

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: HEAT TREATMENTS OF METALS & ALLOYS
(Code: 3342105)

Diploma Programme in which this course is offered	Semester in which offered
Metallurgy Engineering	4 th Semester

1. RATIONALE

In industry, various products of metals and alloys are provided with different degrees of heat treatment to develop properties like- hardness, toughness, tempering, etc the diploma engineers are expected to supervise these operations for quality outputs. Hence, this course deals with the understanding of principles and procedures of different types of heat treatment for engineering metals and alloys. This course will help the student to understand the underlying physical metallurgy principles and application of different types of heat treatment for obtaining the desired properties in the alloys.

2. COMPETENCY

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

- **Plan and Supervise different heat treatment operations and its results.**

3. COURSE OUTCOMES (COs)

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.

- Describe construction and working of different type of pyrometer
- Describe different types of Annealing and its applications.
- Explain process of Tempering & Hardening.
- Describe the process for surface hardening
- Describe Precipitation Hardening of Al-Cu alloys.

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	30	20	

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

5 DETAILED COURSE CONTENT

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I Pyrometry	1a. State importance of pyrometers. 1b. Classify pyrometers. 1c. Describe construction and working of different type of pyrometer.	1.1 Importance & Relevance 1.2 Resistance pyrometers: principles, construction and working. 1.3 Thermocouples pyrometry: principles, construction and working. 1.4 Radiation pyrometry: principles, construction and working. 1.5 Optical pyrometers: principles, construction and working.
Unit – II Annealing	2a. State importance of heat treatment process. 2b. Classify Annealing process. 2c. Describe different types of Annealing and its applications.	2.1. Introduction to heat treatment. 2.2. Principle, objectives & process of Annealing. 2.3. Classification and application of Annealing.
Unit – III Normalising	3a. Describe Normalizing process. 3b. Differentiate between Annealing and Normalizing.	3.1 Principle, objectives & process of Normalizing. 3.2 Difference between Annealing & normalizing.
Unit – IV Hardening & Tempering	4a. Differentiate Hardening and Hardenability. 4b. Describe methods of Hardening. 4c. Describe characteristics of quenching media. 4d. Describe Martensite transformations. 4e. Explain process of Tempering.	4.1. Objectives of Hardening and Hardenability. 4.2. Methods of Hardening and quenching media. 4.3. Martensite transformation. 4.4. Tempering- objectives and process.
Unit – V T.T.T. Diagram	5a. Draw T.T.T diagram for typical alloys. 5b. Interpret T.T.T diagram. 5c. Describe C.C.T diagram. 5d. State applications of T.T.T and C.C.T.	5.1 Definition & its importance. 5.2 Construction. 5.3 T.T.T. diagram for different types of steel. 5.4 Factors affecting T.T.T. diagram & its limitations. 5.5 C.C.T. Diagram.
Unit – VI Surface Hardening processes	6a. Explain the need for Surface Hardening. 6b. Classify Surface hardening process. 6c. Describe different Surface hardening processes.	6.1 Objectives of surface Hardening. 6.2 Carburising. 6.3 Nitriding. 6.4 Cyaniding. 6.5 Induction Hardening & Flame Hardening.
Unit – VII Heat Treatment of Non-Ferrous Metals & Alloys	7a. Explain Precipitation Hardening. 7b. Describe Precipitation Hardening of Al-Cu alloys.	7.1 Precipitation Hardening. 7.2 Hardening of Al-Cu alloy system.

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	Pyrometry	2	2	2	2	6
II	Annealing	10	8	4	4	16
III	Normalising	4	2	2	2	6
IV	Hardening & Tempering	8	6	4	2	12
V	T.T.T. Diagram	4	2	2	2	6
VI	Surface Hardening	6	6	2	4	12
VII	Heat Treatment of Non-Ferrous Metals & Alloys	8	4	4	4	12
Total Hrs		42	30	20	20	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)	Approx. Hrs. Required
1	I	Perform Annealing heat treatment on steel specimen and examine microstructure.	4
2	I	Perform Normalising heat treatment on steel specimen and examine microstructure.	4
3	II	Draw and Label T.T.T. diagram and show cooling curves for pearlite, bainite and martensite transformation.	2
4	III	Perform hardening and Tempering Heat treatment on steel specimen and examine microstructure.	4
5	III	Determination of Hardenability by Jominy end Quench Test.	4

S. No.	Unit No.	Practical/Exercise (Outcomes' in Psychomotor Domain)	Approx. Hrs. Required
6	IV	Demonstrate effect of carburising on hardness of carbon steel.	2
7	V	Demonstrate effect of nitriding on hardness of plain carbon steel	2
8	VI	Identify various parts and Demonstrate constructional features of Heat treatment Furnaces (Muffle furnace, salt bath furnace, Induction and Carburising furnace)	4
9	VI	Perform Rockwell Hardness Test. as per ASTM standards	2
Total Hrs			28

8. SUGGESTED LIST OF STUDENT ACTIVITIES

- Visit industries, organisations, where differ kinds of Heat treatment is imparted.
- Observe study and prepare report.
- Carryout hands on practice of annealing, normalizing ,hardening and tempering heat treatments in workshop
- Present case studies by students in groups.

9 SPECIAL INSTRUCTIONAL STRATEGIES (If Any)

- Industrial Visits.
- Videos on surface hardness heat treatments.

10 SUGGESTED LEARNING RESOURCES

A. List of Books

S. No.	Title of Books	Author	Publication
1	Heat Treatment :Principles and Techniques	Ashok Kumar Sharma , T.V. Rajan , C. P. Sharma	Prentice-Hall india
2	Introduction to Physical Metallurgy	S. H. Avner	Tata Mc-Graw Hill
3	Physical Metallurgy for Engineers	D. S. Clark and W. R. Varney	East-West press
	Heat Treatment, Selection, and Application of Tool Steels	William E. Bryson	Modern Machine Shop Publications
4	Handbook of heat treatment of steels	K H Prabhu deva	K H publishers

B. List of Major Equipment/Materials

- i) Muffle Furnace
- ii) Standard specimen preparation set-up for metallurgical micro-examination.
- iii) Metallurgical Microscope
- iv) Image Analyzer
- v) Rockwell Hardness tester

C. List of Software/Learning Websites

- i) www.industrialheating.com
- ii) <http://ocw.mit.edu/courses/materials-science-and-engineering>
- iii) <http://nptel.iitm.ac.in>
- iv) <http://www.astm.org>

11 COURSE CURRICULUM DEVELOPMENT COMMITTEE**Faculty Members from Polytechnics**

- **Prof. S L Chauhan**, Head of Department (Metallurgy) ,Government polytechnic Bhuj.
- **Prof. H H Jadav**, Assistant Professor (Metallurgy), Government Engineering College, Sector 28, Gandhinagar

Coordinator and Faculty Members from NITTTR Bhopal

- **Dr. K. K. Jain**, Professor and Dean, Department of Mechanical Engineering.
- **Dr. C. K. Chugh**, Professor, Department of Mechanical Engineering