B. Tech. – III Year I Semester

S.No.	Category	Title	L	T	P	Credits
1	Professional Core	Mine Hazards and Rescue	3	0	0	3
2	Professional Core	Underground Coal Mining	3	0	0	3
3	Professional Core	Mining Machinery	3	0	0	3
4	Professional Elective - I	1. Mine closure and Reclamation 2. Resource Evaluation and Geo-statistics 3. Rock Slope Engineering 4. Mine Safety & Ergonomics	3	0	0	3
5	Open Elective-I	OR Entrepreneurship Development & Venture Creation 1. Introduction to Underground Mining 2. Introduction to Surface Mining 3. Tunnelling and Underground Space Design 4. Introduction to Mine Environment	3	0	0	3
6	Professional Core	Mining Machinery-I Lab	0	0	3	1.5
7	Professional Core	Mine Hazards and Rescue Lab	0	0	3	1.5
8	Skill Enhancement course	Soft Skills	0	1	2	2
9	Engineering Science	Tinkering Lab	0	0	2	1
10	Evaluation of Community Service Internship	Community Service/ Internship	-	-	-	2
	Total		15	1	10	23
MC	Minor Course (Student may select from the same specialized minors pool)		3	0	3	4.5
MC	Minor Course through SWAYAM / NPTEL (Minimum 12 Week, 3 credit course)		3	0	0	3
HC	Honors Course (Student may select from the same Honors pool)		3	0	0	3
HC	Honors Course (Student may select from the same Honors Pool)		3	0	0	3

B. Tech. III Year II Semester

S.No.	Category	Title	L	T	P	Credits
1	Professional Core	Mine Planning and Design	3	0	0	3
2	Professional Core	Surface Mining	3	0	0	3
3	Professional Core	Underground Metal Mining	3	0	0	3
4	Professional Elective-II	1. Computer Applications in Mining 2.Remote Sensing and GIS 3. Optimization of Mining Systems 4. Mine Automation	3	0	0	3
5	Professional Elective-III	1. Mine Waste Management 2. Dimensional Stone Mining 3. Advanced Mining Techniques 4. Tunnelling and Underground Space Technology	3	0	0	3
6	Open Elective - II	1. Mineral Economics 2. Landslides & Slope Stability Engineering 3. Remote Sensing and GIS 4. Geostatistics	3	0	0	3
7	Professional Core	Mining Machinery-II Lab	0	0	3	1.5
8	Professional Core	Mine Planning and Design Lab	0	0	3	1.5
9	Skill Enhancement course	Computer Applications in Mining Lab	0	1	2	2
10	Audit Course	Technical Paper Writing and IPR	2	0	0	-
	Total		**20**	**1**	**08**	**23**
	Mandatory Industry Internship of 08 weeks duration during summer vacation					
MC	Student may select from the same minors pool		3	0	3	4.5
MC	Minor Course (Student may select from the same specialized minors pool)		3	0	0	3
HC	Student may select from the same honors pool		3	0	0	3
HC	Honors Course (Student may select from the honors pool)		3	0	0	3

Minors and Honors in Mining Engineering

S.No.	Title	L	T	P	Credits
Minor in "Mine Environment" (Any 5 theory and 2 Labs)					
1	Mine Ventilation	3	0	0	3
2	Surface Mine Environment	3	0	0	3
3	Sustainable Mining	3	0	0	3
4	Mine Hazards and Rescue	3	0	0	3
5	Mine Closure and Reclamation	3	0	0	3
6	Mine Safety & Ergonomics	3	0	0	3
7	Noise & Vibrations Control	3	0	0	3
8	Environmental Impact Assessment & Management Plan	3	0	0	3
9	Mine Hazards and Rescue Lab	0	0	3	1.5
10	Mine Ventilation Lab	0	0	3	1.5
	Total				18

S. No.	Title	L	T	P	Credits
Honors (Any 5 theory and 2 Labs)					
1	Surface Mine Planning & Design	3	0	0	3
2	Advanced Exploration Techniques	3	0	0	3
3	Mine Safety and Ergonomics	3	0	0	3
4	Advanced Coal and Metal Mining	3	0	0	3
5	Geo-Informatics	3	0	0	3
6	Advanced Rock Engineering	3	0	0	3
7	Numerical Methods in Geomechanics	3	0	0	3
8	Advanced Mine Surveying	3	0	0	3
9	Mining Geomatics Lab	0	0	3	1.5
10	Computer Applications in Mining Engineering Lab	0	0	3	1.5
	Total				18

III Year–		L	T	P	C
I Semester	**MINE HAZARDS AND RESCUE**	3	0	0	3

Course Objectives: To make students conversant with mine fires, explosions, and their rescue and recovery.

Unit – I:
Mine Fires: Causes of mine fires; spontaneous combustion - mechanism, susceptibility indices, factors affecting spontaneous combustion; detection and prevention of spontaneous heating; accidental fires – causes and prevention; dealing with mine fires - direct and indirect methods, fire stopping: fires in quarries, coal stacks and waste dumps.

Unit – II:
Mine Explosions: Firedamp and coal dust explosions – mechanisms, causes and prevention; stone-dust and water barriers; investigations after an explosion.

Unit-III
Inundation: Causes and prevention, precautions and techniques of approaching old workings; safety boring apparatus, pattern of holes; design and construction of water dams, shaft dams, emergency bulk heads, strengthening of dams.

Unit – IV:
Illumination: Illumination in mines- it's effect on safety, efficiency and health; common types of safety lamps & their uses and limitations, maintenance and examination of lamps, their charging, cleaning, lighting, relighting; lamp room. Lighting from mains – different types of illumination devices; illumination of pit bottoms. main roads, faces, pump houses and haulage rooms; standards of illumination in underground and opencast mines

Unit – V:
Airborne respirable dust in underground mines - generation, dispersion, measurement and control; classification, physiological effects, dust measurement, sampling of air-bone dust.
Rescue and Recovery: Rescue equipment and their uses, rescue stations and rescue rooms; organization of rescue and recovery areas, re-opening of sealed-off workings.

Text Books
1) Mine Fires, Inundation and Rescue: M.A.Ramlu,The Orient Blackswan, 2018
2) Mine Illumination by Trotller, CRC Press, 1988.

References:
1) Spontaneous Combustion: S C Banerjee, Taylor & Francis, 2008.
2) Mine Fires: L C Kaku, Jaipur Oriental Pub. 1985.
3) Mine Fires: Mitchell, Maclean Hunter Publishing Company, 1990.
4) Mine Ventilation and Air conditioning: Hartman, Wiley-Interscience, 1997.

5) Subsurface Ventilation and Environmental Engineering : McPherson, Chapman and Hal, 1993.

Course Outcomes:
Students will be able to explain mine fires, explosions, and their rescue and recovery.

III Year–	**UNDERGROUND COAL MINING**	L	T	P	C
I Semester		3	0	0	3

Course Objectives: Students will gain knowledge about various traditional and modern underground coal mining methods.

UNIT - I
Introduction: Present situation and future growth of coal mining industry in India and world, different coal mining industries in India, factors effecting selection of mode of entry and different types of mode entry: incline, shaft, inclined shaft, coal mine development and its scenario, different terminology used in coal mine development, different coal mining methods, factors influencing choice of coal mining methods. Software application in coal mines for development and depillaring operations.

UNIT - II
Bord and Pillar Mining: applicability, limitations, advantages and disadvantages of Bord and pillar mining method, development and depillaring sequence operations in Bord and Pillar mining, and its related calculations, local fall, main fall, air blast. Dangers associated with B& P method and precautions. Case study with layout.

UNIT – III
Longwall Mining: Applicability, limitations, merits and demerits, different longwall mining methods, factors influencing selection of longwall method, method of development and depillaring and its related calculations. Thin seam and thick seam mining with longwall mining method, Case study with layout.

UNIT - IV
Thick Seam and deep seam Mining: Problems associated with thick and deep seam Mining, selection of mining method, caving and stowing methods, limitations and applicability: different slicing methods-(inclined Slicing, Horizontal Slicing, Diagonal Slicing, Transversely Inclined Slicing),and Caving methods (Sublevel Caving) Working Steep and Moderately Thick Seams: Blasting Gallery Method , room and pillar method , The Velenje Method, Descending Shield Method of Mining.

UNIT – V
Special coal mining methods: Applicability, limitations, merits and demerits of Inseam Mining and Horizon Mining, Hydraulic Mining, plough methods, chirimiri caving method, method of extraction by coal gasification and contiguous seam. Working underneath surface features, extraction of multi seams, problems and issues: Coal Bed Methane, Goaf Control: strip packing or solid stowing, Hydraulic Stowing etc. Procurement of stowing materials and its transportation, theoretical aspects and case studies.

TEXT BOOKS:
1. Principles and Practices of Modern Coal Mining – R. D. Singh, New Age International, 1997.

2. Modern Coal Mining Technology – S. K. Das, 2nd edition, Lovely Prakashan Publishers, 1994.

REFERENCE BOOKS:
1) Underground Coal Mining Methods – J. G. Singh, BrajKalpa Publishers, Varnasi, 2000.
2) Coal Mining – I.C.F. Statham, Vol. I, II, III and Vol. III. The Caxton Publishing Company Ltd. Inc. 1958.
3) Elements of Mining technology- D.J Deshmukh Vol.1 , Denett & Company, 2010
4) Modern Coal mining Technology: Samir Kumar Das, Lovely Prakashan
5) Underground winning of coal: T.N Singh, Oxford & IBH Publishing Co Pvt.Ltd, 1992.

Course Outcomes: Students will be able to explain various traditional and modern underground coal mining methods.

III Year–	**MINING MACHINERY**	L	T	P	C
I Semester		3	0	0	3

Course Objectives: Students will be able to gain knowledge about various mine hoisting and transportation systems.

UNIT – I
Pit-Top and Pit-Bottom Circuits: Simple pit-bottom circuits, pit-top circuits, tipplers, screening and handling plants, railway sidings. Wire Ropes: Wire ropes of different types and their construction and selection, space factor, fill factor, bending factor and factor of safety. Rope deterioration, estimation of size of rope, rope capping, recapping and rope splicing.

UNIT – II
Haulages: Heat Treatment of steel and steel alloys, properties, uses and application. Rope Haulages: Types of rope haulages, selection, computations, and safety devices. Mine tubs, mine cars, links, clips and rope capel. Application of rope haulages. Track laying and maintenance.

UNIT – III
Locomotives: Types; diesel, electric trolley wire, construction and operation, application and maintenance. Locomotive haulage computations, safety devices. Track laying and maintenance, Man riding systems in underground mines: Types, Chair-lift system, Mono-rail system, construction, and safety devices,

UNIT – IV
Transportation system: Construction and operation of belt, chain and cable belt conveyors. Conveyor computations. High angle conveyors, shiftable conveyors, Head gears; types and fittings. Shaft fittings; signals, guides, Keps, tilting platform, cage receivers, protective roofing. Suspension gear, cages, and skips. Aerial ropeways: Types, construction, application and operation, safety devices.

UNIT – V
Opencast Machinery: Shovels, draglines, dumpers, wheel loaders; their main features, applicability, selectionand production capacities.
Continuous surface mining equipment: bucket wheel excavators, surface miners, spreaders, dredging equipment; their main features, applicability, selection and production capacities

TEXT BOOKS:
1) Mine Winding & Transport : S.C. Walker, Elsevier, 2012.
2) SME Mining Engineer's Handbook by Society for Mining Metallurgy, 2011.

