GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

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

Course Title: **Introduction to Engineering Materials**
(Course Code: 4312101)

Diploma Programme in which this course is offered	Semester in which offered
Metallurgy Engineering	First

1. RATIONALE

This course has been intended to introduce the students about the characteristics of various types of engineering materials available and used for various applications. There have been many changes in man's choice of materials for his engineering activities. The use of material discovered by the human being on the earth is identified as the development process through which of human development has gone through like the Stone Age, the Iron Age and the current Silicon age, etc. The challenges of current worlds needs are constantly fuelling the need of discovery and development of new kinds of materials with the desired properties and the relevant cost to meet the challenges. Newer and more advanced materials are developed to suit the service requirements. This course aims at developing knowledge about various properties of the material and selecting the relevant material as per the requirement.

2. COMPETENCY

The purpose of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Use engineering materials for various engineering applications.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

a) Apply criteria to select materials for given engineering applications.
b) Select relevant Ferrous and Non- Ferrous Metals & Alloys for a given engineering applications.
c) Select relevant Ceramics, Polymers and Composite materials for given engineering applications.
d) Identify suitable advanced materials for different 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	
3	1	0	4	30*	70	00	00	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. SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) are the sub-components of the COs. *Some of the **PrOs** marked **'*'** are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'.*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
-NOT APPLICABLE-			

Note

i. *More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list of practical.*

ii. *The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency.*

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
-NOT APPLICABLE-		

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

These major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to usher in uniformity of practical's in all institutions across the state.

S. No.	Equipment Name with Broad Specifications	PrO. No.
-NOT APPLICABLE-		

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above mentioned COs and PrOs. More could be added to fulfill the development of this course competency.

a) Work as a leader/a team member.
b) Follow ethical practices.

The ADOs are best developed through the laboratory/field based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. 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	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit – I **Introduction to Engineering Materials**	1a. Describe importance of Engineering Materials 1b. Explain the properties of engineering materials 1c. Differentiate between various properties of engineering material	1.1 Introduction to Engineering Materials 1.2 Engineering requirements of different materials 1.3 Classification of Engineering Materials 1.4 Properties of Engineering materials: Mechanical Properties, Optical Properties, Physical Properties and Electrical Properties 1.5 Criteria for selection of materials for engineering applications.
Unit – II **Ferrous and Non- Ferrous Metals & Alloys**	2a. Enlist various ferrous and non-ferrous metals 2b. Describe the difference between various ferrous metals and alloys 2c. Describe non-ferrous metals and their alloys	2.1 Ferrous Metals & Alloys: Introduction, Classification, properties, composition and applications of Pig Iron, Cast Irons, Carbon Steel and Alloy Steels (S.S., Tool steel). 2.2 Non Ferrous Metals & Alloys Introduction, Classification properties and applications of Cu alloys and Al-alloys

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit– III **Ceramics, Polymers & Composite Materials**	3a. Explain the classification properties and applications of engineering ceramic materials. 3b. Describe the different forms of polymers along with their applications. 3c. Differentiate between different types of composite materials.	3.1 Ceramic Materials: 3.1.1 Engineering Ceramics-Introduction and Classification of Ceramic Materials 3.1.2 Properties and Applications of Ceramics 3.2 Polymer Materials: 3.2.1 Introduction, Classification and forms of polymers. 3.2.2 Thermosetting and thermoplastic polymers 3.2.3 Applications of polymeric materials. 3.3 Composite Materials: 3.3.1 Introduction and classification of Composite Materials 3.3.2 Fiber and Matrix Phases in Composite Materials 3.3.3 Polymer-Matrix Composites, Metal-Matrix Composites, Ceramic-Matrix Composites 3.3.4 Applications of Composite Materials
Unit– IV **Advanced Materials**	4a. Describe the functions and working of advanced materials 4b. Explain the applications of advanced materials	4.1 Advanced Materials (Definition, Introduction and Applications): 4.1.1 Shape Memory alloys, Piezoelectric Material and Self healing material 4.1.2 Nano-Materials and Bio Materials 4.1.3 High temperature superconductors 4.1.4 Cryogenic Materials and Optical Fiber.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction to Engineering Materials	08	02	04	04	10
II	Ferrous and Non- Ferrous Metals & Alloys	08	04	05	06	15
III	Ceramics, Polymers & Composite Materials	14	06	10	09	25
IV	Advanced Materials	12	06	07	07	20
Total		**42**	**18**	**26**	**26**	**70**

