FAILURE ANALYSIS AND DESIGN
(Professional Elective - II)

I Semester

Course Code: 19ME2156

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3	0	3

Course Outcomes: At the end of the course, the student will be able to
CO1: Analyze the role of failure models in design.
CO2: Demonstrate the analysis of the elastic-plastic fracture mechanics.
CO3: Determine solutions for the prediction of fatigue life of machine components.
CO4: Explain the significance of creep and low-cycle fatigue.
CO5: Explain the role and significance of different types of wear.

UNIT-I **(10-Lectures)**

Fracture mechanics: Introduction, role of failure prevention analysis in mechanical design, some design objectives, definition of failure mode, types of failure modes, glossary of mechanical failure modes.
Linear Elastic Fracture Mechanics (LEFM), three modes of failure, use of fracture mechanics in design, stress intensity factors, fracture toughness, elastic-plastic fracture mechanics, plastic zone correction factors, Dugdale approach, simple problems.
Learning outcomes:

1. Identify the role of failure prevention analysis in mechanical design. (L1)
2. Classify the different types of failure modes. (L4)
3. Explain the significance of Linear elastic fracture mechanics. (L2)

UNIT-II **(10-Lectures)**

Fatigue cracks and analysis: Introduction to fatigue, nature of fatigue, fatigue loading, fracture phases, fatigue cracks, initiation, propagation, fatigue life, Griffith's theory, concepts of surface energy, energy release rate, example of a Double Cantilever Beam (DCB), crack resistance and J-Integral, simple problems.

Learning outcomes:

1. Classify the different types of fracture phases. (L4)
2. Determine the fatigue life of mechanical components. (L3)
3. Explain the concept of J-Integral in fracture mechanics. (L2)

UNIT-III **(10-Lectures)**

Low-cycle fatigue: Introduction, strain cycling concept, strain life curve and low cycle fatigue relationships, influence of non-zero mean strain and non-zero mean stress, cumulative damage rule in low cycle fatigue.

Learning outcomes:

1. Apply the strain life curve for the prediction of fatigue life. (L3)
2. Outline the low cycle fatigue relationships to design. (L4)
3. Identify the importance of cumulative damage rule in low cycle fatigue. (L1)

UNIT-IV **(10-Lectures)**

Creep in materials: Introduction to creep, long-term behavior of materials, mechanism and causes of creep, influence of stress and temperature, phases of creep, creep strength, relaxation, mathematical modeling of creep behavior – Maxwell and Voigt-Kelvin models, simple problems.

Learning outcomes:

1. Explain the mechanism and causes of creep. (L2)
2. Analyze the Maxwell and Voigt-Kelvin models for the different materials of the creep. (L4)
3. Solve simple problems on the determination of the creep for various materials. (L3)

UNIT-V **(10-Lectures)**

Fretting, wear and corrosion: Introduction to fretting failure, variables of importance in the fretting process, fretting fatigue, fretting wear, fretting corrosion, prevention of fretting damage.
Introduction to wear - adhesive wear, abrasive wear, surface fatigue, deformation, wear coefficient
Corrosion, causes of corrosion, types of corrosion, corrosion wear, stress corrosion cracking, prevention of corrosion.
Learning outcomes:

1. Explain the variables of importance in the fretting process. (L2)
2. Classify the different types of wear. (L4)
3. Apply the importance of stress corrosion cracking to the different types of wear. (L3)

TEXT BOOKS:

1. Jack A.Collins, *Failure of Materials in Mechanical Design*, 2nd Edition, Wiley Inter science Publishers, 2013.
2. Prashant Kumar, *Elements of Fracture Mechanics*, Wheeler Publishing, 1999.

REFERENCE BOOKS:

1. David Broek, Fifthoff and Noerdhoff, *Elementary Engineering Fracture Mechanics*, 4th Edition, Springer Publishers, 2013.
2. Ewalds, H.L. and Wanhill, R.J.H., *Fracture Mechanics*, Edward Arnold Edition, 1999.
3. Surjya Kumar Maiti, *Fracture Mechanics - Fundamental and Applications*, Cambridge University Press, Delhi 2015.
4. Gope, P.C., *Machine Design – Fundamentals and Applications,* PHI Learning Private Limited, New Delhi, 2012.