REFERENCES:
1) Underground Mining Methods Handbook: William A. Hustrulid, 1982.
2) Mine Hoisting : M.A.Ramlu, Oxford & IBH, 1996

Course Outcomes:

    Students will be able to analyze various mine hoisting and transportation systems.

III Year– I Semester	**MINE CLOSURE AND RECLAMATION**	L	T	P	C
		3	0	0	3

Course objective: To understand the basic concepts and the principles of mine closure and reclamation procedures along with CSR and environmental policies and laws.

UNIT – I
Recent changes in development paradigms; concepts of carrying capacity and sustainable development; environmental problems caused by mining and influencing factors. Environmental aspects of various Mining Machines.
Mine Closure: Progressive mine closure, Final mine closure and their guidelines, Preparation of mine closure plan.

UNIT – II
Land Degradation; land use categories; pre-mining investigations; landscape planning and visual impact; waste disposal, overburden dumps and tailings impoundment.

UNIT – III
Land reclamation procedures; Influence of type of deposit, topography and equipment; top soil characteristics; top soil removal and storage; application of mulches, stabilizing agents and fertilizers;
Land Reclamation: Re-vegetation and restoration methodologies; Plant species selection; Reclamation methods by using different combination of equipment, Case studies of coal and metalliferous mine dumps/spoils.

UNIT – IV
Physical and biological reclamation; afforestation of mine areas, tailing ponds, mine closure and amenity banks; best practices of mined out land reclamation.

UNIT – V
Corporate Social Responsibility towards mine closure and reclamation: Concepts and principles.
Environmental policies and laws: Environmental management systems, environmental impact assessment and environmental management planning; base line studies, environmental audit, ISO 14001, OHSAS.

TEXT BOOKS:
1) Dr. B.B. Dhar, Environmental Management of Mining Operations. Pub
2) Bulk Handling in Open Pit Mines & Quarries: Reinhard H.Wohlbier
3) Coal Mines Regulations, 1957 and Metalliferous Mines Regulations, 1961
4) Introductory Mining Engineering: Howard L. Hartman

REFERENCES:
1) Modern Coal Mining Technology: Samir Kumar Das
2) Opencast Mining – Technology and Integrated Mechanization: V.V.

Rzhevsky
3) Opencast Mining – Unit Operations: V.V. Rzhevsky
4) SME Hand Books
5) Surface Mining : G.B. Misra
6) Surface Mining Technology: Samir Kumar Das
7) Proceeding of the National & International Seminars/Symposium organized in concern with mine environment

Course outcome: Students will be able to understand and apply the basic concepts and principles of mine closure and reclamation procedures along with environmental policies and laws.

III Year–	RESOURCE EVALUATION AND GEO-	L	T	P	C
I Semester	STATISTICS	3	0	0	3

Course Objectives

- To familiarize students with the sampling, reserve calculation and mine valuation.

- To develop analytical skills for resource estimation.
- To familiarize students with the basic concepts of geostatistics.

- To understand the point and global methods for natural resource estimation.

Unit 1: Examination of Mineral properties, Mine sampling, estimation of reserves and grades, Impurities and quality control, commercial uses of minerals and ores

Unit 2: Mine valuation. Depreciation methods decision trees, Mineral Industry of India National Mineral Policies, conservation, taxation, trading, mining entrepreneurship, Principles of company law, shares and debentures

Unit 3: Joint Stock Company and public company partnership business, capital formation, Cost Volume-Profit analysis and break-even analysis, budgetary control, wages and incentives, purchases, stores and inventory control, sales and dispatches.

Unit 4: Expectation Spatial Description: Contour maps, Indicator maps, Moving window statistics, Proportional effect, Spatial continuity, h-scatter plots, correlation functions, covariance function and variograms, cross h-scatter plots Random function

Unit 5: From statistics to Geostatistics, Modeling sample variograms, Regionalized variables Global estimation: Polygonal declustering, cell declustering, comparison of declustering methods Point estimation: Polygon, triangulation, inverse distance methods, search neighborhoods Kriging: Ordinary kriging, simple kriging Block Kriging Search strategy cross validation Variance volume relationships,

Text Books

1) R. T. Deshmukh, *Mineral and Mine Economics*, Myra Publ., Nagpur , 1986
2) R. K. Sinha and N. L. Sharma, *Mineral Economics*, Oxford & IBH Pub., 3rd Ed, , 1970

References

1) O. P. Khanna, *Industrial Engineering and Management*, Dhanpat Rai Delhi , 1993
2) R. N. P. Arogyaswamy, *Courses in Mining Geology*, Oxford and IBH Pub., 2nd Edition

Course Outcomes

1. Student will be able to understand the sampling and reserve estimation technique.

2. Students will be able to analyze the real mine data for better mine planning and design.

3. Students will be able to comprehend different geostatistics techniques for resource estimation.

III Year– I Semester	ROCK SLOPE ENGINEERING	L	T	P	C
		3	0	0	3

Course objectives: To understand the basic mechanics of rock slope failures and influencing parameters, rock strength properties, plane failures and circular and toppling failures.

UNIT I   Basic mechanics of rock slope failure
Rock slope economics; continuum mechanics approach to slope stability; slope parameters; effect of water pressure; factor of safety of slopes; slope height vs slope angle; overall slope angles, design of slopes.

UNIT II   Geological and rock strength properties:
Geological parameters affecting slope stability; graphical representation of geological data; plotting and analysis of field measurements; physic – mechanical properties affecting slope stability, shearing on incline plane, determination of shear strength of rock and rock discontinuities; Ground water flow in rock masses; field measurement of permeability; measurement of water pressure.

UNIT III Types of slope failures
Plane failure: Plane failure analysis; graphical analysis of stability; influence of ground water on stability; influence of tension crack; analysis of failure on a rough plane; rock reinforcement of slopes;
Wedge failure: Analysis of wedge failure; wedge analysis including cohesion and water pressure; Wedge stability charts for friction only; case studies. Numerical problems.
Circular failure; Derivation of circular failure analysis; effect of ground water; circular failure charts; Bishop's methods of failure analysis; case studies. Types of toppling failure; secondary toppling modes; analysis of toppling failure; limit equilibrium analysis of toppling failures;

UNIT IV Stability analysis and design of slopes
Factors affecting slope stability, Stability analysis and design of internal dump, external dump, ultimate pit, working bench slopes using Empirical methods, Kinematic analysis,Limit Equilibrium methods, Numerical methods: Software, Case studies.

UNIT V Slope monitoring and stabilization:
Types of slope movement, Surface and Sub-surface monitoring methods including instrumentation and techniques & Guidelines for monitoring programs. Causes of rock falls; Rock slope stabilization programs – stabilization by Gabion wall, rock reinforcement; protection measures against rock falls.
Influence of slope curvature on stability; slope depressurisation; protection of slopes; control of rock falls; measurement and monitoring and interpretation of slope displacements. Numerical problems.

TEXT BOOKS:

1. Hoek, and Bray, J.W., Rock Slope Engineering, Institution of Mining and Metallurgy, 1991.
2. Goodman, R.E., Rock Mechanics, John Wiley and Sons, 1989.
3. Singh, R.N. and Ghose, A.K., Engineered Rock Structures in Mining.
4. A.A. Balkema, Civil Construction, Netherlands, 2006.

REFERENCE BOOKS:

1) Duncan C. Wylie and Chris Mah, Rock Slope Engineering, 4th Edition, 4th Edition, CRC Press, 456p, 2004.
2) John Read and Peter Stacey, Guidelines for Open Pit Slope Design, 1st Edition, CRC Press, 510p, 2009.
3) William A. Hustrulid(Ed), Michael K. McCarter (Ed) and Dirk J. A. Van Zyl (Ed), Slope stability in Surface Mining, Society for Mining, Metallurgy, and Exploration, 442p, 2001.
4) John Jaeger, N. G. Cook and Robert Zimmerman, Fundamentals of Rock Mechanics, 4th Edition, Wiley-Blackwell; 4 edition, 488p, 2007.

Course Outcome: Students will learn the basic mechanics of rock slope failures and influencing parameters, rock strength properties, plane failures, circular and toppling failures.

III Year–	**MINE SAFETY & ERGONOMICS**	L	T	P	C
I Semester		3	0	0	3

Course Objective: To create awareness among students about the mine safety and human factors and systems along with design.

Unit 1 Mine accidents
Causes of Mine accidents, Recommendations of national safety conferences, Accident analysis, Zero harm potential, Accident investigation cases Mine disasters and court of enquiries, Case studies of mine disasters and accidents.

Unit II Safety Management Plan (SMP)
Hazard identification, Risk Assessment, Risk classification, Preparation of safety management plan, Control plan, Review and audit of SMP, Crisis management plan, Occupational health and safety in mines. Safety Education, and Training, Vocational Training Rules.

Unit III Introduction to Human factors and systems.
Information Input: Information input and processing, Text, Graphics, Symbols, and Codes, Visual displays of dynamic information, Auditory, Tactual, and Olfactory displays, communications
Human Output and Control: Physical Work and Manual Materials Handling, Motor Skills, Human Control of Systems, Controls and Data Entry Devices, Hand Tools and Devices

Unit IV Workplace Design:
Applied Anthropometry, Work-Space Design and Seating, Arrangement of Components within Physical Space, Interpersonal Aspects of Workplace Design.

Unit V Conditions & Applications
Environmental Conditions: Illumination, Climate, Noise, Motion
Human Factors Applications: Human Error. Accidents, and Safety, Human Factors in Systems Design

Text books:
1) B. K. Kejriwal, Safety in Mines, Lovely Prakashan, 2002, Dhanbad
2) L.C.Kaku, A study of Mine Management, Legislation and general safety, Lovely Prakashan, 2020 , Dhanbad

References:
1) Human Factors in Engineering and Design, by Mark S. Sanders and Ernest J. McCormic, Tata McGraw-Hill & McGraw-Hill International Editions.
2) Human Factors Methods: A Practical Guide for Engineering and Design by Paul M. Salmon, Neville A. Ashgate Publishing, Ltd.
3) Ergonomics at Work by David J. Oborne, John Wiely & Sons Ltd.

4) Fitting the Task to the Man – A Text Book of Occupational Ergonomics by Taylor & Francis.
5) A Guide to the Ergonomics of Manufacturing by Martin Helender, Taylor & Francis.
6) Human Factors in Product Design by William H. Cushman and Daniel J. Rosenberg, Elsevier.

Course Outcome: Upon completion of course, students should be able to explain about mine safety and human factors and should be able to design the systems.

III Year–	INTRODUCTION TO UNDERGROUND	L	T	P	C
I Semester	MINING	3	0	0	3

Course Objectives: To understand the concepts of coal mining growth in India and methods of underground mining.

UNIT-I
Introduction: Present situation and future growth of coal mining industry in India and world, different coal mining industries in India, factors effecting selection of mode of entry and different types of mode entry: incline, shaft, inclined shaft, coal mine development and its scenario, different terminology used in coal mine development, different coal mining methods, factors influencing choice of coal mining methods. Software application in coal mines for development and depillaring operations.

UNIT-II
Bord and Pillar Mining: applicability, limitations, advantages and disadvantages of Bord and pillar mining method, development and depillaring sequence operations in Bord and Pillar mining, and its related calculations, local fall, main fall, airblast. Dangers associated with B& Pmethod and precautions. Case study with layout.

UNIT–III
Longwall Mining: Applicability, limitations, merits and demerits, different long wall mining methods, factors influencing selection of long wall method, method of development and depillaring and its related calculations. Thin seam and thick seam mining with long wall mining method, Case study with layout.

