COMPOSITE MATERIAL

ENAS 203

Lecture : 2 **Year : II**
Tutorial : 1 **Part : I**
Practical : 0

Course Objectives:
The objective of this course is to provide basic understanding on the benefits of diverse composites to a variety of reinforcements and matrix materials as well as mechanisms behind reinforcement and failure in composites along with appropriate tools, manufacturing techniques and testing methods.

1 Introduction (4 hours)

1.1 Fundamentals of composite materials: Definition, composite materials, and its applications, classification based on matrix and structure, properties, advantages, and applications of composite materials
1.2 Reinforcement: Whisker, glass fiber, carbon fiber, ceramic fiber, aramid and boron fiber

2 Metal Matrix Composite (4 hours)

2.1 Metallic materials: Superalloys, titanium alloys, intermetallic and metal matrix composites, functionally graded materials
2.2 Types of metal matrix composite (MMC): Particle-reinforced MMCs, short fiber or whisker-reinforced MMCs, Continuous fiber or sheet-reinforced MMCs
2.3 Processing of MMCs: Liquid state methods, solid state methods, semi-solid-state methods, in situ methods, deposition methods, their types and applications

3 Ceramics Matrix Composite (7 hours)

3.1 Fundamentals of ceramics matrix composite: Matrix, reinforcements and their types
3.2 Ceramic materials: Polymer-derived ceramics, thermal barrier coatings, silica tiles, ceramic aerogels, porous ceramics and ceramic foams, ultrahigh temperature ceramics, glass ceramics
3.3 Types of ceramics matrix composite (CMC): Carbon-carbon composite, carbon-silicon carbide composites, silicon carbide-silicon carbide composites, oxide–oxide composites, silicon carbide/ aluminum oxide composites

3.4 Processing of CMCs: Sintering, hot pressing, melt infiltration process, matrix deposition or infiltration from the gas phase, in-situ chemical reaction techniques, sol-gel method, polymer pyrolysis method, cold isostatic processing, hot isostatic processing

3.5 Rule of mixture: Volume fraction, weight fraction, determination of longitudinal and transverse modulus of composite, influence of fiber length, critical length, strength calculation of composite materials

4 Polymer Matrix Composite (5 hours)

4.1 Types of polymer matrix composite: Thermosets, thermoplastics and rubber

4.2 Reinforcements used in PMCs: Glass, carbon, aramids, boron, Roving's, yarns, fabrics

4.3 Thermoset matrices for aerospace components- polyesters, epoxies, phenolics, vinyl esters, cyanate esters

5 Specialty Materials (5 hours)

5.1 Materials for the space environment: Radiation shielding materials, atomic oxygen-resistant materials, space suit materials, and materials for life support systems

5.2 Composites for satellites and advanced launch vehicles

6 Nanocomposite (5 hours)

6.1 Nanomaterials: Introduction to nanomaterials, size and shape-dependent properties and their uniqueness; energy at the nanoscale: surface characteristics and electrostatic stabilization, quantum confinement: zero-dimensional, one-dimensional and two-dimensional nanostructures

6.2 Nanocomposites types: Core-shell structured nanocomposites, super hard nanocomposites and improvements in mechanical properties, self-cleaning nanocomposites, metal matrix nanocomposites (Metal with nanoceramic fillers such as TiO2, SiC, ZrO2 PTFE, CNTs and graphene) and their properties and functional applications

6.3 Applications of nanocomposite in the aerospace industry

Tutorial (15 hours)

1. Influence of length and diameter of reinforcement fiber in composite materials
2. Metal composite on Aeronautics and Automotive
3. Ceramics composite in the aviation sector
4. Polymer composite in the aviation sector
5. Composite materials characterization techniques
6. Numerical problems on the rule of mixtures

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapter	Hours	Marks distribution*
1	4	6
2	4	8
3	7	16
4	5	10
5	5	10
6	5	10
Total	**30**	**60**

* There may be minor deviation in marks distribution.

References

1. Jones, R.M. (1999). Mechanics of Composites (2nd edition). Taylor & Francis.
2. Gutowski, T.G. (Ed.) (1997). Advanced Composites Manufacturing. New York: John Wiley & Sons.
3. Savage, G. (1993). Carbon-Carbon Composites (1st edition). Chapman and Hall.