GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

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

Course Title: Material Science and Technology
(Course Code: 4320503)

Diploma programme in which this course is offered	Semester in which offered
Chemical Engineering	Second

1. RATIONALE

The industries related to chemical manufacturing requires study of various classes of materials like metals and alloys, ceramics, coatings, insulating, polymeric materials and lubricants for different applications. This study has importance towards the understanding of properties of materials for construction of various equipments and piping systems. Properties of materials affect the life and performance of equipments to the large extent. Thus information of properties of these materials helps in accepting the importance of material science with respect to cost and safety.

2. COMPETENCY

The course content should be taught and implemented with the aim to develop different types of skills leading to the achievement of the following competencies:

- Process different materials for chemical plant equipments, piping, insulation and lining.

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with this competency are to be developed in the student to display the following COs:

a) Identify various engineering materials used in chemical industries and Describe solid state of material science
b) Apply concept of corrosion to control and prevent it
c) Select metals and alloys in industries
d) Select different ceramic, composites, lubricants, insulating and polymeric materials in industries
e) Select different coating materials in industries.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (CI+T/2+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
CI	T	P	C	CA	ESE	CA	ESE	
3	0	0	3	30*	70	0	0	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: CI**-Class Room Instructions; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit, **CA** - Continuous Assessment; **ESE** - End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES – Not Applicable

The following practical outcomes (PrOs) that 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'.*

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx .Hrs. required
	Total		

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.*

*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..*

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Question answer or Writing steps exercise	30
2	Executing of exercise	30
3	Result	40
		100

6. MAJOR EQUIPMENT/ INSTRUMENTS AND SOFTWARE REQUIRED– (Not Applicable)

These major equipment/instruments and Software required to develop PrOs are given below with broad specifications to facilitate procurement of them by the administrators/management of the institutes. This will ensure conduction of practical in all institutions across the state in proper way so that the desired skills are developed in students.

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
1		

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 fulfil the development of this competency.

a) Work as a leader's / ateam leader
b) Follow ethical practices
c) Practice environmentally friendly methods and processes (environmental related**)**

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 formulated as given below and only higher level UOs of *Revised Bloom's taxonomy* are mentioned for development of the COs and competency in the students by the teachers. (Higher level UOs automatically include lower level UOs in them). If required, more such higher level 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 Application level)	Topics and Sub-topics
Unit – I Properties of Materials	1a Describe scope of material science 1b Explain important properties of materials 1c Select suitable materials considering properties	1.1 Scope of material science 1.2 General principles of selection of materials 1.3 Definition and explanation of 1.3.1 Melting point 1.3.2 Boiling point 1.3.3 Specific heat 1.3.4 Thermal conductivity 1.3.5 Thermal expansion 1.3.6 Thermal insulation 1.3.7 Stress 1.3.8 Strain 1.3.9 Yield stress 1.3.10 Fatigue 1.3.11 Creep
Unit – II Solid state	2a. Explain important types of crystalline solids 2b. Describe different types of unit cells 2c.Evaluate packing efficiency of HCP, CCP and BCC 2d. Evaluate Unit cell dimensions	2.1 General characteristics of solid state 2.2 Amorphous and crystalline solids 2.3 Classification of crystalline solid 2.3.1 Molecular solids 2.3.2 Ionic solids 2.3.3 Metallic solids 2.3.4 Covalent or Network solids 2.4 Crystal lattices and Unit cells 2.5 Primitive cubic unit cell 2.6 Close packed structures 2.7 Packing efficiency 2.8 Calculations involving Unit cell Dimensions 2.9 Imperfections in solids 2.10 Electrical properties of solids

Unit	Unit Outcomes (UOs) (4 to 6 UOs at Application level)	Topics and Sub-topics
Unit – III Corrosion	3a Define corrosion and describe it's types 3b Control and prevention of corrosion	3.1 Definition of corrosion 3.2 Types of corrosion: 3.2.1 Direct corrosion 3.2.2 Electro-chemical corrosion 3.2.3 Galvanic corrosion 3.2.4 High temperature corrosion 3.3 Factors affecting corrosion rate 3.4 Methods for control and prevention of corrosion
Unit– IV Metals	4a Describe and compare metals 4b Describe non-Ferrous metals	4.1 Characteristics of metals 4.2 Physical properties and application of metals: 4.2.1 Iron 4.2.2 Copper 4.2.3 Aluminum 4.2.4 Chromium 4.2.5 Nickel 4.2.6 Tin 4.2.7 Lead 4.2.8 Zinc 4.2.9 Cobalt 4.2.10 Tungsten 4.2.11 Silver 4.2.12 Stainless steel
Unit -V Alloys	5a Describe and compare alloys	5.1 Classification of alloys 5.2 Composition , Properties and application of alloys: 5.2.1 Alloy steel 5.2.2 Duralumin, 5.2.3 Gun metal 5.2.4 Monel metal 5.2.5 Babbit metal 5.2.6 Brass 5.2.7 Bronze
Unit -VI Polymeric Materials	6a Describe and classify plastics, rubbers and fibers	6.1 Definition, Classification, Properties and Uses of: 6.1.1 Plastic 6.1.2 Rubber 6.1.3 Fiber
Unit– VII Protective coatings and Lubricants	7a Describe and classifypaints 7b Describe and classify Varnishes 7c Describe and classify lubricants	7.1 Paints: Properties, classification, ingredients and uses 7.2 Varnishes: Properties, classification , ingredients and uses 7.3 Classification, properties and uses of lubricants

