

SYLLABUS
MAE233A - FRACTURE MECHANICS
Spring Quarter 2009

Tuesday/Thursday 11:00 – 12:20 Room 147 SEQUO

INSTRUCTOR:

Professor Sia Nemat-Nasser
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OFFICE HOUR:

Tuesday 1:30 – 2:30 4209 EBUI

TOPICS COVERED:

Linear Fracture Mechanics

- Ideal Strength
- Stress Concentrators
- Linear Fracture Mechanics – Anti-Plane Shear
- Basic Equations of 2-D Linear Elasticity
- Asymptotic Solution
- Energy Method
- Relation between G and K
- Fracture Criterion
- J-Integral
- Stability and Crack Growth
- Compliance Method
- Unstable Growth of Tension Cracks in Brittle Solids
- Experimental Techniques

Nonlinear Fracture Mechanics

- The Size of Plastic Zone
- Dugdale Model
- Application of J-Integral
- Shape of Plastic Zone
- The Plastic Constraint Factor
- Singular Behavior in a Hardening Material
- Anti-Plane Shear – Perfect Plastic Material
- Use of J-Integral in Nonlinear Range
- Perfectly Plastic Material
- J Controlled Crack growth

PREREQUISITE:

Theory of elasticity, e.g. MAE231B or equivalent

GRADING:

There will be one midterm exam and the final exam. In addition, homework will be assigned and checked, but not graded.

The grades will be calculated as follows:

| | |
|---------|------------|
| Midterm | 35% |
| Final | <u>65%</u> |
| Total | 100% |

[Note: There will be no make-up exams. Hence, if the midterm is missed then a zero grade will be assigned].

EXAM SCHEDULE:

Midterm – Thursday, April 23rd [closed book and closed notes]

Final Exam – Tuesday, June 9th 11:30 – 2:30 [closed book and closed notes]

RECOMMENDED READING:

- Broek, D. (1978), *Elementary Engineering Fracture Mechanics*, Sijthoff & Noordhoff Intl.
- Cherepanov, G.P. (1979), *Mechanics of Brittle Fracture*, McGraw-Hill.
- Cottrell, A.H. (1953), *Dislocations & Plastic Flow in Crystals*, Oxford.
- Cottrell, A.H. (1964), *The Mechanical Properties of Matter*, Wiley.
- FRACTURE: An Advanced Treatise* (1971), Edited by H. Liebowitz, Vol. III, Chapters 1 and 2, Academic Press, New York and London.
- FRACTURE MECHANICS: Fundamentals and Applications* (1995), Edited by T.L. Anderson, 2nd Edition, CRC Press LLC, Florida.
- Frenkel, J. (1926), *Zeit. Phys.*, Vol. 37, p. 572.
- Gao, Y.C. and S. Nemat-Nasser (1983), Dynamic fields near a crack tip growing in an elastic-perfectly-plastic solid, *Mech. Mat.*, Vol. 2, pp. 47-60.
- Nemat-Nasser, S. (1980), Variational methods for analysis of stability of interacting cracks, *Variational Methods in the Mechanics of Solids*, edited by S. Nemat-Nasser, Pergamon Press, pp. 249-253.
- Nemat-Nasser, S., L.M. Keer and K.S. Parihar (1978), Unstable growth of thermally induced interacting cracks in brittle solids, *Intl J. of Solids and Structures*, Vol. 14, pp. 409-430.
- Nemat-Nasser, S. and M. Hori (1999), *Micromechanics: Overall Properties of Heterogeneous Materials*, Elsevier Science Publishers, 2nd Edition, Section 21, pages 723-770.
- Rice, J.R. (1968), A path independent integral and the approximate analysis of strain concentration by notches and cracks, *J. Appl. Mech*, June 1968, pp. 379-386.