

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: THERMAL TREATMENT OF METALS AND ALLOYS
(COURSE CODE: 3352106)

| Diploma Programme in which this course is offered | Semester in which offered |
|---|---------------------------|
| Metallurgy Engineering | 5 th Semester |

1. RATIONALE

Thermal treatment is one of the most important process in metallurgical industries to develop required properties in metals and alloys. Almost all metallurgical units have their thermal treatment set up. This course in addition to course on heat treatments of metals and alloys will make comprehensive coverage of thermal treatment of commercially available metals and alloys with emphasis both in theoretical and practical aspect. It is therefore an important course.

2. LIST OF COMPETENCY

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:

- **Plan and supervise the thermal treatment process of metals and alloys.**

3. COURSE OUTCOMES

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

- Operate the thermal treatment furnaces.
- Supervise the thermal treatment processes of commercial steels.
- Operate the thermal treatment equipment for different types of iron.
- Supervise the thermal treatment processes of alloy steel.
- Control the quality of thermal treatment processes.

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 | | |
| L | T | P | C | ESE | PA | ESE | PA | 150 |
| 3 | 0 | 2 | 5 | 70 | 30 | 20 | 30 | |

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 Thermal Treatment processes and furnaces | 1a. Describe the effect of thermal treatment of metals and alloys 1b. Describe the features of thermal treatment processes 1c. Describe the construction of Muffle furnace, Salt bath furnace, Continuous type furnace with sketches 1d. Explain the working of Muffle furnace, Salt bath furnace, Continuous type furnace with sketches 1e. Describe the operation and maintenance procedure of the above mentioned furnaces. 1f. Describe the process of atmosphere control in thermal treatment furnaces 1g. Describe the process of temperature measurement and control in thermal treatment furnaces. | 1.1 Effect of thermal treatment of metals and alloys. 1.2 Features of thermal processes. 1.3 Thermal treatment furnaces: Muffle furnace, Salt bath furnace, Continuous type furnace construction, salient features, working and maintenance procedure 1.4 Operation and maintenance of the above furnaces 1.5 Atmosphere control in thermal treatment furnaces. 1.6 Temperature measurement and control in thermal treatment furnaces. |
| Unit – II Thermal Treatment of Commercial Steels | 2a. Describe thermal treatment of low carbon steel 2b. Describe thermal treatment of medium carbon steel 2c. Describe thermal treatment of high carbon steel. 2d. Describe the operation and basic maintenance of the above mentioned thermal treatment equipment | 2.1 Thermal treatment of: Low Carbon steel, Medium carbon steel, High carbon steel. 2.2 Operation and basic maintenance procedure of thermal treatment equipment |
| Unit – III Thermal Treatment of Different Types of Iron | 3a. Justify the thermal treatment of different types of iron. 3b. Describe thermal treatment for Gray Cast iron, S. G. Iron, Ni-Hard white C.I Ni-Resist C.I. 3c. Describe the process of malleabilizing of white cast iron. 3d. Describe the operation and basic maintenance process of the equipment for thermal treatment of iron and malleabilizing equipment. | 3.1 Thermal treatment of: Cast iron, Gray Cast iron, S.G.iron, Ni-Hard white C.I. Ni-Resist C.I. 3.2 Malleabilizing of White Cast iron. 3.3 Operation and basic maintenance procedure of the equipment for thermal treatment of iron and malleabilizing equipment. |
| Unit – IV Thermal Treatment of Alloy | 4a. Describe the thermal treatment process of Hadfield - Mn - steel, Spring steel, Bearing steel (Cr - steel), H.S.S., Stainless steel like Austenitic S.S., | 4.1 Thermal treatment of: Hadfield - Mn - steel, Spring steel, Bearing steel (Cr - steel), H.S.S., Stainless |

| Unit | Major Learning Outcomes (in cognitive domain) | Topics and Sub-topics |
|--|---|--|
| Steel | Ferritic S.S., Martensitic S.S., Structural steel like rolled, cold drawn and cold rolled steels. 4b. Describe the operation and maintenance process of the equipment used in thermal treatment process of Alloy Steel | steel like Austenitic S.S., Ferritic S.S., Martensitic S.S., Structural steel like rolled, cold drawn and cold rolled steels. |
| Unit – V Quality Control in Thermal Treatment | 5a. Explain causes of defects during thermal treatment. 5b. Describe the remedies of defects during thermal treatment. 5c. Describe the steps to be taken to maintain quality control 5d. Describe the process of inspection 5e. Describe the factors affecting the quality of thermal treatment of products 5f. Justify the functions of quality control department | 5.1 Defects and remedies during thermal treatment. 5.2 Steps and objectives of quality control. 5.3 Inspection process 5.4 Factors affecting the quality of thermal treatment product. 5.5 Functions of quality control department. |

