

Syllabus

Topics	Time (hours)
The material cycle: Material flow, recyclability of materials, quantifying material cycle.	2
Introduction to Sustainability: Environmental context, Brief history of sustainability, the concept, sustainability frameworks	2
Different resources for metals: Earth crust, seawater, sea nodules, metallurgical waste, end-of-life products	1
General mineral beneficiation and metal extraction processes: Communication, classification, gravity separation, magnetic separation, electrostatic separation, flotation.	1
Metal extraction processes: Principles, Pyrometallurgical, hydrometallurgical and electrometallurgical processes that are relevant for waste utilisation and recycling	3
Energy consumption in primary production: Embodied energy, global warming potential, ore grade vs energy consumption, theoretical energy requirement	1
Waste generation and management in primary production: Solid wastes, liquid wastes and gases. The impact of wastes on humans and environment, waste regulations, management of waste	3
Availability and demand for metals: metal availability in different sources, metal substitution, dematerialization.	2
Options for waste utilisation: waste utilisation for metal recovery, waste utilisation in bulk applications such as roads, cements and bricks.	1
End-of-life products and recycling: Waste management hierarchy, drivers for recycling, benefits, and limitations of recycling, Theory of recycling, the energy required for recycling	3
Achieving zero waste and sustainability: Reducing and eliminating wastes, Cleaner production, Waste reduction through process modifications, industrial ecology, closing the material cycle	4
Case studies on metallurgical waste utilisation: Bauxite residue, Iron ore tailings, Jarosite etc.	4
Case studies on recycling: Steel, Copper, Aluminium, Lead, Zinc, Batteries, WEEEs etc.	8
Students presentations	5
Total	40