COURSE SYLLABUS

ME 524

Fracture Mechanics

FACULTY CONTACT INFORMATION:
Instructor: Reza Abedi
Office Location: Room B203
Phone: (931) 393-7334 **E-mail**: rabedi@utsi.edu
Web page: http://www.rezaabedi.info/

I. **COURSE DESCRIPTION**: Mechanisms of fracture and crack growth; stress analysis; crack tip plastic zone; energy principles in fracture mechanics; fatigue-crack initiation and propagation; fracture mechanic design and fatigue life prediction. Analytical, numerical, and experimental methods for determination of stress intensity factors. Current topics in fracture mechanics.

Registration Permission: Consent of instructor.

II. **COURSE OBJECTIVE**: The objective of the course is to prepare students to develop theoretical background in linear elastic and plastic fracture mechanics. This will include energy approaches, stress intensity factors, plastic zones, and J-integral. Subsequently, we employ various models in computational fracture mechanics. Through a term project with commercial finite element software and paper reviews on modern fracture mechanics topics students are expected to develop necessary background to conduct research in the field.

III. **STUDENT LEARNING OUTCOMES**: Students will be able to:

- Discern the connections between stress and energy approaches, and between elastic and plastic fracture mechanics methods for crack tip mechanical fields.
- Understand notions such as stress intensity factor and J integrals and solve for those using commercial finite element software.
- Get familiar with recent research directions in fracture mechanics.
- Employ or formulate appropriate fracture models for various applications.

IV. **SELECTED BIBLIOGRAPHY:**

- Course textbook:
    1. T. L. Anderson, Fracture Mechanics: Fundamentals and Applications, 3rd Edition, CRC Press, USA, 2004 (main textbook).

  Some reference textbooks for fracture mechanics
    2. D. Broek, Elementary Engineering Fracture Mechanics, 4th Revised Edition, Springer, 1982 (or reprint 2013).
    3. B. Broek, The Practical Use of Fracture Mechanics, Springer, 1998.
    4. S. Murakami, Continuum Damage Mechanics: A Continuum Mechanics Approach to the Analysis of Damage and Fracture, Springer Netherlands, Dordrecht, 2012.
    5. Suresh, S. Fatigue of Materials. 2nd ed. Cambridge University Press,

1998.
6. L.B. Freund, Dynamic Fracture Mechanics, Cambridge University Press, 1998.
7. B. Lawn, Fracture of Brittle Solids, Cambridge University Press, 1993.
8. M.F. Kanninen and C.H. Popelar, Advanced Fracture Mechanics, Oxford Press, 1985.
9. R.W. Hertzberg, Deformation and Fracture Mechanics of Engineering Materials. 5th ed. John Wiley & Sons, Inc., 2012 (materials focus).
10. S Al Laham, Stress Intensity Factor and Limit Load Handbook, British Energy Generation Limited, 1998.

V. **COURSE REQUIREMENTS, ASSESSMENT AND EVALUATION METHODS:**

- Assignments(20%+5%): Extra 5% is for challenge problems.
- Term project (20%): We use commercial software for application of several computational tools such as cohesive and damage models, and for computation of FM crack tip fields.
- 4-page report & presentation on a topic on fracture mechanics (20%): The topic and sources for the study will be chosen based on student's interest and available topics. Each student will have a 10 minute presentation at the end of the semester.
- Midterm exam (15%)
- Final exam (25%)

VI. **UNIVERSITY POLICIES:** The students should abide by the UTK honor statement included on the Campus Syllabus available on the Provost and TennTLC websites, and the online UT catalog. The honor statement includes information about discrimination, scholastic dishonesty, cheating, and plagiarism policies. All the homework assignments and exams are individual assignments unless otherwise noted by the instructor.

VII. **COURSE OUTLINE:** All the concepts in the course outline will be taught with reference to familiar structures such as rigid bodies, bars, beams, and plates.

I. Fracture modes
   a. Fracture Classification
   b. Ductile vs. brittle fracture
II. Linear elastic fracture mechanics (LEFM)
   a. Energy Approach, Griffith criterion
   b. Stress Intensity Factors
III. Elastic-plastic fracture mechanics
   a. Plastic zone size
   b. J integral
   c. Crack tip opening displacement (CTOD)
IV. Computational fracture mechanics
   a. Crack path and bifurcation criteria
   b. Bulk damage models
   c. Traction Separation Relations
   d. FEM aspects (XFEMs, adaptive meshing, etc)
   e. Current trends in computational fracture mechanics
V. Bulk damage models
VI. Fatigue
   a. Fatigue crack propagation and life prediction

b. Paris law

VII. Dynamic fracture mechanics and rate effects

VIII. IMPORTANT DATES IN THE ACADEMIC CALENDAR