GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

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

Course Title: Ceramic Process Calculations
(Course Code: 4335203)

Diploma programmer in which this course is offered	Semester in which offered
Ceramic Technology	Third

1. RATIONALE

The course Ceramic Process Calculations refers to various calculations done in ceramic Industries for process control. This course is introduced to provide knowledge on calculations used in the manufacturing stream and to provide foundation for diploma ceramic engineers who want to further specialise in the field of ceramics. In this course the students are trained to find moisture and loss on ignition of raw materials, understand shrinkage in wares, manage dimensional changes in the product, control the density of slurry for wet processing, understanding pore structure and its effect and method to find porosity, water absorption and density.

2. COMPETENCY

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

Apply basic principles of mathematics to solve various numerical problems related to ceramic engineering. This will provide a background for applying these principles to industrial problems.

3. COURSE OUTCOMES (COs)

The theoretical 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) Understand the significance of moisture content and its determination.
b) Predict and evaluate the dimensional changes of the ceramic product.
c) Calculate the density, porosity and absorption characteristics of porous body.
d) Calculate and manipulate the density of ceramic suspensions.
e) Compute the strength of ceramic bodies

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. 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 includes 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 **Moisture content**	1a. Define Moisture content. 1b. Able to explain different types of moisture content. 1c. Determine moisture content in ceramic materials. 1d. Measure loss on ignition and water of plasticity of materials. 1e. Calculate moisture content.	1.1 definition of moisture content. 1.2 different types of moisture content mechanical, hygroscopic & chemical water. 1.3 Effect on quality and price of the material, determination of moisture content. 1.4 significance of loss on ignition and water of plasticity. 1.5 calculations of moisture content and its equipments.
Unit – II Dimensional **Changes**	2a. Define shrinkage of article. 2b. Able to explain linear shrinkage & volume shrinkage. 2c. Relate moisture content and shrinkage. 2d. Calculate shrinkage of article.	2.1 Definition drying & firing shrinkage. 2.2 Types of shrinkage linear shrinkage & volume shrinkage. 2.3 Effect of moisture content on shrinkage. 2.4 Calculation of linear drying & firing shrinkage, volume drying and firing shrinkage & total shrinkage. Estimate the green size and final size of the product with known shrinkage factors..
Unit– III Porous Solids	3a. Define Archimedes principle. 3b. Able to explain Archimedes principle. 3c. Identify various Pores structures. 3d. Calculate Bulk density, Specific Gravity, Apparent Porosity and Water Absorption of article.	3.1 Definition of Archimedes principle 3.2 Explain the application. 3.3 Open pore, closed pore, solid volume & apparent solid volume. Calculate volume of porous and nonporous solids. 3.4 Definition of Bulk density & true density. Calculation of Bulk Density, apparent solid density, Specific

		Gravity, Apparent porosity & Water absorption.
Unit– IV Ceramic Suspensions	4a. Define Ceramic slip. 4b. Prepare ceramic slip. 4c. Calculate density of slip. 4d. Calculate Solid particles in the slip.	4.1 Definition of slip. 4.2 Explain the preparation of slip. 4.3 **C**alculating density of a body batch & slip, adjusting density of batch, preparing slip of known density. 4.4 Calculations relating to Mixtures of solid particles and water, use of Brongniart's formula in fluid calculations-calculating dry content in slip, Increasing the density of slip by adding dry content & Dilution problems.
Unit– V Strength of Ceramic bodies	5a. Able to explain Importance of strength of ceramic bodies. 5b. Identify various strengths of ceramic body. 5c. Calculate strength of ceramic bodies. 5d. Identify various Equipments used to measure strength of body.	5.1 Define strength, Study the factors affecting strength of a body. 5.2 cold crushing strength, tensile strength, Modulus of Rupture. 5.3 Calculations on Cold Crushing Strength, Tensile Strength, Modulus of Rupture. 5.4 List of equipments used for measuring of strength.

***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.*

6. 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	Moisture content	08	2	3	5	10
II	Dimensional changes	08	3	4	8	15
III	Porous Solids	08	4	4	7	15
IV	Ceramic Suspensions	12	4	4	7	15
V	Ceramic Suspensions	12	4	4	7	15
Total		**48**	**17**	**19**	**34**	**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.*

7. 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 some YouTube videos related to topics.
b) Give seminar on any relevant topic.
c) Prepare chart on different instruments used in ceramic testing.

8. 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.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.

9. 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:

1. Make a report on modern instruments used in finding moisture content of material.
2. Make a report on any other methods of finding density of slurry in industry.

3. Make a report on instruments used in finding mechanical strength of ceramic products.

10. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Calculation in ceramics	R. GRIFFITHS & Radfardceramics	New impression edition, 0950560405
2	Ceramics test & calculation	By A. I ANDREWS.	John Wiley and Sons, publishers B001I0O2Z0

11. SUGGESTED LEARNING WEBSITES

a) http://www.calculatoredge.com/new/avgdiameter.htm
b) http://www.ilmc.org/Publications/ILMCFinalCombo8-02B.pdf

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12. PO-COMPETENCY-CO MAPPING

Semester III	CERAMIC PROCESS CALCULATIONS (Course Code: 4335203)								
	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
Competency Apply basic principles of mathematics to solve various numerical problems related to ceramic engineering.	2	3	3	3	1	0	3	2	2
Course Outcomes CO a) Understand the significance of moisture content	2	3	3	3	1	0	2	2	1

and its determination.									
CO b) Predict and evaluate the dimensional changes of the ceramic product.	2	2	3	3	1	0	2	1	1
CO c) Calculate the density, porosity and absorption characteristics of porous body.	2	3	3	3	1	1	2	2	2
CO d) Calculate and manipulate the density of ceramic suspensions.	2	3	3	3	1	1	2	2	2
CO e) Compute the strength of ceramic bodies	2	3	3	3	1	1	2	3	2

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

13. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

S. No.	Name and Designation	Institute	Contact No.	Email
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