

GUJARAT TECHNOLOGICAL UNIVERSITY

METALLURGY ENGINEERING (21) PRINCIPLES OF EXTRACTIVE METALLURGY SUBJECT CODE: 2142102 B.E. 4th SEMESTER

Type of Course: Engineering Science

Prerequisite: Knowledge of Metallurgical Thermodynamics Principles

Rationale: Principles of Extractive Metallurgy program is to prepare students for careers in Engineering where Principles of Metal Extraction can be applied to the Industries dealing with Extraction operations. This education at the undergraduate level will enable students to seek employment in Metal Industries upon graduation while, at the same time, provide a firm foundation for the pursuit of graduate studies in Metallurgy Engineering.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P		Theory Marks			Practical Marks			
			ESE (E)	PA (M)		ESE (V)		PA (I)		
				PA	ALA	ESE	OEP			
4	1	0	5	70	20	10	30	0	20	150

Content:

Sr. No.	Topics	Teaching Hrs.	Module Weightage
1	Extractive Metallurgy: Introduction, Types, Advantages and limitations of Different extraction Processes, Comparison in Pyrometallurgy and hydrometallurgy.	05	8
2	Pyrometallurgy: Drying, Calcination, Pelletizing, Sintering, Roasting, Smelting, Converting, Refining. Pyrometallurgical processes using vacuum. Thermodynamic stability diagrams (Ellingham diagram), Use of Ellingham diagram in pyrometallurgy, limitations of Ellingham diagrams. Metallic-oxide reduction by C, CO, hydrogen and metals, Principles of metallothermic reduction and halide metallurgy; Physico-chemical principles of fused salt electrolysis.	15	25
3	Hydrometallurgy: Principles, General considerations, Kinetics. Leaching -reagents, techniques, kinetics, role of oxygen, pressure leaching, Bacterial leaching. Solvent extraction, Ion exchange, Gaseous reduction of aqueous solutions.	11	20
4	Electrometallurgy: Electrowinning and Electrorefining of metals from aqueous and fused salt systems, Fundamentals of unit process, Applications.	8	11
5	Flow-sheets of Extraction of Important Metals Simplified Flow-sheets for the production of Iron and Steel, Aluminium, Copper, Zinc, Lead, Tin and Magnesium.	07	11
6	Reaction Kinetics Order of Reaction and Molecularity. Arrhenius Equation. Theories of	14	25

Reaction Kinetics. Role of Activation Energy. Collision Theory. Theory of Absolute Reaction Rate.		
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Suggested Specification table with Marks (Theory):

Distribution of Theory Marks				
R Level	U Level	A Level	N Level	E Level
20%	30%	30%	10%	10%

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate 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) Principles of Extractive Metallurgy -A. Ghosh and H. S. Ray, Pub.- John Wiley & Sons
- 2) Extraction of Non-ferrous Metals -H. S. Ray, R. Sridhar and K. P. Abraham, Pub.- Affiliated East-West Press, New Delhi.
- 3) Extractive Metallurgy by Joseph Newton, Pub.- John Wiley & Sons
- 4) Principles of Extractive Metallurgy by T. R. Rosenquist , Pub.-Mc Graw Hill

Course Outcomes:

After successful completion of the course students should be able to:

- 1) Understand about Extractive metallurgy processes and their relative merits and demerits.
- 2) Understand different Pyrometallurgy operations and use of Ellingham diagrams.
- 3) Understand different Hydrometallurgy and Electrometallurgy operations.
- 4) Know flow sheets of extraction of different metals.
- 5) Understand and use principles of reaction kinetics.

List of Open Source Software/learning website:

- I. <http://nptel.iitm.ac.in/>
- II. www.ocw.mit.edu

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.