6. 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 |
| I | Thermal Treatment Processes and Furnaces | 06 | 04 | 02 | 04 | 10 |
| II | Thermal Treatment of Commercial Steels | 08 | 06 | 03 | 05 | 14 |
| III | Thermal Treatment of Different Types of Iron | 10 | 06 | 06 | 06 | 18 |
| IV | Thermal Treatment of Alloy Steel | 09 | 04 | 04 | 06 | 14 |
| V | Quality Control in Thermal Treatment | 09 | 04 | 04 | 06 | 14 |
| Total | | 42 | 24 | 19 | 27 | 70 |

7. SUGGESTED EXERCISES/PRACTICALS

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/course outcomes. Following is the list of practical exercises for guidance.

Note: outcomes in psychomotor domain are listed here 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 members 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 | Practical / Exercise (outcomes in psychomotor) | Approx. Hrs. required |
|-------------------|------|---|-----------------------|
| 1 | I | Determine the effects of quenching media on hardness of steels.(air, oil, brine, water) | 4 |
| 2 | I | Perform heat treatment of Ball Bearing steel. (Annealing, Hardening, Tempering.) | 4 |
| 3 | II | Perform heat treatment of Spring steel. (Hardening, Tempering.) | 4 |
| 4 | II | Perform heat treatment of En-24 steel. (Hardening, Tempering.) | 4 |
| 5 | III | Perform heat treatment of En-8 steel. (Hardening, Tempering.) | 4 |
| 6 | V | Identify defects in thermal treated products. | 4 |
| 7 | V | Calculate Energy consumption in thermal treatment from given data. | 4 |
| Total Hrs. | | | 28 |

8. SUGGESTED LIST OF STUDENT ACTIVITIES

- i. Students may prepare layout of integrated steel plant including thermal treatment shop by collecting information from Internet.
- ii. Industrial visit of any nearby steel plant having thermal treatment facilities.

9. SPECIAL INSTRUCTIONAL STRATEGIES (If Any)

- i. Video/animation film presentation to explain the theory, process and equipment for heat treatment process.
- ii. Seminar by group of students on different aspects of heat treatment processes.

10. SUGGESTED LEARNING RESOURCES

(A) List of Books

| S. No. | Title of Books | Author | Publication |
|--------|--|------------------------------|-------------|
| 1 | Heat treatment principles and techniques | Rajan, T.V. and Sharma, C.P. | |
| 2 | Handbooks of heat treatment | Prabhudev, K.H. | |
| 3 | Physical metallurgy for Engineers | Clark and Varney | |
| 4 | Physical metallurgy | Avener | |

(B) List of Software/Learning Websites

- i. <http://www.industry.siemens.com/verticals/metals-industry/en/metals/steelmaking/ld-steelmaking/Pages/home.aspx>
- ii. http://www.carbonandgraphite.org/pdf/steel_production.pdf
- iii. <http://corporate.arcelormittal.com/who-we-are/from-ore-to-steel>

- iv. <http://www.topforge.co.uk/Processes.htm>
- v. <http://en.wikipedia.org/wiki/Steelmaking>
- vi. <http://www.steel.org/Making%20Steel/How%20Its%20Made/Processes/Processes%20Info/The%20Basic%20Oxygen%20Steelmaking%20Process.aspx>
- vii. http://www.steelconstruction.info/Steel_manufacture

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Coordinator and Faculty Members from NITTTR Bhopal

- **Dr. C. K. Chugh**, Professor, Department of Mechanical Engineering
- **Dr Joshua Earnest**, Professor, Department of Electrical and Electronics Engineering