

**GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)**

**Competency-focused Outcome-based Green Curriculum-2022 (COGC-2022)**

Semester-III

**Course Title: Fuels & Furnaces**

(Course Code: 4335205)

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

**1. RATIONALE**

Fuels & furnace course introduces basic knowledge about solid, liquid and gaseous fuels, their origin, classification, preparation procedure and characterization in terms of physico-chemical properties. It also covers fundamentals of combustion along with combustion appliances. Drying and Firing process is a heart of ceramic manufacturing process. Diploma ceramic students should have knowledge of Fuels, Burners and Furnaces to understand firing technique of ceramic industry.

**2. COMPETENCY**

Plan and perform firing operation for both kiln and furnace.

**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:

- Distinguish various types of furnace & kilns.
- Define various types of fuels.
- Explain uses of different types of fuels and combustion appliances.
- Define various types of burners & its uses.
- Distinguish temperature measurement equipment.

**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	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 INTRODUCTION	1a. State History of kiln and furnaces. 1b. Explain principle of firing. 1c. Explain importance of kiln & furnaces.	1.1 Kilns & furnaces used in the ancient age 1.2 Importance of fuels in ceramic industry. 1.3 Principles of combustion. 1.4 Importance of kilns and furnaces
Unit – II CLASSIFICATION OF FUELS	2a. Give classification of fuels. 2b. Explain manufacturing process of synthetic fuels.	2.1 Various types of fuels, Solid, Liquid, Gaseous, Electricity. 2.2 Method of manufacturing of various types synthetic fuels.
Unit– III PROPERTIES OF FUELS	3a. Explain properties of different fuels. 3b. Calculate calorific value of fuels 3c. Identify suitable fuels for ceramic industry.	3.1 Properties of solid fuels. 3.2 Properties of liquid fuels. 3.3 Properties of gaseous fuels. 3.4 Properties of synthetic and electric fuels. 3.5 Method of determining calorific value of fuels. 3.6 Efficiency of fuels. 3.7 Suitability of fuels for ceramic industries.
Unit– IV Classification of Kilns for Ceramic Industry	4a. Give classification of kilns & Furnaces. 4b. Explain construction and function of kilns.	4.1 Classification of kilns & furnaces 4.2 Construction and function of up draft kilns and down draft kilns 4.3 Construction and function of tunnel

		<p>kilns</p> <p>4.4 Construction and functions of modern type of shuttle kilns and roller kilns</p>
<p>Unit– V</p> <p>Glass and Enameling Furnaces</p>	<p>5a. Explain construction and function of furnaces.</p>	<p>5.1 Construction and function of pot furnace</p> <p>5.2 Construction and function of tank furnaces</p> <p>5.3 Construction and function of recuperative and regenerative type of furnaces</p> <p>5.4 Construction and function of muffle furnace for enameling.</p> <p>5.5 Construction and function of frit furnace.</p>
<p>Unit –VI</p> <p>Kiln Accessories</p>	<p>6a. List and explain about kiln accessories.</p> <p>6b. Explain about burners.</p>	<p>6.1 Brief explanation about fire box, chimney, crown, damper, saggars, muffles &amp; kiln furniture.</p> <p>6.2 Explain about burners &amp; types of Burners.</p>
<p>Unit – VII</p> <p>TEMPERATURE AND ITS MEASUREMENT</p>	<p>7a.Explain temperature measurement process inside the kiln.</p> <p>7b.Discuss temperature measurement equipment.</p>	<p>7.1 Detail study of measurement inside the kilns temperature.</p> <p>7.2 Details of various equipments for measurements to such as thermo couple pyrometers, pyroscopes.</p> <p>7.3 Details of optical pyrometer, resistance pyrometer and radiation pyrometer</p>

**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	INTRODUCTION	4	3	2	0	5
II	CLASSIFICATION OF FUELS	6	2	3	3	8
III	PROPERTIES OF FUELS	6	2	4	4	10
IV	CLASSIFICATION OF KILNS FOR CERAMIC INDUSTRY	8	3	5	5	13
V	GLASS AND ENAMELING FURNACES	7	3	5	5	13
VI	BURNERS	5	3	5	4	12
VII	TEMPERATURE AND ITS MEASUREMENT	6	2	3	3	8
<b>Total</b>		<b>42</b>	<b>12</b>	<b>28</b>	<b>30</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.

## 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 topics of fuels & furnace.
- d) Search internet to collect different applications kilns.

## 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:

- a) Comparative study of fuel combustion in different kilns/furnaces.
- b) Calculate calorific value of different fuels.

### 10. SUGGESTED LEARNING RESOURCES

S. No	Title of Book	Author	Publication with place, year and ISBN
1	Fuels furnaces and refractory	O.P. Gupta	KHANNA PUBLISHERS ISBN : 978-8174090881
2	Fuels, Furnaces, Refractories and Pyrometry	A V K Suryanarayana	BSP Books Private Limited ISBN : 9352300688
3	Industrial Furnaces	W Trinks	Wiley-Interscience ISBN: 978-0471387060
4	Industrial Ceramic	F.singer	Springer ISBN : 978-9401752596
5	Refractories	F.H. Norton	McGraw-Hill Inc.,US ISBN: 978-0070475380

### 11. SUGGESTED LEARNING WEBSITES

- a) <https://www.indfurnace.com>
- b) <https://en.wikipedia.org/wiki/Furnace>
- c) <https://www.hightemp-furnaces.com/>
- d) <https://thepotterywheel.com/types-of-kiln/>
- e) <http://ecoursesonline.iasri.res.in/mod/page/view.php?id=945>

## 12. PO-COMPETENCY-CO MAPPING

Semester III	INTRODUCTION TO CERAMICS (Course Code: 4335205)								
	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
<b>Competency</b> Plan and perform firing operation for both kiln and furnace.	1	1	0	1	1	0	3	2	2
<b>Course Outcomes</b> Co a) Distinguish various types of furnace & kilns.	2	1	1	1	1	0	2	2	1
Co b) Define various types of fuels.	3	0	1	0	0	0	2	1	1
Co c) Explain uses of different types of fuels and combustion appliances.	3	0	0	2	0	1	2	2	2
Co d) Define various types of burners & its uses.	2	0	1	1	0	1	2	2	2
Co e) Distinguish temperature measurement equipment.	2	1	1	2	1	0	1	2	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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