Minor Stream: Environment and Safety in Mining

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
241MN023	Sustainable Mining	FC	3			3	50	50	100	DMD
241MN024	Drilling & Blasting	IC	3			3	50	50	100	DMD
241MN025	Safety Practices in Mines	IC	3			3	50	50	100	UCMT
241MN026	Environmental Impact Assessment	IC	3			3	50	50	100	SM
241MN027	Mine Health & Safety Engineering	IC	3			3	50	50	100	SPM
241MN028	Environmental Pollution & Control	IC	3			3	50	50	100	UCMT/UMMT
241MN029	Industrial Safety	IC	3			3	50	50	100	-
241MN030	Waste Water Treatment & Recycling	IC	3			3	50	50	100	-
241MN031	Environment & Safety	IC	3			3	50	50	100	-
241MN032	Mine Closure Planning	AC	3			3	50	50	100	SM
241MN033	Safety Engineering	AC	2			2	50	50	100	MHSE
Total			**32**			**32**				

Sustainable Mining

	L	T	P	C
Course Code: 241MN023	**3**	**0**	**0**	**3**

Course Outcomes:

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

CO1: Analyze different stages in the EIA

CO2: Analyze the participation of public and NGO'S in environmental decision making.

CO3: Analyze the special methods and components of EIA.

CO4: Generate the awareness of assessment of impacts air, water, soil, noise biological, socio & cultural environments.

CO5: Analyze the Case studies related to the Mining sectors.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	1	3	-	-	-	-	1	1	-	-	-
CO2	1	3	-	-	-	-	1	1	-	-	-
CO3	1	3	-	-	-	-	1	1	-	-	-
CO4	1	3	-	-	-	-	1	1	-	-	-
CO5	1	3	-	-	-	-	1	1	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	2	-
CO2	2	-
CO3	2	-
CO4	2	-
CO5	2	-

UNIT – I

Foundations of Sustainable Mining : Concept of Sustainable Development for Mining Industry, Overview of Current Mining Practices and Their Impact on Sustainability, Legislative Measures for Sustainable Development: MMDR Act, Star Rating of Indian Mines (Coal & Non-coal), Milos Statement on Sustainable Mineral Industry.

UNIT – II

Current Practices and Policies : International Sustainability Reporting and Tools for Measurement, National Mineral Policies in Mineral Based Countries, Indian National Mineral Policy: Historical Development and Sustainable Practices, Lease Issues, Auctions, and their Impact on Sustainability.

UNIT – III

Sustainable Mining Technologies and Techniques : Overview of Clean Coal Technologies: Coal beneficiation, Coal Bed Methane, Underground Coal Gasification, Metal Recovery Techniques: Leaching of Old Dumps, Recycling of Metals, CO2 Sequestration - Reducing Emissions through Technology.

UNIT – IV

Best Practices and Innovations: Case Studies on Best Mining Practices for Sustainability, Innovative Techniques and Technologies in Sustainable Mining, Benefits of Sustainability for mineral development in India.

UNIT – V

Environmental and Social Initiatives for Sustainable Mining: Environmental Responsibility and Corporate Social Responsibility, District Mineral Fund: Collection, Utilization, and Impact, Integration of Artificial Intelligence in Mining Industries for Sustainable Practices

Text Books:

1. Advances in Productive, Safe, and Responsible Coal Published, Joseph Hirschi, Elsevier Ltd, 2019. ISBN: 9780128171057.
2. Capacity building in Geosciences and Sustainable Development, Mukherjee, Saumitra, Min. of Mines. ISBN: 978-8190191601.

Reference Books:

1. Annual Report of Ministry of Coal, Ministry of Mines, MoEF & Climate Change.
2. National Seminar on Sustainable Development in Mineral & Earth Resources, New Delhi, The Indian Mining & Engineering Journal, Bhubaneswar & AKS University, Satna.

Web Links:

1. https://sdimi.org/wp-content/uploads/2021/11/SDIMI2003_milos_decl_org.pdf
2. https://www.sciencedirect.com/science/article/abs/pii/S0969698914001143

Drilling & Blasting

	L	T	P	C
Course Code: 241MN024	**3**	**0**	**0**	**3**

Course Outcomes:

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

CO1: Differentiate between types of drilling machines.
CO2: Identify and classify explosives
CO3: Analyze problems associated with open cast blasting and mitigation.
CO4: Analyze problems associated with underground blasting and mitigation.
CO5: Assess blasting in metal mines.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	1	3	2	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-
CO3	1	3	-	-	-	-	-	-	-	-	-
CO4	1	3	-	-	-	-	-	-	-	-	-
CO5	1	3	-	-	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	3	3
CO2	3	3
CO3	3	3
CO4	3	3
CO5	3	3

UNIT – I

Drilling: Drillability, mechanics of drilling, major types of drilling machines, Principles of drilling, Types of drill, Drill rods and drill bits -Types and applications, Exploratory and Production Drilling.

UNIT – II

Explosives and Blasting Accessories: Mechanism of blasting, Explosives- types and properties. Selection of explosives, Handling, and storage of explosives. Types of initiating systems – Electrical Detonators, Detonating Fuse, Detonating Relays, NONEL, Electronic Detonators, Blasting accessories, exploders. Blast Design in Surface and Underground Mines.

UNIT – III

Drilling and Blasting in Surface Mines: Factors affecting blasting, Blast design - estimation of burden and spacing, estimation of charge requirement; Initiation patterns; secondary blasting – pop and plaster shooting; Problems associated with blasting, Ground vibration and air over pressure.

UNIT – IV

Drilling and Blasting in Underground Coal Mines: Blast hole patterns and their applicability, blasting-off-solid, ring hole blasting, calculation of specific charge, specific drilling and detonator factor, initiation patterns.

UNIT – V

Drilling and Blasting in Underground Metal mines: Blast hole patterns and their applicability, blast design for horizontal drivage, long hole blasting, vertical crater retreat blasting.

Text Books:

1. Principle of rock drilling, B. Misra, U.M. Rao Karanam, Taylor & Francis, CRC Press. ISBN: 9781138033646.
2. Drilling & Blasting Minetech, Pradhan G.K., Ghose A.K., Bhubaneswar, India: Mintech. ISBN: 9789383183039.

Reference Books:

1. Elements of Mining Technology,DJ Deshmukh, Denett, First Edition, Vol. 1. ISBN: 978-81-89940-02-7.
2. Surface mining, GB Mishra, Dhanbad, Vol.1. ISBN: 978-0873351027.

Web Links:

1. https://archive.nptel.ac.in/courses/123/105/123105003/
2. https://www.rpmdrilling.co.za/blast-hole-drilling-process/
3. www.railsystem.net/drill-and-blast-method/

Safety Practices in Mines

	L	T	P	C
Course Code: 241MN025	**3**	**0**	**0**	**3**

Course Outcomes:

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

CO1: Describe about M.V.T.R training course.
CO2: Analyze safety operating procedures of mine machinery.
CO3: Analyze safe act and safe environment.
CO4: Use safety appliances
CO5: Apply safety audit methods.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	3	-	-	-	-	-	-	-	-	-
CO2	2	3	-	-	-	-	-	-	-	-	-
CO3	2	3	1	-	-	-	-	-	-	-	-
CO4	2	3	-	-	-	-	-	-	-	-	-
CO5	2	3	1	-	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	3	-
CO2	3	-
CO3	3	-
CO4	3	-
CO5	3	-

UNIT – I

Training Programmes: Basic training course, Refresher training course and Special training courses as per M.V.T.R. 1966

UNIT – II

S.O.P : Safe operating procedures for dumper, shovel, drills and dozers, Safe operating procedures at working face and dumps.

UNIT – III

Safe Act and Safe Environment: Unsafe act and unsafe environment, Accident analysis, Near-miss analysis, Heinrich and Pearson Triangle for mine accident.

