Course Contents – ME 293
Fracture Mechanics

Chap. 1: Energy Concepts in Fracture Mechanics

–Atomistic view of fracture

–Griffith energy balance & Irwin-Orowan extension

–Energy release rate G; Compliance method

–Crack growth stability and Resistance (R) curve

Chap. 2: Linear Elastic Fracture Mechanics

–Field equations of elasticity

–Stress/displacement fields near the crack tip – William's eigenfunction expansion.

–Stress intensity factor (SIF) K and relation to applied load, fracture geometry

–Relation between G and K

–Fracture characterization by K – Small scale yielding conditions

–Irwin's plastic zone correction; Dugdale model.

–Fracture toughness K_c

Chap. 3: Analytical methods for determining SIF

–Complex potentials method

–Westergaard method

–Principle of superposition

–Green's function method

–Weight function method

Chap. 4: Fatigue Failure

–S-N Diagram and its limitations
–Fatigue crack propagation – Similitude concept; Empirical laws
–Crack closure; Fatigue Threshold
–Variable amplitude loading; Overload cycle
–Damage Tolerant Design Methodology

Chap. 5: Mixed-mode Fracture / Fracture of Interfaces

–Thermal stresses in multi-layers
–Interfacial crack tip fields
–Crack kinking and deflection at interfaces; substrate penetration
–Steady-state channel cracks
–Delamination of films due to residual stresses

Chap. 6: Nonlinear Fracture Mechanics

–J Integral
–Plastic crack tip (HRR) fields
–Ductile fracture criterion
–J Integral Testing
–J-controlled crack growth and stability
–Engineering approach to Plastic Fracture

Chap.7: Dynamic Fracture– (depending on time availability)

–Examples and motivation

–Dynamic loading of stationary crack

–Energy flux into moving crack tip

–Dynamic crack growth

–Crack tip equation of motion

References

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2. M.F.Kanninen and C.H.Popelar, “Advanced Fracture Mechanics”, Oxford press, 1985.
3. D.Broek, “Elementary Engineering Fracture Mechanics”, Martinus Nijhoff publishers, 1982.
4. J.W.Hutchinson, Z.Suo, “Mixed-mode cracking in layered materials”, *Advances in Applied Mechanic*s, V.29 (1992), pp.63-91.
5. Kare Hellan, “Introduction to Fracture Mechanics”, McGraw Hill, 1984.
6. L.B.Freund, “Dynamic Fracture Mechanics”, Oxford, 1990.
7. Fracture Journals : *Engineering Fracture Mechanics* (Elsevier); *International Journal of Fracture* (Springer); *Fatigue and Fracture of Engineering Materials and Structures* (Blackwell).