

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

**COURSE CURRICULUM
COURSE TITLE:REFRACTORY
(Code: 3345205)**

Diploma Programme in which this course is offered	Semester in which offered
Ceramic Technology	4 th Semester

1. RATIONALE

This course imparts knowledge of manufacturing process, properties and application of refractory products. A ceramic engineer should have the knowledge of refractory raw materials, processing of raw materials, manufacturing process, properties, testing and application of refractory. Hence the course has been design to develop these competencies and its associated cognitive, practical and effective domain learning out comes.

2. COMPETENCY

The course should be taught and curriculum should be implemented with the aim to develop required skills so that students are able to acquire following competency:

- **Plan and supervise the manufacturing of refractory.**
- **Perform different types of tests on refractory.**

3. COURSE OUTCOMES

The theory should be taught and practical should be carried out in such a manner that students are able to acquire required learning out comes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

- i. Distinguish various manufacturing process of refractory
- ii. Perform different types of Test for Refractory.
- iii. Implement pollution control and safety measures in refractory industries

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				Total Marks
L	T	P		Theory Marks		Practical Marks		
			C	ESE	PA	ESE	PA	
3	0	4	7	70	30	40	60	200

Legends: L - Lecture; T - Tutorial/Teacher Guided Student Activity; P - Practical; C - Credit; ESE - End Semester Examination; PA - Progressive Assessment

5. COURSE DETAILS

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I Introduction	1a. Explain Scope of refractory 1b. Define Refractory.	1.1 Scope of refractory in relation to other industries. 1.2 Definition of the term and its general application in various other industries.
Unit – II Methods of Manufacture	2a. Describe different manufacturing process. 2b. Distinguish various manufacturing process of bricks 2c. Select appropriate refractory bricks.	2.1 Methods of manufacturing of refractory products. 2.2 Manufacturing process of firebricks, Chromite Brick, Dolomite Brick, Magnesite Brick, chrome-magnetite bricks, Mullite Brick, Sillimanite Brick and Insulating Brick 2.3 Properties and use of different Refractory bricks
Unit – III Properties and Tests of Refractory	3a. Identify different physical properties of Refractory. 3b. Perform different types of Test for Refractory.	3.1 Physical properties of different types of refractory bricks like porosity, permeability, specific gravity, bulk density etc. 3.2 Determination of fusion point, load bearing capacity, expansion and shrinkage of refractory, bulk density, thermal conductivity, electrical conductivity, abrasion resistance and spalling resistance
Unit – IV Uses	4a. Identify appropriate Refractory materials for Industries.	4.1 Use of refractory in ferrous industries. 4.2 Use of refractory in non-ferrous industries 4.3 Use of refractory in boilers. 4.4 Use of refractory in power generators and gas generators. 4.5 Use of refractory in current industries.
Unit – V Pollution Control and Safety in Refractory Industries	5a. Explain various reasons for pollution. 5b. Apply precaution	5.1. Pollution in Refractory industries 5.2. Precaution during manufacturing process of Refractory articles.

6. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction	5	5	5	0	10
II	Methods of Manufacture	12	6	9	6	21
III	Properties and Tests of Refractory	11	4	6	6	16
IV	Uses of Refractory	7	2	4	6	12
V	Pollution Control and Safety in Refractory Industries	7	3	5	3	11
Total Hrs		42	20	29	21	70

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

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

7. SUGGESTED LIST OF EXERCISES/PRACTICAL

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills (**outcomes in psychomotor and affective domain**) so that students are able to acquire the competencies/programme outcomes. Following is the list of practical exercises for guidance.

Note: Here only outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of **Course Outcomes** related to affective domain. Thus over all development of **Programme Outcomes** (as given in a common list at the beginning of curriculum document for this programme) would be assured.

Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.

S. No.	Unit No.	Practical/Exercise (Outcomes' in Psychomotor Domain)	Hours
1	II	Prepare I.S. 6 brick.	8
2	II	Prepare I.S. 7 brick.	8
3	II	Prepare I.S. 8 brick.	8
4	II	Prepare Insulating brick.	8
5	II	Prepare acid resistance brick.	8
6	II	Prepare high alumina brick.	8
7	III	Identify physical properties of Refractory on samples.	2
8	III	Determine the porosity of a given refractory brick sample.	4
9	III	Determine the Bulk Density of a given refractory brick sample.	4
10	III	Determine the pyrometric cone equivalent of the given sample.	4

S. No.	Unit No.	Practical/Exercise (Outcomes' in Psychomotor Domain)	Hours
11	III	Determine drying and firing shrinkage of a given refractory brick sample.	4
12	III	Determine Cold Crushing Strength of a given refractory brick sample.	2
13	III	Determine Thermal Shock resistance of Refractory sample.	4
Total Hours			72

8. SUGGESTED LIST OF STUDENT ACTIVITIES

- i. Teacher guided self-learning activities.
- ii. Library survey regarding Refractory used in different industries.
- iii. Industrial Visits of one or two nearby Industries.
- iv. Presentation on different manufacturing process of Refractory brick.

9. SPECIAL INSTRUCTIONAL STRATEGIES (if any).

- i. Show video film/animation films/photographs related to refractory manufacturing process and its defects.
- ii. Give internet based assignments.

10. SUGGESTED LEARNING RESOURCES

A. List of Books

S. No.	Title of Books	Author	Publication
	Refractories, Their Manufacture, Properties and Uses	M.L.MISRA	M.L.MISRA
	Refractories	F.H.Norton	McGraw-Hill
	Refractories and its Applications	Kenneth Shaw	Halsted Press Div., Wiley

B. List of Major Equipment/Materials

- i. Different types of Refractory clays, Minerals and additives.
- ii. Weighing Balance, Varnier scale, sieving machine with sieves.
- iii. Lab Type Ordinary Pug Mill, De-arising Pug Mill, Mixers
- iv. Lab Type Toggle press, Hydraulic Press, Universal Testing Machine
- v. Lab Type Tray dryer, Hot Plate Dryer, rapid moisture Meter
- vi. Lab Type Chamber Kiln

C List of Software/Learning Websites

- i. http://en.wikipedia.org/wiki/Category:Refractory_materials
- ii. http://nptel.iitm.ac.in/courses/113104059/lecture_pdf/Lecture%209.pdf
- iii. <http://www.cosmile.org/Manual/pdf/chapter12.pdf>

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. B. B. Patel** , Lecturer L. E. College, Morbi
- **Prof. H. B. Dedania**, Retired Lecturer L. E. College, Morbi
- **Prof. S. Prasaad**, Retired Lecturer L. E. College, Morbi

Coordinator and Faculty Members from NITTTR Bhopal

- **Dr. Abhilash Thakur**. Associate Professor, Department of Applied Sciences
- **Dr. Bashirullah Shaikh**, Assistant Professor, Department of Applied Sciences