UNIT-IV
Thick Seam and deep seam Mining: Problems associated with thick and deep seam Mining, selection of mining method, caving and stowing methods, limitations and applicability: different slicing methods- (inclined Slicing, Horizontal Slicing, Diagonal Slicing, Transversely Inclined Slicing),and Caving methods (Sublevel Caving) Working Steep and Moderately Thick Seams: Blasting Gallery Method, room and pillar method,

UNIT– V
Modern coal mining methods: applicability, limitations, merits and demerits of Inseam Mining and Horizon Mining, Hydraulic Mining, plough methods, working underneath surface features, extraction of multi seams, problems and issues:
Future Innovations: blind long hole pre-shattering methods, scientific mining approach, application of mining software for mine development and extraction and production planning and design of workings, Size and grade control by CSP and CWP, case study.

TEXTBOOKS:
1. Principles and Practices of Modern Coal Mining–R.D. Singh, New Age International,1997.
2. Modern Coal Mining Technology–S.K.Das, 2ⁿᵈedition, Lovely PrakashanPublishers,1994.

REFERENCEBOOKS:

1. Under ground Coal Mining Methods–J.G.Singh, BrajKalpa Publishers, Varnasi,2000.
2. Coal Mining – I.C.F. Statham, Vol. I, II, III and Vol. III. The Caxton Publishing CompanyLtd.Inc.1958.
3. Elements of Minning technology-D.JDeshmukhVol.1
4. Modern Coal mining Technology: SamirkumarDas
5. Under ground winning of coal:T.NSingh

Course outcome: Students will be able to explain the concepts of coal mining growth in India and methods of underground mining.

III Year– I Semester	INTRODUCTION TO SURFACE MINING	L	T	P	C
		3	0	0	3

Course Objectives: To impart the knowledge about opencast mining, ground water control, use of drilling machines, blasting, mining methods and conveyors systems.

UNIT-I:
Introduction: General consideration for the applicability of open cast mining, limits of opencast mining and its advantages and disadvantages. Method of opening box cut, selection of site for boxcut.

UNIT-II:
Open Pit Layout and Design: Planning the layout and open pit mine with special reference to large mechanized mines. Optimum dimensions of open pit mines. Removal of over burden and disposal, open cast bench-number, height, width and slope angle of the bench. Factors affecting the stability of the slope. Various types of slope failures, problems on slope failures. Ground water control.

UNIT-III:
Drilling and Blasting: Drill ability, mechanics of drilling, major types of drilling machines, basics of mechanics of blasting, principles of fragmentation.
Design of blasting: with special reference to heavy blasting, air blasting, ground vibrations, fly rocks novel methods of drilling, smooth blasting and pre-splitting.

UNIT-IV:
Surface Mining Methods: Casting, strip, quarrying and Placer Mining, and Modern Methods Excavation and loading: Shovels, Dragline, Front-end loader, Stackers, Graders. Non-Cyclic Surface Mining: Bucket Wheel Excavators and Continuous surfaceminers.

UNIT-V:
Transport Equipment: Dumpers, Aerial ropeways-monocable and bicable types and their constructional details. Shovel – dumper combination, high angle conveyor and in-pit crusher. Selection of equipment.

TEXT BOOKS:
1. Surface Mining Technology by S.K.Das, Lovely Prakashan, Dhanbad,1994.
2. Surface Mining by G.B. Mishra, Dhanbad Publishers,1978.

REFERENCE BOOKS:
1. Elements of Mining Technology, Vol.–I, D.J.Deshmukh, 6thEdition, Central Techno Publications,Nagpur,1998.
2. Opencast Mining–R.T.Deshmukh, M.Publications, Nagpur,1996.
3. Latest Development of Heavy Earth Moving Machinery Amithosh De, Annapurna Publishers, Dhanbad,1995.
4. Rock Slope Engineering, Hoek and Bray,

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theInstitutionofMiningandMetallurgy,1981.

5. Introductory Mining Engineering, Hartman, John Wiley and Sons,1987.

Course outcome: Students will be able to learn about opencast mining, ground water control, blasting, and conveyors systems.

III Year– I Semester	TUNNELLING & UNDERGROUND SPACE DESIGN	L	T	P	C
		3	0	0	3

Course Objectives: To understand drilling and blasting methods of tunnels, mechanized tunnelling and to design a tunnel.

UNIT I
INTRODUCTION: Congestion in cities and its impact on development of social infrastructure for transport, water and power supply, separation of pedestrian and motorized vehicles and its movements, storage of materials, defense facilities including civil shelters. Parameters influencing location, shape and size; geological aspects; planning and site investigations. Tunnels for various purposes like road, rail, hydropower tunnels and caverns, Underground storage applications.

UNIT II
TUNNELLING METHODS: Types and purpose of tunnels; factors affecting choice of excavation techniques; soil and rock sampling and testing, Methods - soft ground tunneling, hard rock tunneling, shallow tunneling, deep tunneling; Shallow tunnels – cut and cover, cover and cut, pipe jacking, jacked box excavation techniques, methods of muck disposal, supporting, problems encountered and remedial measures.

UNIT III
TUNNELLING BY DRILLING AND BLASTING: Unit operations in conventional tunneling; Drilling - drilling principles, drilling equipment, drilling tools, drill selection, specific drilling, rock drillability factors; Blasting - explosives, initiators, blasting mechanics, blast holes nomenclature; types of cuts - fan, wedge and others; 21 blast design, tunnel blast performance - powder factor, parameters influencing, models for prediction; mucking and transportation equipment selection.

UNIT IV
MECHANIZED TUNNELLING: Cutting principles, method of excavation, selection, performance, limitations and problems. Boring principles, method of excavation, selection, performance, limitations and problems; Road headers, Impact Hammers, Tunnel Boring Machines and applications.

UNIT V
TUNNEL DESIGN: Planning and design, Assessment of behavior of tunneling media, deformation modulus and rock pressure assessment; determination of appropriate size and shape; Design of openings in rocks with the help of field data; Instrumentation and monitoring; Numerical modeling to assess the stability.

TEXT BOOKS:
    1) Hudson, J.A., Rock Engineering Systems Theory and Practice, Ellis Horwood, England.
    2) Clark G.B., (1987), Principles of Rock Fragmentation, John Wiley and Sons,

New York.

REFERENCES:

1) Lohanson, John and Mathiesen, C.F., Modern trends in Tunnelling and Blast Design, AA Balkima, 154 P, 2000.
2) Bickel J.O., Kuesel T.R. and King E.H., Tunnel Engineering Hand Book, Chapmen & Hill Inc., New York and CBS Publishers, New Delhi 2nd addition.

Course Outcome: Students will be able to explain drilling and blasting methods of tunnels, mechanized tunneling and to design a tunnel.

III Year– I Semester	INTRODUCTION TO MINE ENVIRONMENT	L	T	P	C
		3	0	0	3

Course Objective: To create awareness on various mine environment concepts like spontaneous heating, mine fires, explosion, mine inundation along with rescue and recovery.

UNIT 1:
SPONTANEOUS HEATING Causes, detection and preventive measures in underground and surface coal mines, control of spontaneous heating in stacks and dumps..

UNIT 2:
MINE FIRES Mine fires, control of fires and fires extinguishers, study of atmosphere behind sealed off areas, fire stopping and sealing off an area, pressure balancing, conditions and procedure of reopening a sealed off area, firefighting organization. Fires in opencast mines and surface storage systems, emergency organization in mines.

UNIT 3:
EXPLOSION Fire damp and coal dust explosions, their causes and prevention, stone dust and water barriers, investigations of explosion.

UNIT 4:
MINE INNUNDATION Causes and precautionary measures, bulk head doors, barriers, dams, their design, precautions to be taken while approaching old workings, burnside drilling apparatus, recovery of flooded mines and de watering of old workings.

UNIT 5:
RESCUE AND RECOVERY Types of rescue equipment and their use, features of rescue stations and rescue rooms, first aid appliances, training of personnel, and organization of rescue and recovery work during mine fires, explosion, inundation.

Text Books:
1) Mine Environment By G.B. Mishra
2) Elements of Mining Tech. Vol.2 by D. J. Deshmukh
3) Subsurface Mine Ventilation. by Mcpherson

Reference Books:
1) Mine fires by Dr. Ramlu
2) Underground Mine Environment, M. Mcpherson
3) Subsurface Mine Ventilation, H.L. Hartman

Course Outcome: On completion of this course, students will be able to explain various mine environment concepts like spontaneous heating, mine fires, explosion, mine inundation along with rescue and recovery.

III Year–	**MINING MACHINERY-I LAB**	L	T	P	C
I Semester		0	0	3	1.5

Course Objectives: To experiment the various machinery, ropes, conveyors and different types of loading machines.

List of experiments:
1. Study of jack Hammer, lubricator and air leg.
2. Study of construction of different types of wire ropes.
3. Study of safety hooks used in winding.
4. Study of different types of haulage systems and attachment of tubs to the rope.
5. Study of tensioning arrangement in endless haulage and different types of haulage clips.
6. Study of haulage track, curves, diamond crossing.
7. Study of construction of mine tubs and cars along with their couplings.
8. Study of safety devices provided of haulage roads
9. Study of submersible pumps.
10. Study of Electrical and hydraulic layouts for long wall faces.
11. Study of aerial rope ways.
12. Study of various types of head gear and fleet angle.
13. Study of shaft fittings-signal systems, guides, safety dogs and protective roofing.

Course Outcome: Students will be able demonstrate various machinery, ropes and conveyors and different types of loading machines.

III Year–	**MINE HAZARDS AND RESCUE LAB**	L	T	P	C
I Semester		0	0	3	1.5

Course Objective: To experiment with various instruments and devices which are used in mines and to avoid mine hazards.

List of Experiments:
1) Study of constructional features & working of Self-contained breathing apparatus.
2) Study of various types of Fire Extinguishers used in Mines.
3) Study of constructional features & working of Self-Rescuer.
4) Study of constructional features & working of Gas Mask.
5) Study of constructional features & working of Reviving apparatus.
6) Study of working of Burn Side Safety Boring Machine.
7) Study of constructional features & working of Stone Dust Barriers.
8) Study of constructional features & working of Water barrier
9) Design of underground water dams.
10) Study of illumination of underground mines.
11) First aid training to be explained and conducted.
12) Emergency organization in underground mines.

TEXT & REFERENCE BOOKS:

1) P.Seshagiri Rao, Law of Mines & Minerals. Pub: Asia Law House, Hyderabad
2) Rakesh & Prasad, Legislation in Indian Mines Vol. I & II. Pub:Mrs. Asha Lata Varanasi
3) Classified Mine Circulars Issued by DGMS (Compiled)
4) Relevant Act, Rules and Regulations, Published by Govt. of India
5) Elements of Mining Technology Vol-2, D. J. Deshmukh
6) Mine Disasters and Mine Rescue – M.A. Ramlu, Oxford & IBH, New Delhi.
7) Hand book on First Aid, Published by Multi-Disciplinary Centre on Safety, Health & Environment, Bhubaneswar
8) Mine Safety & Legislation, by S.K.Das, Lovely Prakashan, Dhanbad.

Course Outcome: Students will be to distinguish various instruments and devices which are used in mines and apply the knowledge to avoid mine hazards.

