THE UNIVERSITY OF TEXAS AT AUSTIN

EM 388F: Fracture Mechanics

Spring 2004

SYLLABUS

UNIQUE NUMBERS: 12165

TIME: TTh, 2:00pm - 3:30pm

ROOM: WRW 312

INSTRUCTOR: Rui Huang, WRW 117D, 471-7558, ruihuang@mail.utexas.edu

OFFICE HOURS: Open

SYNOPSIS:
Fracture involves processes at multiple time and length scales. Fracture Mechanics is an interdisciplinary field of engineering and science requiring understanding from the viewpoints of solid mechanics, material science, physics, and chemistry. This course covers the basic topics including energy balance, crack tip fields, toughness, dissipative processes, and subcritical cracking. Fracture processes are then examined as they occur in some modern technologies, such as advanced ceramics, coatings, composites, and integrated circuits.

PREREQUISITES: None.

TEXTBOOKS: Not required.

Recommended References:
M.F. Kanninen and C.H. Popelar, *Advanced Fracture Mechanics*, Oxford University Press, 1985.
B. Lawn, *Fracture of Brittle Solids*, Cambridge University Press, 1975, 1993.
J.W. Hutchinson and Z. Suo, "Mixed-mode cracking in layered materials", *Advances in Applied Mechanics* 29, 63-191 (1992).
Z. Suo, "Reliability of Interconnect Structures", pp. 265-324 in Volume 8: Interfacial and Nanoscale Failure (W. Gerberich, W. Yang, Editors), *Comprehensive Structural Integrity* (I. Milne, R.O. Ritchie, B. Karihaloo, Editors-in-Chief), to be published. Preprint available at http://www.deas.harvard.edu/suo/, Publication 139.

Other References:
D. Broek, Elementary Engineering Fracture Mechanics, Kluwer Academic Publishers.
R.W. Hertzberg, *Deformation and Fracture Mechanics of Engineering Materials*, John Wiley.
L.B. Freund, *Dynamic Fracture Mechanics*, Cambridge University Press.
S. Suresh, *Fatigue of Materials*, Cambridge University Press.
H. Tada, P.C. Paris, G.R. Irwin, *The Stress Analysis of Cracks Handbook*, ASME Press.
R.E. Peterson, *Stress Concentration Factors*, John Wiley.

TOPICS:

- **Elements of elasticity** (3): Strength-based design. Field equations. Stress concentration.
- **Energy balance** (4): Griffith theory. Surface energy. Irwin's energy release rate. Fracture criterion.
- **Crack tip fields** (3): Fracture modes. Stress intensity factors. Irwin's relation.
- **Engineering fracture mechanics** (3): Small-scale yielding. Design against fracture. Fracture testing. Resistance curve. Fracture around an inclusion.
- **Fatigue** (1): Cyclic load. High-cycle fatigue. Low-cycle fatigue. Fatigue crack growth.
- **Stress corrosion** (1): Static load. Environmental effects. Subcritical cracking.
- **Mixed mode fracture** (1): Crack path selection. Interface cracks in layered structures. Anisotropic fracture.
- **Nonlinear fracture mechanics** (2): Nonlinear elasticity. Ilyushin theorem. J-integral. HRR field.
- **Crack bridging** (4): Bridging law. Small-scale bridging. Large-scale bridging. Bridging mechanism.
- **Time-dependent fracture** (1): Creep crack growth. Viscoelastic crack growth. Fracture dynamics.
- **Case studies** (1): Cracking in thin film structures.

GRADING POLICY: Homework (80%) and a term paper (20%)

EVALUATION:
The Measurement and Evaluation Center forms for the College of Engineering will be used during the last week of class to evaluate the course and the instructor.

SPECIAL NOTES:
The University of Texas at Austin provides upon request appropriate academic adjustments for qualified students with disabilities. For more information, contact the Office of the Dean of Students at 471-6259, 471-4641 TDD or the College of Engineering Director of Students with Disabilities at 471-4321.