GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

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

CourseTitle: CERAMIC MATERIALS
(Course Code: 4325203)

Diploma programme in which this course is offered	Semester in which offered
Ceramic Technology	Second

1. RATIONALE

It is an introductory subject to be given to students opting for ceramic engineering. It will expose the students to various areas to be covered in this course and various field jobs where they will find employment. This knowledge is essentially required for supervisors. The students will also be exposed to various categories of ceramics.

2. COMPETENCY

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

- **Select appropriate ceramic materials on the basis of their properties.**

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) Describe the properties and uses of clay materials.
b) Identify the sources of silica and its importance in triaxial body.
c) Describe the different types of fluxes, carbonate and sulphate are used in ceramic manufacturing.
d) Describe the different forms of alumina and synthetic raw materials.
e) Describe the methods of Utilization and Dispose of ceramic waste.

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	-	2	4	30*	70	25	25	150

(*): 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) that are the sub-components of the COs. *Some of* the PrOs marked '*' are compulsory*, as they are crucial for that particular CO. These PrOs need to be attained at least at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'*.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	Identify the different types of raw materials based on their physical properties.	I	06*
2	Determine the water of plasticity of different clay.	II	06*
3	Determine the water of plasticity of non plastic materials.	II	06
4	Determine LDS(Linear Drying Shrinkage) of clay body	II	04*
5	Determine firing shrinkage of clay body.	II	06*
6	Determine LDS of triaxial body compositions.	II	04
7	Determine Firing Shrinkage of Triaxial body compositions.	II	04
8	Determination of density of above fired bodies(clay body &triaxial body).	II	02
9	Measure plasticity and setting time using Vicat apparatus.	II	02
10	Determine the Loss on ignition of clay.	III	04
11	Determine the Loss on ignition of silica.	III	04
12	Determine the Loss on ignition of feldspar.	III	04
13	Determine the moisture content test of china clay.	III	02*
14	Determine the moisture content test of ball clay.	III	02
15	Determine the moisture content test of fire clay .	III	02
16	Determine the moisture content test of quarts clay.	III	02
17	Determine the moisture content test of feldspar.	III	02
18	Determine the moisture content test of alumina.	IV	02
19	Determine the specific gravity test of fire clay.	IV	02
20	Determine the specific gravity test of Alumina.	IV	02
21	Determine the specific gravity test of Quarts.	IV	02
22	Determine the specific gravity test ofFeldspar.	IV	02
	Minimum practical Exercises Required #		**28 hrs**

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..*

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Prepare of experimental setup	20
2	Perform the practical	20
3	Follow safe practices measures	10
4	Record observations correctly	20

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
5	Interpret the result and conclude	30
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS AND SOFTWARE REQUIRED

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.

S. No.	Equipment Name with Broad Specifications	PrO.No.
1	Sieve shaker with sieve set	1,2,3
2	Digital weight balance	1 to 14
3	Hot air oven	4,6, 13-18
4	Muffle furnace	5,7,10,11,12
5	Vicat apparatus	9
6	Specific gravity bottle	19-22

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/a team member.
b) Follow ethical practices.
c) Practice environmental friendly methods and processes.

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 **Clay**	1a. Explain the formation of clays. 1b. Explain the classification of clays. 1c. Describe winning method of clays. 1d. Explain the purification methods of clays.	1a. Definition of clay, Formula of clay, weathering of rocks. 1b. Primary and secondary clays with examples. 1c. Methods of winning ceramic materials from earth, open pit, underground mining methods, machineries and Clay storage. 1d. Purification of clay – mechanical and chemical methods – sorting, air separation, magnetic separation.
Unit – II **Silica**	2a. Describe the occurrence of silica. 2b. Explain the properties of silica. 2c. Describe the forms of silica. 2d. Explain the role of silica in triaxial body.	2.1. Occurrence of various silica raw materials like quartz, sand, sand stone, quartzite, ganister, flint and their uses in the manufacture of various ceramic articles. 2.2. Physical and chemical properties of silica. 2.3. Effect of heat on silica. 2.4. Role of silica in triaxial body.
Unit– III Fluxes,	3a. Explain the occurrence of fluxes. 3b. Describe the various types of feldspar and other flux minerals. 3c. Explain the properties of feldspar and other flux minerals. 3d. Explain the role of feldspar in triaxial body. 3e. Explain the different types of carbonates and sulphates.	3.1 Occurrence of various fluxes, 3.2 Types of feldspar like Potash Feldspar, Soda feldspar, Lime Feldspar, Cornish stone, nephelinesyenite. 3.3 Properties of Potash Feldspar, Soda feldspar, Lime Feldspar, Cornish stone, nephelinesyenite. 3.4 Role of feldspar in triaxial body. 3.5 Different types of carbonates like Sodium carbonate, potassium carbonate, calcium carbonate and Sulphates like sodium sulphate, potassium sulphate, calcium