III Year– I Semester	SKILL ENHANCEMENT COURSE SOFT SKILLS	L	T	P	C
		0	1	2	2

Course Objectives:

- To encourage all round development of the students by focusing on soft skills
- To make the students aware of critical thinking and problem-solving skills
- To develop leadership skills and organizational skills through group activities
- To function effectively with heterogeneous teams

UNIT – I: Soft Skills & Communication Skills   -10 Hrs

Introduction, meaning, significance of soft skills – definition, significance, types of communication skills - Intrapersonal & Inter-personal skills - Verbal and Non-verbal Communication

Activities:

Intrapersonal Skills- Narration about self- strengths and weaknesses- clarity of thought – self- expression – articulating with felicity

(The facilitator can guide the participants before the activity citing examples from the lives of the great, anecdotes and literary sources)

Interpersonal Skills- Group Discussion – Debate – Team Tasks - Book and film Reviews by groups - Group leader presenting views (non- controversial and secular) on contemporary issues or on a given topic. Verbal Communication- Oral Presentations- Extempore- brief addresses and speeches- convincing- negotiating- agreeing and disagreeing with professional grace. Non-verbal communication – Public speaking – Mock interviews – presentations with an objective to identify non- verbal clues and remedy the lapses on observation

UNIT – II: Critical Thinking-10 Hrs

Active Listening – Observation – Curiosity – Introspection – Analytical Thinking – Open-mindedness – Creative Thinking

Activities:

Gathering information and statistics on a topic - sequencing – assorting – reasoning – critiquing issues – placing the problem – finding the root cause - seeking viable solution – judging with rationale – evaluating the views of others - Case Study, Story Analysis

UNIT – III: Problem Solving & Decision Making-10 Hrs

Meaning & features of Problem Solving – Managing Conflict – Conflict resolution – Methods of decision making – Effective decision making in teams – Methods & Styles

Activities:

Placing a problem which involves conflict of interests, choice and views – formulating the problem – exploring solutions by proper reasoning – Discussion on important professional, career and organizational decisions and initiate debate on the appropriateness of the decision.

Case Study & Group Discussion

UNIT – IV: Emotional Intelligence & Stress Management-10 Hrs
Managing Emotions – Thinking before Reacting – Empathy for Others – Self-awareness – Self-Regulation– Stress factors – Controlling Stress – Tips

Activities:
Providing situations for the participants to express emotions such as happiness, enthusiasm, gratitude, sympathy, and confidence, compassion in the form of written or oral presentations.
Providing opportunities for the participants to narrate certain crisis and stress –
ridden situations caused by failure, anger, jealousy, resentment and frustration in
the form of written and oral presentation, Organizing Debates

UNIT – V: Leadership Skills-   10 Hrs
Team-Building – Decision-Making – Accountability – Planning – Public Speaking – Motivation – Risk- Taking - Team Building - Time Management.

Activities:
Forming group with a consensus among the participants- choosing a leader- encouraging the group members to express views on leadership- democratic attitude- sense of sacrifice – sense of adjustment – vision – accommodating nature- eliciting views on successes and failures of leadership using the past knowledge and experience of the participants, Public Speaking, Activities on Time Management, Motivation, Decision Making, Group discussion etc.

Note:
- The facilitator can guide the participants before the activity citing examples from the lives of the great, anecdotes, epics, scriptures, autobiographies and literary sources which bear true relevance to the prescribed skill.
- Case studies may be given wherever feasible for example for Decision Making- The decision of King Lear or for good Leadership – Mahendar Singh Dhoni etc.

Textbooks:
1) Personality Development and Soft Skills (English, Paperback, Mitra BarunK.)Publisher: Oxford University Press; Pap/Cdr edition (July 22, 2012)
2) Personality Development and Soft Skills: Preparing for Tomorrow, Dr Shikha KapoorPublisher : I K International Publishing House; 0 edition (February 28, 2018)

Reference Books:
1) Soft skills: personality development for life success by Prashant Sharma, BPB publications 2018.
2) Soft Skills By Alex K. Published by S.Chand
3) Soft Skills: An Integrated Approach to Maximise Personality Gajendra Singh Chauhan, Sangeetha Sharma Published by Wiley.
4) Communication Skills and Soft Skills (Hardcover, A. Sharma) Publisher: Yking books

5) SOFT SKILLS for a BIG IMPACT (English, Paperback, RenuShorey) Publisher: Notion Press
6) Life Skills Paperback English Dr. Rajiv Kumar Jain, Dr. Usha Jain Publisher: Vayu Education of India

Online Learning Resources:
https://youtu.be/DUlsNJtg2L8?list=PLLy_2iUCG87CQhELCytvXh0E_y-bOO1_q
https://youtu.be/xBaLgJZ0t6A?list=PLzf4HHlsQFwJZel_j2PUy0pwjVUgj7KlJ
https://youtu.be/-Y-R9hDl7lU
https://youtu.be/gkLsn4ddmTs
https://youtu.be/2bf9K2rRWwo
https://youtu.be/FchfE3c2jzc

Course Outcomes:
- Memorize various elements of effective communicative skills
- Interpret people at the emotional level through emotional intelligence.
- Apply critical thinking skills in problem solving.
- Analyze the needs of an organization for team building
- Judge the situation and take necessary decisions as a leader
- Develop social and work-life skills as well as personal and emotional well-being.

III Year– I Semester	ENGINEERING SCIENCE TINKERING LAB	L	T	P	C
		0	0	2	1

A tinkering laboratory serves as a platform to nurture curiosity and foster innovation among young minds. It is a space where young individuals can bring their ideas to life. Here, they experiment with materials and concepts to fully understand their potential, refining their insights to develop better solutions for existing challenges. Tinkering is all about hands-on learning, embracing failure as a stepping stone, and allowing unstructured time to explore and create. Through exploration and invention, the foundation for innovation is built, encouraging young people to develop practical skills and creativity through DIY projects and hands-on experiences.

2 or 3 students should form a group and each group should develop any 12 working models from the following:

1) Robotic Arm
2) Drone
3) Smart Glasses
4) GPS Tracker for vehicle
5) Brallie Printer1
6) Brallie Printer2
7) Smart Toll
8) Automatic guitar using gesture control
9) Firefighting Robot
10) Adwiss (All Direction wheel integrated system)
11) Accident Detection
12) Chargeable cycle
13) Air Quality Management System
14) Automatic irrigation system
15) Self-Balancing Bike
16) Blind Specs
17) Bio metric Security System
18) Accidental Avoider
19) Power Generation System
20) LPG Gas Detection System
21) Smart Irrigation System
22) Surveillance BOT
23) Automatic Water Gardening System
24) Smart Irrigation
25) Surveillance BOT
26) Automating Water Gardening System
27) SPY BoT
28) Assistance Kit for Blind
29) Parking Assistant
30) Face Recognition Door lock System
31) Augmented Transportation
32) Mechanical Spider
33) Android app controlled robotic arm

34) Mini CNC
35) Omni Surface Stylus
36) Load Adjustment Device
37) Mine/Metal detection car
38) Intelligent safety helmet for coal mines
39) Wireless controlled Hovercraft
40) Self-balancing scooter
41) Quadcopter
42) Vending Machine
43) Stubble to Manure
44) Smart Traffic System
45) Flow Monitoring System
46) Vehicle Accident Alarm System
47) Prototype of Deployable Bridge
48) Smart dustbin
49) IOT based medical system
50) Smart shoes/Navigation to a free parking space
51) SA compact device to melt Ghee/Coconut oil during winter
52) Smart Irrigation System
53) Surveillance BOT
54) Automatic Water Gardening System
55) Smart Chair
56) Prosthetic Arm
57) 3D-Mapping using LiDAR
58) Smart Mirror
59) Smart Parking & Smart container
60) Service Bot
61) Solar Tracker and Automatic Irrigation System
62) Speech Recognition based Door Lock
63) Drone Surveillance
64) IOT based smart agriculture system
65) Animatronic Arm
66) Robotic arm controlled by mimicking the movements of human arm
67) IOT based smart agriculture system
68) Wall painting robot
69) Low cost 3D printer
70) Home automation
71) Automated wheelchair
72) Hand gesture recognition

III Year– II Semester	MINE PLANNING AND DESIGN	L	T	P	C
		3	0	0	3

Course Objectives:
1) To understand the planning of opencast & underground mines and equipment utilization.
2) To study project implementation and monitoring.

UNIT - I
Introduction: Technical factors in mine planning, methodology of mine planning, short range & long range, Optimization Techniques in Mine Planning; mine plan preparation; Choice between surface and underground mining.

UNIT - II
Opencast Mining: Selection of initial mine cuts and geometrical considerations; location of surface structures, division of mining area into blocks, mine design, Impact of various parameters like depth, dip, stripping ratio, geology and strength of mineral and overburden on mine planning; Selection of Mining Systems; Development of Ultimate Pit Configuration (open pit limits) and its determination –hand method, floating cone technique(2D&3D), Lerchs-Grossmann algorithm and computer assisted hand method; Determination of optimum mine size and sequencing by nested pits; Lanes algorithm for estimation of optimum mill grade and production planning; calendar plan, production scheduling ,economic productivity indices. Quality Control-Ore Blending; Planning for mine closure.

UNIT - III
Underground Mining: Design of mine entries – shafts, inclines, design of stopes – size, level interval, design of coal mining district, mine boundaries; design of shaft pillars and protective pillars, planning of production capacity , optimization of mine size – mine production capacity, layout of development drives/raises/winzes length of faces, planning of support systems, ventilation, layout of drainage system;
Production planning & Production scheduling, selection of depillaring / stoping method, manpower management economic/ productivity indices, Productivity and quality control; Techno- economic analysis, Planning for mine closure.

UNIT - IV
Equipment Planning: Planning and selection of equipment, their capacities and population for different mining conditions. Maintenance planning and scheduling including spare management; Equipment information – performance monitoring and expert systems.

UNIT - V
Project Implementation and Monitoring: Pre-project activities – feasibility report, environmental clearance, detailed project report, sources of funds, import of technology, selection of contracts and contract administration, time management, cost control material management system, project quality assurance, social responsibility.

Text Books:
1) Principles of Mine Planning- Jayanth Bhattacharya, Allied Publishers, Delhi 2003.

2) Fundamentals of Open Pit Mine Planning and Design, Hustrulid, W. and Kuchta, M., (eds).
Elsevier, 1995.

Reference Books:
1) Mining Modelling, Ehrenburger, V and Fajkos, A., Elsevier, 1995.
2) Innovative Mine Design for the 21st Century Elsevier, Bawden, W.F., and Archibald., J.F., 1993.
3) Mining Engineering Analysis, 2nd Edition, Society for Mining, Metallurgy, and Exploration,
Christoper J. Bise, 2003.
4) Design of Underground Hard Coal Mines, Pazdziora, J., Elsevier, 1988.
5) Underground Hard Coal Mines, Swilski, and Richards, Elsevier, 1986.
6) Blasting in Underground excavations and mines, Singh, B. and Pal Roy, P., CMRS Dhanbad,
1993.
7) Longwall Mining, Peng, S.S. and Chaing, H.S., John Wiley & Sons, New York, 1984.
8) Opencast Mining – Technology and Integrated Mechanisation, Rzhevsky, V.V., MIR Publishers,Moscow, 1987.
9) Opencast Mining – Unit Operations, Rzhevsky, V.V., MIR Publishers, Moscow, 1987.

Course Outcomes: The students will
1) Have knowledge on planning of opencast mining, underground mining and equipment
utilization.
2) Learn about initial designs, sequence of designs and various methods used to design ultimate
pit configuration.
3) Able to perform capacity calculations, design mine entries, manpower management and
calculate productivity indices.
4) Understand about planning and selection of appropriate machinery and able to perform their
capacity calculations.
5) Acquire knowledge about project implementation and monitoring and about time management,
scheduling etc.

III Year– II Semester	SURFACE MINING	L	T	P	C
		3	0	0	3

Course Objectives: Students will acquire knowledge about the concepts of surface mining, mineral deposits and dump formation.

