



# GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma Engineering

Level: Diploma

Branch: Ceramic Technology

Subject Code: DI04052081

Subject Name: Refractories for Iron and Steel Plants

|                                |                            |
|--------------------------------|----------------------------|
| <b>w.e.f. Academic Year:</b>   | 2025-26                    |
| <b>Semester:</b>               | 4 <sup>th</sup>            |
| <b>Category of the Course:</b> | Professional Elective - II |

|                      |  |
|----------------------|--|
| <b>Prerequisite:</b> | NA   |
| <b>Rationale:</b>    | Iron and steel manufacturing industries use a wide range of refractory materials in furnaces, ladles, and related equipment. Understanding the selection, application, and maintenance of these refractories is essential for ceramic engineers. This course provides in-depth knowledge of refractory materials used in iron and steel making, their performance, wear mechanisms, and maintenance practices. |

### Course Outcome:

After Completion of the Course, Student will able to:

| No | Course Outcomes   | RBT Level |
|----|---|-----------|
| 01 | Explain various iron-making processes and identify refractories used in each zone.                  | U         |
| 02 | Describe refractories used in blast furnace, their characteristics, and operational requirements.   | U         |
| 03 | Illustrate the functioning and refractories used in hot metal handling and steel-making equipment.  | A         |
| 04 | Select operation and refractory practices in LD converter, ladles, and de sulphurisation processes. | A         |
| 05 | Select secondary steel-making refractories, TRM (Total Refractory Management), and safety measures. | A         |

*\*Revised Bloom's Taxonomy (RBT)*

### Teaching and Examination Scheme:

| Teaching Scheme<br>(in Hours) |   |    | Total Credits<br>L+T+(PR/2) | Assessment Pattern and Marks |        |       |                     | Total<br>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 |
|--|---|--------------|----------------|
| <b>Unit-I</b><br>Introduction to Iron and Steel Making Processes           | <b>1.1</b> Overview of iron and steel production routes – Blast Furnace, Corex, Finex, and DRI process.<br><b>1.2</b> Flow diagram of iron and steel making with refractory application points.<br><b>1.3</b> Importance and selection of refractories for high-temperature zones.    | 08           | 20%            |
| <b>Unit – II</b><br><b>Refractories for Iron Making – Blast Furnace</b>    | <b>2.1</b> Construction and operation of blast furnace.<br><b>2.2</b> Refractories used in hearth (carbon), bosh & belly (alumina/SiC), and stack (alumina/graphite).<br><b>2.3</b> Refractory wear, gunning, patching, and maintenance practices.                                    | 09           | 20%            |
| <b>Unit – III</b><br><b>Hot Metal Handling and Primary Steel Making</b>    | <b>3.1</b> Hot metal transfer ladles, runners, torpedoes – construction and refractory types.<br><b>3.2</b> LD Converter – process, refractory lining (MgO-C), slag splashing, and laser thickness measurement.<br><b>3.3</b> Desulphurisation process and refractory used in lances. | 08           | 10%            |
| <b>Unit – IV</b><br><b>Secondary Steel Making and Casting Refractories</b> | <b>4.1</b> Steel ladle – design, refractories used, life analysis, slide gate and purging plug.<br><b>4.2</b> RH Degasser and vacuum vessel refractories.<br><b>4.3</b> Continuous casting platform refractories – tundish, shroud, SEN, and maintenance                              | 12           | 20%            |
| <b>Unit – V</b><br><b>Total Refractory Management (TRM) and Safety</b>     | <b>5.1</b> Concept of TRM, importance, and scope in steel industries.<br><b>5.2</b> Common safety precautions during refractory erection and maintenance.<br><b>5.3</b> Sustainable refractory practices and waste reduction.   | 08           | 30%            |



