

**GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)****Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)**

Semester-V

**Course Title: Applied Ceramics**

(Course Code: 4355201)

<b>Diploma programme in which this course is offered</b>	<b>Semester in which offered</b>
Ceramic Technology	5 <sup>th</sup> Semester

**1. RATIONALE**

Applied ceramic subject is important because ceramics have a wide range of practical applications across many industries. These subjects involve applications of ceramics in various fields like construction, Composite, Nano-ceramic, coating, electrical, electronics, and energy - environment field. Ceramics exhibits unique combination of properties, such as high strength, hardness, and resistance to wear, corrosion, and high temperatures and they having other desirable properties, such as electrical conductivity, piezoelectricity, and magnetic properties, making them useful for electronic and magnetic applications. Ceramics can be used in energy generation and storage applications, such as fuel cells and batteries, and in environmental applications, such as water filtration and air purification. Ceramics can also be used as a replacement for traditional materials that are less environmentally friendly, such as plastics and metals.

**2. COMPETENCY**

The course should be taught and curriculum should implement with the aim to develop required skills so that students are able to acquire following competency leading to the achievement of the following competency:-

**Apply principles of ceramics in various applications of ceramic products.**

**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) Classify Ceramic Product based on different criteria.
- b) Select suitable application of ceramic materials in construction, composite and Nano ceramic.
- c) Select suitable application of ceramic materials in coating, surface treatment, environment and energy field.
- d) Select suitable application of ceramic materials in electrical and electronic field.

#### 4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (CI+T/2+P/2)	Examination Scheme				Total Marks
CI	T	P		Theory Marks		Practical Marks		
			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	Classify ceramic products based on different criteria.	I	4
2	Identify application of ceramic products in construction.	II	4
3	Visit to wall tile industry and prepare a report.	II	6
4	Visit to Vitrified tile industry and prepare a report.	II & IV	6
5	Visit to Sanitary ware industry and prepare a report.	II & IV	6
6	Visit to Red brick production unite and prepare a report.	II & IV	6
7	Visit to Salt glaze pipe industry and prepare a report.	II & IV	6
8	Visit to Refractory industry and prepare a report.	II& III	6
9	Visit to Insulator manufacturing industry and prepare a report.	IV & VI	6
10	Visit to ceramic composite manufacturing industries and prepare a report.	III	6
11	Visit to Advance ceramic manufacturing industry and prepare a report.	III,IV,V &VI	6
12	Perform Coating of ceramic article by glazing process.	IV	6

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
13	Perform Coating of metallic part by enameling.	IV	6
14	Visit to energy and environment field related. industries.	V	6
15	Visit to electronics spare parts making industries.	VI	6
<b>Minimum Practical Exercises required #</b>			<b>28 hrs</b>

**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	Perform the practical or industrial visit	60
2	Follow safe practices measures	10
4	Record observations during visit or practical	10
5	Prepare report of visit	20
<b>Total</b>		<b>100</b>

**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	Pr.No.
1	Spray gun for coating glaze and enamel	12,13
2	Portable air compressed unite	12,13

**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 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 1<sup>st</sup> year
- ii. 'Organization Level' in 2<sup>nd</sup> year.
- iii. 'Characterization Level' in 3<sup>rd</sup> year.

## 7. 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 Introduction	1a. Define applied ceramics with examples. 1b. Classify Ceramic Product based on different criteria. 1c. Explain properties of ceramic products.	1.1 Define applied ceramics with examples. 1.2 Classify ceramic products based on composition, function and temperature resistance etc. 1.3 Different properties of ceramic products.
Unit – II Ceramics in construction	2a. List out various products used in construction. 2b. Select suitable manufacturing process of various products.	2.1. Wall tile, floor tile, roofing tile, red brick, sanitary ware and salt glaze pipe etc. 2.2. Manufacturing methods of wall tile, floor tile, roofing tile, red brick, sanitary ware and salt glaze pipe etc.
Unit– III Ceramics in composite and Nano applications	3a. Explain various ceramic composite materials with applications. 3b. Identify Nano-ceramic applications in various fields.	3.1 Various composites like Ceramic matrix, Metal matrix, Polymer matrix, Ceramic -polymer, Ceramic -metal and Ceramic-glass etc. 3.2 Nano ceramic application in bioceramic, Energy, Environment, Electronic, structural, Aerospace, Automotive field and sporting goods etc.
Unit– IV Ceramics in coating and surface treatment	4a. Select suitable ceramic materials used in surface coating. 4b. Explain various coating and surface treatment process.	4.1 Zirconia, alumina, Titania, silicon carbide, boron carbide, silicon nitride etc. 4.2 Glazing, thermal barrier coatings, Anti-corrosion coatings, Self – cleaning coatings, Wear-resistant coatings etc.
Unit– V	5a. Select various applications of	5.1 Gas turbines, nuclear reactors,