UNIT – IV

Safety appliances: Safety appliances with respect to mine gasses and inundation, Rescue apparatus, Automatic fire suppression, fire extinguishers, and Protective equipment for miners.

UNIT – V

Safety Awareness: Safety audit methods, Safety record management and recent trends in development of safety engineering approaches. Safety Management Plan.

Text Books:

1. Safety at work, Ridley .J& C Channing, Butter worth, Oxford. ISBN: 978-0750654936.
2. Introduction of system safety engineering, Rodgers. W.P, John Wiley &Sons Inc, New York. ISBN: 0471720020.

Reference Books:

1. Introductory Mining Engineering, Howard L. Hartman, Jan M. Mutmansky. ISBN: 978-0471348511.
2. Safety in Mines Research, Greem A. R, A, R. Balkena, Rotterdam. ISBN: 978-9061915075.
3. Mine vocational Training rules 1966.

Web Links:

1. https://arlweb.msha.gov/Fatals/AccidentClassifications.asp
2. https://www.hsa.ie/eng/Topics/Managing_Health_and_Safety/Safety_Statement_and_Risk_Assessment/

Environmental Impact Assessment

	L	T	P	C
Course Code: 241MN026	**3**	**0**	**0**	**3**

Course Outcomes:

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

CO1: Analyze different stages in the EIA.

CO2: Analyze the participation of public and NGO'S in environmental decision making

CO3: Analyze the special methods and components of EIA.

CO4: Generate the awareness of assessment of impacts air, water, soil, noise biological, socio & cultural environments

CO5: Analyze the Case studies related to the Mining sectors.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	-	3	-	-	-	-	-	-	-	-	-
CO2	-	3	-	-	-	-	-	-	-	-	-
CO3	-	3	-	-	-	-	-	-	-	-	-
CO4	-	3	-	-	-	-	-	-	-	-	-
CO5	-	3	-	-	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	3	-
CO2	3	-
CO3	3	-
CO4	3	-
CO5	3	-

UNIT – I

Introduction: Environment and Forest Clearance-Legal and regulatory aspects. Environmental Impact Assessment (EIA) - Environmental Impact Statement, Environmental management plan. Contribution of greenhouse gasses from mining causing climate change.

UNIT – II

Components and Methods: Components of EIA - Processes - Screening - Scoping - Setting - Analysis - mitigation. Matrices – (Leopold matrix, Battle Environment Evaluation Systems (BEES)) Networks - Checklists - Connections and combination of processes - Cost benefit analysis - Analysis of alternatives - Software packages for EIA- Expert systems in EIA.

UNIT – III

Prediction, Assessment of Impacts and Reporting: Prediction tools for EIA - Mathematical modeling for impact prediction - Assessment of impacts - Air - Water - soil - noise - biological - socio - cultural environment .Mine closure planning-progressive and final mine closure planning, closure risk assessment.

UNIT – IV

Societal Impact Assessment: Cross sectorial issues and terms of reference in EIA - Participation of Public and Non - Governmental Organizations in environmental decision making. Rehabilitation and Resettlement of PAP. Socio-economic impact assessment.

UNIT – V

Case Studies: Case studies on EIA and EMP of Mining projects.

Text Books:

1. Environmental Impact Assessment - Practical solutions to recurrent problems, Lawrence D.P, Wiley –Inter science, New Jersey. ISBN: 978-0471290472.
2. Hand book of Environmental Impact Assessment, Petts, J. Blackwell Science London, Vol - I and II. ISBN: 978-0632042604. & 978-0632042611.

Reference Books:

1. Environmental Impact Assessment, R.R.Barthwal. ISBN: 978-0074622687.
2. Environmental Impact Assessment, N.S.Ramman. ISBN: 978-0632042602.

Web Links:

1. https://www.cbd.int/impact/whatis.shtml
2. https://www.sciencedaily.com/terms/environmental_impact_assessment.htm
3. https://www.gdrc.org/sustdev/concepts/08-eia.html
4. https://www.journals.elsevier.com/environmental-impact-assessment-review

Mine Health & Safety Engineering

	L	T	P	C
Course Code: 241MN027	**3**	**0**	**0**	**3**

Course Outcomes:

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

CO1: Explain the different health hazards and its prevention in mining industries.
CO2: Distinguish the mine accidents occurring in surface and underground mining area.
CO3: Illustrate the various approaches towards safety risk assessment.
CO4: Discuss the safety planning and safety management systems
CO5: Analyze the innovations in mine safety engineering.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	3	-	-	-	-	-	-	-	-	-
CO2	2	3	-	-	-	-	-	-	-	-	-
CO3	2	-	-	1	-	-	-	-	-	-	-
CO4	2	-	2	-	-	-	-	-	-	-	-
CO5	2	3	-	-	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	3	-
CO2	3	-
CO3	3	-
CO4	3	-
CO5	3	-

UNIT – I

Occupational health hazards in mines: Pneumoconiosis, Gas Poisoning, Radiation, noise induced hearing loss (NIHL), Metal Toxicity, Prevention of health hazards in mines.

UNIT – II

Mine accidents: Classification, Genesis, Analysis & Prevention in Surface & Underground mines.

UNIT – III

Safety Risk Assessment: Hazard identification, analysis and evaluation, control. Qualitative & Quantitative approaches FTA, ETA, HAZOP, FMEA, WRAC etc., Formulation of safety management plan

UNIT – IV

Behaviors Based Safety & Safety Culture. Ergonomics& Mine Safety. OHS Structure for different mining companies.

UNIT – V

Safety audits, Innovations in Mine Safety Engineering. Case Studies.

Text Books:

1. Safety at work; Ridley .J& C Channing; Butter worth, Oxford. ISBN: 978-0408031014.
2. Introduction of system safety engineering, Rodgers. W.P, John Wiley &Sons Inc, New York. ISBN: 978-0471066077.

Reference Books:

1. Introductory Mining Engineering, Howard L. Hartman, Jan M. Mutmansky. ISBN: 978-0471297107.
2. Safety in Mines Research: Greem A. R, A, R. Balkena, Rotterdam. ISBN: 978-9061919680.

Web Links:

1. https://arlweb.msha.gov/Fatals/AccidentClassifications.asp
2. https://www.hsa.ie/eng/Topics/Managing_Health_and_Safety/Safety_Statement_and_Risk_Assessment/

Environmental Pollution & Control

	L	T	P	C
Course Code: 241MN028	**3**	**0**	**0**	**3**

Course Outcomes:

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

CO1: Illustrate the fundamentals of environmental issues in mining
CO2: Examine the various causes of water pollution.
CO3: Analyze the various causes of air pollution.
CO4: Analyze the methods for mine reclamation
CO5: Assess environmental impact due to mining.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	2	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-
CO5	3	2	-	-	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	3	-
CO2	3	-
CO3	3	-
CO4	3	-
CO5	3	-

UNIT – I

Air Pollution: Atmospheric science; Sources of air pollution in mines; Effect of air pollution and preventive measures; Ozone layer and greenhouse effect; Dispersion model.

UNIT – II

Water Pollution: Sources of water pollution; Effect and preventive measures of water pollution; Ground water and its contamination; Water pollution modeling - biological oxygen demand and chemical oxygen demand; Acid mine drainage; Waste water treatment.

UNIT – III

Noise Pollution: Terminologies associated with noise; Sources and effects of noise; Measurement of noise; Noise standard and guidelines; Noise control strategies.

UNIT – IV

Land Reclamation and Rehabilitation: Causes of land degradation; Land reclamation method- Rehabilitation, Reclamation, Restoration; Factor affecting the land restoration; Land reclamation planning.

UNIT – V

Socio-Economic Impact Assessment: Socio-economic impact of mining, Quality of life index.