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## Suggested Specification Table with Marks (Theory):

| Unit         | Unit Title                                      | Teaching Hours | Distribution of Theory Marks |           |           |             |
|--------------|---|----------------|------------------------------|-----------|-----------|-------------|
|              |   |                | R Level                      | U Level   | A Level   | Total Marks |
| I            | Introduction to Iron and Steel Making Processes | 8              | 5                            | 5         | 2         | 12          |
| II           | Refractories for Iron Making – Blast Furnace    | 9              | 4                            | 6         | 6         | 16          |
| III          | Hot Metal Handling and Primary Steel Making     | 8              | 2                            | 5         | 5         | 12          |
| IV           | Secondary Steel Making and Casting Refractories | 12             | 2                            | 8         | 8         | 18          |
| V            | Total Refractory Management (TRM) and Safety    | 8              | 2                            | 5         | 5         | 12          |
| <b>Total</b> |   | <b>45</b>      | <b>15</b>                    | <b>29</b> | <b>26</b> | <b>70</b>   |

| Distribution of Theory Marks (in%) |         |         |         |         |         |
|------------------------------------|---------|---------|---------|---------|---------|
| R Level                            | U Level | A Level | N Level | E Level | C Level |
| 21%                                | 41%     | 37%     | -       | -       | -       |

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

## References/Suggested Learning Resources:

### (a) Books:

| Sr. No. | Title of Book  | Author        | Publication with place, year and ISBN  |
|---------|--|---------------|--|
| 1       | Elements of Fuels, Furnaces & Refractories           | O.P.Gupta     | Khanna publications;2016;9788120351578 |
| 2       | Refractory Technology: Fundamentals and Applications | Ritwik Sarkar | CRC press;2016;1498754252              |



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|   |   |                                   |   |
|---|---|-----------------------------------|---|
| 3 | Refractory Materials:<br>Processing, Properties and<br>Applications | Subir Biswas                      | Ane Books Pvt. Ltd; 2021,<br>978-9390658725 |
| 4 | Refractories  | F.H.Norton                        | McGraw-Hill                                 |
| 5 | industrial Ceramics   | Felix Singer ,<br>Sonja S. Singer | Springer Dordrecht<br>978-94-017-5257-2     |

**(a) Open source software and website:**

1. [http://en.wikipedia.org/wiki/Category:Refractory\\_materials](http://en.wikipedia.org/wiki/Category:Refractory_materials)
2. <https://en.wikipedia.org/wiki/Refractory>
3. [https://www.cumi-murugappa.com/refractories/ind\\_carbon.html](https://www.cumi-murugappa.com/refractories/ind_carbon.html)
4. <http://www.firebricks.co.in>

**Suggested Course Practical List:**

| S. No. | Practical Outcomes (PrOs)   | Unit No.   | Approx. Hrs. required |
|--------|---|------------|-----------------------|
| 1      | Study & Identification of Refractory Samples                          | I, II, III | 4                     |
| 2      | Determination of Bulk Density & Apparent Porosity of Refractory Brick | I, II, III | 4                     |
| 3      | Cold Crushing Strength (CCS) Test of Refractory Specimen              | I, II, III | 4                     |
| 4      | Determine the bulk density of given refractory sample.                | IV         | 2                     |
| 5      | Determination of Modulus of rupture (MOR) of refractories.            | IV         | 2                     |
| 6      | Determine the porosity of a given refractory sample.                  | IV         | 2                     |
| 7      | Determine Cold Crushing Strength of given Refractory sample.          | IV         | 2                     |
| 8      | Determine specific gravity of given Refractory sample.                | IV         | 2                     |
| 9      | Determine R.U.L of given Refractory sample.                           | IV         | 4                     |
| 10     | Determine P.C.E Value of a given sample.                              | IV         | 4                     |
|        | <b>Total</b>  |            | <b>30Hrs</b>          |



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## List of Laboratory/Learning Resources Required:

| S. No. | Equipment Name with Broad Specifications | PrO.No.     |
|--------|--|-------------|
| 1      | Sieve shaker with sieve set              | 1,2,3       |
| 2      | Digital weight balance                   | 1,2,3,4,6,8 |
| 3      | Water bath                               | 4,6,8       |
| 4      | Hot air oven                             | 4,6,8       |
| 5      | Furnace                                  | 1,2,3,9,10  |
| 6      | Pastel and Mortar                        | 1,2,3       |
| 7      | UTM,C C S, PCE MACHINE                   | 5,7         |
| 8      | Pressing machine                         | 1,2,3       |

## Suggested Project List:

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

- Prepare list of some Refractory articles.
- Undertake micro-projects in teams
- Give seminar on any relevant topic..

## 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 5 pages for each activity. They should also collect/record physical evidences for their (student's) portfolio which may be useful for their placement interviews:

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

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