UNIT - I
Role of surface mining in mineral production in India, elements of surface mine planning-height, width, and slope of benches, overall and ultimate pit slopes, stripping ratio, cutoff grade, different mining costs and preliminary evaluation of surface mining prospects, surface mining equipment.

UNIT – II
Types of surface mining systems — applicability, limitations, advantages and disadvantages Opening up of deposits – different systems of opening of deposits, site preparation, box cut, formation of benches, and haul roads. Layouts using different combinations of main excavation, loading and transportation systems.

UNIT – III
Blasting: Blasting practices and blast design in surface mines Extraction Methods: Extraction of subsurface deposits - bedded deposits, massive deposits, pipe type, cap type and vein type deposits; mining of beach sands, placer mining, dimensional stone mining. Layouts with In-pit crushing and conveying, surface miners.

UNIT – IV
Surface mining of coal seams developed by underground methods, surface mining over underground workings, mining in fiery coal seams, deep mining problems, Specific precautions to be taken to extract the developed seams and geological disturbed areas.

UNIT – V
Dump Formation: Types of waste dump - internal and external; dump formation methods and equipment. Reclamation methods by using different combination of equipment. Utilization of fly ash in reclamation.

TEXT BOOKS:
1) Bulk Handling in Open Pit Mines & Quarries: Reinhard H.Wohlbier
2) Coal Mines Regulations, 1957 and Metalliferous Mines Regulations, 1961
3) Introductory Mining Engineering: Howard L. Hartman

REFERENCE BOOKS:
1) Modern Coal Mining Technology: Samir Kumar Das
2) Opencast Mining – Technology and Integrated Mechanization: V.V.Rzhevsky
3) Opencast Mining – Unit Operations: V.V.Rzhevsky
4) SME Hand Books
5) Surface Mining : G.B.Misra
6) Surface Mining Technology : Samir Kumar Das

Course Outcome: Students will be able to explain the concepts of surface mining, mineral deposits and dump formation.

III Year– II Semester	**UNDERGROUND METAL MINING**	L	T	P	C
		3	0	0	3

Course Objectives: Students will be able to gain knowledge about the principles, concepts and operations of metal mining methods along with relevant statutory guidelines.

UNIT - I
Introduction: Terminology; Typical modern metal mine features; exploration, estimation of block wise and mine wise reserves and actual production, typical pre-stoping, ore block constructional features; classification of metal mining methods.

UNIT - II
Development: Mode of mine and stope entry; Layouts; Determination of optimum production level; sequence of extraction, production scheduling; Basic design – Level Intervals, ore pass, commonore pass, size of blocks ore handling in stope and other openings, overview of constructional features– X cuts, Raises, Winzes, Mechanized methods etc.

UNIT – III
General concepts of Stoping Methods: Techno-economic characteristics impacting choice of method; typical lunit cost parameters; optimum size of a mine and stope. stope layout, design, equipment selection; preparing a stoping block; sequence of stoping; organization; production cycle; unit cost calculation; comparison of methods and costs. MMR and other relevant guidelines.

UNIT - IV
Stoping Methods: Unsupported methods – Stope and pillar, room and pillar, shrinkage, sub level stoping etc. supported stoping– cut and fill, stull, square set, rill, etc. caving methods – Top slicing, sublevel cav ing, block caving. Case studies of Indian and foreign underground metal mines. Comparison of various methods of stoping and costs.

UNIT – V
Advanced Stoping Techniques: Hydraulic mining, slurry mining, solution mining, nuclear mining; Rapid excavation; Radial – axial splitter; Thermal fragmentation; shock wave breaking; Deep mining; narrow contiguous veins; shaft and remnant pillars; VCR; Ring drilling; Large Blast hole stoping.Statutory guidelines:

TEXT BOOKS:
1) Hartman, H.L., Introductory Mining Engineering, John Wiley and Sons, New York, 1987.
2) Hustrulid, W.A. Ed., Underground Mining Methods Handbook Society of Mining Engineering
   AMIE, New York, 1990.

REFERENCE BOOKS:
1) BICCARD J C, Gold mining in Witwatersrand, The Transvaal chamber of mines, Volume I, II, 1946.

2) Hartman, H. L. (Editor), SME Mining Engineering Handbook, 3rd edition, Vol I & II, Society of Mining Engineers, New York, 2011.

Course outcome: Students will be to learn and apply the principles, concepts and operations of metal mining methods along with relevant statutory guidelines.

III Year–	COMPUTER APPLICATIONS IN MINING	L	T	P	C
II Semester		3	0	0	3

Course Objectives:
1) To impart knowledge on hardware and software issues concerned with computers in mining industry.
2) To develop algorithms and programs on various mining related problems.
3) To impart knowledge on high-end simulation methodologies.
4) To study modern techniques on solving mining problems.

UNIT - I
Algorithm, flow charts and Programming of mining application like pillar design, blast design, subsidence.

UNIT - II
Design of the mine entries such as Incline, Shaft, Decline and Adit. Stability analysis and design of coal pillars, coal panels, stope pillars and barriers using mining and geotechnical software such as Rocscience.

UNIT - III
Subsidence prediction: Long wall, Continuous miner, Bord and Pillar, Cut & Fill method and Shrinkage stoping using mining and geotechnical software such as Rocscience.

UNIT - IV
Stability analysis and design of high walls, production fronts, dumps of opencast coal mine and metal mines using mining and geotechnical software such as Rocscience.

UNIT - V
Development of ventilation network for Bord & Pillar, longwall, Continuous miner in coal and metal mine methods. Network analysis for the emerging mining methods. Design of the mine fan capacity using software like Ventsim.

TEXT BOOKS:
1) Computer Applications in the Minerals Industries, Kadri Dagdelen, Editor, Colorado School of Mines, 1999.
2) Computers in Mineral Industry, Ramani R.V., et al. Oxford and IBH Publishers, 1994.

REFERENCE BOOKS:
1) APCOM Proceedings Application of Computers and Operations, R. V. Ramani – Editor, Research in the Mineral Industry, The Society of Mining, Metallurgy and Exploration, Inc., 1996.
2) Computers Applications in Mineral Industry, Fytas, K. and Singhal, R. K. A. A. Balkema Publication, 1988.
3) Fundamentals of Computers, E Balagurusamy, Mc Graw Hills Publication, 2009.
4) Computers Today Fourth Edition, Basandra S K, Galgotia Publications Pvt. Ltd, 2004.

Course Outcomes: Upon completion of course, the students will have

1) Basic programming knowledge and its applications on various mining related applications.
2) Familiarity with hardware and software issues during development of programs.
3) Knowledge on stability analysis and ventilation network analysis in coal and metal mines
4) A perspective on high-end simulation methodologies and modern techniques to solve mining problems.

III Year– II Semester	**REMOTE SENSING AND GIS**	L	T	P	C
		3	0	0	3

Course Objectives: Students will gain knowledge about the principles, analysis and applications of remote sensing and GIS.

UNIT – I
Introduction to Remote sensing: Basic concepts of remote sensing, interaction with atmosphere, energy interaction with the earth surfaces, characteristics of remote sensing systems, types of resolutions, types of sensors, airborne remote sensing, space borne remote sensing, image data characteristics, digital image data formats-band interleaved by pixel, band interleaved by line, band sequential, IRS, LANDSAT, SPOT & Recent satellite.

UNIT – II
Image analysis: Introduction, elements of visual interpretations, digital image processing- image preprocessing, image enhancement, image classification, supervised classification, unsupervised classification.

UNIT – III
Geographic Information System: Basic Principles, components, application areas of GIS, map projections. Data entry and preparation: spatial data structures, raster and vector data formats, data inputs, data manipulation, data retrieval, data analysis and data display.

UNIT – IV
Spatial data analysis: Introduction, overlay function-vector overlay operations, raster overlay operations, arithmetic operators, comparison and logical operators, conditional expressions, overlay using a decision table, network analysis-optimal path finding, network allocation, network tracing.

UNIT – V
Applications: Land cover and land use, agriculture, forestry, geology, geomorphology, urban & transportation, Hydrology and Water Resources: Flood zoning and mapping, groundwater prospects, groundwater quality monitoring and potential recharge zones, watershed management of application with case studies.

TEXTBOOKS:
> 'Remote Sensing and GIS', by Bhatta B, Oxford University Press, (2011) 2nd Edition'.
1. 'Remote Sensing and Image Interpretation, by Lillesand, T.M, R.W. Kiefer and J.W. Chipman, Wiley India Pvt. Ltd., (2015), 7th Edition.
2. 'Remote Sensing - Models and Methods for Image Processing' by Robert A Schowenger, Elsevier publishers, (2009).
3. 'Fundamentals of Remote Sensing' by George Joseph, Universities Press, (2013) 3rd Edition.
4. 'Fundamentals of Geographic Information Systems' by Michael N. Demers, Wiley India Pvt. Ltd, (2012) 4th Edition.

REFERENCES:

1. 'Remote Sensing and its Applications' by Narayan LRA, Universities Press, 2012.
2. 'Concepts and Techniques of Geographical Information System' by Chor Pang Lo and Albert K.W. Yeung, Prentice Hall (India), (2016) 2ⁿᵈ Edition.
3. 'Introduction to Geographic Information Systems' by Kang Tsung Chang, McGraw Hill Higher Education, (2020) 9ᵗʰ Edition.
4. 'Basics of Remote sensing & GIS' by S. Kumar, Laxmi Publications, New Delhi, 2005.
5. 'Principals of Geographical Information Systems' by Burrough P A and R.A. McDonnell, Oxford University Press, 2006.

Course outcome: Students will be able to discuss and apply the principles and analyze various applications of remote sensing and GIS.

III Year– II Semester	OPTIMIZATION OF MINING SYSTEMS	L	T	P	C
		3	0	0	3

Course Objectives: The student will acquire the knowledge to
1) Understand Linear Programming models
2) Learn Transportation and sequencing problems
3) Solve replacement problems and analyze games theory models
4) Understand waiting line and project management problems
5) Learn dynamic programming and simulation.

UNIT – 1
Introduction - definition– characteristics and phases – types of operation research models – applications.
Allocation::Problem formulation – graphical solution – simplex method – artificial variables techniques -two–phase method, big-M method – duality principle.

UNIT – 2
Transportation problem: Formulation – optimal solution, unbalanced transportation problem – degeneracy, assignment problem – formulation – optimal solution - variants of assignment problem- travelling salesman problem.
Sequencing– Introduction – flow –shop sequencing – n jobs through two machines – n jobs through three machines – job shop sequencing – two jobs through 'm' machines.

UNIT – 3
Replacement theory: Introduction – replacement of items that deteriorate with time – when money value is not counted and counted – replacement of items that fail completely, group replacement.
Inventory: Inventory: Introduction – Single item, Deterministic models – Purchase inventory models with one price break and multiple price breaks –Stochastic models – demand may be discrete variable or continuous variable – Single Period model and no setup cost.

UNIT – 4
Waiting line models: Introduction – single channel – poison arrivals – exponential service times – with infinite population and finite population models– multichannel – poison arrivals – exponential service times with infinite population single channel.
Project management: Basics for construction of network diagram, Program Evaluation and Review Technique (PERT), Critical Path Method (CPM) – PERT Vs. CPM, determination of floats- Project crashing and its procedure.

UNIT – 5
Dynamic programming: Introduction – Bellman's principle of optimality – applications of dynamic programming-shortest path problem – linear programming problem.
Simulation: Definition – types of simulation models – phases of simulation– applications of simulation – inventory and queuing problems – advantages and disadvantages.