Text Books:

1. Environmental Pollution and Control, Peirce J. Jeffrey, Elsevier Science & Technology, Fourth Edition, 2018. ISBN: 978-0128125428.
2. Principle and practices of modern coal mining,R.D. Singh, New Age International. ISBN: 978-8122416464.

Reference Books:

1. Ground Control, Peng, S.S. Wiley Publications, New York. ISBN: 978-0471775410.
2. Open pit mine planning and Design, W. Hustrulid and M. Kuchta, A. A. Balkema Rotterdam, 1st edition, Vol – I. ISBN: 978-9056990736.
3. Surface Mining, G. B. Mishra, Lovely Prakashan Dhanbad, 1st edition. ISBN: 978-81-85500-42-6.

Web Links:

1. https://miningandblasting.wordpress.com/2011/08/30/mine-planning-and-scheduling-smart practice
2. https://onlinecourses.nptel.ac.in/noc22_ce22/preview

Industrial Safety

	L	T	P	C
Course Code: 241MN029	**3**	**0**	**0**	**3**

Course Outcomes:

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

CO1: Evaluate the effectiveness of different safety engineering methods in mitigating risks.

CO2: Analyze the impact of ergonomic practices on productivity and job satisfaction.

CO3: Describe Importance of Industrial safety.

CO4: apply regulatory standards and best practices related to the use of personal protective equipment.

CO5: Analyze the common characteristics and patterns associated with different types of accidents.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	3	-	-	-	-	-	-	-	-	-
CO2	2	3	-	-	-	-	-	-	-	-	-
CO3	2	3	-	-	-	-	-	-	-	-	-
CO4	2	3	-	-	-	-	-	-	-	-	-
CO5	2	3	-	-	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	2	-
CO2	2	-
CO3	2	-
CO4	2	-
CO5	2	-

UNIT – I

Introduction to industrial safety

Safety scenario in national and international arena, Overview of safety engineering principles, identification of safety issues in different industries and their remedial measures, general safety practices.

UNIT – II

Ergonomics

Ergonomics – Importance,Types of ergonomics – physical, cognitive, and organizational. Ergonomics Hazards – Musculoskeletal Disorders and Cumulative Trauma Disorders, ergonomics case studies. Whole Body Vibration, Hand Arm Vibration, Foot Transmitted Vibrations.

UNIT – III

Industrial Health and Hygiene

Occupational health hazard & classification of health hazards, Occupational health and hygiene surveillance, legislative measures and prevention of health hazards.

UNIT – IV

Personal Protective Equipment
Types of personal protective equipment and their usages- head protection, eye and face protection, respiratory and hearing protection.

UNIT – V

Accident Prevention Techniques
Types of accidents, causes of accidents- unsafe acts and conditions, human factors, mechanical failures, environmental factors. accident investigation and prevention.

Text Books:

1. The Factories Act with amendments, Govt. of India Publications, DGFASLI, Mumbai. ISBN: 978-9352471010.
2. Loss of prevention in Process Industries, Frank P Lees, Butterworth- Heinemann Ltd., Vol. 1 and 2. ISBN: 978-0750633016 & 978-0750633023.

Reference Books:

1. Accident Prevention Manual – NSC, Chicago. ISBN: 978-1118240295.
2. Occupational safety Manual BHEL, Trichy, ISBN: 978-81-73190163.
3. Safety Management,John V. Grimaldi and Rollin H. Simonds, All India Travelers Book seller, New Delhi. ISBN: 978-8173190162.

Web Links:

1. https://environmentclearance.nic.in/writereaddata/online/RiskAssessment/070920177YH10QMZRiskAssessment.pdf
2. https://www.lightguidesys.com/resource-center/blog/what-is-ergonomics/#:~:text=There%20are%20three%20types%20of,physical%2C%20cognitive%2C%20and%20organizational.
3. https://www.ccohs.ca/oshanswers/chemicals/whmis_ghs/hazard_classes.html
4. https://www.anbusafety.com/mining-ppe-2/

Waste Water Treatment & Recycling

	L	T	P	C
Course Code: 241MN030	**3**	**0**	**0**	**3**

Course Outcomes:

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

CO1: Analyze about Wastewater Generation.
CO2: Explain about the Sources and Types of Waste water
CO3: Analyze Waste water Characteristics.
CO4: Analyze Secondary Treatment Processes of waste water.
CO5: Assess Wastewater Treatment Systems.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	3	1	-	-	-	-	-	-	-	-
CO2	2	-	1	-	-	-	-	-	-	-	-
CO3	2	3	1	-	-	-	-	-	-	-	-
CO4	2	3	1	-	-	-	-	-	-	-	-
CO5	2	3	1	-	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	-	3
CO2	-	3
CO3	-	3
CO4	-	3
CO5	-	3

UNIT – I

Introduction: Introduction to wastewater, Wastewater Generation and Characteristics, Natural Attenuation of Pollutants in Wastewater, Treatment Philosophy, Objectives of wastewater treatment, Preliminary and Primary Treatment Processes, Secondary Treatment Processes, Secondary Treatment Processes-Anaerobic, Sludge Management, Tertiary (Advanced) Treatment Processes, Current Treatment Approaches, Wastewater Recycling: Scope and demands, Technology Selection and Decision Making. Acid Mine Drainage.

UNIT – II

Sources and Types of Wastewater Pollutants in Wastewater: Point and Non-point Sources, Wastewater Management: Concept of Treatment and Recycling, Issues and Challenges, Wastewater Generation and Quantity Estimation, Quantity Estimation of Sewage, Population Forecasting Methods, Quantity Estimation of Sewage Flow, Sewage Quantity Estimation: Practice Problems.

UNIT – III

Wastewater Characteristics: Quality Parameters, Practice Problems, Terrace - Introduction, Bench Terraces, Problems on Bench Terraces, Broad-base Terraces, Problems

on Broad-base Terraces, Mass Balance: Application in Specific Cases, Mass Balance in Reactors: Application and Practice Problems.

UNIT – IV

Secondary Treatment Processes: Introduction to Biological Treatment of Waste water Biological Treatment of Wastewater: Microbial Growth and its Kinetics, Activated Sludge Process, Sludge Stabilization and Conditioning, Dewatering, Hibernization, Disposal/Reuse. Tertiary (Advanced) Treatment of Waste water: Nutrients Removal, Adsorption and Ion Exchange, Disinfection and Chemical Treatments.

UNIT – V

Wastewater Treatment Systems: Options and Conventional Approach, Alternate Wastewater Treatment Systems; Integrated Systems: Wetlands, SBR and SBBR, MBR and MBBR, Wastewater Reuse and Recycling: Challenges, Risks and Research Trends, Decision Making in Wastewater Reuse and Recycling, Wastewater Reuse and Recycling: Public Acceptance for Recycled Water Use, Global Practices and Case Studies

Text Books:

1. Wastewater Engineering, Metcalf and Eddy, McGraw-Hill. ISBN: 978-0073401188.
2. Environmental Engineering, Peavy, Rowe and Tchobanoglous, McGraw-Hill. ISBN: 978-0071002556.

Reference Books:

1. Water Quality Engineering: Physical / Chemical Treatment Processes, Lawler and Benjamin, John Wiley & Sons. ISBN: 978-0470177922.
2. Unit Operations and Processes in Environmental Engineering, Reynolds and Richards, CL Engineering. ISBN: 978-0133049605.

