



# GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering

Level: Diploma

Branch: Metallurgy Engineering

Course / Subject Code: DI03021051

Course / Subject Name: Fuel, Furnaces and Refractories

<b>w. e. f. Academic Year:</b>	2024-25
<b>Semester:</b>	3 <sup>rd</sup>
<b>Category of the Course:</b>	PCC

<b>Prerequisite:</b>	This course introduces students to the fundamentals and applications of fuels, combustion processes, industrial furnaces, and refractory materials. It emphasizes fuel types, combustion efficiency, furnace operation, design parameters, and selection of refractories based on application requirements.
<b>Rationale:</b>	Fuels are fundamental to the operation of metallurgical furnaces, which are essential for metal extraction and processing. The type and quality of fuel directly impact both the efficiency and cost of metallurgical products. Key metallurgical processes such as melting, heat treatment, and refining are carried out in various types of furnaces. Efficient fuel utilization and quality control depend heavily on furnace design and operation. Refractory materials play a crucial role in furnace construction, ensuring thermal efficiency and durability under high-temperature conditions. Therefore, a thorough understanding of fuels, furnaces, and refractories is essential for students pursuing a career in metallurgy.

## Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
01	Apply knowledge of fuel types, properties, and testing methods to select suitable fuels for industrial applications.	A
02	Use various metallurgical furnaces based on construction, working and operations.	A
03	Apply knowledge of refractory materials to select suitable types, manufacturing processes, and testing methods for various applications.	A

\*Revised Bloom's Taxonomy (RBT)

## Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
L	T	PR		C	Theory		Tutorial / Practical	
			ESE (E)		PA(M)	PA(I)	ESE (V)	
3	0	2	4	70	30	20	30	150



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## Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	<b>Introduction to Fuel</b> 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	8	18
2.	<b>Solid and Gaseous Fuels</b> <b>2.1 Coal</b> 2.1.1. Origin, composition and types of coal. 2.1.2. Testing of coal- Calorific value by Bomb calorimeter, Proximate and Ultimate analysis of coal <b>2.2 Coke</b> 2.2.1. The scope and objectives of carbonization of coal 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 water gas and producer gas. 2.5 Composition and use of blast furnace gas and Coke oven gas.	12	26
3.	<b>Metallurgical furnaces</b> 3.1. Define furnace 3.2. Classify furnaces based on application, processes and fuels. 3.3. Principle, construction, working and application of below mentioned furnaces; <b>a. Production furnaces-</b> Blast furnace, Electric Arc furnace. <b>b. Melting furnaces</b> – Cupola furnace, Crucible furnace, Induction furnace, Electric furnaces. <b>c. Heat treatment furnaces</b> -Muffle furnace, Salt bath furnace 3.4 Atmospheric control in various furnaces	13	28
4.	4.1 Definition and classification of refractory. 4.2 Properties of refractory material. 4.3 General method of manufacturing refractory 4.4 Properties and applications of silica, fire clay, magnesia, dolomite, chrome magnesite, and graphite bricks. 4.5 Test of refractories like visual inspection, Pyrometric cone equivalent (PCE) test, RUL test Spaling test.	12	28
	<b>Total</b>	<b>45</b>	<b>100</b>



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## Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	U Level	A Level	N Level	E Level	C Level
30	40	30			

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

## References/Suggested Learning Resources:

### Open source software and website:

- [www.iitk.ac.in/nptel](http://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>

## Books:

Sr No.	Title of Book	Author	Publication with Place, year and ISBN
1	Fuels Furnaces and Refractories	O.P.Gupta	Khanna Publication, New Delhi, 6 <sup>th</sup> Edition
2	Industrial Furnaces	W.Trinks	Wiley, New York, 5 <sup>th</sup> edition, 1967
3	Refractories	F.H.Norton	Mc-Grow Hill, New York, 4 <sup>th</sup> Edition, 1968
4	Introduction to Foundry Tech	A.K.Winter Ekay Winter	McGraw-Hill, New York, 1958 or latest edition



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## Suggested Course Practical List

Sr No.	Practical List	Unit No	Approx. Hrs. Required
1	Explore various fuel types, their significance, and industrial applications.	1	04
2	Determine the calorific value of coal using a Bomb Calorimeter.	2	04
3	Perform a proximate analysis to evaluate coal properties.	2	04
4	Identify the different types of furnaces, their purposes, and their areas of application.	3	02
5	Conduct a comprehensive study of the blast furnace and analyze its functional mechanisms.	3	02
6	Examine the design, operation, and applications of cupola furnaces.	3	02
7	Review the operation and applications of electric arc furnaces.	3	02
8	Explore the structure and working principles of induction furnaces.	3	02
9	Experimentally determine the refractoriness of materials using the Pyrometric Cone Equivalent (P.C.E) method.	4	04
10	Determination of thermal shock resistance of refractory materials.	4	04
	<b>Total</b>		<b>30</b>

## List of Laboratory/Learning Resources Required:

Sr. No.	Instrument
1.	Bomb Calorimeter



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2.	Precision thermometer
3.	Muffle Furnace up to 1600°C
4.	Moisture Analyzer
5.	Sieve Shaker
6.	Small-scale cupola furnace
7.	Induction Furnace
8.	Pyrometric Cone Set

### Suggested Project List:

1. Prepare models of different furnaces.
2. Collection and Study of various types of fuel and refractories.
3. Prepare charts of classification of refractories.
4. Comparative Study of Different Types of Refractory Bricks.

### Suggested Activities for Students:

1. Debate on Environmental Impact of Fuels
2. Visit to Industrial Furnace Facility
3. Small-Scale Furnace Design
4. Refractory Manufacturing Process Study
5. Case Study Presentation on Refractory Materials

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