CIVE 664: Mechanics of Fatigue and Fracture

Instructor:	Dr. Hussam Mahmoud
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Office Hours:	Wed, 8:00 a.m. – 10:00 a.m. at A205A

Prerequisites:	CIVE 560, or consent of the instructor
Ref. Textbooks:	Anderson, T. L., *Fracture Mechanics – Fundamentals and Applications,* 3rd Edition, CRC Press, 2005 [ISBN 9780849316562 [order from: www.amazon.com]
	Dowling, D. E., *Mechanical Behavior of Materials: Engineering Methods for Deformation, Fracture, and Fatigue*, 4th Edition, Prentice Hall, 2012 **Reference:** [ISBN 978-0131395060]
Software:	MATLAB or Mathcad and ABAQUS
Coordinator:	Dr. Hussam N. Mahmoud, Assistant Professor of Civil and Environmental Engineering

Course objectives: This course reviews the basic fundamental concepts of fracture mechanics including linear elastic, elastic-plastic, and dynamic fracture with focus on ductile and cleavage fracture in metals. Different test methods for estimating the fracture toughness of metals will be outlined and their relative significance will be compared. The course will also cover fatigue crack initiation and propagation under different loading modes. The S-N curves and detail categories used in typical design codes will be discussed along with the hot-spot stress approach. The course will outline the procedure for conducting fitness-for-purpose evaluation of steel structures and will conclude with discussion on various effective repair and retrofit methods. Additional topics will be included such as low and ultra-low cycle fatigue and fatigue and fracture of hard human tissues including skeletal bones and teeth.

Students successfully completing this course will have a solid understanding of the concept of fatigue and fracture. At the conclusion of this course, the students are expected to be able to conduct fatigue and fracture evaluation of structures including fracture potential, estimate of crack growth rate, and remaining life.

Homework: No late assignments will be accepted without a documented excuse. Some assignments will require the use of a computer and a spreadsheet or MathCAD, MATLAB, ABAQUS, etc. You are responsible for providing your own hardware and software (all these software are available at the engr. computer laboratory). You may ask questions of each other, and discuss general procedures and strategies about how to approach a problem. For individual projects, the step-by-step calculations, figures, and conclusions that you submit must be your own work. You may use spreadsheets for calculations, but you must also write out the entire problem in your worked solution, showing the equations at each step. You may submit the results from a program such as MathCAD or Mathematica if the equations for every step and the units are shown in the output and the problem is clearly organized.

Term Exams: There will be one take-home midterm exam. No late exams will be accepted. The exam is tentatively scheduled for November 17

Project: You will be assigned to a group for the group projects. Every member of the group is expected to contribute, but you may break up the tasks among yourselves in any way you want. You (as a group)

will make a 25-minute presentation (during the final exam time) to the class on your groups findings. Each group member is responsible for the quality of the work and must understand all aspects of the work. Questions will be asked of all group members during these presentations and will be considered when determining your project grade. More details on the term project will be given in class.

Schedule:

wk 1 Introduction to fracture mechanics
wk 2 Brittle fracture (LEFM)
wk 3 Ductile fracture (EPFM)
wk 4 Dynamic fracture
wk 5 Test methods for fracture toughness estimates
wk 6 Fatigue crack initiation and propagation
wk 7 Fatigue crack initiation and propagation
wk 8 Distortion induced fatigue
wk 9 Stress corrosion cracking and corrosion fatigue
wk 10 S-N curves for fatigue design and evaluation
wk.11 Hot-spot stress approach
wk.12 Fitness-for-purpose assessment
wk.13 Repair and retrofit
wk.14 Additional topics (low cycle and ultra-low cycle fatigue)
wk.15 Additional topics (fatigue and fracture in hard human tissues)
wk.16 Project/presentations

Final Exam: A comprehensive exam, Dec 14, 2:00 p.m. – 4:00 p.m.

Grading:

Homework	40%
Midterm exam	25%
Term Project and Exam	30%
Participation	5%
Total	100%