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Fracture Mechanics

Instructor

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Department: Mechanical Engineering

Course Time: Tuesday & Thursday, 3:30 p.m. to 5 pm

Lecture venue: MMCR, Mechanical Engg Department

Detailed Course Page:

Announcements

Brief description of the course

This course is intended for students with background in Solid Mechanics who wish to learn about mechanics of fracture of materials. It will expose the student to fundamentals of linear elastic fracture mechanics, nonlinear (Elastic-Plastic) fracture mechanics and fatigue crack growth. The student will learn about stress / strain and deformation fields near a crack tip, fracture characterizing parameters like stress intensity factor and J integral and kinetics of fatigue crack growth.

Prerequisites

ME242 : Solid Mechanics or equivalent course.

Syllabus

1. Overview of Fracture Mechanics

2. Energy concepts in Fracture Mechanics.

3. Linear Elastic Fracture Mechanics.

4. Analytical methods for determining stress intensity factors.

5. Fatigue crack growth.

6. Elastic-Plastic Fracture Mechanics.

7. Interfacial fracture.

Course outcomes

Fracture Mechanics is important both from the perspective of material development and design of engineering components. While conventional design for strength, stiffness or fatigue life make use of elementary concepts based on Strength of Materials and Theory of Elasticity, these may give erroneous estimates of load bearing capacity or life of a structural component due to presence of flaws. In this course, the student will learn about mechanics of crack tip fields and appropriate fracture characterizing parameters like stress intensity factor and J integral or nonlinear energy release rate and how to compute them using various methods. Special emphasis will be given to experimental methods for determining the fracture toughness (for example, ASTM standard procedure for JIC testing). Failure of structures by fatigue crack growth is another important topic which the student will learn in this course. Various empirical fatigue crack growth laws, role of stress ratio, overload cycle, etc., will be discussed. An engineering approach to elastic-plastic fracture mechanics which makes use of a handbook style approach to evaluate important fracture characterizing parameters like J and CMOD will be described. At the end of the course, the student should be able to apply the concepts that he/she has learnt to design of structural components taking into account presence of flaws, nature of loading and constitutive behavior of the material. Also, he / she should be able to conduct experiments in the laboratory following standard test procedures to determine the fracture toughness of materials.

Grading policy

Assignments & mid term tests : 50%

Final exam: 50%

Assignments

There will be some assignments illustrating ideas discussed in the lectures - for example, on complex variable methods to calculate stress intensity factors or compliance / line integral methods to evaluate energy release rate.

Resources

1. Anderson, : Fracture Mechanics: Fundamentals and Applications, CRC press, 3rd Ed., 2005

2. Broek, Engineering Fracture Mechanics, Martinus Nijhoff publishers, 1982.

3. M.F.Kanninen and C.H.Popelar, Advanced Fracture Mechanics, Oxford press, 1985.

4. KRY Simha, Fracture Mechanics, University Press.