Web Links:

1. https://water.unl.edu/article/wastewater/wastewater-what-it
2. https://afrosai-e.org.za/wp-content/uploads/2021/05/PA-Report-Management-of-Wastewater-Treatment_Botswana.2020.pdf

Environment & Safety

	L	T	P	C
Course Code: 241MN031	**3**	**0**	**0**	**3**

Course Outcomes:

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

- **CO1** Assess the scope of environmental and safety issues in mining
- **CO2** Describe the principles and procedures involved in conducting an EIA
- **CO3** Apply effective waste management techniques in mining
- **CO4** Identify occupational health hazards in mining and implement prevention strategies
- **CO5** Apply the principles and practices of sustainable mining

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	3	-	-	-	-	-	-	-	-	-
CO2	2	3	-	-	-	-	-	-	-	-	-
CO3	2	-	-	1	-	-	-	-	-	-	-
CO4	2	-	2	-	-	-	-	-	-	-	-
CO5	2	3	-	-	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	2	-
CO2	2	-
CO3	2	-
CO4	2	-
CO5	2	-

UNIT – I

Introduction to Environmental and Safety Issues in Mining: Overview of environmental and safety challenges in mining, Historical context and evolution of mining practices, Key regulations and standards in mining safety and environmental protection.

UNIT – II

Environmental Impact Assessment (EIA) and Monitoring: Principles and procedures of Environmental Impact Assessment (EIA), Baseline studies and environmental monitoring, Mitigation measures and best practices.

UNIT – III

Waste Management and Pollution Control in Mining: Types of waste generated by mining activities, Waste management techniques (tailings, waste rock, slag), Pollution control measures (air, water, soil).

UNIT – IV

Health and Safety in Mining Operations: Occupational health hazards in mining, Safety management systems and risk assessment, Emergency response and disaster management.

UNIT – V

Sustainable Mining Practices and Future Trends: Principles of sustainable mining, Rehabilitation and reclamation of mine sites, Emerging technologies and future trends in mining safety and environmental protection.

Text Books:

1. Mine Health and Safety Management. Karmi's, M. SME. ISBN: 978-0873353861.
2. Introduction to Mine Health and Safety Management. McAree, P. R, University of Queensland. ISBN: 978-0- 87335-200-0.

Reference Books:

1. Mineral Processing Technology: An Introduction to the Practical Aspects of Ore Treatment and Mineral Recovery. Wills, B. A., & Finch, J, Wills' Butterworth-Heinemann. ISBN: 978-0080970530.
2. Mining Waste Management and Environmental Sustainability. Awasthi, A., CRC Press. ISBN: 9780367331166.

Web Links:

1. https://www.icmm.com/en-gb/our-principles
2. https://www.sgu.se/en/itp308/knowledge-platform/4-mining-waste/

Mine Closure Planning

	L	T	P	C
Course Code: 241MN032	**3**	**0**	**0**	**3**

Course Outcomes:

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

CO1: Describe about strategies for mine reclamation and closure planning.
CO2: Analyze challenges of mine closure
CO3: Analyze Socio- economic Aspects of Mine closure
CO4: Analyze financial provisions
CO5: Assess best practices in mine closure planning.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	3	-	-	-	-	-	-	-	-	-
CO2	2	3	-	-	-	-	-	-	-	-	-
CO3	2	3	1	-	-	-	-	-	-	-	-
CO4	2	3	-	-	-	-	-	-	-	-	-
CO5	2	3	1	-	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	3	
CO2	3	
CO3	3	
CO4	3	
CO5	3	

UNIT – I

Introduction: Principles and strategies for mine reclamation and closure planning. Land Reclamation: Issues of land degradation due to mining activities, environmental factors affecting revegetation in the mine site.

UNIT – II

Challenges of mine closure: Societal and environmental Issues in implementation of mine closure and reclamation planning. EIA and EMP, Environmental laws and standards, Preparation of EMP for various mineral industries.

UNIT – III

Socio-economic aspects: Systems approach for mine closure & reclamation, development of closure plan, Socio- economic Aspects of Mine closure and reclamation.

UNIT – IV

Financial provisions: Mine closure and recamation risk assessment, financial provisions for reclamation and closure in India, District mineral fund, Introduction to the Functioning of Escrow Account.

UNIT – V

Case Studies: Technological and biological reclamation of waste dumps, best practices in mine closure planning. Technologies to monitor reclmation and closure activities.

Text Books:

1. Handbook of Environmental Management and Technology, G. Burke, B. R. Singh and L. Theodore, Wiley-Interscience, 2nd edition. ISBN: 978-0471656782.
2. Mine Waste Management, P. G. Hutchison, and R. D. Ellison, CRC Press, 1st edition. ISBN: 978-0367336438.

Reference Books:

1. Environmental Engineering, McGraw- H. S. Peavy, D. R. Rowe and G. Tshibangu's, Hill Publishing Co; 7th Rev Ed edition. ISBN: 978-0073401182.
2. Mining Environment Management Manual, N. C Saxena, Scientific Publishers (India). ISBN: 9788172333669.
3. Environmental Management: Principles and Practice (Routledge Environmental Management Series), C. J. Barrow, Routledge , 1st edition. ISBN: 978-0415185227.

Web Links:

1. https://miningandblasting.wordpress.com/2011/10/01/challenges-in-mine-planning-and-scheduling
2. https://fipr.floridapoly.edu/about-us/phosphate-primer/reclamation-strategies-and-stages.php

Safety Engineering

	L	T	P	C
Course Code: 241MN033	**2**	**0**	**0**	**2**

Course Outcomes:

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

CO1: Describe classification of accidents
CO2: Explain methods for analyzing accidents
CO3: Describe Risk Assessment and Safety Management
CO4: Apply Human Factors and Behavioural Aspects in Safety
CO5: Analyze Crisis Management and Economic Aspects of Safety

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	3	-	-	-	-	-	-	-	-	-
CO2	2	3	-	-	-	-	-	-	-	-	-
CO3	2	-	-	1	-	-	-	-	-	-	-
CO4	2	-	2	-	-	-	-	-	-	-	-
CO5	2	3	-	-	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	2	-
CO2	2	-
CO3	2	-
CO4	2	-
CO5	2	-

UNIT – I

Overview of safety engineering principles, Classification of Accidents, Examples and case studies, Causes of Accidents-Human factors, Mechanical failures, Environmental factors.

UNIT – II

Accident Prevention and Analysis-Causes & Prevention of Various Types of Accidents, identifying root causes, Prevention strategies and best practices, Accident Analysis and Control- Methods for analyzing accidents, Control measures to mitigate accidents, Accidental Enquiry, Significance of accident investigations, Steps to prepare an accident enquiry report.

UNIT – III

Risk Assessment and Safety Management- Risk Assessment, Techniques for assessing risk, Risk management processes, Safety Management and Organization, Organizational roles in safety management, Techniques Used in Safety Analysis, Tools and methodologies for safety analysis, Application of safety techniques in various industries.

UNIT – IV

Human Factors and Behavioural Aspects in Safety, Aspects of Human Behavior in Accidents, Psychological and social factors, Human Behavioural Approach in Safety, Training and development for safety awareness, Behavioural safety programs, Workers Participation for Promotion of Safety, Importance of worker involvement, Strategies to enhance participation.

UNIT – V

Crisis Management and Economic Aspects of Safety- Crisis Management and Its Role in Safety Planning for crisis scenarios, Role of crisis management in ensuring safety. Accidents Costs- Direct and indirect costs of accidents, Economic impact analysis, Concepts of ZAP & MAP Implementation and benefits.

Text Books:

1 Legislation in Indian mines- A critical appraisal , Rakesh & Prasad, Ashalatha. ISBN: 978-81-908799-0-0.
2 Safety at Work; Ridley, J & Channing, J. Butterworth-Heinemaan, Oxford. ISBN: 978-0750622826.

Reference Books:

1 Introduction to System Safety Engineering, Rodgers, W.P. John Wiley & Sons Inc. ISBN: 978-0471025790.
2 Safety in Mines Research; Green, A.R.; A.A. Balkena; Rotterdam. ISBN: 0-415-06943-7.

