

# GUJARAT TECHNOLOGICAL UNIVERSITY

## BRANCH NAME: METALLURGY

**SUBJECT NAME:** Physical Metallurgy of Special Purpose Non-ferrous Metals and Alloys

**SUBJECT CODE: 2172112**

**B.E. 7<sup>th</sup> SEMESTER**

**Type of course: Core**

**Prerequisite: NIL**

**Rationale:** Now a days due to specialized requirements nonferrous alloys application are increasing due to low weight, higher conductivity, non-magnetic property and resistance to corrosion so it is required for student to understand physical metallurgy of nonferrous metals and alloys for specific application. This course emphasize on different nonferrous metals and alloy phase diagram, their heat treatment to modify their properties and applications and to choose or design heat treatment for given metal and alloy.

### 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)		
				PA	ALA	ESE	OEP			
4	0	2	6	70	30	00	30	00	20	150

### Content:

Sr. No.	Content	Total Hrs	% Weightage
1	<b>Introduction</b> :Introduction to non-ferrous metals & their alloys: Aluminium Alloys, Copper Alloys, Nickel Alloys, Magnesium Alloys, Titanium Alloys, Lead Alloys, Zinc Alloys, Tin alloys, Babbitts (Antifriction Alloys)and Rare metals and their Alloys.	6	10
2	<b>Aluminium and its alloys:</b> Classification of Aluminum Alloys, Non-heat treatable Wrought Aluminum Alloys, Heat treatable Wrought Aluminum Alloys, Cast Aluminum Alloys with their Phase Diagrams, Compositions, heat treatments, properties and applications.	8	15
3	<b>Copper and its alloys:</b> Copper, Brass and Bronze Phase Diagrams, Compositions, heat treatments, properties and applications.	8	15
4	<b>Nickel and its alloys:</b> Ni-Cr alloys, Ni-Al alloys, Ni-Cr-Al alloys, Ni-Cr-Al-Ti alloys, Complex Nickel- base alloys Phase diagram with compositions, Heat treatments, properties and applications.	8	12
5	<b>Magnesium and its alloys</b> : Classification of Magnesium Alloys, Wrought Magnesium Alloys, Cast Magnesium Alloys with their Phase Diagrams, Compositions, heat treatments, properties and applications.	6	10

<b>6</b>	<b>Titanium and its alloys:</b> Compositions, heat treatments, properties and applications.	<b>6</b>	10
<b>7</b>	<b>Lead , Zinc and Tin and their alloys:</b> Lead and Its alloys Phase Diagrams, Compositions, heat treatments, properties and applications., Zinc and its alloys Phase Diagrams, Compositions, heat treatments, properties and applications., tin and its alloys Phase Diagrams, Compositions, heat treatments, properties and applications.	<b>8</b>	14
<b>8</b>	<b>Babbitts(Antifriction alloys):</b> Phase Diagrams, Compositions, heat treatments, properties and applications.	<b>4</b>	9
<b>9</b>	<b>Precious metal &amp; their alloys:</b> Silver, Gold, Platinum, Palladium & their alloys. Iridium, Osmium, Rhodium, Ruthenium & their electrical applications.	<b>4</b>	9
<b>10</b>	<b>Rare metals and their alloys:</b> Characteristics and mechanical properties of these alloys.	<b>2</b>	4

#### Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
<b>10</b>	<b>40</b>	<b>30</b>	<b>15</b>	<b>5</b>	<b>0</b>

**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. Engineering Physical Metallurgy by Lakhtin , CBS Publisher
2. Physical Metallurgy for Engineers – Donald S. Clark, & Wilbur R. Varney, CBS Publishers & Distributors, New Delhi
3. Heat Treatment, Structure and Properties of Non-ferrous Alloys – Charlie R. Books, 1982, ASM.
4. Introduction to Physical Metallurgy – Sidney H. Avner, McGraw-Hill Book Company, New Delhi
5. Metals Handbook Ninth Edition – Vol.2, Properties and Selection: Non-ferrous alloys and Pure Metals, American Society for Metals, Metals Park, Ohio.
6. Heat Treatment Principle and techniques – T V Rajan, C P Sharma, Ashok Sharma , Second Edition, PHI Publications.

#### Course Outcome:

After learning the course the students should be able to:

1. Classify Different types of non-ferrous alloys.
2. Identify & explain Light metals & their alloys with properties & specific applications.
3. Identify & explain Color alloys & Noble metal with their properties applications.
4. Identify & explain Special alloys (super alloys) with their properties & applications.
5. Identify & explain Refractory metals with their specific application.

6. Explain & choose Different heat treatments for non-ferrous metals to improve properties for applications.

**List of Experiments:**

1. To study microstructure of standard aluminium alloys under metallurgical microscope and discuss structure properties relationship.
2. To study the microstructure of Brasses under metallurgical microscope and discuss structure properties relationship.
3. To study the microstructure of Bronzes under metallurgical microscope and discuss structure properties relationship.
4. To study the microstructure of Bearing alloys (Babbitts) under metallurgical microstructure and discuss properties relationship.
5. To study the microstructure of Nickel base alloy and discuss structure properties relationship.
6. To study the heat treatment of cast aluminium alloys.
7. To study the heat treatment of wrought aluminium alloys.
8. To study the heat treatment of magnesium alloys.
9. To study the heat treatment of titanium alloys.
10. To study the heat treatment of copper alloys & nickel alloys.

**Design based Problems (DP)/Open Ended Problem: Nil**

**Major Equipment:**

1. Metallurgical Microscope
2. Muffle furnace
3. Image Analyzer system

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

[www.nptel.ac.in](http://www.nptel.ac.in)

<http://engineershandbook.com/Materials/nonferrous.htm>

<https://manufacturability.wordpress.com>

<http://www.steelforge.com/literature/ferrousnon-ferrous-materials-textbook>