GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
Semester-VI

Course Title: Composite Material
(Course Code: 4362105)

Diploma Programme in which this course is offered	Semester in which offered
Metallurgy Engineering	6th Semester

1. RATIONALE

The significance of the Composite Material course has grown substantially for Metallurgical/Material engineers to align with the demands of contemporary applications, including the production of aircraft, automobiles, spacecraft, sports equipment, and more. This course encompasses an overview and diverse categories of composites, examining their constituent phases, manufacturing techniques, and applications across various industries. The primary objective of this course is to familiarize students with cutting-edge technologies and their practical applications in the realm of composites.

2. COMPETENCY

The course should be taught and curriculum should be implemented with the aim to develop required skills in students, so that they are able to acquire following competencies.

- **Recommend the appropriate type of composite material based on specific requirements.**

3. COURSE OUTCOMES (COs)

At the end of the study of this course the student will able to;

CO1: Select appropriate composite material based on reinforcing and matrix phases.

CO2: Acquire knowledge in the fabrication techniques of different types of composite materials.

CO3: Recommend advance composite material according to specific applications.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
2	0	0	2	30*	70	--	--	100

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

Legends: ***L****-Lecture;* ***T****–Tutorial/Teacher Guided Theory Practice;* ***P*** *-Practical;* ***C*** *– Credit;* ***CA*** *- Continuous Assessment;* ***ESE*** *-End Semester Examination*

5. AFFECTIVE DOMAIN OUTCOMES

1. Compare the set of technological properties of the advance materials with the conventional materials.
2. Identify the strengthening mechanism adopted in particular type of composite material.
3. Practice ecofriendly methods and processes.

6. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of Revised Bloom's taxonomy that are formulated for development of the COs and competency. If required, more such UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Major Learning Outcomes	Topics and sub-topics
Unit-I Introduction to Composite Materials	1.a. Define composites, matrices, and reinforcement. 1.b. Give importance of composites over other materials. 1.c. Classify different types of composites. 1.d. Write applications of composite materials. 1.e. Write advantages and limitations of composite materials.	1.1. Define Composite 1.2. Importance of composite materials. 1.3. Types of composites. 1.4. Applications of composites. 1.5. Advantages and limitations of composites.
Unit-II Theory of Composites	2.a. Give functions of matrices and reinforcement. 2.b. Write Characteristics and materials of reinforcement and matrices. 2.c. Classify various reinforcement. 2.d. Explain strengthening mechanism of composites. 2.e. Explain aspect ratio of composites. 2.f. Describe rule of mixture in composites. 2.g. Enlist fiber and resin materials. 2.h. Describe critical fiber length. 2.i. Explain fiber orientation. 2.j. Explain role of interface in composites.	2.1. Functions of matrices. 2.2. Form and functions of reinforcement. 2.3. Characteristics and materials of reinforcement and matrices. 2.4. Classification of reinforcement. 2.5. Strengthening mechanism of composites. 2.6. Aspect ratio of composites. 2.7. Rule of mixture in composites. 2.8. Fiber and resin materials. 2.9. Critical fiber length. 2.10. Fiber orientation. 2.11. Role of interfaces.

Unit-III Classes of Composites	3.a Explain fabrication processes of below composites with their applications and limitations. • Polymer matrix(PMC) • Metal matrix(MMC) • Ceramic matrix(CMC) • Carbon-Carbon • Intermetallic • Laminated composites • Particulates and Flakes	3.1. Major classes of composites: I. Polymer matrix(PMC) II. Metal matrix(MMC) III. Ceramic matrix(CMC) IV. Carbon-Carbon V. Intermetallic VI. Laminated composites VII. Particulates and Flakes
Unit-IV Advance Composites	4.a. Write applications of advance composites. 4.b. Explain below composites with suitable example. • Hybrid composites • Sandwich composites • Green composites • Nanocomposites	4.1. Applications of advance composites. 4.2. Hybrid composites 4.3. Sandwich composites. 4.4. Green composites. 4.5. Nanocomposites.

7. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of theory marks			
			R Level	U Level	A Level	Total Marks
I	Introduction to Composite Materials	04	03	04	03	10
II	Theory of Composites	08	07	10	03	20
III	Classes of Composites	10	08	14	08	30
IV	Advance Composites	06	03	03	04	10
	Total	**28**	**21**	**31**	**18**	**70**

Legends: *R = Remember; U = Understand; A = Apply and above levels (Bloom's revised taxonomy)*

Notes:

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

b) Ask the questions from each topic as per marks weightage. Numerical questions are to be asked only if it is specified. Optional questions must be asked from the same topic.

8. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related co-curricular activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group.

1. Hands-on Composite Fabrication:
    - Organize a workshop where students can work with basic composite materials like fiberglass and epoxy resin.
    - Have them create small composite parts or simple structures, such as a composite panel or a cylindrical structure.
2. Case Studies:
    - Assign case studies on real-world applications of composite materials in industries such as aerospace, automotive, or sports equipment.
    - Students can analyze the success and challenges faced in these applications.
3. Guest Speakers:
    - Invite professionals working in the composite materials industry to give guest lectures or conduct workshops.
    - This provides students with real-world insights and networking opportunities.

9. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

Sr. No.	Unit Title	Strategies
I	Introduction to Composite Materials	1. Case study of various Composite fabrication Units. 2. Use of ICT tools in classroom teaching. 3. Expert lecturer/ Seminar on recent trends. 4. Workshop on Industrial automation.
II	Theory of Composites	
III	Classes of Composites	
IV	Advance Composites	

10. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project is group-based. However, in the fifth and sixth semesters, it should be preferably be individually undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should not exceed three.

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student

will have to maintain a dated work diary consisting of individual contributions in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than 16 (sixteen) student engagement hours during the course. The student ought to submit a micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

1. Prepare chart for different types of composites.
2. Review and report on manufacturing of metal matrix composite.
3. Review and report on manufacturing of Polymer matrix composite.
4. Make a demonstrative chart showing comparison between Composite material and standard material.
5. Prepare a presentation based on a case study of Nanocomposites.
6. Review and report on manufacturing of Ceramic matrix composite.
7. Prepare a presentation on characteristics of composite materials.

11. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author / Editor	Publication with place, year and ISBN
1	Composite Materials; science and engineering	Krishan K. Chawla	Springer Science & Business Media, 2012. (ISBN:978-1-4939-5015-7)
2	Composite Materials; Design and applications	Daniel Gay, Suong V. Hoa, Stephen W. Tsai	CRC Press, 2003. (ISBN:1-58716-084-6)
3	Composite materials; testing, design, and acceptance criteria	Zureick, Abdul-Hamid, and Alan T. Nettles	Vol. 1416. ASTM International, 2002. (ISBN:0-8031-2893-2)

12. SOFTWARE/LEARNING WEBSITES

Search engine could be used to locate steel manufacturing related sites, such as

i. https://nptel.ac.in/courses/112104168
ii. https://en.wikipedia.org/wiki/Composite_material
iii. https://www.britannica.com/technology/composite-material
iv. https://www.intechopen.com/chapters/71222

13. PO-COMPETENCY-CO MAPPING

Semester VI	Composite Material [Course Code: 4362105]						
	POs						
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design / development of solutions	PO 4 Engineering tools, Experimentation & Testing	PO 5Engineering practices for society, Sustainability & environment	PO 6 Project Management	PO 7 Life-long learning
Competency	Recommend the appropriate type of composite material based on specific requirements.						
Course Outcomes: CO1: Select appropriate composite material based on reinforcing and matrix phases.	3	-	-	2	-	2	3
CO2: Acquire knowledge in the fabrication techniques of different types of composite materials.	3	-	3	2	-	3	2
CO3: Recommend advance composite material according to specific applications.	3	-	-	-	-	3	3

*Legend: '**3**' for high, '**2**' for medium, '**1**' for low or '**-**' for the relevant correlation of each competency, CO, with PO/ PSO*

14. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons:

Sr. No.	Name and Designation	Institute	Email
1	Mr. Ehjajehmad Usmanbhai Ghanchi, Lecturer Metallurgy	Government Polytechnic, Bhuj	azazghanchi92@gmail.com
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