

**Name of Institute: Indus Institute of Technology & Engineering**

**Name of Faculty: Dr.K. Santhy**

**Course Code: MME0502**

**Course Name: Non Ferrous Extractive Metallurgy**

Pre-requisites: Students must be aware about the basic concept of chemistry, Ferrous and Non-Ferrous metal.

Credit points: 03

Offered Semester: V

**Course Coordinator (weeks 01–15)**

Full Name: Dr.K. Santhy

Department with sitting location: 3<sup>rd</sup> Floor, Staff room

Telephone: 9787710922

Email: santhy.mt@indusuni.ac.in

Consultation times: 4:15 PM – 5:00 PM

**Course Lecturer (weeks 01–15)**

Full Name: Dr.K. Santhy

Department with sitting location: 3<sup>rd</sup> Floor, Staff room

Telephone: 9787710922

Email: santhy.mt@indusuni.ac.in

Consultation times: 4:15 PM – 5:00 PM

Students will be contacted throughout the session personally via e-mail with important information relating to this course.

**Course Objectives**

1. To make the students aware about basics of non-ferrous metals and its extraction processes.
2. To impart the knowledge about the basic steps followed in extraction and their importance.

**Course Outcomes (CO)**

CO1. To apply the knowledge regarding the auxiliary operation and the advancement in various extractive process.

CO2. The fundamental understanding of principles of extraction.

CO3. Awareness about modern extraction and refining techniques in production of copper, zinc, aluminum, titanium, uranium, thorium and zirconium.

CO4. To apply the theory about the extraction practice of different non-ferrous metals.

## Course Outline

The course will discuss the theoretical and practical aspects of extraction of nonferrous metals. The various methods will be considered for beneficiation, extraction and refining of nonferrous metals. The course will highlight the energy and environmental aspects of extraction processes.

## Method of delivery

Online lectures

## Study time

3 Hour Lecture per week

## CO-PO Mapping (PO: Program Outcomes)

### Mapping CO's with PO's

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>CO1</b>	3	3	3	3	1	1	1	1	3	2	1	2
<b>CO2</b>	3	3	3	3	1	1	1	1	3	1	1	2
<b>CO3</b>	3	1	1	3	2	1	1	1	3	1	1	2
<b>CO4</b>	3	3	2	3	2	1	1	1	3	1	1	2

1-Lightly Mapped      2- Moderately Mapped      3- Highly Mapped

## Blooms Taxonomy and Knowledge retention (For reference)

(Blooms taxonomy has been given for reference)

