NON-FERROUS EXTRACTIVE METALLURGY

Course Type	Course Code	Name of the Course	L	T	P	Credits
DE	FMD 463	Non-ferrous Extractive Metallurgy	3	0	0	9

Course Objective

The objective of the course is to provide the knowledge of extraction process of non-ferrous metals from its ores.

Learning Outcomes

Upon successful completion of this course, students will:

- have a broad understanding of principles of extraction of metals.
- have a high-level understanding of process variables to enhance the productivity and efficiency of different processes.
- be able to understand basic flowsheet of non-ferrous metal extraction.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1.	Brief Introduction to Principles of metals extraction processes in pyro, hydro and electrometallurgical route.	3	To recollects the basics
2.	Introduction to extraction of non-ferrous metals and their sources. General methods used for the extraction metals from sulphides, oxides, hydroxides, native metals etc.	4	This will help the students to understand the various methods/ routes and sources used in the extraction processes.
3.	Extraction of metals from hydroxide/oxide minerals: Extraction of Aluminium, Bayer's process for the production of alumina and its under lying principles. Fused salt electrolysis, factors affecting fused salt electrolysis Hall-Heroult process, role of cryolite and mechanism involved in the process. Newer Process for Aluminium production (ALCOA Process). Extraction of Tin, smelting and refining of tin concentrate. Extraction magnesium (PIDGEON and DOW Process), with reaction mechanisms involved in the processes.	12	Students will gain the knowledge of production of typical metals from hydroxides /oxide by different methods.
4.	Extraction of metals from sulphides: Extraction of copper by conventional (roasting, smelting and converting) process. Newer processes for copper extraction such as Flash smelting, WORCRA and NORANDA processes. Extraction of lead. Refining of lead bullion, Parke's desilverization. Modern development in lead smelting. Extraction of zinc, different methods involved in the process, Imperial Smelting Process, Condensation of zinc vapours, Roast leach electrolytic process. Extraction of nickel by pyrometallurgical process, hydrometallurgy of nickel sulphides concentrate.	12	This will enable the students to understand extraction of base metals from their sulphides.
5.	Extraction of Nuclear Metals: Hydrometallurgical Extraction of uranium by acid and alkali leaching. Extraction of Titanium. Smelting of Ilmenite, Sorel Process. Production of Ti sponge by KROLLs Process. Extraction of rare earth metals.	4	This portion will help in knowing the extraction of nuclear metal and rare earth metals.
6.	Production of precious metals: Extraction of gold and silver by cyanidation process and their under lying principles. Recovery of gold by reductive precipitation, CIP and CLL processes. Extraction of platinum group of metals.	3	Provides necessary fundamental and application of extraction of precious metal from its native ores.
7.	By-product recovery from waste, such as red mud, dross, anode slime and its utilization.	2	This will help knowing the utilization of by-products.
8.	Flow sheets and general methods of refining, (Drossing, Fractional distillation, Zone and fire refining.)	2	This will enable the students to the flow sheets and brushup refining techniques.
	Total	42	

Text Books:

TEXT BOOKS			
NO.	RESOURCE/BOOK NAME	AUTHOR(S)/EDITOR(S)	PUBLISHER
1	Extraction of Nonferrous Metals	H. S. Ray, R. Sridhar, K. P. Abraham	Affiliated East-West Press
2	Hydrometallurgy	H.S. Ray, A. Ghosh	New Age International
3	Hydrometallurgical Extraction and Reclamation	Eric Jackson	Ellis Horwood

Reference Books:

NO.	RESOURCE/BOOK NAME	AUTHOR(S)/EDITOR(S)	PUBLISHER
1	Extractive Metallurgy	W.H. Dennis	Pitman Publishing
2	Principles of Extractive Metallurgy, Volume 1	Fathi Habashi	CRC Press
3	Principles of Extractive Metallurgy	Terkel Rosenqvist	Tapir Academic Press
4	Non-Ferrous Production Metallurgy	J. L.Bray	John Wiley and Sons
5	Unit Processes of Extractive Metallurgy	Robert D. Pehlke	Elsevier
6	Introduction to Melts: Molten Salts, Slags and Glasses	H. S. Ray	Allied Publishers
7	Energy In Minerals & Metallurgical Industries	H. S. Ray, B. P. Singh, Sarama Bhattacharjee, Vibhuti N. Misra	Allied Publishers