GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG Branch:
Metallurgy
Subject Code: BE03021021
Subject Name: Introduction to Mineral Processing and Extractive Metallurgy

w. e. f. Academic Year:	2024-25
Semester:	3
Category of the Course:	Professional Core Course

Prerequisite:	Nil
Rationale:	The study of Mineral Processing and Extractive Metallurgy is to provide students with the essential knowledge and skills required to extract valuable minerals from ores efficiently and sustainably. This subject integrates principles from engineering, chemistry, and physics, helping students understand the processes involved in crushing, grinding, separation, concentration of minerals, and extraction principles and techniques. It prepares students for careers in industries such as mining, environmental management, and materials engineering, while also laying the groundwork for further academic pursuits in engineering and related fields.

Course Outcomes:

Sr. No.	CO statement	Marks % Weightage
CO-1	Understand basic fundamentals of mineral processing with unit operations.	35
CO-2	Select the separation process for enrichment of minerals as per physical/chemical characteristics.	35
CO-3	Understand about extractive metallurgy processes and their relative merits and demerits.	30

Teaching and Examination Scheme:

Teaching - Learning Scheme (in Hours per Semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL*	TH		ESE (E)	PA (M)	PA/ (I)	TW/ SL (I)	ESE (V)	
30	0	60	30	120	04	70	30	20	30	50	200

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, ESE = End-Semester Examination, PA = Progressive Assessment

Content:

Sr. No.	Content	Total Hours	% Weightage
1	**Introduction and Scope of Mineral processing:** Introduction and scope of mineral processing in extractive metallurgy. Ores, Mineral resources in India and worldwide for basic metals like Iron, Copper, Aluminium, lead, Zinc. Physical and chemical characteristics of industrial minerals.	04	14
2	**Liberation, Comminution, Sizing and Classification:** Liberation and its significance, Comminution and sizing, Laws of Comminution, Crushing and Grinding- types and equipment. Washing, Sorting and hand-picking; Laboratory and industrial screening equipment, screen efficiency; Classifier- mechanical and hydraulic, sizing and sorting classifiers.	05	20
3	**Minerals Separation Processes:** Gravity concentration methods, Tabling, Jigging, Heavy media separation (Dense Media Separation), Separation in vertical and streaming currents, Sedimentation, Dewatering techniques, Thickener, Filtration and Drying. **Froth flotation:** Physico-Chemical principles, reagents like collectors, modifiers and frothers. Process variables in floatation, Study of flow sheet for flotation of sulfide ores. **Magnetic and Electrostatic separation:** principle, wet and dry separators.	07	22
4	**Simplified beneficiation Flow Sheets:** Beneficiation flow sheets of copper, aluminium, lead, zinc, Iron with reference to Indian Deposits	03	10
5	**Introduction to Extractive Metallurgy:** Introduction, Advantages and limitations of Different extraction Processes, Comparison in Pyrometallurgy and hydrometallurgy. **Pyrometallurgy:** Drying, Calcination, Pelletizing, Sintering, Roasting, Smelting, Converting, and Refining.	05	20
6	**Hydrometallurgy:** Leaching techniques and reagents. Role of oxygen in leaching, Pressure leaching and bacterial leaching. Solvent Extraction, Ion Exchange. **Electrometallurgy:** Electrowinning and Electrorefining of metals.	04	14
	Total	**28**	**100**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level

20	40	25	15	00	00

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. Principles of Mineral Dressing, A. M. Gaudin, Tata McGraw Hill.
2. Will's Mineral Processing Technology by B. A. Wills & T. J. Napier-Munn.
3. Mineral Processing: (Including Mineral dressing, Experiments and Numerical) Vandana Rao, Sonam Patel & Avinash Lele, IK International Publishing House Pvt. Ltd.
4. Mineral Processing Technology, S K Jain, CBS Publisher.
5. Mineral Processing, E. J. Pryor, Pergamon Press.
6. Principles of Extractive Metallurgy -A. Ghosh and H. S. Ray, Pub.- John Wiley & Sons.
7. Extraction of Non-ferrous Metals -H. S. Ray, R. Sridhar and K. P. Abraham, Pub. - Affiliated East-West Press Pvt. Ltd., New Delhi.

