I YEAR M. TECH (MACHINE DESIGN) FIRST SEMESTER

17MEMD1T6B MECHANICS OF COMPOSITE MATERIALS Credits 4

Lecture: 4 periods/week **Internal assessment: 40 marks**

Tutorial: - - **Semester end examination: 60 marks**

COURSE OBJECTIVE:

- Familiarization with the basic expressions and methods used in the mechanics of composite structures.
- To identify the behavior of fiber and matrix materials used in composites, as well as some common manufacturing techniques
- To predict the elastic behavior of composites with micromechanics and macro mechanics approaches
- To understand the failure behavior of the composite materials to evaluate their life

COURSE OUTCOMES:

After completion of the course, student should be able to

1. Understanding of types, manufacturing processes, and applications of composite Materials
2. Analyze problems on macro mechanical behavior of lamina
3. Analyze problems on micromechanical behavior of lamina
4. Analyze problems on macro mechanical behavior of laminate
5. Apply failure criteria and critically evaluate their behavior

UNIT-I

BASIC CONCEPTS AND CHARACTERISTICS:

Geometric and Physical definitions, natural and man-made composites, applications, types and classification of composites. Reinforcements: Fibers – Glass, Silica, Kevlar, carbon, boron, silicon carbide, and born carbide fibers. Particulate composites, Thermoplastics, Thermosetts, Metal matrix and ceramic matrix composites. Manufacturing Methods for Composite Materials, Autoclave Molding, Filament Winding, Resin Transfer Molding.

UNIT-II

ELASTIC BEHAVIOR OF UNIDIRECTIONAL LAMINA:

Stress-Strain Relations-General Anisotropic Material, Specially Orthotropic Material, Transversely Isotropic Material, Orthotropic Material Under Plane Stress, Isotropic Material, Relations Between Mathematical and Engineering Constants, Stress-Strain Relations for a Thin Lamina (Two-Dimensional), Transformation of Stress and Strain (Two-Dimensional), Transformation of Elastic Parameters (Two-Dimensional), Transformation of Stress-Strain

Relations in Terms of Engineering Constants (Two-Dimensional), Transformation Relations for Engineering Constants (Two-Dimensional), Micromechanical predictions of elastic constants

STRENGTH OF UNIDIRCETIONAL LAMINA

Longitudinal Tension-Failure Mechanisms and Strength, Longitudinal Compression, Transverse Tension, Transverse Compression, In-Plane Shear, Out-of-Plane Loading, General Micromechanics Approach. Macro-mechanical strength parameters, macro-mechanical failure theories, maximum stress theory, maximum strain theory, Tsai- hill, Tsai-Wu theory.

UNIT-III

ELASTIC BEHAVIOR OF MULTIDIRECTIONAL LAMINATES:

Laminates, Basic assumptions, Strain-Displacement Relations, Stress-Strain Relations of a Layer Within a Laminate, Force and Moment Resultants, General Load-Deformation Relations: Laminate Stiffness, Inversion of Load-Deformation Relations: Laminate Compliances. Symmetric Laminates: Symmetric Laminates with Isotropic Layers, Symmetric Laminates with Specially Orthotropic Layers (Symmetric Cross-ply Symmetric Angle-Ply Laminates Anti symmetric Laminates, Anti symmetric Cross-ply Laminates, Anti symmetric Angle-Ply Laminates, Balanced Laminates,

UNIT-IV

FAILURES AND LIFE PREDICTIONS:

Possible modes of failure, stress analysis of first ply failure, ultimate laminate failure or analysis of last ply failure: Total- ply failure method and partial-ply failure method, inter laminar stress.

FAILURE MODES: Matrix cracking, Delamination, Tensile fiber failure, Micro buckling, global instability, Common Features of Life Prediction Methodology, Damage Characterization.

Learning Resources

Text Books:

1. Engineering Mechanics of Composite Materials by Isaac and M Daniel, Oxford University Press, 1994.
2. Mechanics of Composite Materials by R. M. Jones, Mc Graw Hill , New York, 1975.
3. Mechanics of composite materials by Madhujit Mukhopadhyay, Universities press.

References:

1. Analysis and performance of fibre Composites by B. D. Agarwal and L. J. Broutman, Wiley Inter-science, New York, 1980.
2. Mechanics of Composite Materials (2nd Edition) by Autar K. Kaw, Publisher: CRC Taylor and Francis.