Web Links:

1 https://www.dgms.gov.in/writereaddata/Content/User%20(External)%20Manual%20of%20Accident%20Module%20(1).pdf
2 https://www.zehntech.com/7-benefits-of-using-zap-tool-for-security-testing/
3 https://www.hse-network.com/behavioural-safety-approaches-to-hse-management/#:~:text=The%20definition%20of%20behavioural%20safety,the%20cause%20of%20the%20incident.

Minor Stream: Innovative Mining

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
241MN034	Planning for Mining Projects	FC	3			3	50	50	100	DMD
241MN035	Geo-Statistics	IC	3			3	50	50	100	DMD
241MN036	Mineral Economics	IC	3			3	50	50	100	DMD
241MN037	Advanced Exploration Techniques	IC	3			3	50	50	100	DMD
241MN038	Advanced Surveying Technology	IC	3			3	50	50	100	MS
241MN039	Geo Spatial Imaging & Geo-informatics	IC	3			3	50	50	100	-
241MN040	Remote Sensing Applications in Mining	IC	3			3	50	50	100	-
241MN041	Green Mining	IC	3			3	50	50	100	-
241MN042	Utilisation of Solar Energy in Mines	IC	3			3	50	50	100	-
241MN043	Deep Sea Mining	AC	3			3	50	50	100	DMD
241MN044	Space Mining Technology	AC	2			2	50	50	100	-
Total			32			**32**				

Planning for Mining Projects

	L	T	P	C
Course Code: 241MN034	**3**	**0**	**0**	**3**

Course Outcomes:

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

CO1: Prepare feasibility report
CO2: Design open pit slope angels & ultimate pit limit
CO3: Select transport and dumping systems.
CO4: Examine stability analysis.
CO5: Explain transition of underground to opencast mines.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	1	-	-	-	-	-	-	-	-	-	-
CO2	1	-	3	-	-	-	-	-	-	-	-
CO3	1	-	3	-	-	-	-	-	-	-	-
CO4	1	3	-	2	-	-	-	-	-	-	-
CO5	1	-	3	-	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	3	-
CO2	3	-
CO3	3	-
CO4	3	-
CO5	3	-

UNIT – I

Preliminary Investigations: Stages of planning, Unit operations, Techno economic feasibility studies.

UNIT – II

Production planning and scheduling, Estimation of mine life, Ultimate pit limit, Equipment selection, Development & extraction phases in surface mining.

UNIT – III

Transport and Material Handling , Design of haul roads, Transport and dumping systems, Ore blending.

UNIT – IV

Design of slopes, Design of rock slope and waste dump- factors affecting slopes, types of slope failure, slope stability analysis.

UNIT – V

Other Mining Technique, Beach sand and placer mining, Transition of underground to opencast mines and vice versa.

Text Books:

1. Opencast Mining, R. T. Desmukh, Lovely prakashan Dhanbad, 1st edition. ISBN: 9788189904333.
2. Open Cast Mining Unit Operations, Rzhevsky, V.V., Mir publishers. ISBN: 9788189904212.

Reference Books:

1. Ground Control, Peng, S.S. Wiley Publications, New York. ISBN: 978-0471389303.
2. Open pit mine planning and Design, W. Hustrulid and M. Kuchta A. A. Balkema Rotterdam, 1st edition, , Vol – I. ISBN: 978-0415374104.
3. Surface Mining, G. B. Mishra, Lovely Prakashan Dhanbad, 1st edition. ISBN: 978-81-85881-79-6.

Web Links:

1. https://www.scribd.com/document/335051910/Mine-Planning-and-Scheduling-Smart-Practices-Mining-and-Blasting
2. https://www.911metallurgist.com/ultimate-pit-limit/
3. https://www.cdc.gov/niosh/mining/userfiles/works/pdfs/ic8758.pdf

Geo-Statistics

	L	T	P	C
Course Code: 241MN035	**3**	**0**	**0**	**3**

Course Outcomes:

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

CO1: Interpret key statistical measures
CO2: Apply various probability distribution functions
CO3: Solve problems involving advanced probability theories
CO4: Apply appropriate sampling methods
CO5: Apply various reserve estimation techniques in both vertical and horizontal sections

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	1	3	-	-	-	-	-	-	-	-	-
CO2	1	3	-	-	-	-	-	-	-	-	-
CO3	1	3	1	-	-	-	-	-	-	-	-
CO4	1	3	-	-	1	-	-	-	-	-	-
CO5	1	3	1	-	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	3	3
CO2	3	3
CO3	3	3
CO4	3	3
CO5	3	3

UNIT – I

Introduction to Statistics: Arithmetic mean; Median; Mode; Standard deviation; Mean deviation or the average deviation; coefficient of variance; coefficient of correlation; Rank correlation.

UNIT – II

Introduction to Probability: Probability distribution function; Normal distribution function; Poisson distribution function; Exponential distribution; Expectation of a variance.

UNIT – III

Theories of Probability: Additional theory of probability; Theorem of total probability for compound events; Bay's theorem; Mean square error.

UNIT – IV

Sampling: Type of sampling, Methods of sampling- grab sampling, channel sampling, chip sampling, face sampling, bulk sampling, drill hole sampling, Error in sampling.

UNIT – V

Reserve Estimation Techniques: Determination of average grade of ore in a vertical section, Determination of average grade of ore in a horizontal section- Triangular method, Determination of average grade of ore in a horizontal section- Polygonal method.

Text Books:

1. Introduction to the Practice of Statistics, David S. Moore, George P. McCabe, Bruce A. Craig, W.H. Freeman & Company, 9th Edition, 2020, ISBN: 978-1319013387.
2. Introduction to Probability, Joseph K. Blitzstein and Jessica Hwang, CRC Press, 2nd Edition, 2019, ISBN: 978-1138369915.

Reference Books:

1. Principles of Sampling and Analysis, J. Chrismer, Springer, 1st Edition, 2023, ISBN: 978-3030543487.
2. Reserve Estimation Techniques for Mining, A.K. Gorai, CRC Press, 1st Edition, 2021, ISBN: 9780367331834.

Web Links:

1. https://www.investopedia.com/terms/c/correlationcoefficient.asp
2. https://dspmuranchi.ac.in/pdf/Blog/SAMPLING%20METHODS-%20ROCK,%20SOIL,%20SEDIMENT,%20VEGETATION,%20VAPOUR.pdf

Mineral Economics

	L	T	P	C
Course Code: 241MN036	**3**	**0**	**0**	**3**

Course Outcomes:

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

CO1: Describe importance of strategic minerals.
CO2: Classify grading and pricing of minerals.
CO3: Estimate total reserve of minerals.
CO4: Estimate Internal Rate of Return and Net Present Value
CO5: Assess organizational and financial project management.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	3	-	-	-	-	-	-	-	-	-
CO2	2	3	-	-	-	-	-	-	-	-	-
CO3	2	3	1	-	-	-	-	-	-	-	-
CO4	2	3	-	-	-	-	-	-	-	-	-
CO5	2	3	1	-	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	3	-
CO2	3	-
CO3	3	-
CO4	3	-
CO5	3	-

UNIT – I

General Economic importance of the mineral industry; Risky nature of the mining industry; Demand and Supply analysis, National mineral policy; Mineral price and pricing International monetary system, Factors affecting mineral price, kinds of price quotation, Mineral price index, Mineral prices.

UNIT – II

Mineral Resource/Reserve Concept, classification and estimation of reserves. Applications of Geostatistics. Mineral inventory concept, characteristic features, composition and economic significance; Estimation of life index. Demand analysis and Market survey Meaning and law of demand; methodology of demand analysis, Market survey

UNIT – III

Conservation of mineral resources – Means of conservation and limitations in the scope of Conservation. Sampling Definition, purpose and scope, Preparation of samples, methods and computations; Application of statistical methods in sampling Loss of mineral in mining - Classification and incorporation of losses, co-efficient of completeness of mineral extraction, Dilution and recovery.

