

# GUJARAT TECHNOLOGICAL UNIVERSITY

## METALLURGY ENGINEERING (21)

### COMPOSITE MATERIALS

SUBJECT CODE:2182116

B.E. 8<sup>th</sup> SEMESTER

**Type of course:** Science & Engineering

**Prerequisite:** Knowledge of Engineering Materials.

#### Rationale:

The course on Composite Materials has become very essential for a Metallurgical / Materials engineer to meet the demand of the today's world applications, where advances in Technological needs demands High strength, corrosion resistance, fatigue / creep resistant & stiff structure with very lesser densities such as in making of automobiles, aircrafts, space crafts, Sports items etc. This course covers various classes of composite materials, their constituents' phases, manufacturing techniques, characteristics and tastings of the composites and relevant applications in various fields.

This course also covers the state of the art fabrication techniques of composite materials and brief introduction to Hybrid composites, green composites & Nano-composites which are currents under trends of research. The aim of this course is to make students conversant with the latest technological materials in demand & their scope of applications.

#### Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P		Theory Marks			Practical Marks			
			ESE (E)	PA (M)		ESE (V)		PA (I)		
				PA	ALA	ESE	OEP			
4	2	0	6	70	20	10	30	0	20	150

#### Content:

Sr. No.	Content	Total Hrs	% Weightage
1	<b>Introduction to Composites:</b> Matrices, Reinforcements, Classifications, Applications, Comparison with Metals and Importance over other materials, design fabrication and economic consideration, General requirements.	6	10
2	Classification of composites on the basis of reinforcement and matrix, Classification of Reinforcement, Form and functions of reinforcement, Functions of matrices. Dispersion strengthened, particle strengthened and fiber-reinforced composites. Fibres and resin materials.	08	14
3	Strengthening mechanisms, Aspect Ratio, Rule of Mixture, discontinuous and continuous fiber composites and their comparison, Characteristics and materials of reinforcements and matrices. Critical Fiber Length, Short and Continuous Fibers, Fiber Orientation.	08	14
4	Major composite classes: polymer matrix, metal matrix, ceramic matrix, carbon-carbon, and intermetallic composites. Hybrid composites, Laminated composites. Examples of each class of composites.	08	13

	Particulates, Flakes, Whiskers, Fibers.		
5	Role of interfaces in composites, Interfacial Bonding Mechanisms. Pull-out & Push-out Testing. Control of Bond Strength. Toughening mechanisms in PMCs, MMCs, and CMCs.	06	10
6	Fabrication of PMC's :- Fabrication of Fibers, Plastic Fiber Forms, Prepregs, Molding Compounds-Processes, Lay-Ups, Filament Winding, Pultrusion, and Recycling. ; Matrix –Reinforcement Interface, Wettability.	08	13
7	Fabrication of CMC's: Hot-Pressing, Infiltration, In Situ Chemical reaction Techniques. CVD & CVI, Sol-gel. Fabrication of MMC'S : Liquid Infiltration- Casting, Solid State Processes-Diffusion Bonding & In Situ Technique.	08	13
8	Applications of advanced composite materials. Environmental effects in Composites, Green composites, Synthesis and Properties of Nanocomposites. Surface Composites & Surface metal matrix composites: Need, Synthesis, Properties and applications,	08	13
	Total	60	100

**Suggested Specification table with Marks (Theory):**

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	30	35	10	10	05

**Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)**

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

**Reference Books:**

1. K.K. Chawla, Composite Materials – Science & Engg., Springer- Veslag, New York, 1988.
2. Mel M. Schwartz, Composite Materials: Properties, Non-destructive testing and Repair, Prentice Hall, New Jersey
3. L.J. Broutman and R.M. Krock, Modern Composite Materials, Addison-Wesley, 1967.
4. David A Colling & Thomas Vasilos, Industrial Materials: Polymers, Ceramics and Composites, vol. 2, Prentice Hall, N. Jersey, 1995

**Course Outcome:**

After learning the course the students should be able to:

- Understand the significance of advanced materials.
- Compare the set of technological properties of the advanced materials with the conventional materials.
- Distinguish the construction, constituent's phases & characteristics of the composite materials.
- Calculate the strength of the composite under transverse & longitudinal loading applications.
- Identify the strengthening mechanics adopted in a particular type of composite material.
- Explain the fabrication techniques of different types of composite materials.

- Explain the need of the research in the composite materials to fulfill the demand of the hi-tech applications.

**Design based Problems (DP)/Open Ended Problem:**

- Calculations to distinguish fiber length & classify as long fiber-short fiber or whiskers.
- Calculate the strength of composite materials under Longitudinal & transverse loading applications.
- Justify the materials of construction in advanced materials based on the properties requirements.
- Prepare a layout of Environmental friendly Green” composite materials” & suggest its suitable applications.

**List of Open Source Software/learning website:**

1. [nptel.ac.in/courses/101104010/](http://nptel.ac.in/courses/101104010/)
2. [www.doitpoms.com](http://www.doitpoms.com)
3. [composite.about.com](http://composite.about.com)
4. <https://compositesuk.co.uk/composite-materials>
5. [www.asminternational.org/documents/10192/1849770/05287G\\_Sample\\_Chapter.pdf](http://www.asminternational.org/documents/10192/1849770/05287G_Sample_Chapter.pdf)

**ACTIVE LEARNING ASSIGNMENTS:** Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should be submitted to GTU.