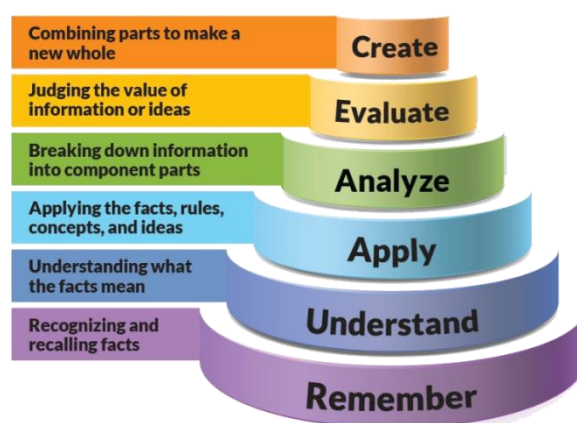


Figure 1: Blooms Taxonomy

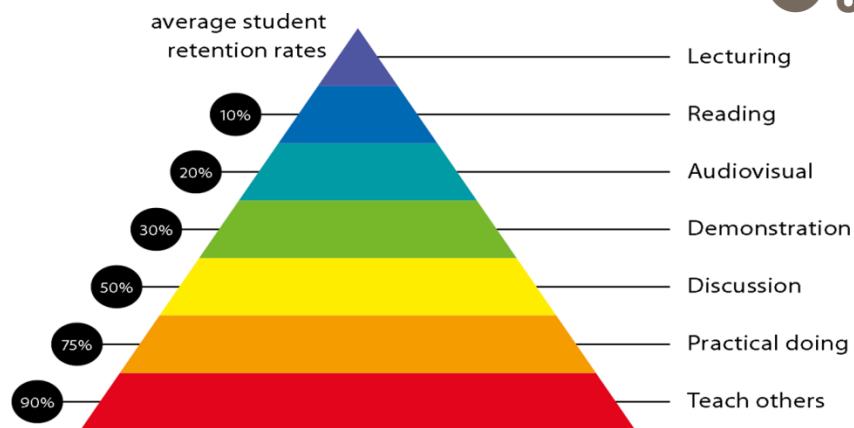


Figure 2: Knowledge retention

### Graduate Qualities and Capabilities covered (Qualities graduates harness crediting this Course)

General Graduate Qualities	Specific Department of _____ Graduate Capabilities
<b>Informed</b> Have a sound knowledge of an area of study or profession and understand its current issues, locally and internationally. Know how to apply this knowledge. Understand how an area of study has developed and how it relates to other areas.	<b>1 Professional knowledge, grounding &amp; awareness</b>
<b>Independent learners</b> Engage with new ideas and ways of thinking and critically analyze issues. Seek to extend knowledge through ongoing research, enquiry and reflection. Find and evaluate information, using a variety of sources and technologies. Acknowledge the work and ideas of others.	<b>2 Information literacy, gathering &amp; processing</b>
<b>Problem solvers</b> Take on challenges and opportunities. Apply creative, logical and critical thinking skills to respond effectively. Make and implement decisions. Be flexible, thorough, innovative and aim for high standards.	<b>4 Problem solving skills</b>
<b>Effective communicators</b> Articulate ideas and convey them effectively using a range of media. Work collaboratively and engage with people in different settings. Recognize how culture can shape communication.	<b>5 Written communication</b>
	<b>6 Oral communication</b>
	<b>7 Teamwork</b>

<b>Responsible</b> Understand how decisions can affect others and make ethically informed choices. Appreciate and respect diversity. Act with integrity as part of local, national, global and professional communities.	<b>10 Sustainability, societal &amp; environmental impact</b>
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### Practical work:

(Mention what practical work this Course involves)

NA

### Lecture/tutorial times

Lecture Monday	10.50 – 11.45 AM	Lab 02
Lecture Wednesday	09.00 – 09.50 AM	Lab 02
Lecture Thursday	09.55 – 10.50 AM	Lab 02

### Attendance Requirements

The University norms states that it is the responsibility of students to attend all lectures, tutorials, seminars and practical work as stipulated in the Course outline. Minimum attendance requirement as per university norms is compulsory for being eligible for mid and end semester examinations.

### Details of referencing system to be used in written work

#### Text books

1. H.S. Ray, R. Sridhar and K.P. Abraham, “Extraction of Nonferrous Metals”, Affiliated East West Press Pvt Ltd, 1<sup>st</sup> Edition, 2008, ISBN: 9788185095639.

#### Additional Materials

#### Reference Books

1. W. H. Dennis, “Extractive Metallurgy”, Pitman Publishing, 1<sup>st</sup> Edition, 1965, ISBN: 9780273404729.
2. F. Habashi, “Principles of Extractive Metallurgy”, Gordon & Breach, 1<sup>st</sup> Edition, 1970, ISBN: 9780677017808.
3. T. Rosenqvist, “Principles of Extractive Metallurgy”, McGraw Hill, 1<sup>st</sup> Edition, 1974, ISBN: 9780070538474.
4. J. L. Bray, “Nonferrous Production Metallurgy”, John Wiley and Sons, 2<sup>nd</sup> Edition, 1947, ASIN: B0007E2TW6.

5. R. D. Pehlke, "Unit Processed in Extractive Metallurgy", Elsevier, 1<sup>st</sup> Edition, 1973, ISBN: 9780444001306.
6. H. S. Ray, "Introduction to Melts: Molten Salts, Slags and Glasses", Allied Publishers Pvt Ltd 1<sup>st</sup> Edition, 2006, ISBN: 9788177648751.
7. H.S. Ray, B.P Singh, S. Bhattacharjee and V. N. Misra, "Energy in Minerals and Metallurgical Industries", Allied Publishers Pvt Ltd, 1<sup>st</sup> Edition, 2005, ISBN: 8177648748.
8. H. S. Ray and A. Ghosh, "Principles of Extractive Metallurgy", New Age Publishers, 2<sup>nd</sup> Edition, 1991, ISBN: 9788122403220.

