



# GUJARAT TECHNOLOGICAL UNIVERSITY

**Bachelor of Engineering Subject Code:**

**3162107 Semester – VI**

**Subject Name: Heat treatment**

**Type of course:** Science & Engineering

**Prerequisite:** Physical Metallurgy I

**Rationale:**

Graduate of Metallurgy is expected to achieve material properties by different heat treatment processes. This course on Heat Treatment deals with understanding of principles and procedures for metals and alloys. Heat treatment also deals with microstructure and property relations and achieving the desired properties by developing suitable structure by using proper heat treatment cycle.

**Teaching and Examination Scheme:**

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
2	0	4	4	70	30	30	20	150

**Content: Suggested Specification table with Marks (Theory)**

Sr. No.	Content	Total Hrs
1	<b>Introduction to Heat treatment Process:</b> Annealing, Normalizing, Hardening, Tempering, Special Heat treatment processes like Austempering, Martempering, Ausforming, Patenting, Sub-zero treatment etc., Thermo-Mechanical treatments etc.	8
2	<b>Transformation on Heating :</b> Austenitic Transformation	2
3	Importance and Determination of Austenitic grain size	2
4	<b>Transformation on Cooling:</b> Pearlitic Transformation, Bainitic Transformation and Martensitic Transformation	8
5	<b>Construct and interpret TTT and CCT diagram:</b> Types of TTT diagram, Critical cooling rate, Effect of alloying elements on TTT diagram, Applications, Continuous Cooling transformation Diagram.	2
6	<b>Quenchants:</b> Characteristics of Quenchants, Different quenching media, Synthetic Quenchants, Mechanism of quenching.	2
7	<b>Surface Treatments:</b> Induction and Flame hardening methods, Laser hardening, Case carburizing (solid, liquid and gaseous), Cyaniding, Carbonitriding, Nitriding, Plasma nitriding etc.	4
	Total	<b>28</b>

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Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	25	25	30	10	5

**Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's 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.

### Reference Books:

1. Heat Treatment (Principles and Techniques) by T. V. Rajan, C. P. Sharma and A. Sharma, PHI
2. Physical Metallurgy for Engineers by D. S. Clark and W. R. Varney, East-West Press
3. Introduction to Physical Metallurgy by S. H. Avner, Tata Mc-Graw Hill
4. Engineering Physical Metallurgy and Heat Treatment by Yu. M. Lakhtin, MIR Publishers
5. Material Science and Metallurgy for Engineers by V D Kodgire and S V Kodgire, Everest Publishing House
6. ASM, Metals Hand Book: Heat Treating, Vol. 4, 9th Ed., Metals Parks, Ohio
7. Heat Treatment of Metals, Singh Vijendra, Standard Publishers distributors, Delhi

### Course Outcomes:

Sr. No.	CO statement	Marks % Weightage
CO-1	Understand all transformations kinetics and mechanism.	30
CO-2	Interpret TTT and CCT diagram and Quenchants	10
CO-3	Select type of heat treatment processes	60

### List of Experiments:

1. Introduction to Heat treatment Processes and demonstration of Heat Treatment equipments and consumables.
2. Measurement of austenitic Grain size
3. To Examine the effect of quenching media on hardening of steel.
4. To Measure hardenability of given materials with Jominy End quenched Test.
5. To Perform heat treatment and microstructure of En: 8 steel.
6. To Perform heat treatment and microstructure of En: 31 steel.



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7. To Perform heat treatment and microstructure of En: 31 steel.
8. To Perform heat treatment and microstructure of H 13 tool steel.
9. To Demonstrate heat treated defect parts with their causes and remedies
10. Industrial Visit

### **Major Equipment:**

1. Metallurgical Microscopes
2. Sample Cutting Machine
3. Rough Belt Surface grinder
4. Double Disc Polishing Machine
5. Jominy End Quench Test Setup
6. Hardness Tester
7. Muffle Furnace
8. Image Analysis System

### **List of Open Source Software/learning website:**

1. <http://nptel.iitm.ac.in/>
2. [www.ocw.mit.edu](http://www.ocw.mit.edu)