

MT-106- Elements of Metallurgical Engineering

Course Title	Elements of Metallurgical Engineering	Course Code	MT-106
Semester	I	Course Group	Core
Teaching Scheme in Periods (L:T:P)	4:1:0	Credits	3
Methodology	Lecture +Tutorial	Total Contact Periods	150
CIE	60 Marks	SEE	40 Marks

Prerequisites: Basic knowledge of mathematics, physics and chemistry of school level

Course Outcomes: At the end of the course, the student will be able to

CO1	Generalize various divisions of Metallurgy With respect to industrial applications
CO2	Analyze the ferrous and non- ferrous metals and alloys with their composition, properties and applications
CO3	Develop the principles of Hydrometallurgical Extraction for liberation of metals from ores
CO4	Observe the principles of Electrometallurgical Extraction in recovery of metals
CO5	Summarize unit processes and principles employed in Pyro-metallurgy Extraction of metals to enable recovery of valuable metals
CO6	Construct various smelting and refining methods for purification of metals

Course contents:

UNIT-1: INTRODUCTION TO METALLURGY:

Duration: 25 periods

Materials classification, metal properties & classification, divisions of metallurgy, economic importance of metallurgical industries, important metal extraction plants in India.

UNIT-2: FERROUS, NON-FERROUS METALS AND THEIR ALLOYS:

Duration: 25 periods

Classification of steels and their applications, Important ferrous metals: Steel, Cast iron, Alloy steels, Important Non-ferrous metals: brass, bronze, Muntz metals - their compositions, properties and applications.

**UNIT-3: PRINCIPLES OF EXTRACTIVE METALLURGY-HYDRO
METALLURGY:**

Duration: 25 periods

Introduction –Advantages and Limitations of Hydro metallurgy-important stages in hydro metallurgy- leaching- properties of leachant -suitable Materials for leaching- types of important leaching operations

**UNIT-4: PRINCIPLES OF EXTRACTIVE METALLURGY-ELECTRO
METALLURGY:**

Duration: 25 periods

Introduction- Electrolysis: Definition & principle- Cathodic & Anodic reactions of electrolysis, Faraday's laws of electrolysis, electrolysis of molten salt & aqueous solutions

**UNIT-5: PRINCIPLES OF EXTRACTIVE METALLURGY-PYRO
METALLURGY-I:**

Duration: 25 periods

Introduction- Types of Pyro metallurgical operations- Drying, Calcination and Roasting, Classification of roasting operations, multiple hearth roaster, Flash Roaster & fluidized bed roaster.

**UNIT-6: PRINCIPLES OF EXTRACTIVE METALLURGY-PYRO
METALLURGY-II**

Duration: 25 periods

Smelting: Types of smelting-principle of Reduction smelting & Matte smelting, Refining Definition & purpose -Types of refining: Drossing, fire refining & Zone refining.

TEXT BOOKS:

- Non-Ferrous extractive Metallurgy - Ray. Abraham and Sridhar

REFERENCE BOOKS :

1. *Introduction to Physical Metallurgy * by Sidney H. Avner-Publisher: McGraw-Hill-Publishing year: 1974 .
2. *Principles of Extractive Metallurgy* by Terkel Rosenqvist-Publisher: McGraw-Hill-Publishing Year: 1974
3. *Metallurgical Engineering: Principles and Application* by Lawrence K.A. Gale, Thomas C. Totemeier-Publisher: Wiley - Publishing year: 2010
4. *Physical Metallurgy Principles* by Robert E.Read-Hill, reza Abbaschian, publisher: cengage Learning-Publishing Year: 2009
5. *Extractive Metallurgy of copper* by William G. Davenport, Mathew J.King, Mark E. Schlesinger, A.K. Biswas-Publisher: Elsevier Science-Publishing Year:2011

LIST OF LEARNING WEBSITES

<http://www.nptel.ac.in/course.php>

<https://www.msm.cam.ac.uk/ug-study/part-ia>

<https://www.phase-trans.msm.cam.ac.uk/teaching.html>

LEARNING Outcomes:

