion with the professor about discrepancies between your self-assessment and the professor’s assessment of your work.
   - Refraining from comparing assessments and grades with classmates’ so as not to diminish classmates’ self-esteem.

4) **Avoid harassment, discrimination, and exploitation by:**
   - Getting to know classmates and the professor as individuals rather than applying prejudices and stereotypes.
   - Contributing your full effort in team and collaborative projects.
   - Respectfully voicing your expectations of full participation in team and collaborative projects to fellow students.
   - Not discouraging, in any way, a member’s full participation in a collaborative project.
   - Being careful not to make racist, sexist, and other types of discriminatory remarks during class.
   - Being careful not to monopolize class discussion time so that others do not have a chance to participate or are intimidated about participating.


Also see “Academic Integrity: A Guide for Students, a brochure posted on the Purdue Dean of Students web site:

http://www.purdue.edu/odos/osrr/academicintegritybrochure.php