Legends: R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)

Note*: This specification table provides general guidelines to assist students for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions to assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may slightly vary from above table.*

10. 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 perform following activities in group and prepare reports of about 5 pages for each activity. They should also collect/record physical evidences for their (student's) portfolio which may be useful for their placement interviews:

a) Prepare a PowerPoint on different types of material and its application.
b) Make a chart of classification of engineering materials/stress-strain diagram.
c) Prepare banners of applications of advanced engineering materials
d) Give seminar on the topic given by the teacher.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) Guide student(s) in undertaking micro-projects.
c) ***'L' in section No. 4*** means different types of teaching methods that are to be employed by teachers to develop the outcomes.
d) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessed using different assessment methods.
e) With respect to ***section No.10***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
f) Guide students on how to address issues on environment and sustainability

12. 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-projects are group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, 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 dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The duration of the microproject should be about **14-16** ***(fourteen to sixteen) student engagement hours*** during the course. The students ought to submit 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:

a) Collect the sample of different types of metals and material used in our daily life and prepare the report on the basis of its material, properties , function and use etc.
b) Visit to any manufacturing industry and prepare a report on the basis of different types of material used to prepare the product, different types of product, functions , properties , and justification for using the that material etc.
c) Gather different types of engineering materials from industries and research centers and prepare a report based on the criteria given by the teacher.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Material Science and Metallurgy	O.P Khanna	Dhanpat Rai, New Delhi, 2nd Edition, 2014 ISBN: 9789383182459, 9383182458
2	Engineering Materials and Metallurgy	Er. R. K Rajput	S. Chand New Delhi, 2006 ISBN: 9788121927093
3	Materials Science and Engineering: An Introduction	William D. Callister Jr., David G. Rethwisch	Wiley, United States of America, 10th Edition, June-2018 ISBN: 978-1-119-40549-8
4	Introduction to Materials Science for Engineers	James F. Shackelford	Pearson Education London UK, Edition 2020 ISBN:9789353941390, 9789353941390
5	Material Science and Metallurgy	Dr. G.H. Upadhyay Dr. Bharati R Rehani Prof. A. H. Dafda	Atul Prakashan Ahmedabad, January 2020 edition ISBN: 978-93-81518-38-0

14. SOFTWARE/LEARNING WEBSITES

- https://www.coursera.org/lecture/material-behavior/1-6-composites-R1boo
- https://www.open.edu/openlearn/science-maths-technology/science/chemistry/introduction-polymers/content-section-0?active-tab=description-tab
- https://www.sciencelearn.org.nz/resources/1769-what-are-ceramics
- https://www.classcentral.com/course/swayam-advanced-materials-and-processes-13888
- https://ocw.mit.edu/courses/materials-science-and-engineering

15. PO-COMPETENCY-CO MAPPING

Semester I	**Introduction to Engineering Materials (Course Code: 4312101)**						
	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 5 Engineering practices for society, sustainability & environment**	**PO 6 Project Management**	**PO 7 Life-long learning**
Competency	**Use engineering materials for different engineering applications.**						
Course Outcomes CO a) Apply criteria to select materials for given engineering applications.	3	2	1	-	2	-	3
CO b) Select relevant Ferrous and Non-Ferrous Metals & Alloys for a given engineering problem	3	1	-	-	2	-	3
CO c) Select relevant Ceramics, Polymers & Composite Materials for given engineering applications.	3	2	1	-	2	-	2
CO d) Identify suitable advanced materials for different applications.	3	3	1	-	2	-	3

*Legend: '**3**' for high, '**2**' for medium, '**1**' for low and '**-**' for no correlation of each CO with PO.*

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

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