After the completion of the course, the student should be able to

CO1: Generalize various divisions of Metallurgy With respect to industrial applications

- 1.1 Define material and classify them.
- 1.2 Define metal and state its properties.
- 1.3 Classify the metals.
- 1.4 Explain metallurgy and its importance.
- 1.5 Classify the divisions of metallurgy and explain them.
- 1.6 List out important metal extraction plants in India a) Integrated Iron & steel Plants, b) Aluminum plants, c) Copper plants, d) Zinc & Lead plants

CO2: Analyze the ferrous and non- ferrous metals and alloys with their composition, properties and applications

- 2.1 State the basic classification of plain carbon steels.
- 2.2 List out the applications of the steels.
- 2.3 State the need for alloying the steel with other elements.
- 2.4 Explain the composition, properties and industrial applications of alloy steels.
- 2.5 Explain the properties of tool steels
- 2.6 Explain the composition and properties of high-speed tool steels.
- 2.7 Explain the composition of special cutting materials like Stellites, cemented carbides

- 2.8 Explain the classification of cast irons - Gray, white, malleable, Spheroidal - composition, properties and applications.
- 2.9 Explain the need for non-ferrous metals and their alloys in engineering application.
- 2.10 List out the composition, properties, and industrial application of the important-Non-ferrous alloys like brass, bronze, Muntz metal.

CO3: Develop the principles of Hydrometallurgical Extraction for liberation of metals from ores

- 3.1 Define Hydrometallurgy.
- 3.2 State the advantages & Limitations of Hydro Metallurgy.
- 3.3 List out the important stages in Hydro Metallurgy.
- 3.4 Define leaching & identify the materials for leaching.
- 3.5 State the properties of leachant.
- 3.6 List important Leaching operations.
- 3.7 Explain Pressure, Bacterial, Ammonical, Acid & Heap leaching.

CO4: Observe the principles of Electrometallurgical Extraction in recovery of metals

- 4.1 Define electrometallurgy.
- 4.2 State the advantages & Limitations of electrometallurgy
- 4.3 Classify Electro Metallurgical operations
- 4.4 Define Electrolysis.
- 4.5 State Faradays' laws of Electrolysis.
- 4.6 State the principle of electrolysis with respect to Anodic and Cathodic reactions.
- 4.7 Explain the electrolysis of molten salts.
- 4.8 Explain the electrolysis of aqueous solutions.

CO5: Summarize unit processes and principles employed in Pyro metallurgy: Extraction of metals to enable recovery of valuable metals

- 5.1 State the salient features of extractive metallurgy

- 5.2 Define Pyro metallurgy & List the Pyro metallurgical operations.
- 5.3 Explain drying.
- 5.4 Explain Calcination.
- 5.5 Explain Roasting & classify the roasting operation.
- 5.6 Explain Oxidizing, Sulphatising with chemical reactions.
- 5.7 Explain multiple hearth roaster, Flash roaster & Fluidized bed Roaster.

CO6: Construct various smelting and refining methods for purification of metals

- 6.1 Explain smelting.
- 6.2 Explain Flux, Slag and Matte.
- 6.3 Classify smelting operations a) Reduction Smelting - Carbothermic & Metallothermic b) Matte Smelting.
- 6.4 State the importance of Coke as a reducing agent in Carbothermic Reduction
- 6.5 Explain refining & State the purpose of refining.
- 6.6 List important methods of Refining.
- 6.7 explain Drossing & fire refining.
- 6.8 Explain Zone Refining.

