



Mechanical Engineering Dept. Department

Syllabus

ME 457: Failure of Materials & Prevent (3-0-3)

Course Catalog Description:

Modes of failure of engineering materials with emphasis on preventive measures during design, material selection, operation, and monitoring using non-destructive methods. Review of stiffness and strength limited designs, fracture, fracture toughness, fatigue, creep, creep rupture, oxidation of high-temperature alloys, corrosion, common corrosion forms, friction and wear, lubrication. A brief introduction to major non-destructive methods: liquid penetrant, magnetic flux leakage, radiography, and ultrasonic.

Course Pre-requisites:

- ME 205: Materials Science
- ME 207: Materials Science for CHE
- ME 216: Materials Science and Engg.

Course Objectives:

1. To teach students the major modes of materials failure and the associated consequences of capital and human losses.
2. To emphasize the role of engineers in preventing materials failures during design, materials selection, operation, and monitoring.
3. To examine failure analysis case studies and be able to evaluate the findings and conclusions.

Course Learning Outcomes:

CLO1. Describe characteristic features, causes and prevention methods of mechanical failures: fracture, fatigue, creep, and wear.

CLO2. Describe characteristic features, causes and prevention methods of environmental failures: corrosion, and oxidation.

CLO3. Apply mechanics approaches to predict design limits for stiffness and strength limited designs for elastic behavior of materials.

CLO4. Apply basic design approaches and analyses in fracture mechanics, fatigue, creep, and wear to predict/prevent mechanical failures in engineering members

CLO5. Evaluate basic corrosion and oxidation effects on materials durability

CLO6. Work in small teams to apply materials failure analysis and be able to present the main findings.

CLO7. Evaluate basic materials failure case studies.

Learning Resources:

- Engineering Materials I by D. Jones, and M. Ashby, 5th Ed. 2019, BH
- A. J. McEvily, Metal Failures: Mechanisms, Analysis, Prevention. Wiley, 2002. D. J. Wulpi, Understanding How Components Fail, 2nd ed, ASM, 2000. C. Brooks and A. Choudhury, Failure Analysis of Engineering Materials, McGraw-Hill, 2002. ASM handbook, volume 11: failure analysis and prevention.
- Mechanics of Materials by Hibbeler (textbook of CE203)

Lecture Assessment Plan:

Assessment Task	Week Due	Weight
project#1	10	10.0%
project#2	15	15.0%
final exam	16	30.0%
HW and Quizzes	4, 6, 9, 12, 14	25.0%
Mid-term	8	20.0%

Lecture Weekly Schedule:

Week#	Topics
1	Overview of materials failures and prevention, cost of materials failure, and selected major historical failure cases e studies in modulus-limited design
2	Stiffness limited design and case studies
3	Stiffness limited design and case studies (Continue)
	Strength limited design and case studies
4	Strength limited design and case studies (Continue)
5	Brittle Fracture, toughness, fracture probability, and case studies
6	Brittle Fracture, toughness, fracture probability, and case studies (Continue)
7	Brittle Fracture, toughness, fracture probability, and case studies (Continue)
8	Fatigue failures, HCF and the use of S-N curves, LCF data, FCP, case studies
9	Fatigue failures, HCF and the use of S-N curves, LCF data, FCP, case studies (Continue)
10	Creep failures, creep resistant materials
11	Creep failures, creep resistant materials (Continue)
	Oxidation of materials
12	Oxidation of materials (Continue)
	Wet corrosion and case studies
13	Wet corrosion and case studies (Continue)

Week#	Topics
14	Wet corrosion and case studies (Continue)
	Friction and wear and case studies
15	Friction and wear and case studies (Continue)
	Term project presentations