List of Experiments:

1. To recognize and classify different types of ores and minerals based on their characteristics.
2. To determine the extent of size reduction achieved by the jaw crusher with a given ore sample.
3. To perform secondary size reduction on the ore that has already been crushed in the primary stage using a roll crusher.
4. To determine the efficiency of a ball mill in terms of its ability to reduce ore particle size.
5. To determine the particle size distribution of an ore sample by passing it through a sieve shaker.
6. To separate ore particles according to their settling velocities using air classifiers.
7. To separate the minerals by gravity media separation using a jigging machine.
8. To separate the sulfide minerals by a froth flotation cell.
9. Compare the effectiveness and limitations of different extraction methods: pyrometallurgy, and hydrometallurgy.
10. To study the influence of various reagents (e.g., sulfuric acid, cyanide) on the leaching process for different ores.
11. Solve numerical based on different ore dressing processes.
12. Industry/Laboratory visits.

Major Equipment: Roll crusher, Jaw crusher, Sieve shaker, Air classifier, Ball mill.

List of Open Source Software/learning website:

1. https://onlinecourses.nptel.ac.in/noc22_ce30/preview
2. https://www.open.edu/openlearn/science-maths-technology/minerals-and-the-crystalline-state/?active-tab=description-tab

- **List of suggested activities for Problem Based Learning:**

Sl. No.	Name of the activity	No. of hours	Evaluation Criteria
1.	Industry/Research laboratory visit	Visit = 5hrs., Report preparation = 5hrs. Total = 10hrs.	Based on report submitted. Report should contain observations and calculations based on industry/ lab data.
2.	Technical Video based learning related to the subject	Duration of video = 5hrs. Report preparation = 5hrs. Total = 10hrs.	Report /presentation based on the video learning outcomes.
3.	Assignment writing. Numericals based assignment is preferable.	5 assignments of 4hrs. each. Total = 20hrs.	Based on the correctness of submittedassignment.
4.	Problem solving/Coding using C, C++, MATLAB, Python, SCILAB,modeling and Analysis software or any other software	5 small coding-based assignment of 2hrs. each. Total = 10hrs.	Based on the coding solution submitted.
5.	Self-learning online course	Minimum duration of the course should be 10hrs.	Examination based assessment at the end of course. Based on the certificate produced.
6.	Identification and solution of Complex problem	Maximum 2 problems. Study of the problem and solution finding, Total = 10hrs.	Based on the depth of the solution submitted.
7	Videos on Industrial safety/Disaster Management aspects based on subject	Duration of video = 5hrs. Report preparation = 5hrs. Total = 10hrs.	Based on quiz/report submitted
8	Technical paper reading and summarization of research papers based on relevant subject	5 research papers = 20 hrs.	Summarize research paper and evaluation critical parameters
9.	Poster/chart/power point preparation on technical topics	Duration = 6 hrs.	Based on poster/chart preparation and presentation skills

10	Working/non-working model on technical topics	Working = 12 hrs. Non- working = 8 hrs.	Based on inter department/external evaluation
11	Industrial exposure for 2-3 days to observe and provide tentative solutions on society/environment/ health/sustainability/ any other issue	Duration = 15 hrs. for industrial exposure Problem identification and tentative solution = 10 hrs. Total = 20 hrs.	Based on evaluation of critical problems and solutions
12	Group Discussion on emerging/trending technical topics based on subject	Duration = Min. 1 hr.per subject. Max. 3 hrs. per subject	Based on performance in group discussion, technical depth, knowledge etc.
13.	Real world case studies-based learning	Duration of data collection/study = 5hrs. Report preparation = 5hrs. Total = 10hrs.	Based on in-depth study, technical depth, data collected, fact finding, etc.
14.	Application/Software development	Duration = 10 hrs.	Depending on the complexity of the Application/Software
15.	Research paper publication	Duration = 10 hrs.	Based on submission of proof of publication
16.	Upgradation/Reverse engineering studies of existing equipment of the laboratory	Duration 10 hrs.	Based on the performance of the equipment
17.	Expert lecture/session	Duration 3 hrs. For attending the lecture/session– 2 hrs. and for report writing 1 hr.	Based on the proof of attendance and report submitted
18.	Annotated Video Explanation of Concept/Problem	10h (Preparation + Recording + Submission)	Based on accuracy of explanation, clarity, and presentation style.
19.	Patent Search and Innovation Gap Identification	10h (Search + Report)	Based on number of relevant patents analyzed and identification of innovation scope.

Note:

- All the suggested activity should be related to the subject.
- The number of hours are suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
- Rubrics for the evaluation can be prepared by the faculty.

- Subject teacher can add the relevant activities other than those listed above, with the consent of head of the department and DQAC.
- All records pertaining to the evaluation and assessment of self-learning activities must be properly maintained and preserved at the institute level. These records should be made available to the university upon request.
- Institutes are encouraged to utilize digital platforms, such as Microsoft Teams, for effective record-keeping and to ensure transparency in the evaluation and assessment of self-learning activities.

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