### **Web Resources**

1. NPTEL Course on "Non-Ferrous Extractive Metallurgy"  
(<http://nptel.ac.in/courses/113105021/>)

### **ASSESSMENT GUIDELINES**

Your final course mark will be calculated from the following:

MSE	40%
Assignment	10%
Attendance	5%
Class Interaction	5%
Final exam ( <i>closed book</i> )	40%

### **SUPPLEMENTARY ASSESSMENT**

Students who receive an overall mark less than 40% in mid semester or end semester will be considered for supplementary assessment in the respective components (i.e., mid semester or end semester) of semester concerned. Students must make themselves available during the supplementary examination period to take up the respective components (mid semester or end semester) and need to obtain the required minimum 40% marks to clear the concerned components.

### **Practical Work Report/Laboratory Report:**

A report on the practical work is due the subsequent week after completion of the class by each group.

### **Late Work**

Late assignments will not be accepted without supporting documentation. Late submission of the reports will result in a deduction of -% of the maximum mark per calendar day.

### **Format**

All assignments must be presented in a neat, legible format with all information sources correctly referenced. **Assignment material handed in throughout the session that is not neat and legible will not be marked and will be returned to the student.**

### Retention of Written Work

Written assessment work will be retained by the Course coordinator/lecturer for two weeks after marking to be collected by the students.

### University and Faculty Policies

Students should make themselves aware of the University and/or Faculty Policies regarding plagiarism, special consideration, supplementary examinations and other educational issues and student matters.

**Plagiarism** - Plagiarism is not acceptable and may result in the imposition of severe penalties. Plagiarism is the use of another person's work, or idea, as if it is his or her own - if you have any doubts at all on what constitutes plagiarism, please consult your Course coordinator or lecturer. Plagiarism will be penalized severely.

***Do not copy the work of other students.***

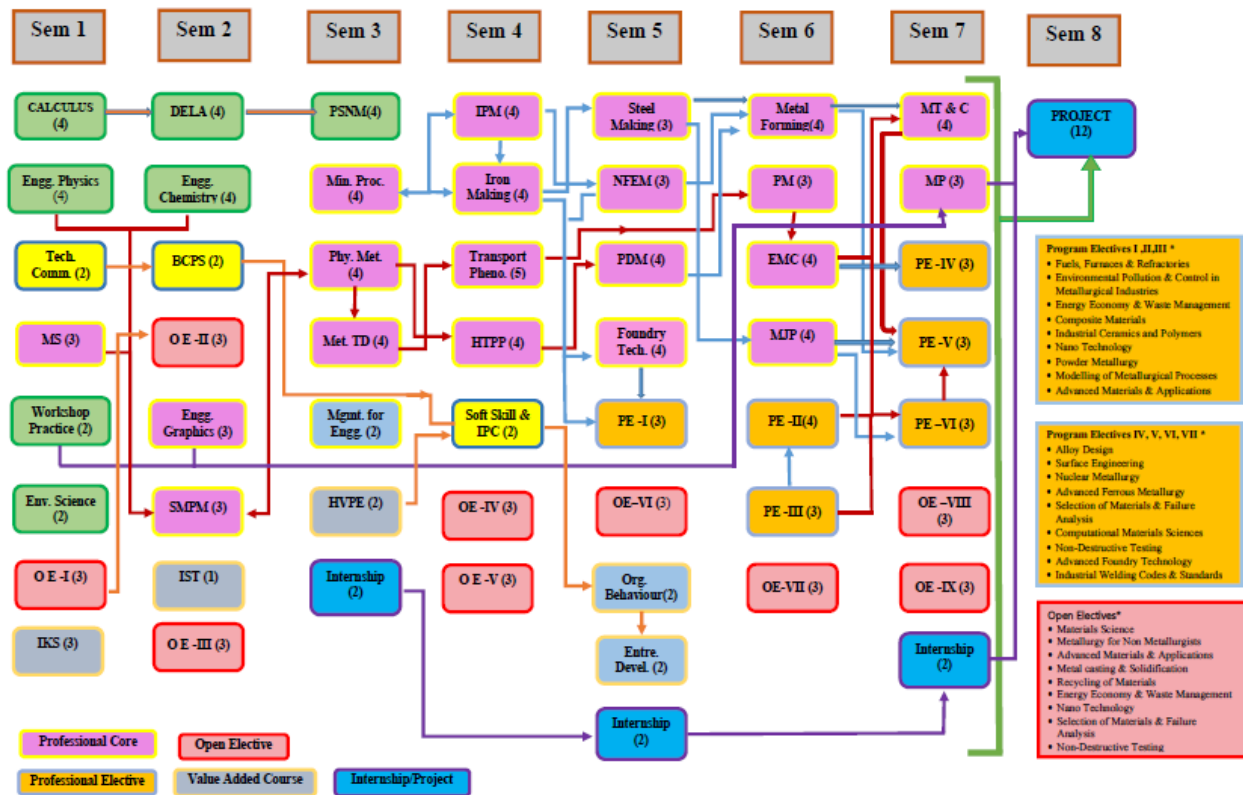
***Do not share your work with other students (except where required for a group activity or assessment).***