Unit	Unit Outcomes (UOs) (4 to 6 UOs at Application level)	Topics and Sub-topics
Ceramics in energy and environment field	ceramics in energy field. 5b. Select various applications of ceramics in environment field.	solar energy, batteries, fuel cells, insulation etc 5.2 Water treatment, air pollution control, soil remediation, waste management, environment sensors, and renewable energy
Unit– VI Ceramics in Electrical and Electronics field	6.1. Identify various applications of ceramic products in electric field. 6.2. Identify various electronics applications of ceramic products	6.1. Insulators, piezoelectric devices, capacitors, sensors, substrates etc. 6.2. Printed circuit boards, capacitors, resistors, induction, transducers, sensors etc.

**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.

## 8. 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	4	2	3	0	5
II	Ceramics in Construction	10	3	7	6	16
III	Ceramics in composite and Nano applications	7	3	7	4	14
IV	Ceramics in coating and surface treatment	8	2	7	5	14
V	Ceramics in energy and environment field	7	2	6	4	12
VI	Ceramics in Electrical and Electronics field	6	2	4	3	9
<b>Total</b>		<b>42</b>	<b>14</b>	<b>34</b>	<b>22</b>	<b>70</b>

**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.

## 9. 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) Collect information regarding advance technology used in ceramic or glass industries.
- b) Collect information regarding advanced ceramic products.
- c) Undertake micro-projects in teams
- d) Give seminar on any relevant topic.
- e) Undertake a market survey for advance ceramic products.
- f) Prepare showcase portfolios.

#### 10. 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 assessing 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) **Advance ceramic industries in India or World:** Identify the different advance ceramic industries located in different parts of India or World and prepare the report. **(Duration: 8-10 hours)**
- b) **Different types of advance ceramic products with application:** prepare a chart or report for different types of advance ceramic products with applications.
- c) **Merits of ceramic products over other materials:** prepare report on advantage of ceramic products over other materials.
- d) **Compare Advance Ceramic and Traditional Ceramic:** Prepare report on additional features of advance ceramic over traditional ceramics.

#### 14. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Industrial Ceramics	Felix Singer , Sonja S. Singer	Springer Dordrecht 978-94-017-5257-2
2	Hand book of advance ceramics	Shigeyuki somiya	Academic Press with ISBN No. 978-0-12-385469-8
3	Applications of Advanced Ceramics in Science, Technology, and Medicine	Chandra Babu Naidu (Author) and N Suresh kumar	Bentham Science Publishers ISBN No. 978-981-14-7817-8

#### 15. SUGGESTED LEARNING WEBSITES

- a) <https://www.preciseceramic.com/blog/advanced-ceramics-background-types-and-applications.html>
- b) <https://www.syalons.com/2019/01/08/ceramic-materials-in-defence-applications/>
- c) <https://www.sciencelearn.org.nz/resources/1775-uses-for-advanced-ceramics>
- d) <https://www.britannica.com/technology/capacitor-dielectric>
- e) <https://www.wundermold.com/what-common-application-advanced-ceramics/>
- f) <https://www.ceramic-applications.com/>

**PO-COMPETENCY-CO MAPPING**

Semester V	Applied Ceramic (Course Code: 4355201)						
	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
<u>Competency</u>	Apply principles of ceramics in various applications of ceramic products.						
<u>Course Outcomes</u>							
CO a) Classify Ceramic Product based on different criteria.	2	0	1	0	0	0	1
CO b) Select suitable application of ceramic materials in construction, composite and nano ceramic.	1	1	2	2	1	1	2
CO c) Select suitable application of ceramic materials in coating, surface treatment, environment and energy field.	1	1	2	2	1	1	2
CO d) Select suitable application of ceramic materials in electrical and electronic field.	1	1	2	2	1	1	2

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

**17. COURSE CURRICULUM DEVELOPMENT COMMITTEE****GTU Resource Persons**

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