Unit	Unit Outcomes (UOs) (4 to 6 UOs at Application level)	Topics and Sub-topics
		sulphate.
Unit– IV Alumina& synthetic raw material**.**	4a. Explain the occurrence of alumina. 4b. Describe the various types of alumina. 4c. Explain the properties of alumina. 4d. Describe alumino silicates. 4e. Explain synthetic raw materials.	4.1 Occurrences of various forms of alumina. 4.2 Different types of alumina like gibbsite, Diaspora, bauxite, corundum, fused alumina and sintered alumina, tubular alumina. 4.3 Alumino silicates like kyanite, Sillimanite, andalusite&mullite. 4.4 Synthetic raw materials like Carbides, Nitrides, Borides.
Unit– V **Recycling of Industrial Wastes**	5a. Justify the need of understanding recycling of industrial waste like Cullet, Grog, Fly Ash and Blast Furnace Slag. 5b. Establish the relationship of sustainability and recycling of industrial waste. 5c. Suggest methods of recyclingceramic waste with examples. 5d. Suggest methods to dispose ceramic waste	5.1 Concept of recycling waste. 5.2 Sustainability and recycling 5.3 Methods to recycleceramic waste 5.4 Methods to dispose ceramic waste

Note*:TheUOs 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.*

10. 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	Clay	12	4	8	6	18
II	Silica	10	4	7	8	19
III	Fluxes	12	4	8	6	18
IV	Alumina and synthetic raw materials	10	2	4	4	10
V	Recycling of industrial waste	04	1	2	2	5
Total		**48**	**12**	**28**	**30**	**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.*

11. 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 list of some ceramic products.
b) Undertake micro-projects in teams
c) Give seminar on any relevant topic.
d) Undertake a market survey for ceramic product.
e) Prepare showcase portfolios.
f) Prepare charts containing details of various raw materials.

12. 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 assess during different assessment methods.
e) With respect to ***section No.11***, 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 using the knowledge of this course.
g) Guide students for using data manuals.

13. 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 (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 ***14 to 16(Fourteen to 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) **Ceramic industries in India**: Identify the different ceramic industries located in different parts of India and prepare the report. (**Duration: 8-10 hours**)
b) **Raw materials:** prepare a chart of ceramic raw materials with formula and Collect different types of ceramic raw material samples from local industries.
c) **Decorative ware:** prepare Clay article, decorate it and prepare a report.
d) **Ceramic waste**: Compile a report of handling ceramic waste with figures, tables and comparative charts and strategies used and suggested.

14. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Ceramic Raw Materials	W EWORRALL	Elsevier Scientific Publishing Company, New York
2	Introduction to ceramics	WD Kingery	Elsevier Scientific Publishing Company, New York
3	Ceramic white wares	SudhirSen	Oxford & IBH Publishing Co., New Delhi
4	Refractories	M.L. Mishra	Oxford & IBH Publishing Co., New Delhi
5	Industrial ceramics	springer	Singer and singer

15. SUGGESTED LEARNING WEBSITES

a) www.ceramics.org
b) http://en.wikipedia.org/wiki/Ceramic
c) http://www.nzdl.org/cgi-bin/library/ceramic
d) **https://www.ceramicindustry.com/ceramic-materials-properties-charts**

16. PO-COMPETENCY-CO MAPPING

Semester II	CERAMIC MATERIALS (Course Code: 4325203)									
	POs and PSOs									
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	**PSO 1**	**PSO 2**	**PSO 3** (If needed)
Competency Use principles of different types of Ceramic raw materials in various engineering applications.	3	1	2	2	2	1	1	2	1	
Course Outcomes CO a) Describe the properties and uses of clay materials.	3	1	2	2	1	1	1	2	1	
CO b) Identify the sources of silica and its importance in triaxilabody.	3	1	2	1	1	1	1	2	1	
CO c) Describe the different types of fluxes used in ceramic manufacturing.	3	2	2	1	1	1	1	2	1	
CO d) Describe the forms of alumina and synthetic raw materials.	3	1	2	1	1	1	1	2	1	
CO e) Describe the methods of Dispose of ceramic waste	2	1	1	2	3	1	1	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

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