### Course schedule

Weeks	Topic & contents	CO Addressed	Teaching Learning Activity (TLA)
Week01	<b>General:</b> World resources of Non-ferrous metals and their occurrence. Present and future position of non-ferrous metallurgical industry in India-resources, production and consumption.	CO1	Interactive teaching using PPT and google meet
Week02	Indian scenario of non-ferrous ores and mineral deposits. Production plants for non-ferrous metals such as copper, zinc, lead, tin, Aluminum, nickel, magnesium, titanium, etc. Problem Solving	CO1	Interactive teaching using PPT and google meet
Week 03	Basics of Pyro metallurgy, Hydrometallurgy and electrometallurgy	CO1, CO2	Interactive teaching using PPT and google meet
Week 04	<b>Aluminum:</b> Occurrence of Bauxite. Bayer's process for production of alumina. Alternatives to Bayer's process. Hall-Heroult process-conventional and new materials for construction of Aluminum reduction cell, nature of electrolyte.	CO1, CO2	Interactive teaching using PPT and google meet
Week 05	Electrolysis of alumina with emphasis on physico-chemical principles and secondary-reactions, factors affecting current efficiency. Alternatives to Hall-Heroult process. Refining of Aluminum.	CO1, CO2	Interactive teaching using PPT and google meet

Week 06	<b>Copper:</b> Occurrence of copper ores. Roasting. Matte-smelting, Converting and Refining process as applied to copper production and their physico-chemical aspects.	CO1, CO2	Interactive teaching using PPT and google meet
Week 07	Single step and multistep continuous processes. Hydrometallurgical process for production of primary copper. Recovery of copper from copper slag.	CO1, CO2	Interactive teaching using PPT and google meet
Week 08	<b>Nickel:</b> Occurrence of nickel ores, Pyrometallurgical and Hydrometallurgical processes for nickel production and refining.	CO1, CO2	Interactive teaching using PPT and google meet
Week 09	<b>Lead and Zinc:</b> Occurrence of lead and zinc ores, Pyrometallurgical and Hydrometallurgical processes for lead and zinc	CO1, CO2	Interactive teaching using PPT and google meet
Week 10	production and their physio-chemical aspects, Refining of lead and zinc, Recovery of byproducts.	CO1, CO2	Interactive teaching using PPT and google meet
Week 11	<b>Tin:</b> Occurrence of tin, various methods of extraction of tin from its ores and other sources. Uses of tin.	CO1, CO2	Interactive teaching using PPT and google meet
Week 12	<b>Gold and Silver:</b> Occurrence of gold and silver. Various methods for production of gold and silver from their ores and other sources. Problem Solving	CO1, CO2	Interactive teaching using PPT and google meet
Week 13	Recovery of gold, silver and platinum from secondary sources such as Copper Anode Mud, Red Mud, Zinc dross and electrolytic solutions. Problem Solving	CO1, CO2, CO4	Interactive teaching using PPT and google meet
Week 14	<b>Magnesium:</b> Occurrence of magnesium, Methods of production of magnesium oxide and magnesium chloride, Pyrometallurgical extraction of magnesium, Electrolytic extraction and refining of magnesium.	CO1, CO2, CO4	Interactive teaching using PPT and google meet
Week 15	<b>Titanium:</b> Occurrence of titanium, Extraction, Production, recovery, properties and application.	CO1, CO2, CO3	Interactive teaching using PPT and google meet