UNIT – IV

Mine valuation Basic concept, Earlier approaches to mine valuation, recent approaches to evaluation Investment appraisal Elements of investment appraisal, Static methods of investment appraisal, Dynamic methods of appraisal, discounted cash flow analysis Mining costs Capital and operating costs; Factors affecting operating cost; Methods of estimating future costs; Standard cost and forecast; Budget and budgetary control.

UNIT – V

Mine finance Capital generation for mining companies Mineral taxation system Theory of taxation on minerals, Mineral tax designing, Types of mineral taxes, Taxes affecting mineral sector, Internal and external trade Taxes and duties; Imports and exports; International investment and trade in mineral materials & products.

Text Books:

1. minerals deposit evaluation: A practical approach, Alwyn E. Annels. ISBN: 978-0750626124.
2. Mine and mineral economics, Deshmukh R.T, Emdee publishers. ISBN: 978-8177431220.

Reference Books:

1. Industrial engineering and management, O.P.Khanna, Dhanpat Rai, Delhi. ISBN: 978-81-7079-078-0.
2. courses in mining geology, R.N.P. Arogyaswami, Oxford and IBH. 2nd Edition. ISBN: 978-8120408815.

Web Links:

1. https://redstagfulfillment.com/what-is-demand-forecasting/
2. https://corporatefinanceinstitute.com/resources/valuation/discounted-cash-flow-dcf/
3. https://www.fedmin.com/fedmin/taxation.pdf

Advanced Exploration Techniques

	L	T	P	C
Course Code: 241MN037	**3**	**0**	**0**	**3**

Course Outcomes:

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

CO1: Apply knowledge on various geophysical and geochemical prospecting techniques

CO2: Choose the proper techniques of exploration and estimation of the reserves.

CO3: Apply knowledge of different mineral processing techniques.

CO4: Analyze the methods of preparation of feasibility reports and its evaluation techniques.

CO5: Study the prefeasibility and feasibility reports and its evaluation methods

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	3	-	-	-	-	-	-	-	-	-
CO2	2	3	-	-	-	-	-	-	-	-	-
CO3	2	3	1	-	-	-	-	-	-	-	-
CO4	2	3	-	-	-	-	-	-	-	-	-
CO5	2	3	1	-	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	3	-
CO2	3	-
CO3	3	-
CO4	3	-
CO5	3	-

UNIT – I

Exploration Geochemistry, Field Procedure, Analytical Methods, Mineral Exploration - Triangulation, Establishment of Local Base from National Grid Base- - Exploration Strategy, Groups and their role, Strategy and structure of the exploration group, government policies Exploration investment decision, exploration targets.

UNIT – II

Electrical Methods: Scope of exploration geophysics – physical properties of the earth – Electrical methods – SP, IP, EM and Resistivity - methods of electrode arrangement – field methods resistivity, self-potential methods- interpretation -application in mineral prospecting – groundwater targeting, electrical logging methods in oil exploration.

UNIT – III

Magnetic and Gravity Methods — types of magnetometer-field survey – anomaly - interpretation and prospecting. Magnetic methods – principle - field procedure – magnetometers – interpretation of magnetic data – size and shape of bodies – correction of magnetic data - applications - airborne geophysical surveys.

UNIT – IV

Practice of semi-variogram modelling; practice of kriging - steps and procedure. Ordinary Kriging: definition, point/block estimation procedures, techniques of semi-variogram model fitting; Geo-statistical evaluation scheme; Effect of Nugget variance on kriged weights.

UNIT – V

Integrating Surface/ Underground mapping Drilling Sampling to evolve a 3D Model - Fold/Fault Interpretation from Maps and Bore hole Data - GIS Applications in mining and Mineral Projects. Evaluation of exploration and development projects, study of typical pre-feasibility and feasibility reports.

Text Books:

1. Aspects of Ore Treatment and Mineral Recovery, Butterworth-Heinemann, 8th Edition. ISBN: 978-0750625396.
2. Prospecting manual, Chaussier, J.B., and Mores, J Mineral North Oxford Academic press. ISBN: 978-0195041440.

Reference Books:

1. Geochemistry, Arthur Brownlow, Pearson Education, INC., Australia. ISBN: 978-0131495105.
2. Principles and applications of Geochemistry, Faure, G, Pearson Education, INC. ISBN: 978-0130142715.
3. Essentials of Geochemistry, John V. Walther, Jones and Bartlett Publishers, Boston. ISBN: 978-0763753146.

Web Links:

1. https://www.sciencedirect.com/science/article/abs/pii/0016714268900136
2. https://www.esri.com/en-us/industries/mining/overview

Advanced Surveying Technology

	L	T	P	C
Course Code: 241MN038	**3**	**0**	**0**	**3**

Course Outcomes:

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

CO1: Analyze the base line measurement and triangulation work.
CO2: Determine different types of hydro graphic surveying.
CO3: Explain the basic principles of photogrammetric surveying.
CO4: Analyze the correction in astronomical observations.
CO5: Apply modern instruments of surveying total station and GPS

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	1	3	-	-	-	-	-	-	-	-	-
CO2	1	2	-	2	-	-	-	-	-	-	-
CO3	1	2	-	-	-	-	-	-	-	-	-
CO4	1	3	-	-	-	-	-	-	-	-	-
CO5	1	3	-	-	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	3	-
CO2	3	-
CO3	3	-
CO4	3	-
CO5	3	-

UNIT – I

Geodetic Surveying: Definition, importance, triangulation system, order of triangulation, size and shape of triangulation, strength of figure criterion, triangulation fieldwork, base line measurement- tape corrections, problems in baseline measurement, measurement of angles.

UNIT – II

Hydrographic Surveying: Tides-lunar tides, solar tides, spring and neap tides, measurement of tides- shore lines, soundings, sounding equipment's, depth surveys, river and marine surveys.

UNIT – III

Photogrammetric Surveying: Basic principles, -photo theodolite, horizontal and vertical angles from terrestrial photographs, elevation of a point by photographic measurement, determination of focal length of the lens, applications of surveying.

UNIT – IV

Astronomical Surveying: Spherical Trigonometry, latitude and longitude, solar system, astronomical teams, coordinate systems-altitude, azimuth system, declination, hour angle system, time and astronomical work-sidereal time, apparent solar time, mean solar time,

standard time, standard time, application of astronomy in surveying, corrections to astronomical observations.

UNIT – V

Total stations: Importance, measurement of horizontal angles, vertical angles, horizontal distance, slope distance, height of object-remote elevation measurement (REM).
Global Positioning System: Principles of GPS, components of GPS, types of GPS, applications of GPS, sources of error GPS and limitations.

Text Books:

1. Surveying and Levelling, R. Subramanian, Oxford University Press, New Delhi. ISBN: 978-0198080422.
2. A text book of Surveying, C. Venkatramaiah, University Press, New Delhi. ISBN: 978-8173712777.

Reference Books:

1. Remote Sensing and its Applications, L A R Narayan, Universities Press, New Delhi. ISBN: 978-8173714184.
2. Geographical Information Science, Narayan Panigrahi, Universities Press, New Delhi. ISBN: 978-8173716583.

Web Links:

1. https://www.rasasurvey.com/advanced-technologies/
2. https://appliedtechnology.santarosa.edu/surveying-technology
3. https://www.alifewithoutlimits.com.au/about-surveying/technology/

Geo Spatial Imaging & Geo- Informatics

	L	T	P	C
Course Code: 241MN039	**3**	**0**	**0**	**3**

Course Outcomes:

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

CO1: Describe importance of remote sensing
CO2: Outline different remote sensing techniques
CO3: Describe importance of GIS
CO4: Analyze GIS functions
CO5: Assess applications of RS & GIS

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	3	-	-	-	-	-	-	-	-	-
CO2	2	3	-	-	-	-	-	-	-	-	-
CO3	2	3	1	-	-	-	-	-	-	-	-
CO4	2	3	-	-	-	-	-	-	-	-	-
CO5	2	3	1	-	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	3	-
CO2	3	-
CO3	3	-
CO4	3	-
CO5	3	-

UNIT – I

Introduction to Remote Sensing: Introduction to Remote Sensing: History, Energy Sources, Sensor Systems, land sat, spot, IRS etc. Satellites, Applications of Remote Sensing: Topographic Mapping, Resource Mapping, Environmental Monitoring, Real Property Boundary Determination. Active and Passive sources.