CO - PO mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	Mapped POs
CO1	1	3						1,2
CO2	3	3						1,2
CO3	3	3	2			2		1,2,3,6
CO4	3	3	2			2		1,2,3,6
CO5	3	3	2			2		1,2,3,6
CO6	3	3				2		1,2,6

MID YEAR-I EXAM

S.No	Unit Name	R	U	A	Remarks
1	Unit-I	1, 2	5(a) 5(b)	7(a) 7(b)	
2	Unit-II	3, 4	6(a) 6(b)	8(a) 8(b)	
Total Questions		4	4	4	
MID YEAR –II EXAM					
S.No	Unit Name	R	U	A	Remarks
1	Unit-III	1, 2	5(a) 5(b)	7(a) 7(b)	
2	Unit-IV	3, 4	6(a) 6(b)	8(a) 8(b)	
Total Questions		4	4	4	

Year End Examination

Sl No	Unit No.	Questions to be set for SEE				Remarks	
		R		U	A		
1	I	4	1		9(a)	13(a)	
2	II						
3	III		2		10(a)	14(a)	
4	IV						
5	V		3	5, 6	9(b)	13(b)	
					11(a)	15(a)	
6	VI			7,8	11(b)	15(b)	
		10(b)			14(b)		
				12(a)	16(a)		
				12(b)	16(b)		
Total Questions		8		8	8		

MODEL QUESTION PAPER

BOARD DIPLOMA MID SEMESTER EXAMINATIONS (C-26)

D.MT.E – I YEAR MID-I EXAMINATION

MT-106-Elements of Metallurgical Engineering

Duration:1 hour

Maximum Marks: 20

PART-A

NOTE: Answer all questions and each question carries ONE mark

4×1 =4

- 1) List any two properties of metal
- 2) Name the divisions of metallurgy
- 3) Classify the plain carbon steels
- 4) List any two applications of steels

PART-B

NOTE : Answer all questions and each question carries THREE marks

2×3 =6

5(a) Summarize the importance of metallurgy

(OR)

5(b) List out important Aluminum plants and Copper plants in India.

6(a) Illustrate the nodular cast iron with labelled microstructure

(OR)

6(b) Apply Faraday's laws in electrolysis of Copper sulphate solution.

PART-C

NOTE: Answer all questions and each question carries FIVE marks

2×5 =10

7(a) List out Integrated Iron and steel plants in India.

(OR)

7(b) Analyze the Muntz metal with respect to composition, properties and applications

8(a) Explain special cutting materials a) Stellites with respect to composition and properties

(OR)

8(b) Analyze the special cutting materials Cemented carbides with respect to composition and properties

MODEL QUESTION PAPER

BOARD DIPLOMA MID SEMESTER EXAMINATIONS (C-26)

D.MT.E – I YEAR END EXAMINATION

MT-106-Elements of Metallurgical Engineering

Duration:1 hour

Maximum Marks: 20

PART-A

NOTE : Answer all questions and each question carries ONE mark

8×1 =8

- 1) Define calcination
- 2) Name two methods of refining.
- 3) What is the use of carbothermic reduction
- 4) How flux is useful in refining
- 5) List out any two properties of metal
- 6) Identify any two applications of steels
- 7) How hydrometallurgy is useful in extraction.
- 8) What is the role of electro metallurgy.

PART-B

NOTE: Answer all questions and each question carries THREE marks

4×3 =12

9(a) Demonstrate Metallothermic reduction.

(OR)

9(b) Mention the purpose of reduction smelting.

10(a) Illustrate the Zone refining

(OR)

10(b) Write two applications of steel

11(a) classify the divisions of metallurgy

(OR)

11(b) Summarize the Faraday`s laws of electrolysis.

12(a) Explain fire refining.

(OR)

12(b) Interpret the oxidizing roasting

PART-C

NOTE: Answer all questions and each question carries FIVE marks

4×5 =20

13(a) Identify Pyro metallurgical operations

(OR)

13(b) Choose sulphatising roasting as pyro metallurgical operation.

14(a) Make use of smelting operation

(OR)

14(b) Analyze the high speed tool steels with respect to composition and properties.

15(a) Apply bacterial leaching.

(OR)

15(b) Utilize Ammonical leaching.

16(a) Analyze the multi hearth roaster with neat diagram.

(OR)

16(b) Elaborate the Fluidized bed roaster with neat diagram.