Text Books:
1) Operations Research-An Introduction/Hamdy A Taha/Pearson publishers

2) Operations Research –Theory & publications / S.D.Sharma-Kedarnath/McMillan publishers India Ltd.

References:
1) Introduction to Operations Research, Frederick S. Hillier, Geralld J. Lieberman, Bodhibrata Nag, Preetam Basu, 2021.
2) Operations Research /A.M. Natarajan, P. Balasubramani, A. Tamilarasi /Pearson Education.
3) Operations Research / R.Pannerselvam/ PHI Publications.
4) Operations Research / Wagner/ PHI Publications.
5) Operation Research /J.K.Sharma/Macmillan Publ.
6) Operations Research/S Kalavathy / Vikas Publishers

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

CO1	Understand Linear Programming models
CO2	Interpret Transportation and sequencing problems
CO3	Solve replacement problems and analyze queuing models
CO4	Understand game theory and inventory problems
CO5	Interpret dynamic programming and simulation.

III Year– II Semester	MINE AUTOMATION	L	T	P	C
		3	0	0	3

Course Objectives: To gain knowledge about the role of automation and automation of equipment in mines.

UNIT - I
Scope and role of automation in mining operation and human related factors- System engineering approach and use of operational data from mining equipment and its use the mining process.
Data communication and modern computerized control systems-data formats and IREDES, mine process data, AGV technology, Automation in Mine exploration and Surveying.

UNIT - II
Basic foundations for automation of mining equipment- navigation, surface navigation and GNSS (satellite navigation), mine planning tools etc.
Automation of drilling and drill rig, drilling process - Automation of underground loading and transportation systems - Automation in tunnelling projects.

UNIT – III
Automation in monitoring of environments in longwall and continuous mining system - Automation of transportation system in surface mining. -Use of robotics in mining for production and disaster management purpose, introduction to machine learning with reference to mining.

UNIT – IV
Online, real-time monitoring of Mine Excavations: Ground control-Mine slope, dump slope, Subsidence, Roof convergence monitoring, Development of stress on pillars, Trigger Action Response Plan (TARP).
Environmental factors, Fire detection by remote methods, mine information systems (MIS), Seismic study, Micro seismic study, Mine tracking systems, Ground vibrations and noise due to blasting.

UNIT – V
Automation in Mining Machinery: Predictive Maintenance, Non-destructive testing and health monitoring of equipment, Accessories of Haulages, Winding ropes, Application of AI enabled technologies, Industrial IoT, Industry 4.0 and 5.0.

TEXT BOOKS:
1) Society of Mining Engineering Handbooks –Vol –I and II
2) Mine Mechanisation and Automation – G. Almgren, U. Kumar, N. Vagenas, CRC Press, 1993.
3) Introduction to IoT, Sudip Misra, Anandarup Mukherjee (Author), Arijit Roy (Author),Cambridge University Press, 2022.
4) Industry 4.0 to Industry 5.0: Explorations in the Transition from a Techno-economic to a Socio-technical Future: 41 (Translational Systems Sciences),Susu Nousala, Gary Metcalf, David Ing, Springer Verlag, Singapore, 2024.
5) Fundamentals of IIoT, Gupta Rajan, BPB Publications, 2023.

6) Industrial Internet of Things, Anand Sharma, Sunil Kumar
   Jangir, ManishKumar, Dilip Kumar Choubey, Tarun Shrivastava, CRC Press,
   2024.

REFERENCES:

1) Introductory Mining Engineering: Hartman
2) Underground Mining Methods Handbook: Hustrulid (SME NY, 1994)

Course Outcomes: Students will be able to explain the role of automation
and automation equipment in mines.

III Year– II Semester	**MINE WASTE MANAGEMENT**	L	T	P	C
		3	0	0	3

Course Objective: The course underlines the Philosophy of mine waste disposal, land form design & rehabilitation and provides an overview of Indian & international regulations pertaining to mine waste disposal. Students learn Physical & chemical nature of mine wastes; disposal of mine wastes; geomechanics of mine waste disposal & rehabilitation; rehabilitation of mine wastes; risk assessment & remedial measures.

UNIT-1
Physical, chemical, and biological characteristics of mine wastes including waste rock, mineral processing wastes (tailings) and wastewater. Environmental hazards of waste generated in mining and mineral processing industries.

UNIT-II
Mine waste disposal and rehabilitation approaches, Waste disposal in slurry form into tailing ponds. Principles of Slurry Rheology. Selection of pumps and type of pumps used for slurry transportation to tailing ponds. Paste thickening of tailings and disposal in the form of paste. Paste Characteristics & Rheology. Thickeners & pumps used for paste pumping.

UNIT-III
Tailings filtration and disposal in solid form. Filtration processes and equipment. Characteristics of filtered tailings. Transportation and stacking issues of filtered tailings. Alternate use of mining waste by generating value added products.

UNIT-IV
Current practices in mining waste utilization – Waste to Wealth concepts. Geomechanics principles in the disposal of mining and mineral processing waste (tailings). Tailing pond design & failure analysis.

UNIT-V
Case study: Tailing dam failures: Causes, impact on environment, society and businesses at large. Deficiencies of conventional mine waste disposal and rehabilitation approaches. National and International regulatory regimes pertaining to waste disposal in mining and mineral processing industries.

Text Books:
1) Mine Wastes, Characterization, Treatment and Environmental Impacts, Bernd Lottermoser, 2010.
2) Mine Waste Management – California Mining Association, CRC Press; 1st edition (21 February 1992).

Reference Books:
1) Mine Waste Management in China: Recent Development, Author - Di Wu, 2020
2) Mine Waste Utilization By Ram Chandar Karra, Gayana B C, Shubhananda Rao P, CRC Press, 2022.

Course Outcome: Students will be able to explain the disposal and rehabilitation of mining and mineral processing wastes in a geotechnical, environment and safety context and also draw a big picture view of mine waste management and rehabilitation, which is vital to the future of sustainable mining and mineral processing industries.

III Year–	DIMENSIONAL STONE MINING	L	T	P	C
II Semester		3	0	0	3

Course Objective: To acquire the knowledge about the essential concepts of dimensional stone mining and its impact on the environment.

UNIT- I
Resources of Marble, Granite, Slate, Sandstone and Limestone as Dimensional stones in India vis-a-vis world, uses, marketing, export. Geological, mineralogical and physico-mechanical properties of dimensional stones, Criteria for selection of dimensional stone deposit, Procedure for obtaining mining lease and preparation of Feasibility Report (FR) and Detailed Project Report (DPR).

UNIT- II
Mining: Conventional mining of Marble and Granite; Recent developments- wire saw including blind cut technique, chainsaw, belt saw, hydraulic splitting, flame jet cutting, water channeling etc; Blasting techniques in dimensional stone mines: various types of explosives used, controlled blasting for providing horizontal & vertical cut; Splitting by swelling material.

UNIT- III
Insitu splitting technique used in compact limestone (Kota stone) for utilization of waste as dimensional stone. Various types of loaders cranes and hydraulic excavator used in dimensional stone mines; Quarry layouts. Hole making technique using hole-finder and laser beam. Application and development of diamond tools, formation of stone block and their handling.

UNIT- IV
Processing: Dressing- Mono block dresser; Sawing- gang saws, circular saws; Preparation and mounting of blades/discs and segments; slab repair by resin Polishing - Manual, Mechanical; Various types of polishing machines; Abrasives- type, use and selection, shaping; Tile preparation; Automatic tiling plant, slurry handling and treatment including water supply. Multiwire technology.

UNIT- V
Environmental impacts of mining and processing of dimensional stones; Secondary use of quarried land and waste of the industry; Land reclamation, Environmental management plan, Environment Protection measures. Statutory guidelines relevant to dimensional stone mining, Export and Import policies.

TEXT BOOK:
1) S. S Rathore., G. S. Bhardwaj and S. C Jain: Dimensional Stone Technology.

REFERENCE BOOKS:
1) S. S., Rathore and V.; Laxminarayana "Safety and Technology in Marble Mining and Processing in New Millennium" Proc. Of National Workshop held March 10-11 200 Udaipur

2) S. S. Rathore, Y. C. Gupta and R. L Parmar; "Recent Development in Machinery and Equipment for Dimensional Stone Mining" held Dec. 13-14, 2003 at Udaipur.

Course Outcome: Students will learn about the important concepts of dimensional stone mining.

III Year–	**ADVANCED MINING TECHNIQUES**	L	T	P	C
II Semester		3	0	0	3

Course objectives: To impart the knowledge of advanced techniques of underground coal and metal mining.

UNIT – I
Introduction: Exploration, resource, reserve, grade, thickness and size of the deposit, the various reserve estimation techniques. Characteristics of planning process, scope of mining activities, stages of mine planning, feasibility report, detailed project report, mining plan, mine closure plan, mine environmental plan and other plans.

UNIT – II
Underground coal mining methods: Classification of methods of mining coal; factors governing choice of coal mining methods, blasting gallery, continuous miner, longwall and other special techniques. Criteria for selection of different mining equipment.

UNIT – III
Design of underground coal mining methods: Blasting gallery and long wall mining-methods and design considerations for exploitation of thick seams by inclined slicing, horizontal slicing and cross-inclined slicing methods; sub-level caving and integrated caving methods. Design and methods of exploitation of contiguous seams, exploitation of seams under water bodies and seams liable to bumps. Design and method of underground hydraulic mining. Underground gasification of coal.

UNIT – IV
Underground metal mining methods: Classification of exploitation methods; choice of mining systems - geomechanical, techno-economical, environmental and safety considerations. Factors governing the choice of methods. The different underground stoping methods: breast stoping, under hand and overhand, room and pillar, sublevel, square set, shrinkage , cut and fill methods and other stoping methods.

UNIT – V
Design of underground metal mining methods: Design of excavations in massive elastic, stratified and jointed rocks. Design of stoping layouts for mining of different types of ore deposits. Unit operations of stoping. Mining in rockburst prone areas. Novel and innovative mining methods: hydraulic, thermal, hydrochemical and biochemical methods; marine mining and nuclear device mining systems.

TEXT BOOKS:
1) Mathur SP. Mine planning for coal. M G Consultants, Bilaspur. 1993.
2) Bhattacharya J. Principles of mine planning. Allied Publishers Pvt Limited, New Delhi. 2003.

REFERENCE BOOKS:
1) Hustrulid W and Kuchta M. Open Pit Mine Planning and Design. A A Balkema Rotterdam. 1995.

2) Vorobjev BM and Desmukh RT. Advanced coal mining vol-II. Asia Publishing house, Bombay, revised edition. 1966

Course Outcome: Student will be able to explain advanced techniques of underground coal and metal mining.

III Year–	**TUNNELLING & UNDERGROUND SPACE**	L	T	P	C
II Semester	**TECHNOLOGY**	3	0	0	3

Course Objectives: To understand drilling and blasting methods of tunnels, mechanized tunnelling and to design a tunnel.

UNIT I
INTRODUCTION: Congestion in cities and its impact on development of social infrastructure for transport, water and power supply, separation of pedestrian and motorized vehicles and its movements, storage of materials, defense facilities including civil shelters. Parameters influencing location, shape and size; geological aspects; planning and site investigations. Tunnels for various purposes like road, rail, hydropower tunnels and caverns, Underground storage applications.

UNIT II
TUNNELLING METHODS: Types and purpose of tunnels; factors affecting choice of excavation techniques; soil and rock sampling and testing, Methods - soft ground tunneling, hard rock tunneling, shallow tunneling, deep tunneling; Shallow tunnels – cut and cover, cover and cut, pipe jacking, jacked box excavation techniques, methods of muck disposal, supporting, problems encountered and remedial measures.