UNIT – II

Remote Sensing Techniques and Digital Image Processing: Sensors and Platforms in Remote Sensing, Digital Image Processing Techniques Introduction to Digital Elevation Modelling (DEM).

UNIT – III

Geographic Information Systems (GIS) Basics: Introduction to GIS: Overview, Components, and Applications, Data Structures in Thematic Maps: Raster vs Vector Data Models, Database Management for GIS and Data Input/Output.

UNIT – IV

Advanced GIS Analysis Functions: Overview of GIS Analysis Functions: Organization, Classification, and Maintenance of Spatial Data, Integrated Analysis of Spatial and Non-spatial Data.

UNIT – V

Applications and Implementation of GIS: Environmental Resource Mapping and Land Development Applications, Applications of GIS in Surface Mining, Road Construction, and Land Development, Hands on Exercise on Image Processing and GIS Packages.

Text Books:

1. Remote sensing and its applications, LRA Narayana, University press. ISBN: 978-8173717068.
2. Principles of Geophysical information systems, Peter A Burragh and Racheal A. MC Donnell, Oxford publishers. ISBN: 978-0198556508.

Reference Books:

1. Concepts and techniques of GIS, C. P. Lo Albert, K. W Yonng, Prentice Hall (India) publication. ISBN: 978-0131496517.
2. Remote sensing and Geographical information systems, M. Anji Reddy, JNTU Hyderabad, B.S Publications. ISBN: 978-81-7436-533-6.
3. Introductory Digital Image Processing, John, R. Jensen, Prentice Hall, New Jersey, 3rd edition. ISBN: 978-0134058404.

Web Links:

1. https://www.esri.com/en-us/what-is-gis/overview
2. https://www.esri.com/content/dam/esrisites/en-us/media/pdf/teach-with-gis/raster-faster.pdf
3. https://www.polosoftech.com/industries/gis-mining/

Remote Sensing Applications in Mining

	L	T	P	C
Course Code: 241MN040	**3**	**0**	**0**	**3**

Course Outcomes:

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

CO1: Explain the principles of remote sensing
CO2: Explain the data acquisition process for remote sensing in mining
CO3: Apply image classification techniques to remote sensing data
CO4: Implement change detection techniques to analyze temporal data
CO5: Explain future trends and identify emerging technologies in remote sensing

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	3	-	1	-	-	-	-	-	-	-
CO2	2	3	-	1	-	-	-	-	-	-	-
CO3	2	3	-	1	-	-	-	-	-	-	-
CO4	2	3	-	1	-	-	-	-	-	-	-
CO5	2	3	-	1	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	3	-
CO2	3	-
CO3	3	-
CO4	3	-
CO5	3	-

UNIT – I

Introduction to Remote Sensing in Mining: Overview of remote sensing technologies, Historical development and evolution of remote sensing in mining, Types of remote sensing data (optical, radar, LiDAR, thermal, hyperspectral).

UNIT – II

Data Acquisition and Processing: Satellite and airborne remote sensing platforms, Sensors and their characteristics, Data acquisition techniques, Preprocessing techniques (radiometric, geometric, and atmospheric corrections).

UNIT – III

Remote Sensing Techniques for Mineral Exploration: Spectral signatures of minerals, Hyperspectral remote sensing in mineral exploration, Image classification techniques (supervised and unsupervised), Case studies of mineral exploration using remote sensing.

UNIT – IV

Monitoring and Environmental Impact Assessment: Monitoring mining activities using remote sensing, assessing environmental impacts (deforestation, land degradation, water pollution), Change detection techniques, Legal and regulatory frameworks.

UNIT – V

Advanced Applications and Future Trends: Integrating remote sensing with GIS for mining applications, Advances in sensor technology, Future trends and emerging technologies.

Text Books:

1. Remote Sensing of the Environment: An Earth Resource Perspective, Jensen, J. R.. Pearson. ISBN: 978-0134550229.
2. Remote Sensing Handbook. Thenkabail, P. S. CRC Press. ISBN: 9780367337853.

Reference Books:

1. Remote Sensing for Environmental Monitoring, GIS Applications, and Geology. Zorn, M, MDPI. ISBN: 978-3-0365-5475-2.
2. Geographic Information Systems and Science. Li, D, Wiley. ISBN: 978-0470016783.

Web Links:

1. https://www.jstage.jst.go.jp/article/jmps/99/3/99_3_83/_pdf/-char/en
2. https://egyankosh.ac.in/bitstream/123456789/39531/1/Unit-3.pdf

Green Mining

	L	T	P	C
Course Code: 241MN041	**3**	**0**	**0**	**3**

Course Outcomes:

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

CO1: Explain the importance of green mining.
CO2: Plan and scheduling of activities related to mine waste management.
CO3: Analyze the impact of water pollution due to mining.
CO4: Distinguish progressive and final mine closure planning
CO5: Explain the usage of renewable energy in mines.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	-	3	1	-	-	-	-	-	-	-	-
CO2	-	-	1	-	-	-	-	-	-	-	-
CO3	-	3	-	-	-	-	-	-	-	-	-
CO4	2	-	-	-	-	-	-	-	-	-	-
CO5	-	3	1	-	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	3	-
CO2	3	-
CO3	3	-
CO4	3	-
CO5	3	-

UNIT – I

Footprint Reduction: Importance of green mining, Sustainable project management, Corporate social responsibility for industrial sustainability, Environment Friendly Mining Equipment's, Clean development mechanism (CDM), CCUS technology, Application of Bio Fuels.

UNIT – II

Mine Waste Management: Types of mine waste Overburden, Tailings and other wastes. Tailings dams – types, construction and design, Characterization, disposal, management of different types of mining waste.

UNIT – III

Mine Water: Sources of pollution, Effect of mining on water bodies, Treatment of mine water, Water conservation initiatives in mines, zero waste water discharge.

UNIT – IV

Mine Closure Planning: Progressive and final mine closure planning, structure of mine closure report, Legislative provisions on mine closure planning.

UNIT – V

Renewable Energy: Usage of renewable energy in mines- Solar and Wind Energy; Application and limitation.

Text Books:

1. Green Mining:The Way Forward, Anil Jha, Das Gupta Co Pvt Ltd Publication, 2019. ISBN: 978-8194161424.
2. Sustainable Mining Practices, A.K. Gorai and D. Nimaje, Narosa Publishing House. ISBN: 9788184876048.

Reference Books:

1. Mining and Environmental Sustainability, G. S. Roonwal, ASTRAL Publication. ISBN: 9789351247591.
2. Advances in Productive, Safe, and Responsible Coal Mining, Joseph Hirschi, Elsevier Ltd, 2019. ISBN: 9780128156263.