Unit	Unit Outcomes (UOs) (4 to 6 UOs at Application level)	Topics and Sub-topics
Unit– VIII Insulating and Ceramic Materials	8a Describe and Classifyinsulations 8b Select type of insulators 8c Describe ceramic materials 8d Compare ceramicmaterial 8e Indentify suitable glass	8.1 Classification of thermal insulators 8.2 Properties and applications of Thermal insulation 8.3 Factors affecting thermal conductivity of insulators 8.4 Composition, properties and uses of Ceramic materials 8.5 Classification, properties and uses of refractories 8.6 Composition, properties and uses of: 8.6.1 Soda lime glass 8.6.2 Borosilicate glass 8.6.3 High silica glass 8.6.4 Fiber glass 8.6.5 Glass wool 8.6.6 Form glass 8.7 Composition, properties and uses of porcelain

***Note**: The UOs need to be formulated at the 'Application Level' and above of Revised Bloom's Taxonomy' to accelerate the attainment of the COs and the competency.*

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	Properties of materials	03	2	3	2	07
II	Solid state	10	3	5	5	13
III	Corrosion	05	2	5	2	09
IV	Metals	06	2	5	3	10
V	Alloys	04	1	4	2	07
VI	Polymeric Materials	03	2	2	2	06
VII	Protective coatings and Lubricants	04	1	4	2	07
VIII	Insulating and Ceramic Material	07	3	5	3	11
Total		**42**	**16**	**33**	**21**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*
Note*: This specification table provides general guidelines to assist student for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions 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 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 conduct following activities in group and prepare small reports (of 1 to 5 page for each activity). For micro project report should be as per suggested format, for other activities students and teachers together can decide the format of the report. Students should also collect/record physical evidences such as photographs/videos of the activities for their (student's) portfolio which will be useful for their placement interviews:

a) Prepare specification of some materials.
b) Undertake micro-projects in teams
c) Give seminar on any relevant topic.
d) Undertake a market survey of different materials.

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) ***'CI" 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 issues on environment and sustainability using the knowledge of this subject

g) Arrange visit to nearby industries for understanding various materials
h) Use different instructional strategies in classroom teaching.
i) Use video/animation films to explain various materials

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-project 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 total work load on each students due to the micro-project should be about ***16 (sixteen) student engagement hours*** (i.e. about one hour per week) during the course. The students ought to submit micro-project by the end of the semester (so that they develop the industry oriented COs).

A suggestive list of micro-projects is given here. This should relate highly with competency of the course and the COs. Similar micro-projects could be added by the concerned course teacher:

a) Build a Chart showing different materials
b) Surf different websites related materials
c) Collect relevant information about materials

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Material science and processes	Hazarachaudhary S. K.	Indian book distribution co.
2	Engineering Materials	Rangwala S C, Rangwala K. S.	Charotar publishing house pvt. limited
3	Engineering Materials	Rajput R. K.	S.Chand and Co., New Delhi
4	Material Science & metallurgy	Dr. R B Choudary	Khanna Publications

14. SUGGESTED LEARNING WEBSITES

a) www.nptel.iitm.ac.in
b) www.khanacademy
c) web.iitd.ac.in/~suniljha/MEL120/L2_Engineering_Materials.pdf
d) http://engineershandbook.com/Materials
e) www.engineeringtoolbox.com/engineering-materials-properties-d_1225.html
f) http://nptel.iitm.ac.in/courses.php

16. PO-COMPETENCY-CO MAPPING

Semester II	Material Science and Technology (Course Code: 4320503)								
	POs								
Competency & Course Outcomes	**PO 1 Basic & Discipline specific knowledge**	**PO 2 Problem Analysis**	**PO 3 Design/ develop-ment of solutions**	**PO 4 Engineering Tools, Experimentation & Testing**	**PO 5 Engineering practices for society, sustainability & environment**	**PO 6 Project Manage-ment**	**PO 7 Life-long learning**	**PSO1 Operation of Equipment**	**PSO2 Laboratory Practical**
Competency	***Use principles of material sciences in chemical engineering applications***								
Course Outcomes CO (a) Identify various engineering materials used in chemical industries and Describe solid state of material science	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO (b) Apply concept of corrosion to control and prevent it.	**2**	**1**	**1**	**-**	**2**	**-**	**1**	**1**	**-**
CO (c) Select metals and alloys in industries.	**2**	**1**	**1**	**-**	**2**	**-**	**1**	**1**	**-**
CO (d) Select different ceramic, composites, lubricants, insulating and polymeric materials in industries	**2**	**1**	**1**	**-**	**2**	**-**	**1**	**1**	**-**
CO (e) Select different coating materials in industries.	**2**	**1**	**1**	**-**	**2**	**-**	**1**	**1**	**-**

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

15. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

Sr. No.	Name and Designation	Institute	Contact No.	Email
1	**Mr. R P Hadiya Lecturer in Chem Engg**	**G P Rajkot**		**rphadiya@yahoo.co.in**
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