GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering

Level: Diploma

Branch: Ceramic Technology

Course / Subject Code: DI03052051

Course/Subject Name: Refractory

w.e.f. Academic Year:	2024-25
Semester:	3rd
Category of the Course:	PCC

Prerequisite:	**NA**
Rationale:	Diploma ceramic students have wide scope in Refractory industries. "Refractory" is the material which with stand high temperature and it's widely used in construction of furnace and kilns. So they should familiar with basic knowledge of Refractory like Definition, classification, Raw material, processing, manufacturing, properties. Refractory is essential foundation for next curriculum of Advance refractory.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
01	Describe the fundamentals of refractory.	U
02	Select suitable refractory raw materials for refractory products.	A
03	Select processing techniques for refractory materials.	A
04	Describe the manufacturing process	U
05	Identify the suitable shaping methods, drying and firing for refractory products.	U

**RevisedBloom'sTaxonomy(RBT)*

Teaching and Examination Scheme:

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

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
Unit–I Fundamentals of refractory	1.1Definition of refractory. 1.2 Explain the classification of refractory based on occurrence, chemical characteristics, and fusion temperature. 1.3 General properties of refractory materials and uses of refractory. 1.4 Brief scope of refractory industries and List of refractory manufacturing industry in Gujarat and India.	10	20%
Unit – II Refractory Raw Materials	2.1 List out different types of refractory raw material. 2.2Detail study of properties, chemical formula, molecular weight and uses of refractory raw materials such as Fire clay, Alumina, kyanite, sillimanite, bauxite, silica, magnesite, zirconia, chromite, lime, graphite, mullite, silicon carbide. ect	08	20%
Unit – III Processing & Machines	3.1 Methods of crushing, grinding, mixing, ageing of refractory materials. 3.2 Details of machineries used for crushing and grinding of refractory materials such as jaw crusher, roller crusher, gyratory crusher, impact crusher etc. 3.3 Details of mixing machines and equipments such as ball mill, pan roller mixer, drum mixer, ribbon mixer, paddle mixer etc. 3.4 Details of body making and formulation.	10	20%
Unit – IV Manufacturing methods	4.1 Batch calculation. 4.2 Methods of manufacturing of refractory products. 4.3 Manufacturing process of fire clay brick, alumina brick, Chromite Brick, Dolomite Brick, Megnesite Brick, chrome-magnetite bricks, Mullite Brick, Sillimanite Brick and Grog.	08	20%
Unit – V Shaping, Drying, Firing of refractory	5.1Various methods of shaping of refractory. 5.2 Different shapes and sizes of refractory bricks. 5. 3 Brief details regarding Dryers used for Drying refractory bricks 5.4 Brief details regarding kilns used for firing refractory bricks	09	20%

Suggested Specification Table with Marks (Theory):

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Fundamentals of refractory	10	7	3	2	12
II	Refractory Raw Materials	08	5	7	2	14
III	Processing & Machines	10	7	6	3	16
IV	Manufacturing methods	08	7	6	3	16
V	Shaping, Drying, Firing of refractory	09	4	6	2	12
Total		**45**	**30**	**28**	**12**	**70**

Distribution of Theory Marks (in%)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
37%	**41%**	**22%**	-	-	-

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

References/Suggested Learning Resources:

(a) Books:

Sr. No.	Title of Book	Author	Publication with place,year and ISBN
1	Refractory Technology: Fundamentals and Applications	Ritwik Sarkar	**Publisher: CRC Press** **ISBN-13: 9781498754255**
2	Fundamentals of Refractory Technology	James P. Bennett & Jeffrey D. Smith	**Publisher:** Wiley / The American Ceramic Society **ISBN-13:** 9781574981339
3	Refractories	M.L. Mishra	Oxford & IBH Publishing Co., New Delhi

4	Elements of Fuels Furnaces & Refractories	O.P.Gupta Khanna	9788120351578
5	Industrial ceramics	springer	Singer and singer

(b) Open source software and website:

1. https://en.wikipedia.org/wiki/Refractory
2. https://www.cumi-murugappa.com/refractories/ind_carbon.html
3. http://www.firebricks.co.in/
4.https://www.corrosionpedia.com/2/1426/corrosion-101/refractory-metalsproperties-types-and-applications
5.https://www.worldrefractories.org/about-refractories
6. https://www.refractorymetal.org/types-of-refractory-materials-applications/

Suggested Course Practical List:

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	Prepare list of different types of refractory products with their application.	I	04
2	Identify various raw materials used in refractory industry.	II	04
3	Perform crushing and grinding operation of a given raw material.	III	04
4	Determine the Grading Sieve analysis of different grog and raw materials.	IV	04
5	Determine the moisture content of a given sample of refractory.	IV	04
6	Prepare fire bricks of given composition.	V	02
7	Preparehigh alumina bricks ≥ 45% Alumina.	V	04
8	Prepare silica bricks ≥ 93% Silica.	V	02
9	Determine Drying Shrinkage of given refractory sample	V	02
10	Determine Firing Shrinkage of given refractory sample.	V	04
11	Visit to refractory industry and prepare a report.	II to V	06
	Minimum practical required #		**30Hrs**

List of Laboratory/Learning Resources Required:

S. No.	Equipment Name with Broad Specifications	PrO.No.
1	Sieve shaker with sieve set	4-8
2	Digital weight balance	3-10
3	Brick press	6-8
4	Muffle furnace	6-10
5	Crushing machine (Jaw crusher/roller crusher/pan mill)	3

Suggested Project List:

AsuggestivelistofProjectsisgivenhere.ThishastomatchthecompetencyandtheCOs.Similarmicro- projects could be added by the concerned course teacher:

PROJECT1: Refractory industries in India: Identify and make a report/PPT on different refractory industries located in different parts of India.

PROJECT 2: Raw materials: prepare a chart of refractory raw materials with formula and Collect different types of refractory raw material samples.

PROJECT 3: Make a report or PPT on different shapes of refractory bricks.

Suggested Activities for Students:

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 perform following activities in group and prepare reports of about 5pages for each activity. They should also collect/record physical evidences for their (student's) portfolio which may be useful for their placement interviews:

a) Undertake micro-projects in team/individually.
b) Encourage Students for creating and designing new products using waste materials.
c) Students are encouraged to register themselves in various **MOOCs** suchas: **Swayam, edx, Coursera, Udemy**etc to further enhance their learning.

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