MECHANICAL BEHAVIOR AND DAMAGE MECHANICS

Module I (12hours)

Mechanical behaviour of engineering materials:

Elastic Behaviour: Mechanisms, Generalised Hooke's law (Stress and Strain relations)

Plastic Behaviour: Mechanisms, Yielding, Flow rule, Consistency condition, Hardening laws

Rate dependent material behaviour: Anelastic and Visco-elastic behaviour, Visco-plasticity

Module II (12hours)

Elements of Fracture Mechanics

Fractures: Types and their characteristics. Nucleation of cracks and their growth, Variables influencing the fracture,

Linear Elastic Fracture Mechanics: Brittle fracture theories (Cleavage fracture, Stress intensity factor K, Application of K to Design & Analysis, Energy principles and criteria for crack growth, Strain Energy Release Rate, G, Trends in K_{IC} with material, Effects of Temperature and loading rate, Micro-structural Influences on $K_{IC,}$ Plane strain and plane stress fracture toughness), Methods to improve fracture strength, Cracks as Stress Raisers, Effects of Cracks on Strength, Effects of Cracks on Brittle versus Ductile Behaviour.

Elastic-Plastic Fracture Mechanics: crack tip plastic zones, Plastic zone size and Plasticity limitation on LEFM for FCG, The J integral - Extension of Fracture Mechanics beyond linear Elasticity CTOD, Crack opening displacement criteria,

Module III (12hours)

Damage in cyclic loading (Fatigue) and rate dependent loading (Creep):

Fatigue: Sources of cyclic loading, defining cyclic loading, Variable Amplitude Loading, The Palmgren - Miner Rule, Cycle Counting For irregular Histories, S-N Curves, Life Estimates, Mechanisms of Fracture and crack growth, Fatigue Crack Growth, Trends in FCG behaviour, Effect of R and stress Range, Design Considerations, Elastic crack tip stress field,

Fatigue crack propagation under constant and variable amplitude loading, Crack closure, Effective stress intensity range, Concept of safe life, Fail safe and damage tolerance, Linear damage accumulation theory, Strain Based Approach, Strain versus life curves, Physical nature of Fatigue Damage Failure modes

Creep: Mechanisms, creep laws, Analysis and Applications in Design; Stress relaxation

Text and Reference Books:

1. Mechanical Behaviour of Material, Englewood Cliffs, Prentice Hall, New Jersey, 1993

2. Fracture Mechanics by Prashant Kumar

3. Mechanical Behaviour of Materials, Keith Bowman

4. Mechanical Behaviour of Material, Norman E. Dowling, Prentice Hall.

5. Mechanical Behaviour of Material, Courtney Browne, McGraw Hill, 1990

6. Mechanical Behaviour of Material, F. McClintock, A.S. Argon, Reading Mass, Addison-Wesley Pub Co, 1966

7. Introduction to Fracture Mechanics - Kare Hellan, McGraw

8. Engineering Fracture Mechanics by David Broek, Martinues Nijhoff Publishers Ltd.

9. Introduction to Fracture Mechanics David Brookes ,

10. Binges D.Jastrzebski, "The Nature and Properties of Engineering Materials, 3rd ed. John Wiley & Sons".

11. A. H. Cottrell, "Dislocation and Plastic Materials".

12. J. P. Hirth and J. Lothe, "Theory of Dislocations, McGraw Hill".

13. Mechanical Metallurgy, Goerge E. Dieter, McGraw Hill

14. Materials Science and Engineering, William D. Callister, David G. Rethwisch