GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

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

Course Title: Drying and Firing
(Course Code: 4345201)

Diploma programmer in which this course is offered	Semester in which offered
Ceramic Engineering	4th Semester

1. RATIONALE

The course drying and firing refers to various heat treatment processes for ceramic products by using different drying and firing techniques. This course is introduced to provide knowledge of drying and firing process for diploma ceramic engineers who want to further specialize in the field of ceramics. Drying and firing course contains Process of Drying, Types of dryers, Process of firing, Process of firing, Kiln efficiency and firing defects.Hence the course has been design to develop skills required for drying and firing.

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 principle of heat treatment during drying and firing process of ceramic articles.

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) Apply suitable processes for drying ceramic article.
b) Classify dryers based on operation.
c) Select suitable firing technique for different ceramic products.
d) Examine effect of heat on ceramic article.
e) Select suitable technique to improve kiln efficiency.

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 Process of Drying	1a. Define drying. 1b. Explain the importance of drying in ceramic industry. 1c. Identify factors affecting of drying process. 1d. Describe stages of drying process. 1e. Illustrate different types of drying process.	1.1 Definition of drying. 1.2 Explain the Importance of drying in ceramic industry 1.3 Explain the Factors affecting drying process. 1.4 Explain the Stages of drying process in ceramic body. 1.5 Explain the types of drying techniques like Natural drying, Advanced drying methods etc.
Unit – II Types of dryers and Drying defects	2a. Classify dryers based on operation. 2b.Explain the working principle of various dryers. 2d. Identify drying defects and suitable solution for their remedies.	2.1 Give the classification of dryers. 2.2 Explain the working of Hot floor dryer, chamber dryer etc. 2.3 Explain the working of spray dryer, tunnel dryer, mangle dryer, rotary dryer etc. 2.4 Explain drying defects such as cracks, warpage and shrinkage etc. with their remedies.
Unit– III Process of firing	3a. Explain the importance of firing. 3b. Select suitable firing technique for various ceramic bodies.	3.1 Explain the importance of firing in ceramic industries. 3.2 Explain the Firing techniques for tile body in detail. 3.3 Explain the Firing techniques for sanitary ware in detail. 3.4 Explain theFiring techniques for crockery ware in detail.
Unit– IV Effect of heat on ceramic bodies.	4a. Examine effect of heat on clay, silica and triaxial body. 4d. Illustrate sintering and vitrification.	4.1 Explain the physical and chemical changes occur in clay. 4.2 Explain the phase transformation of silica with diagram. 4.3 Explain the physical and chemical

		changes occur in clay bodies with diagram. 4.4 Explain sintering and vitrification process.
Unit– V Kiln efficiency and firing defects.	5a. Select suitable methods to waste heat control 5b. Identify firing defects occur in ceramic body. 5c. Identify firing defects occur in glazes. 5d. Select suitable remedies to overcome firing defects.	5.1 Explain the techniques to avoid wastage of heat during firing. 5.2 Explain the types of defects occur in ceramic body. Like firing shrinkage, cracks, pin holes, black spot, warpage etc. 5.3 Explain the types of defects occur in glazes. like blister, pin holes, dunting, crazing, chipping, fish scaling, black spots etc, 5.4 Explain the remedies to overcome firing defects.

***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	Process of drying	07	2	5	5	12
II	Types of dryers	07	3	4	6	13
III	Process of firing	09	4	6	5	15
IV	Effect of heat on ceramic bodies	10	4	4	7	15
V	Kiln efficiency and firing defects	09	2	5	8	15
Total		**42**	**15**	**24**	**31**	**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) Visit any nearer industry and study for drying of ceramic products.
b) Visit any nearer industry and study for firing of ceramic products.
c) Find out different methods to prevent wastage of heat.
d) Visit to ceramic industry and study cost control and fuel efficiency.

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 drying methods.
2. Make a report on advanced firing methods.
3. Make a report on waste heat management.
4. List out types of dryers used to drying various ceramic products.
5. Make a list of advance drying techniques.

10. 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	Fuels furnaces and refractory	O.P.Gupta	Khanna publisher
3	A Hand Book of Modern Pottery Manufacture	H.N.Bose	Ceramic Publishing House,Bhagalpur

11. SUGGESTED LEARNING WEBSITES

a) https://en.wikibooks.org/wiki/Ceramicware_Defects_Handbook/Printable_version
b) http://ijariie.com/AdminUploadPdf/ANALYSIS_OF_DRYING_PROCESS_IN_CERAMIC__TILES_INDUSTRIES_ijariie2063.pdf
c) https://thepotterywheel.com/stages-of-firing-clay/
d) https://www.iqsdirectory.com/articles/dryer/types-of-dryers.html
e) https://moisturecontrol.weebly.com/drying-methods.html
f) https://whatispiping.com/types-of-industrial-dryers/
g) https://www.iqsdirectory.com/articles/furnace.html
h) https://www.beeindia.gov.in/sites/default/files/2Ch4.pdf

12. PO-COMPETENCY-CO MAPPING

a) Apply suitable processes for drying ceramic article.
b) Classify dryers based on operation.
c) Select suitable firing technique for different ceramic products.
d) Examine effect of heat on ceramic article.
e) Select suitable technique to improve kiln efficiency.

Semester IV	DRYING AND FIRING (Course Code: 4345201)						
	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	Apply principle of heat treatment during drying and firing process of ceramic articles.						
Course Outcomes CO a) Apply suitable process for drying ceramic article.	3	1	1	-	1	-	1
CO b) Classify dryers based on operation.	3	-	-	-	-	1	-
CO c) Select suitable firing technique for different ceramic products.	3	1	1	-	1	1	1
CO d) Examine effect of heat on ceramic article.	3	2	-	2	-	1	1
CO e) Select suitable technique to improve kiln efficiency.	-	1	3	2	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

13. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

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