

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

**COURSE CURRICULUM
COURSE TITLE: ADVANCE REFRACTORY
(COURSE CODE: 3355204)**

Diploma Programme in which this course is offered	Semester in which offered
Ceramic Engineering	5 th Semester

1. RATIONALE

Diploma ceramic engineers have to work with the refractory raw material and for this they should know microstructure and properties of refractory materials, manufacturing process, compounding of refractory bodies, chemical and mechanical properties. Advance refractory is a subject that imparts knowledge of oxide refractory, manufacturing process, properties and application, testing of refractory products. Hence the course has been design to develop these skills and its associated cognitive, practical and effective domain learning out comes.

2. COMPETENCY

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

- **Plan and supervise production of different types of 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.

- Identify the problems from refractory industries.
- Draw the thermo-chemical reaction for fire bricks.
- Draw phase diagram for different refractory systems.
- Manufacture different refractory products.
- List-out various factors affecting the compounding of refractory bodies
- Perform chemical and mechanical analysis of refractory raw materials
- Distinguish different types of refractory.
- Identify load bearing capacity of refractory brick.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
L	T	P		Theory Marks		Practical Marks		Total Marks
L	T	P	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 CONTENT DETAILS

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I Introduction	1a. Explain problems of refractory industries. 1b Describe critical assessment of problems regarding raw material and high temperature Firing.	1.1 Introduction 1.2 Problems of refractory industries in India 1.3 Critical assessment of the problems regarding raw materials and firing at high temperature.
Unit – II Micro Structure and its Relation to Properties of Refractory Materials	2a.State different application of Refractory materials. 2b. State thermo-chemical reaction in fire bricks 2c.Explain alumina-silica phase diagrams of different refractory systems.	2.1 Different application of refractory materials 2.2 Thermo-chemical reaction in fire bricks 2.3 Study of alumina-silica phase diagram and other related refractory system
Unit – III Methods of Manufacturing	3a.Explain various manufacturing methods of different refractory products. 3b. Describe chemical bonds and other bonds used in refractory industries.	3.1 Introduction. 3.2 Various methods of manufacture of refractory 3.3 Manufacturing method of refractory bricks, refractory blocks, muffles, saggars and other kiln furniture. 3.4 Manufacture methods of glass house pots, crucible and ladle refractory. 3.5 Details about chemical bonds and other bonds used in refractory industries
Unit – IV Compounding of Refractory Bodies	4a. Explain various factors for compounding of refractory bodies. 4b. Describe effect of raw materials on properties of refractory. 4c. Explain effect of method of manufacturing on properties of finished Refractory. 4d. Explain effect of shaping method on finished products.	4.1 Introduction 4.2 Consideration of various factors during compounding of refractory bodies 4.3 Effect of raw materials used on refractory properties 4.4 Effect of method of manufacture on properties of finished Refractory. 4.5 Effect of shaping method on finished products
Unit –V Chemical and Mechanical Analysis	5a.Describe chemical and mechanical analysis of refractory raw materials and their products.	5.1 Introduction 5.2 Details of chemical analysis and mechanical analysis of refractory raw materials and their products.
Unit-VI Oxide Refractories	6a. Explain oxides, carbide and nitride refractory.	6.1 Introduction 6.2 Brief idea of oxides, carbide and nitride refractory.
Unit-VII	7a. Explain Methods of	7.1 Methods of obtaining fusion point

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Testing of Properties	obtaining fusion point. 7b. list out Factors influencing the load bearing capacity of refractory brick.	(P.C.E.) 7.2 Factors influencing the load bearing capacity of refractory bricks

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
1	Introduction	4	5	0	0	5
2	Micro Structure and its Relation to Properties of Refractory Materials	7	3	6	5	14
3	Methods of Manufacturing	6	3	3	4	10
4	Compounding of Refractory Bodies	8	2	5	5	12
5	Chemical and Mechanical Analysis	5	3	3	3	09
6	Oxide Refractories	6	3	4	3	10
7	Testing of Properties	6	3	4	3	10
Total		42	19	28	23	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)	Apprx. Hrs. Required
1	II	Draw phase diagrams of different refractory systems	4
2	III	Prepare fire bricks and cutting in to Various shape	8
3	III	Prepare acid resistance bricks	8
4	III	Prepare insulating bricks	8
5	III	Determine R.U.L. of given Refractory sample.	4
6	V	Perform chemical and mechanical analysis of refractory raw materials from given test data	4
7	VII	Determine the Apparent porosity of the given sample of the Refractory bricks	4
8	VII	Determine the Apparent Sp.Gr. of given sample of refractory	4
9	VII	Determine the Bulk density of the given sample of refractory	4
10	VII	Determine the cold crushing strength of the given Refractory sample	2
11	VII	Determine of pyrometric cone equivalent or softening point of the given refractory	6
Total			56

8. SUGGESTED LIST OF STUDENT ACTIVITIES

- i. Teacher guided self-learning activities.
- ii. Course/topic based internet based assignments.
- iii. Library/internet survey regarding Refractory used in different industries.
- iv. Industrial Visits of one or two Industries.
- v. Presentation on different manufacturing process of Refractory products.

9. SPECIAL INSTRUCTIONAL STRATEGIES(if any):

- i. Show video films/photographs of production and testing procedure, techniques and machines used in different parts of the world for making special white ware.
- ii. Arrange visit to nearby industry making refractories and ask students to prepare report.
- iii. Facilitate the students to set up practical apparatus on their own.

10. SUGGESTED LEARNING RESOURCES

A. List of Books:

S. No.	Title of Books	Author	Publication
1	Refractories, Their Manufacture, Properties and Uses	M.L.MISRA	M.L.MISRA
2	Refractories	F. H. Norton	McGraw-Hill
3	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, PCE furnace

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**, Lecturer (Retired) L. E. College, Morbi
- **Prof. S. Prasaad**, Lecturer (Retired)L. E. College, Morbi

Coordinator and Faculty Members from NITTTR Bhopal

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