17MD005CREEP, FATIGUE AND FRACTURE MECHANICS

COURSE CODE	COURSE TITLE	L	P	T	C
17MD005	CREEP, FATIGUE AND FRACTURE MECHANICS				

Course Description and Objectives:
The course helps us understanding the most common failure modes. Understanding the modes of failure is the most fundamental necessity of designing machine elements.

- Whenever we are dealing with cyclic loading at elevated temperatures, the failure occurs much less than the static strength. Such failure mode is known as creep. It will be elaborately discussed in this subject.
- Small crack tends to propagate whenever they are subjected to cyclic loading. For understanding these phenomena we need to understand the concepts of fracture mechanics. This course aims to provide basic insights in such areas.

Course Outcomes:
Upon successful completion of this course student should be able to:

- Understand the effect of stress concentrators and flaws in cyclic loading.
- have clear insight on linear elastic fracture mechanics, Elastic- Plastic fracture mechanics.
- predict the fatigue life under given conditions
- Gain insights on fatigue of welded structures
- Design machine elements considering the effect of creep, fatigue and fracture.

SKILLS ACQUIRED:

- Calculation of energy release rate
- Calculation of stress intensity factor
- Calculation of effective crack length
- Prediction of effect of overload
- Prediction of the effect of stress on creep curves

UNIT – I

Theoretical cohesive strength of metals – Ductile brittle transition of metals - Ductile fracture - Brittle fracture.

Modes of fracture failure - Early concepts of stress concentrators and flaws. Inglis solution to stress round an elliptical hole - Surface energy – Griffiths analysis - Energy release rate - Crack resistance - Stable and Unstable crack growth - R-Curve.

Stress intensity factor for a crack. Stresses and displacement in Cartesian and polar coordinates. Critical stress intensity factor - K_{1C} testing.

UNIT – II

Linear Elastic fracture mechanics - Elastic plastic fracture mechanics - Plastic zone shape for plane stress and plane strain – Effective crack length – Irwin plastic zone correction – Dugdole approach - Effect of plate thickness.

Elastic plastic analysis through J – Integral - Path Independence – J_{1C} testing. Crack tip opening displacement

UNIT – III

FATIGUE : Importance of Fatigue in engineering applications – Low cycle fatigue – Coffin Mansonrelation – Strain life equation – Structural features of fatigue – Fatigue crack propagation – High cycle fatigue – Basquin's law. Cumulative fatigue damage.

Effect of Metallurgical variables on fatigue – Design for fatigue –Corrosion fatigue – Effect of temperature on fatigue.

UNIT – IV

Crack growth and application of fracture mechanics to fatigue. Paris erdogan law – Effect of an overload – Crack closure – Variable ampliture fatigue load.

Cycle counting methods – Reservoir Method – Rainflow Method.

Fatigue of welded structures – Factors affecting the fatigue lives of welded joints.

UNIT – V

CREEP: Time dependent mechanical behaviour – Creep curve – Effect of stress on creep curves –Stress rupture test – Structural changes during creep – Creep under combined stresses – Creep fatigue interaction.

TEXT BOOKS:

1. Prashant kumar, "Elements of Fracture Mechanics", 2nd Edition, Tata Mc Graw Hill, 2009.
2. George E.Dieter, "Mechanical Metallurgy", 3rd Edition, Mc Graw Hill Publication, 2007.

REFERENCE BOOKS:

1. Anderson T.L, "Fracture Mechanics: Fundamentals and Applications", 2nd Edition, Taylor & Francis Publications, 2005.
2. Broek.D- Martinus, "Elementary Engineering Fracture Mechanics", 1st Edition, Nijhoff publishers, 1982.V.M. Radha Krishnan, "Welding Technology & Design", 2nd Edition, New Age International Publications, 2006