GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

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

Course title: Fuel, Furnaces and Refractories
(Course Code: 4332104)

Diploma Programme in which this course is offered	Semester in which offered
Metallurgy Engineering	Third

1. RATIONALE

Fuels are basic requirements of Metallurgical furnaces for the extraction of metals. Fuels play a major role in the quality and cost of any metallurgical product. Important metallurgical operations like melting, heat treatment, etc. are carried out in various metallurgical furnaces. For optimum utilization of fuel and quality control in the process, the furnace is the most important equipment. Refractories are a very important material for the construction of furnaces which help in the efficient utilization of furnaces. Thus students need to learn about fuels, furnaces, and refractories.

2. COMPETENCY

The course content should be taught and implemented to develop different types of skills so that students can acquire the following competency:

- **Select the suitable furnace with relevant refractory material and appropriate fuel for the given metallurgical operation**.

3. COURSE OUTCOMES (COs)

At the end of the study of this course the student will be able to:

- List out the relevant fuel for the given furnace.
- Select the relevant liquid and gaseous fuel for the given application.
- Explain construction and working of various furnaces.
- Select the relevant refractory material for the given furnace.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	0	0	3	30*	70	00	00	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: ***L****-Lecture;* ***T*** *– Tutorial/Teacher Guided Theory Practice;* ***P*** *-Practical;* ***C*** *– Credit,* ***CA*** *- Continuous Assessment;* ***ESE*** *-End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES

-Not Applicable –

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

This major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to user in uniformity of practical's in all institutions across the state.

S. No.	Equipment Name with Broad Specifications	PrO. No.
NOT APPLICABLE		

7. AFFECTIVE DOMAIN OUTCOMES

The following sample Affective Domain Outcomes (ADOs) are embedded in many of the abovementioned Cos. More could be added to fulfill the development of this course competency.

- Work as a leader/a team member.
- Follow ethical practices.
- Practice environmental friendly methods and processes. (Environment related)

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of Revised Bloom's taxonomy that are formulated for development of the COs and competency. If required, more such UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Major Learning Outcomes	Topics and Sub-topics
Unit – I **Introduction to Fuels**	1a. Define fuel 1b. List fuels according to the source 1c. Distinguish the features of solid, liquid and gaseous fuel 1d. Know the fossil fuel industries situated in India	1.1. Introduction and classification of fuels. 1.2. Definition of flash point, fire point, and combustion of fuels. 1.3. Importance and comparison of solid, liquid and gaseous fuel 1.4. Fossil fuel industries in India
Unit – II **Industrial Fuels**	2a. Understand the origin of coal 2b. Know the constituents of Coal 2c. Explain the testing methods of coal 2d. Describe the coke making process. 2e. Select the fuel for relevant industrial applications.	**2.1 Coal** 2.1.1. Origin, composition and types of coal. 2.1.2. Characteristics and significance of constituents 2.1.3. Testing of coal- Calorific value by Bomb calorimeter, Proximate and Ultimate analysis of coal 2.1.4. Selection of Metallurgical coal 2.2.1. The scope and objectives of

		carbonization of coal **2.1 Coke** 2.2.2. Carbonization of coal 2.2.3. Low Temperature carbonization (LTC) and High Temperature carbonization (HTC) 2.3 Distillation process of crude petroleum 2.4 Production, composition and uses of Coke oven gas, water gas and producer gas. 2.5 Composition and use of blast furnace gas.
Unit– III **Metallurgical furnaces**	3a. Understand furnace construction and working 3b. Describe the working of production furnaces. 3c. Describe the working of melting furnaces 3d. Describe the working of heat treatment furnaces 3e. Compare the environmental impact of all these types of furnaces 3f. Know the various furnace atmospheres.	3.1. 3.1 Introduction 3.2. 3.2 Classify furnaces based on application, processes and fuels,. 3.3. 3.3 Principle, working procedure, construction and application of below mentioned furnaces; a. **Production furnaces**- Blast furnace, Electric Arc furnace. b. **Melting furnaces** – Cupola furnace, Crucible furnace, Induction furnace, Electric furnaces. c. **Heat treatment furnaces** - Muffle furnace, Salt bath furnace 3.4 Atmospheric control in various furnaces
Unit– IV **Refractories**	4a. Define and classify refractory 4b. List Out duties to perform by refractory 4c. Describe manufacturing of refractories. 4d. Explain the important properties of refractory. 4e. State the different types of testing procedure of refractory materials. 4f. Select the relevant refractory material for the given furnace	4.1 Definition and classification of refractory. 4.2 Duties to perform by refractory 4.3 Properties of refractory material. 4.4 General method of manufacturing refractory 4.5 Properties and applications of silica, fire clay, magnesia, dolomite, chrome magnesite, and graphite bricks. 4.6 Test of refractories like visual inspection, Pyrometric cone equivalent (PCE) test, RUL test and wear resistance test.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
1.	Introduction to fuels	08	08	04	00	12
2.	Industrial fuels	10	10	06	02	18
3.	Metallurgical furnaces	12	08	06	06	20
4.	Refractories	12	10	06	04	20
Total		**42**	**36**	**22**	**12**	**70**

Legends: R = Remember; U = Understand; A = Apply and above levels (Bloom's revised taxonomy)

Notes:

1. This specification table shall be treated as a general guideline for students and Teachers. The actual distribution of marks in the question paper may slightly vary from above Table.
2. Ask the questions from each topic as per marks weightage. Numerical questions are to be asked only if it is specified. Optional questions must be asked from the same topic.

10. 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

1. Make a model/chart on the basis of Furnace design.
2. Prepared a chart on classification fuel.
3. Collect different refractories.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

Sr. No.	Unit Title	Strategies
1	Introduction to fuels	Real life examples. Demonstration of Furnaces. Movies/Animations. Numerical.
2	Industrial fuels	
3	Metallurgical furnaces	
4	Refractories	

12. 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. However, in the fifth and sixth semesters, it should be preferably be individually undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, 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 duration of the micro-project should not be less than 16 (sixteen) student engagement hours during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

1. Prepare models of different furnaces.
2. Collection and Study of various types of fuel and refractories.
3. Prepare charts of classification of refractories.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Fuels, Furnace and Refractories	O. P. Gupta	Khanna publication, New Delhi, 6th edition,
2	**Industrial furnaces**	W. Trinks	Wiley, New York, 5th edition, 1967
3	Refractories	F.H.Norton	McGraw-Hill, New York, 4th edition, 1968
4	Introduction to Foundry Tech	A.K.Winter Ekay Winter.	McGraw-Hill, New York,1958 or latest edition

14. SOFTWARE/LEARNING WEBSITES

- www.iitk.ac.in/nptel
- https://www.youtube.com/watch?v=-DhsmYGoRa4
- https://www.youtube.com/watch?v=aDH8h63WxPo
- https://www.youtube.com/watch?v=9ZODEHKqsVE
- https://www.youtube.com/watch?v=IJ4HsYDo9Xw

15. PO-COMPETENCY-CO MAPPING

Semester I	FUEL, FURNACES AND REFRACTORIES (Course Code: 4332104)						
	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

CO1: List out the relevant fuel for the given furnace	3	-	-	-	2	-	3
CO2:Select the relevant liquid and gaseous fuel for the given application.	3	2	1	1	2	-	3
CO3:Explain construction and working of various furnaces.	3	-	-	-	2	-	2
CO4:Select the relevant refractory material for the given furnace.	3	2	1	1	2	-	3

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

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Sr.	Name and Designation	Institute	Contact Detail
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