Web Links:

1. https://www.mdpi.com/books/pdfview/book/3216
2. https://web.mit.edu/12.000/www/m2016/finalwebsite/solutions/greenmining.html
3. https://www.sciencedirect.com/science/article/pii/S187661021200077X
4. Oxford scientists show how green mining could pave the way to net zero and provide the metals we need for a sustainable future | University of Oxford
5. Green Mining (mdpi.com)

Utilisation of Solar Energy in Mines

	L	T	P	C
Course Code: 241MN042	**3**	**0**	**0**	**3**

Course Outcomes:

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

CO1: Explain the concept of solar radiation and its measurement.
CO2: Describe the working principle of different types of collectors and its types
CO3: Explain the various solar thermal energy technologies and their applications
CO4: Analyze the various solar PV cell materials and conversion techniques.
CO5: Apply solar passive building techniques for cooling and heating applications.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	-	-	-	-	-	1	-	-	-	-
CO2	3	-	-	-	2	-	1	-	-	-	-
CO3	3	-	-	-	2	-	1	-	-	-	-
CO4	3	-	-	-	1	-	1	-	-	-	-
CO5	3	-	-	-	1	-	1	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	2	-
CO2	2	-
CO3	2	-
CO4	2	-
CO5	2	-

UNIT – I

Solar Radiation and its measurement:

Solar angles, Sun path diagrams, Radiation, extraterrestrial characteristics, Measurement of solar radiation, Solar energy measuring instruments, Pyranometer, Pyrheliometer, Sunshine recorder, Estimation of average solar radiation and estimation on horizontal and tilted surfaces.

UNIT – II

Solar Collectors for Industrial process heat:

Flat plate collector, Materials for flat plate collector and their properties, evacuated tubular collectors, concentrator collectors, classification, tracking systems, compound parabolic concentrators, parabolic trough concentrators, concentrators with point focus, Heliostats.

UNIT – III

Solar Thermal Technologies:

Principle of working, types, design, and operation of, Solar heating and cooling systems, Thermal Energy storage systems, Solar Desalination, Solar cooker: domestic, community, Solar Pond, Solar drying, Solar chimney, Solar water disinfection (SODIS), Solar furnaces.

UNIT – IV

Solar Cells:

Semiconductor materials, Doping, PN junction and characteristics, Photovoltaic effect, Photovoltaic material, Parameters of solar cells, Effects of cell temperature on cell efficiency, Types of solar cells, Solar modules and arrays, Solar cell power plant, Silicon, thin film and polymer processing, Silicon wafer based solar cells.

UNIT – V

Solar Passive Architecture:

Thermal comfort, bioclimatic classification, passive heating concepts: direct heat gain, indirect heat gain, isolated gain and sunspaces, passive cooling concepts: evaporative cooling, Radiative cooling, shading - paints and cavity walls for cooling, roof radiation traps.

Text Books:

1. Solar Energy, Sukhatme S P, Nayak J K Tata Mc Graw Hill, 4th Edition. ISBN: 978-0074624771.
2. Solar Energy, Fundamentals Design, Modelling and Applications, Tiwari G. N, Narosa, New Delhi, 5th Edition. ISBN: 978-81-8487-806-7.

Reference Books:

1. Principles of Solar Engineering, D. Yogi Goswami, CRC Press, Taylor and Francis group, New York, 3rd Edition. ISBN: 978-0367330406.
2. Solar Engineering of Thermal Process, Duffie. J.A and Beckman. W.A, Wiley, Canada, 4th Edition. ISBN: 978-1118976017.
3. Solar Energy: Fundamental and Application, Garg H P, Prakash S, Tata Mc Grow Hill, 1st edition. ISBN: 978-0074624708.

Web Links:

1. https://nptel.ac.in/courses/112105051
2. https://nptel.ac.in/content/storage2/courses/112105050/m1l1.pdf

Deep Sea Mining

	L	T	P	C
Course Code: 241MN043	**3**	**0**	**0**	**3**

Course Outcomes:

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

CO1: Explain about marine environment profile of sea.
CO2: Analyse profile of sea.
CO3: Examine marine sediments and continental slope.
CO4: Choose methods of off shore exploration of oil and gas.
CO5: Explain deep sea bed mining.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	-	-	-	-	-	-	-	-	-
CO2	2	1	1	-	-	-	-	-	-	-	-
CO3	2	1	-	-	-	-	-	-	-	-	-
CO4	1	1	-	-	-	-	-	-	-	-	-
CO5	1	1	1	-	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	-	3
CO2	-	3
CO3	-	3
CO4	-	3
CO5	-	3

UNIT – I

Introduction: Introduction to Marine environment, Characteristics of the ocean floor, Environmental impact of ocean mining.

UNIT – II

Profile of the sea: Shelf, slope and rise, nature of the deposits.

UNIT – III

Marine Deposit: Mineralogical studies of marine sediments and continental slope, Continental shelf and deep sea bed mineral resources, Exploration systems of dissolved and un dissolved mineral deposits; Poly metallic manganese nodules.

UNIT – IV

Offshore exploration: Offshore exploration of oil and gas and subsea systems

UNIT – V

Legal Issue of Deep Sea Mining: Legal Aspects of Ocean Floor Mining Deep sea bed Mining, Economic & Technologies, Law of the sea bed authority, legal considerations in ocean mining.

Text Books:

1. Introductory Mining Engineering, Hartman H.L, Willey Eastern. ISBN: 978-0471812205.
2. Issues of Marine Mining, Metals fom sea bed, Manjula R.Shyam. ISBN: 978-8193299838.

Reference Books:

1. Deep-Sea Mining: Resource Potential, Technical and Environmental Considerations, Rahul Sharma,Springer International Publishing. ISBN: 978-3-030-28831-0.
2. Environmental Issues of Deep-Sea Mining Impacts, Consequences and Policy Perspectives by Rahul Sharma, Springer International Publishing, 2019. ISBN: 978-3-030-22386-4.
3. Deep Sea Mining and the Law of the Sea, Alexandra, Springer, Netherlands. ISBN: 978-94-017-8556-0.

Web Links:

1. https://education.nationalgeographic.org/resource/marine-ecosystems/
2. https://www.noaa.gov/education/resource-collections/ocean-coasts/ocean-floor-features

Space Mining Technology

	L	T	P	C
Course Code: 241MN044	**2**	**0**	**0**	**2**

Course Outcomes:

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

CO1: Describe about Space mining operations.
CO2: Analyze the challenges of Moon mining
CO3: Illustrate about Space Mining Excavation
CO4: Analyze the Economic and legal considerations in space mining
CO5: Explain the Environmental impacts of space mining

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	3	-	1	-	-	-	-	-	-	-
CO2	2	3	-	1	-	-	-	-	-	-	-
CO3	2	3	-	1	-	-	-	-	-	-	-
CO4	2	3	-	1	-	-	-	-	-	-	-
CO5	2	3	-	1	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	3	-
CO2	3	-
CO3	3	-
CO4	3	-
CO5	3	-

UNIT – I

Introduction:
Overview of Space mining operations, Space environment, Importance of space mining, unit operations- excavation and logistics support.

UNIT – II

Moon mining:
Types of minable minerals, technologies for moon mining, Asteroid selection and Types: Types of minable minerals, technological scope for asteroid mining.

UNIT – III

Space Mining Excavation:
Space shuttles and Technology, Different excavation techniques, Surface Mining, Shaft Mining, Magnetic rakes, Heating, Mond process, Self-replicating Machine.

UNIT – IV

Economic and legal considerations in space mining:
Economics for the space mining process, Scarcity of the minerals and financial feasibility of the space mining. Regulation and Safety related to space mining.

UNIT – V

Impacts of space mining: Challenges and Opportunities, case studies.

Text Books:

1. Mining the Sky: Untold Riches from the Asteroids, Comets, And Planets, John Lewis. ISBN: 978-0201309602.
2. Mankind Beyond Earth: The History, Science, and Future of Human Space Exploration, Claude A. Piantadosi, Columbia University Press. ISBN: 978-0231181196.

Reference Books:

1. The Technical and Economic Feasibility of Mining the Near-Earth Asteroids, M. J. Sonter. ISBN: 978-0849318681.
2. The Future of Space Mining, Michael Booth. ISBN: 978-0992811920.

Web Links:

1. https://www.qil-qdi.org/regulation-space-resource-rights-meeting-needs-states-private-parties/
2. http://www.absoluteastronomy.com/topics/Asteroid_belt.