UNIT III
TUNNELLING BY DRILLING AND BLASTING: Unit operations in conventional tunneling; Drilling - drilling principles, drilling equipment, drilling tools, drill selection, specific drilling, rock drillability factors; Blasting - explosives, initiators, blasting mechanics, blast holes nomenclature; types of cuts - fan, wedge and others; 21 blast design, tunnel blast performance - powder factor, parameters influencing, models for prediction; mucking and transportation equipment selection.

UNIT IV
MECHANIZED TUNNELLING: Cutting principles, method of excavation, selection, performance, limitations and problems. Boring principles, method of excavation, selection, performance, limitations and problems; Road headers, Impact Hammers, Tunnel Boring Machines and applications.

UNIT V
TUNNEL DESIGN: Planning and design, Assessment of behavior of tunneling media, deformation modulus and rock pressure assessment; determination of appropriate size and shape; Design of openings in rocks with the help of field data; Instrumentation and monitoring; Numerical modeling to assess the stability.

TEXT BOOKS:
1) Hudson, J.A., Rock Engineering Systems Theory and Practice, Ellis Horwood, England.
2) Clark G.B., (1987), Principles of Rock Fragmentation, John Wiley and Sons, New York.

REFERENCES:

1) Lohanson, John and Mathiesen, C.F., Modern trends in Tunnelling and Blast Design, AA Balkima, 154 P, 2000.
2) Bickel J.O., Kuesel T.R. and King E.H., Tunnel Engineering Hand Book, Chapmen & Hill Inc., New York and CBS Publishers, New Delhi 2nd addition.

Course Outcome: Students will be able to explain drilling and blasting methods of tunnels, mechanized tunneling and to design a tunnel.

III Year–	**MINERAL ECONOMICS**	L	T	P	C
II Semester		3	0	0	3

Course Objectives: To gain knowledge about the economic importance in mining industry, mineral resources and reserves and their conservation, valuation and taxation, trade and mining information systems.

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
Mine Sampling: Definition, purpose and scope, Preparation of samples, methods and computations; Application of statistical methods in sampling.
b - Classification and incorporation of losses, co-efficient of completeness of mineral extraction, Dilution and recovery
Examination of mineral properties: Definition, purpose, type and scope of examination.

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.
Mine finance: Capital – its importance, various forms and formation; mine accountancy and book keeping.

UNIT-V
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.
Mineral information system: Data-information-informatics-data base, Mineral information system in India and problems, Mineral information system in outside India.

TEXT BOOKS:
1) Alwyn E. Annels, Mineral Deposit Evaluation: A Practical Approach, Chapman Hall, 1991.
2) Deshmukh R.T. Mine and Mineral Economics, Emdee Publishers, 1986.
3) Arogyaswamy, R.N.P. Courses in Mining Geology, Oxford and IBH Publishing Co., 1994.

REFERENCES:
1) Sloan, D.A., Mine Management, Chapman and Hall, London, 1983.
2) Chatterjee, K.K., Mineral economics, Wiley Eastern, 1992.
3) Park, R.J., Examination and Valuation of mineral property
4) How to read a balance sheet ILO 1992.

Course outcome: Students will be able to explain the economic importance in mining industry, mineral resources and reserves and their conservation, valuation and taxation, trade and mining information systems.

III Year– II Semester	LANDSLIDES & SLOPE STABILITY ENGINEERING	L	T	P	C
		3	0	0	3

Course Objective: To understand the concepts of slopes in surface mines, geotechnical information, water flow, slop failures and to apply the principles in designing pit slopes and waste dumps.

UNIT-I
Introduction
Types and formation of slopes in surface mines, pit slope vis-à-vis mine economics, mechanism of common modes of slope failure, factors influencing stability of slopes, and planning of slope stability investigations.

UNIT-II
Geotechnical Information
Geotechnical data required for highwall slope stability studies. Collection of Geological Data and their interpretation for stability studies of highwall slopes.
Shear Strength
Shear strength of intact rock, discontinuity surfaces, filled discontinuities and rock-mass - estimation and determination; Surface roughness, joint roughness coefficient – estimation and determination.

UNIT-III
Water Flow
Concepts of water flow through a material and its permeability; water flow through rock-mass, water flow through soil type material and broken spoil material; Estimation and measurement of permeability and water pressure; Graphical solution of seepage problems (flow nets), seepage forces and seepage patterns under different conditions.

UNIT-IV
Analysis and Design of Pit Slopes and Waste Dumps
Slope stability assessment methods and techniques; Analysis and design criteria and methodology for highwall slopes and backfill and waste dumps; Probabilistic approaches of slope analysis and design.

UNIT-V
Mechanisms of slope failures
Field investigations and data collection. Design of slopes - physical, empirical, probabilistic methods, analytical (limit equilibrium analysis) and numerical (continuum models, discontinum and crack propagation models) modeling.
Stabilization and reinforcement of slopes. Slope failure monitoring-modern techniques (SSR). Software for slope stability analysis. Case studies

TEXT BOOKS:
1) Hoek, E. and Bray, J.W; Rock Slope Engineering; John Wiley & Sons; New York; 1984
2) Brawner, C.O; Stability in surface mining, SME of USA; New York, 1982.

REFERENCES:

1) Giani, F; Rock Slope Stability Analysis; Balkema; Rotterdam; 1992.
2) Fundamentals and applications of rock mechanics, Deb.D and Verma A.K, PHI Publications.

Course Outcome: Students will be able to explain the concepts of slopes in surface mines, geotechnical information, water flow, slop failures and to apply the principles in designing pit slopes and waste dumps.

III Year–	**REMOTE SENSING AND GIS**	L	T	P	C
II Semester		3	0	0	3

Course Objective: Students will gain knowledge about the principles, analysis and applications of remote sensing and GIS.

UNIT – I
Introduction to Remote sensing: Basic concepts of remote sensing, interaction with atmosphere, energy interaction with the earth surfaces, characteristics of remote sensing systems, types of resolutions, types of sensors, airborne remote sensing, space borne remote sensing, image data characteristics, digital image data formats-band interleaved by pixel, band interleaved by line, band sequential, IRS, LANDSAT, SPOT & Recent satellite.

UNIT – II
Image analysis: Introduction, elements of visual interpretations, digital image processing-image preprocessing, image enhancement, image classification, supervised classification, unsupervised classification.

UNIT – III
Geographic Information System: Basic Principles, components, application areas of GIS, map projections. Data entry and preparation: spatial data structures, raster and vector data formats, data inputs, data manipulation, data retrieval, data analysis and data display.

UNIT – IV
Spatial data analysis: Introduction, overlay function-vector overlay operations, raster overlay operations, arithmetic operators, comparison and logical operators, conditional expressions, overlay using a decision table, network analysis-optimal path finding, network allocation, network tracing.

UNIT – V
Applications: Land cover and land use, agriculture, forestry, geology, geomorphology, urban & transportation, Hydrology and Water Resources: Flood zoning and mapping, groundwater prospects, groundwater quality monitoring and potential recharge zones, watershed management of application with case studies.

TEXTBOOKS:
1) 'Remote Sensing and GIS', by Bhatta B, Oxford University Press, (2011) 2ⁿᵈ Edition'.
2) 'Remote Sensing and Image Interpretation, by Lillesand, T.M, R.W. Kiefer and J.W. Chipman, Wiley India Pvt. Ltd., (2015), 7ᵗʰ Edition.
3) 'Remote Sensing - Models and Methods for Image Processing' by Robert A Schowenger, Elsevier publishers, (2009).
4) 'Fundamentals of Remote Sensing' by George Joseph, Universities Press, (2013) 3ʳᵈ Edition.
5) 'Fundamentals of Geographic Information Systems' by Michael N. Demers, Wiley India Pvt. Ltd, (2012) 4ᵗʰ Edition.

REFERENCES:
1) 'Remote Sensing and its Applications' by Narayan LRA, Universities Press, 2012.
2) 'Concepts and Techniques of Geographical Information System' by Chor Pang Lo and Albert K.W. Yeung, Prentice Hall (India), (2016) 2nd Edition.
3) 'Introduction to Geographic Information Systems' by Kang Tsung Chang, McGraw Hill Higher Education, (2020) 9th Edition.
4) 'Basics of Remote sensing & GIS' by S. Kumar, Laxmi Publications, New Delhi, 2005.
5) 'Principals of Geographical Information Systems' by Burrough P A and R.A. McDonnell, Oxford University Press, 2006.

Course outcome: Students will be able to discuss and apply the principles and analyze various applications of remote sensing and GIS.

III Year–	GEOSTATISTICS	L	T	P	C
II Semester		3	0	0	3

Course Objective: To study various Geo-statistics techniques and their applications to mineral industry.

UNIT – I
Introduction to mineral exploration: Significance and necessity; Prospecting and exploration criteria; Exploration strategy and design - stages of mineral exploration; theory and methods of sampling; resources and reserves - terminology and classification schemes; conventional methods of ore estimation.

UNIT - II
Classical statistical distributions: normal and lognormal, and their applications in resource evaluation. Geo-statistics: definition; schools of thought; stationarity assumptions and regionalized variables; what, when and why of Geo-statistics.

UNIT - III
Semi-variogram and co-variogram: definitions, characteristics, and computations in one, two and three dimensions; mathematical models; associated difficulties viz. anisotropy, non-stationarities, regularization, presence of nugget effect and presence of trend. Extension, estimation and dispersion variance; calculation by discretization and auxiliary functions. Kriging: definition and derivation of Kriging system of equations. Practice of semi-variogram modeling; practice of Kriging - steps and procedure. An introduction to advanced Geo-statistics.

UNIT - IV
Advanced Geo-statistics: Practical difficulties associated with semi-variography, viz. anisotropy, non-stationarity, regularization, misclassified tonnage; grade control plan. presence of nugget effect and presence of trend. Extension, Estimation and Dispersion variances: definitions, methods of calculations and applications; Screen Effect.

UNIT - V
Geo-statistical applications: optimization of exploration drilling; calculation of mineral inventory; establishment of grade-tonnage relations; misclassified tonnage; grade control plan. Geostatistical conditional simulation - theory and approach. Geo-statistical case studies of selected mineral deposits.

Text Books:
1. Sarma DD. Geo statistics with applications in earth sciences. Springer publications. 2009.

References:
1. Journel AG and Huijbregts C J. Mining geo statictics. Academic press. 1981.
2. Andereson F. Geo statictics by example approach using R. 2006.

Course Outcome: Students will be able to explain various Geo-statistics techniques and their applications to mineral industry.

III Year–	**MINING MACHINERY-II LAB**	L	T	P	C
II Semester		0	0	3	1.5

Course Objective: To carry out experiments on various elements of mining mechanization equipment.

LIST OF EXPERIMENTS

1. Different types of ropes, rope capping and rope splicing.
2. Different types of rope haulages.
3. Haulage clips.
4. Haulage track and rolling stocks.
5. Winding drums safety devices and braking systems.
6. Experiments related to Hand held coal drill (its assembly and disassembly), drill bits and drill rods.
7. Single drum shearer loader, mounting arrangement, mountings on AFC and its trapping mechanism (shearer in long wall gallery).
8. Study of Friction prop,
9. Study of closed and open circuit hydraulic prop.
10. Study of chock shield support .

Course Outcome: Students will get exposed to the practical aspects of mining mechanization equipment.

III Year–	**MINE PLANNING AND DESIGN LAB**	L	T	P	C
II Semester		0	0	3	1.5

Course objective: To have practical exposure to various aspects of mining planning and design.

