

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

Course Curriculum

FUEL, FURNACES AND REFRACTORIES

(Code: 3332104)

| Diploma Programmes in which this course is offered | Semester in which offered |
|-----------------------------------------------------------|----------------------------------|
| Metallurgy Engineering | 3 rd Semester |

1. RATIONALE

Fuels are basic requirements of Metallurgical furnaces for extraction of metals. Fuels play a major role in quality and cost of any metallurgical product. Important metallurgical operations like melting, heat treatment etc. are carried out in various metallurgical furnaces. For optimum utilization of fuel and quality control in the process, furnace is most important equipment. Refractories are very important material for construction of furnaces which help in the efficient utilization of furnace. Thus it is very important for students to learn about fuels, furnace and refractories.

2. COMPETENCY (Programme Outcome according to NBA Terminology)

The course content should be taught and implemented with the aim to develop different types of skills so that students are able to acquire following competency:

- **Select the proper type of furnace with relevant refractory material and appropriate fuel for given metallurgical operation.**

3. TEACHING AND EXAMINATION SCHEME

| Teaching Scheme (In Hours) | | | Total Credits (L+T+P) | Examination Scheme | | | | Total Marks |
|---------------------------------------|----------|----------|----------------------------------|---------------------------|-----------|------------------------|-----------|------------------------|
| L | T | P | | Theory Marks | | Practical Marks | | |
| L | T | P | C | ESE | PA | ESE | PA | 100 |
| 4 | 0 | 0 | 4 | 70 | 30 | 0 | 0 | |

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

4. COURSE DETAILS

| Unit | Major Learning Outcomes (Course Outcomes in Cognitive Domain according to NBA terminology) | Topics and Sub-topics |
|--------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Unit – I Introduction to Fuel | 1a. Define fuel 1b. List fuels according to the source 1c. Distinguish the features of solid, liquid and gaseous fuel 1d. Select the relevant fuel for the given furnace. | 1.1. Types of fuel with example (like solid, liquid, gas) 1.2. Sources of different types of fuels. 1.3. Merits and demerits of each fuel. 1.4. Comparison of solid, liquid and gaseous fuel |
| Unit– II Solid, Liquid Gaseous fuel | 2a. Differentiate coal used in various applications. 2b. Explain the importance of calorific value 2c. Select the coal for furnace under consideration | 2.1 Formation of coal, Types of coal. 2.2 Carbonization of coal 2.3 Proximate and ultimate analysis of coal |
| | 2a. Describe testing methods of coal. 2b. Describe the distillation of crude oil 2c. Select the relevant liquid and gaseous fuel for the given application | 2.4 Methods for testing properties like calorific value, Flash point, Fire point. 2.5 Production, composition and uses of water gas and producer gas. 2.6 Composition and uses of blast furnace gas and coke oven gas. 2.7 Fractional distillation of crude oil |
| Unit– III Metallurgical furnaces | 3a. Explain furnace construction and working 3b. Explain various furnace atmosphere 3c. Explain the working of production furnaces | 3.1 Define furnaces. 3.2 Classify furnaces on the basis of uses, process, fuel. 3.3 Production furnaces like Blast furnaces, reverberatory, open hearth, LD, Kaldo. |
| | 3d. Explain the working of melting furnaces 3e. Explain the working of heat treatment furnaces 3f. Compare the environmental impact of all these types of furnaces | 3.4 Melting furnaces like Cupola, Rotary furnaces, Crucible furnaces, Electric furnaces. 3.5 Heat treatment furnaces like muffle and salt bath furnace 3.6 Atmospheric control in various furnaces. |
| Unit– IV Introduction to Refractories | 4a. Describe manufacturing of different types of refractories 4b. List the various types of tests 4c. State the different types of testing procedure of refractory materials. 4d. Select the relevant refractory material for the given furnace | 4.1 Properties of refractory material. 4.2 Manufacturing of acid, basic and neutral refractories 4.3 Test refractories like visual inspection, Pyrometric cone equivalent (PCE) test, RUL test, Spalling test, thermal conductivity test etc. |
| Unit – V Advances in Furnaces | 5a. State the advances in melting furnaces 5b. State the advances in heat | 5.1 Advances in melting furnaces 5.2 Advance in heat treatment furnaces 5.3 Advances in refractories |

| Unit | Major Learning Outcomes (Course Outcomes in Cognitive Domain according to NBA terminology) | Topics and Sub-topics |
|-------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| and Refractories | treatment furnaces 5c. State the advances in Refractories 5d. State substitute of furnaces and refractory materials which can be replaced by the modern ones for the given application | |

5. SUGGESTED SPECIFICATION TABLE WITH HOURS and MARKS (THEORY)

| Unit | Unit Title | Teaching Hours | Distribution of Theory Marks | | | |
|--------------|---------------------------------------|----------------|------------------------------|-----------|-----------|-------------|
| | | | R Level | U Level | A Level | Total Marks |
| 1. | Introduction of fuel | 06 | 04 | 02 | 00 | 06 |
| 2. | Solid, Liquid and Gaseous fuel | 14 | 04 | 10 | 06 | 20 |
| 3. | Metallurgical furnaces | 18 | 06 | 12 | 06 | 24 |
| 4. | Introduction to refractories | 14 | 04 | 08 | 04 | 16 |
| 5. | Advances in furnaces and refractories | 04 | 00 | 02 | 02 | 04 |
| Total | | 56 | 20 | 32 | 18 | 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.

6. SUGGESTED LIST OF EXERCISES/PRACTICALS

Not Applicable

7. SUGGESTED LIST OF PROPOSED STUDENT ACTIVITIES

Following is the list of proposed student activities like:

- i. Industrial visits.
- ii. Collection and Study of various types of fuel and refractories.
- iii. Group discussion on recent fuel scenario.
- iv. Preparation of assignment.
- v. Presentation on recent developments in the furnace technology.

8. SPECIAL INSTRUCTIONAL STRATEGIES (If Any)

- i. Improved lecture method
- ii. Industrial visit
- iii. Video film presentation

9. SUGGESTED LEARNING RESOURCES

A) List of Books

| S. No. | Title of Books | Author | Publication |
|--------|---------------------------------|-------------------------|---------------------------------------------------------|
| 1 | Fuels, Furnace and Refractories | O. P. Gupta | Khanna publication, New Delhi, 6 th edition, |
| 2 | Industrial furnaces | W. Trinks | Wiley, New York, 5 th edition, 1967 |
| 3 | Refractories | F.H.Norton | McGraw-Hill, New York, 4 th edition, 1968 |
| 4 | Introduction to Foundry Tech | A.K.Winter Ekay Winter. | McGraw-Hill, New York, 1958 or latest edition |

B) List of Major Equipment/Materials with Broad Specifications

Not applicable

C) List of Software/Websites

i. www.iitk.ac.in/nptel

10. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Dr. I. B. Dave**, Head, Department of Metallurgy Engineering, Dr. S and S S Ghandhy Engg. College, Surat.
- **Prof. V. N. Kaila**, Lecturer Department of Metallurgy Engineering, Government Polytechnic Rajkot

Coordinator and Faculty Members from NITTTR Bhopal

- **Dr. Vandana Somkuwar**, Associate Professor, Department of Mechanical Engineering
- **Dr. C. K. Chugh**, Professor, Department of Mechanical Engineering