NPTEL: COMPOSITE MATERIALS
[Web-based Course]

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12 MODULES: 48-HOURS with Lecture Plan (Tentative)

Module 1: General Introduction: 4 hours

M1: General Introduction

M1.1. Introduction to Composites (1 hour)

General Introduction and Concept, Historical development, Concept of Composite materials, Material properties that can be improved by forming a composite material& its engineering potential

M1.2. Basic Definitions and Classification of Composites (2 hours)

Basic definitions, Various types of composites, Classification based on Matrix Material: Organic Matrix composites Polymer matrix composites (PMC), Carbon matrix Composites or Carbon-Carbon Composites, Metal matrix composites (MMC), Ceramic matrix composites (CMC); Classification based on reinforcements: Fiber Reinforced Composites, Fiber Reinforced Polymer (FRP) Composites, Laminar Composites, Particulate Composites

1.3 Advanta2es of Composites materials (1 hour)

Comparison with Metals, Advantages & limitations of Composites

Module2 : Basic constituents materials in Composites : 4 hours

2.1 Types of Reinforcements/Fibers (1 hour)

Role and Selection or reinforcement materials, Types of fibres, Glass fibers, Carbon fibers, Aramid fibers , Metal fibers, Alumina fibers, Boron Fibers, Silicon carbide fibers, Quartz and Silica fibers, Multiphase fibers, Whiskers, Flakes etc., Mechanical properties of fibres.

2.2. Matrix Materials (1 hour)

Functions of a Matrix, Desired Properties of a Matrix, Polymer Matrix (Thermosets and Thermoplastics), Metal matrix, Ceramic matrix, Carbon Matrix, Glass Matrix etc

2.3. Fibers Reinforcement composite Materials (1 hour)

Fibre reinforced Polymer (FRP) Laminated composites Lamina & Laminate Lay-up. Ph-orientation definition

Module 3: Behaviour of a Laminate-I: (3 hours)

3.1. Isotropic Elasticity& Plane stress concept in 3-D (1 hour)

Linear Elastic Stress-Strain Characteristics of FRP Composites, Stress and Strain components in 3-D, Generalized Hooke's Law in 3-D, Stress-Strain relations in 3-D for Isotropic case.

3.2 Anisotropic/Orthotropic Elasticity (1 hour)

Stress-Strain relations for isotropic and orthotropic cases

3.3 Torsional & Matrix Notations (1 hour)

Concept of Cartesian tensor, indicial notation and Torsional representations in Elasticity, Voigt's notations

Module 4: Behaviour of a Laminate-II: (4 hours)

4.1. Mechanics of load-transfer in Laminate (2 hours)

4.1.1 Mechanics of load-transfer in a Laminate

4.1.2 Prediction of Engineering Property in a Laminate

4.2. Laminate/Ply Stress-strain relations (2 hours)

Lamina Stress-Strain a relation in material coordinates, Transformation relations, Lamina Stress-Strain relations in Structure Global coordinates

Module 5: Laminated Composites-I (4 hours)

5.1. Mechanics of Plates/Kirchhoff's Plate Theory (l hour)

5.2. Concept of Laminate (1 hour)

Laminate Strain-Displacement relationship based on Kirchhoff's Hypothesis

5.3. Mechanical Behaviour of unidirectional, cross-ply and angle-ply (1 hour)

5.4. Structural Mechanics of Laminates

Module 6: Laminated Composites-II (4 hours)

6.1 Structural Mechanics of Laminates (2 hours)

Laminate Stiffness and ABD-Matrices

6.2. Special Classification of Laminates (2 hours)

Symmetric .Anti-symmetric and Non-symmetric laminates

Module 7: Strength and Failure concepts (4 hours)

7.1. Strength of Laminates (1 hour)

7.2. Failure Mechanics of Composites (1 hour)

7.3. Macro-mechanical Failure Theories (1 hour)

Maximum Stress Theory, Maximum Strain Theory, Tsai-Hill theory, Tsai-Wu Theory

7.4. Comparison of Failure Theories (1 hour)

Module 8: Design Concepts:(4 hours)

8.1. Design issues
8.2. Typical Structural Component design process
8.3. Laminate Analysis/Design software
8.4. Composite Codes & Standards

Module 9 :Manufacturing Processes (4 hours)

9.1. Processing of Composite Materials (1 hour)

Overall considerations, Autoclave curing, Other Manufacturing Processes
Fiber-only performs, Combined Fiber-Matrix performs.

9.2 Manufacturing Techniques (1 hour)

Tooling and Specialty materials, Release agents, Peel plies, release films and fabrics, Bleeder and breather plies, bagging films

Module 10: Special Topics : (4 hours)

10.1 Testing of Composites (ENGN4511)

Mechanical testing of composites, tensile testing, Compressive testing, Intra-laminar shear testing, Inter-laminar shear testing, Fracture testing etc

10.2 Environmental Effects on composites
10.3 Micromechanics of Laminae

Module.11 : Engineering Applications (2 hours)

11.1 General Engineering Applications of FRP composites

Applications related to aerospace, Automobile, Bridge and other Civil Engineering Structures, Case studies.

Module 12 :Civil Engineering Applications (3 hours)

12.1 Typical Applications of FRP Composites in Civil Engineering

Adhesively Bonded FRP composites in strengthening of civil engineering structural components such as beams, Columns, Masonry etc