## B. Tech Materials and Metallurgical Engineering Course Flowchart (IITE, Indus University)





Subject: Non Ferrous Extractive Metallurgy								
Program: B. Tech in Metallurgical Engineering				Subject Code: MME0502			Semester: V	
Teaching Scheme (Hours per week)				Examination Evaluation Scheme (Marks)				
Lecture	Tutorial	Practical	Credits	University Theory Examination	University Practical Examination	Continuous Internal Evaluation (CIE)-Theory	Continuous Internal Evaluation (CIE)-Practical	Total
3	0	0	3	16/40	0	24/60	0	100

### Course Objectives

1. To make the students aware about basics of non-ferrous metals and its extraction processes.
2. To impart the knowledge about the basic steps followed in extraction and their importance.

## CONTENTS

### UNIT-I

[10 hours]

#### **General:**

World resources of Non-ferrous metals and their occurrence. Present and future position of non-ferrous metallurgical industry in India- resources, production and consumption.

Indian scenario of non-ferrous ores and mineral deposits. Production plants for non-ferrous metals such as copper, zinc, lead, tin, Aluminum, nickel, magnesium, titanium, etc.

Basics of Pyrometallurgy, Hydrometallurgy and electrometallurgy

### UNIT-II

[10 hours]

#### **Aluminum:**

Occurrence of Bauxite. Bayer's process for production of alumina. Alternatives to Bayer's process. Hall-Heroult process-conventional and new materials for construction of Aluminum reduction cell, nature of electrolyte. Electrolysis of alumina with emphasis on physico-chemical principles and secondary-reactions, factors affecting current efficiency. Alternatives to Hall-Heroult process. Refining of Aluminum.

#### **Copper:**

Occurrence of copper ores. Roasting. Matte-smelting, Converting and Refining process as applied to copper production and their physico-chemical aspects. Single step and multistep continuous processes. Hydrometallurgical process for production of primary copper. Recovery of copper from copper slag.

### UNIT-III

[10 hours]

#### **Nickel:**

Occurrence of nickel ores, Pyrometallurgical and Hydrometallurgical processes for nickel production and refining.

#### **Lead and Zinc:**

Occurrence of lead and zinc ores, Pyrometallurgical and Hydrometallurgical processes for lead and zinc production and their physio-chemical aspects, Refining of lead and zinc, Recovery of byproducts.

**Tin:**

Occurrence of tin, various methods of extraction of tin from its ores and other sources. Uses of tin.

**UNIT-IV****[10 hours]****Gold and Silver:**

Occurrence of gold and silver. Various methods for production of gold and silver from their ores and other sources.

Recovery of gold, silver and platinum from secondary sources such as Copper Anode Mud, Red Mud, Zinc dross and electrolytic solutions.

**Magnesium:**

Occurrence of magnesium, Methods of production of magnesium oxide and magnesium chloride, Pyrometallurgical extraction of magnesium, Electrolytic extraction and refining of magnesium.

**Titanium**

Occurrence of titanium, Extraction, Production, recovery, properties and application.

**Course Outcomes**

1. To apply the knowledge regarding the auxiliary operation and the advancement in various extractive process.
2. To apply the theory about the extraction practice of different non-ferrous metals.

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