LIST OF EXPERIMENTS:

1) Determination of stripping ratio.
2) Determination of Pit limits.
3) Calculations of powder factor of blasting in open cast & underground mining blasting.
4) Calculation of fleet size for shovel, dumper combination in open cast mine.
5) Estimation/calculation of production in underground mine using, LHD, SDL, RH, CM, long wall equipment.
6) Ventilation study & Calculation for bord &pillar and long wall panels in underground coal mines.
7) Design of Pillars.
8) Subsidence Predictions.
9) Problems on network analysis for ventilation
10) Slope stability problems.

Course Outcome: Students will get exposed to the various practical aspects of mining planning and design.

III Year– II Semester	COMPUTER APPLICATIONS IN MINING LAB	L	T	P	C
		0	1	2	2

Course Objective: To acquire knowledge about drawing mining drawings using various software.

Part-A
1. Learning of the following commands using a CAD package.
2. Drawing Commands: Line, arc, circle; polygon, Donut, Solid, Spline Pline, Text, M Line, ellipse, dimensioning, object snaps point, Hatch, layers, Units.
3. Editing Commands: Limits, Erase, Array, Copy, Move, Offset, Stretch, edit, change properties, Trim, Extend, Fillet, Chamfer, Break, Mirror, Scale, Rotate, Zoom, Pan. Enquiry Commands: Id, list, Dist, Area, DB list, Status Selection sets i.e. window, crossing, fence, W polygon. Plotting.

Part-B
8 exercises (mining drawing) using any of the above commands.

Part-C
1) Introduction to VENT software of simulation of ventilation network of a mine.
2) Introduction to SINET software to design of underground mine ventilation system.
3) Introduction to GALENA software related to slope stability.
4) Introduction to mine planning by DATAMINE and SURPAC.
5) Introduction to Rocscience software.
6) Introduction to FLAC software.

Course Outcome: Students will be able to use CAD graphics to demonstrate the abilities for mine planning.

III Year–	TECHNICAL PAPER WRITING AND IPR	L	T	P	C
II Semester		2	0	0	-

Course Objectives:
1) To understand how to improve the writing skills and level of readability.
2) To illustrate what to write in each section.
3) To understand the skills needed when writing a Title Ensure the good quality of paper at very first-time submission.
4) To analyze the nature of intellectual property rights and new developments
5) To facilitate the need of the patent rights

Unit 1
Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness.

Unit 2
Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction. Review of the Literature, Methods, Results, Discussion, Conclusions, the Final Check. Effective literature studies approaches, analysis Plagiarism, Research ethics, Effective technical writing, how to write report, Paper Developing a Research Proposal,

Unit 3
Key skills are needed when writing a Title, key skills are needed when writing an abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature. Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, and skills are needed when writing the Conclusions. Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission.

Unit 4
Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Unit 5
Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

Text Books:
1) Gold bort R (2006) Writing for Science, Yale University Press (available on Google Books).

2) Day r (2006) How to Write and Publish a Scientific Paper, Cambridge University Press.
3) High man N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. High man's book.
4) Adrian Wall work, English for Writing Research Papers, Springer New York Dordrech Heidelberg London, 2011.
5) Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students".
6) Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction".
7) Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners".

References:
1) Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd, 2007.
2) Mayall, "Industrial Design", McGraw Hill, 1992.
3) Niebel, "Product Design", McGraw Hill, 1974.
4) Asimov, "Introduction to Design", Prentice Hall, 1962.
5) Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age", 2016.
6) T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008.

Course Outcomes: At the end of the Course, Student will be able to:
CO 1: Understand how to improve the writing skills and level of readability.
CO 2: Illustrate what to write in each section.
CO 3: Understand the skills needed when writing a Title Ensure the good quality of paper at
veryFirst-time submission.
CO 4: Analyze the nature of intellectual property rights and new developments
CO 5: Facilitate the need of the patent rights

Minors

Minor	MINOR IN "MINE ENVIRONMENT" MINE VENTILATION	L	T	P	C
		3	0	0	3

Course objective: To Understand atmosphere and mine atmosphere conditions, heat and humidity levels in mines and controlling method. To know the necessity of ventilation in mines and quantity and quality levels. To know about ventilation standards planning and layout.

UNIT-I
Mine air: Atmospheric air composition, mine air composition and comparison, Mine gases origin, occurrence, physiological effects, detection, monitoring and control. Methane layering, degasification of coal seams, production, assessment, physiological effects and control. Sampling and testing of different gases using different detectors including multi-gas detector.

UNIT-II
Mine climate: Sources of heat in mines, effects of heat and humidity in mines, testing methods and devices::psychometry, kata thermometer, control methods or improving of cooling power of mineair:Air conditioning basic vapor cycle, representative layout.

UNIT-III
Ventilation: necessity of ventilation, , different ventilation systems, principles on different basis and its related calculations, factors effecting selection ventilation system, mechanism of airflow through mine openings, Laws of airflow, resistance of airways, equivalentorifice, Distribution of air flow and control devices. Natural ventilation calculation of NVP, thermodynamic aspects, artificial aids to natural ventilation

UNIT-IV
Mechanical ventilation: different types of mine fans installation, operation details, applicability, limitations, efficiencies and characteristic, factors for effecting selection of mine fan, testing and output control of fans, operation of mine fans (Series and parallel).Fan laws, drives, Evasee, diffusers, booster fans, auxiliary ventilation. Reversal of air currents and controlled recirculation.

UNIT– V
Ventilation planning and design: .ventilation survey both quantity and pressure and related calculations. Mine ventilation design criteria and factors, Accessional, declensional, homotropal, anti –tropal ventilation plan. Central and boundary ventilation systems–layouts and comparisons. Standard of ventilation including permissible air velocities,
Ventilation layout for coal mining and metal mining. Calculation of air quantity and total mine head required for ventilatingamine. Introduction to Network analysis, Hardy–Cross method, Ventilation survey. Case study

TEXTBOOKS:
1) Elements of Mining Technology-Vol II-D. J. Deshmukh,9th Edition, Central Techno Publication
2) Mine Environment and Ventilation–G.B.Mishra, Oxford University Press,1994.

REFERENCE BOOKS:

1) Mine ventilation and air conditioning– owardL. Hartman. Wiley International,1976.
2) Environmental Engineering in Mines–Vutukuri & Lama, Cambridge University Press, Cambridge,
3) Legislation in Indian mines a critical appraisal Vol. I and Vol. II – Prasad and Rakesh.VivekPublications,Varanasi 1999.
4) Mine VentilationVol.–II,S.Ghatak,CoalfieldPublishers,1993.

Course Outcome: Familiar with mine ventilation systems, quantity and quality requirements, decide ventilation system and method and develop mine ventilation plan and layout for any given mine.

Minor	MINOR IN "MINE ENVIRONMENT" SURFACE MINE ENVIRONMENT	L	T	P	C
		3	0	0	3

Course objective: To gain knowledge about the environmental management, pollutions and their impact and environment legislations and laws.

UNIT – I
Introduction: Goals, strategies and tools for environmental management – systems approach to environmental management – environmental guideline – National Policies on environment with respects to mining activities – Global and Local environmental issues – resource degradation – desertification – Industrialization, Objectives of Sustainable Development. Structure of the atmosphere – ozone layer depletion – Acid rain – Green house gases and global warming Ambient Air quality and emission standards, Air quality Sampling and monitoring, Dispersion of air pollutants.

UNIT II
Environmental Pollution – I: Environmental Pollutants due to surface – Air, Water, Noise, Sources and Classification of pollutants including dust and their effect on human health, Sources, hazards, sampling and analysis, standards, instrumentation and measurement of pollutants including dust, Air born dust modeling, Control and preventive measures for air pollution including for dust, , Water pollution standards, Noise standards – Measurement – Noise Impact Index assessment, Control and preventive measures for water, noise pollution. Pollution due to blast and equipment vibrations their monitoring, prevention and control.

UNIT III
Environmental Pollution – II: Land pollution, land for alternation dealing with mind out land , re-vegetation, tailing management, tailing dams, method and construction, land use plan, Mine closure planning. Textural classification and properties of soil. Impact of pollution on human health, miner's diseases and their social impact.

UNIT IV
Environmental Management: Environmental quality objectives, Emission and ambient standards – Minimum National standards – International environmental standards – ISO 14000 – EIA Notification – Sitting of Industries – Environmental management plans, Environmental impact assessment, Environmental management system audits, Environmental economics – Principles of cost benefit analysis – Valuing the Environment – Environmental Accounting, Environmental administration- training awareness and competence, Mine subsidence, its prediction and control.

UNIT V:
Environmental Legislations: Environmental laws, the Environmental (Protective) Act, 2004, The Water Act (1974), The Air act (1981), The Forest Act 1927, The forest conservation act 1980, Power and responsibilities of regularity agencies and occupation consent to establish and operate wild life protection act and rules, Environmental clearance procedure for a mining Project.

TEXT BOOKS:
1) Manahan S.E. Environmental Science and Technology.
2) Mackenthun, K.M. Basic Concepts in Environmental Management, Lewis Publications, London, 1998.

REFERENCE BOOKS:
1) Noel de Nevers, Air Pollution Control Engg., McGraw Hill, New York, 1995
2) Anjaneyulu,Y. Air Pollution & Control Technologies, Allied Publishers (P) Ltd, India, 2002.
3) Nick Hanley, Jaison F. Shogren and Ben White. Environmental Economics – In Theory and Practice, Macmillan India Ltd, New Delhi, 1999.
4) Roger Perman, Yue Ma and James McGilvray. Natural Resources and Environmental Economics, Second edition, Addision Wesley Longman Ltd, Singapore, 1997.

Course outcome: Students will be able to utilize the knowledge about the environmental management, pollutions and their impact and environment legislations and laws.

Minor	MINOR IN "MINE ENVIRONMENT" SUSTAINABLE MINING	L	T	P	C
		3	0	0	3

Course objective: To create awareness about the concepts of sustainable development, environmental impact of mining, Socio-economic aspects, develop strategies and international regulations and standards.

Unit 1:
Introduction to Sustainable Development: Definition and history of sustainable development, The three pillars of sustainability: environmental, economic, and social, Sustainable development goals (SDGs) related to mining.

Unit2:
Introduction to Environmental Impact of Mining: Land degradation, deforestation, and biodiversity loss, Water pollution and management, Air pollution and dust control. Environmental impact assessment (EIA), Environmental management plans (EMP), Monitoring and mitigation strategies.

Unit 3:
Economic and Social Aspects of Sustainable Mining: Economic benefits and costs of mining activities, Mineral resource governance and policy frameworks, Local and global economic implications. Community engagement and social license to operate, Health and safety in mining communities.

Unit 4:
Developing Strategies for Sustainable Mining: Frameworks for integrating sustainability into mining operations,.

Unit 5:
National and international regulations and standards, Role of government and non-governmental organizations, Future trends and developments in mining policies

Text Books:
1) Azapagic, A., Perdan, S., & Clift, R., *Sustainable Development in Practice: Case Studies for Engineers and Scientists*, Wiley , 2004
2) Hilson, G., *The Socio-Economic Impacts of Artisanal and Small-Scale Mining in Developing Countries*, CRC Press , 2003

References:
1) Raj, K.S & Kartik C.R., *Sustainable Economic Development And Environment: India and Other Low Income Economies*, Atlatic Publishers & Distributors Pvt Ltd , 2008
2) Baleshwar, T., Rajiv, R.T, Srikumar, C., & Rajesh, K.A., *Resource Management, Sustainable Development and Governance*, Springer International Publishing , 2021

After the end of the course the student will be able to
CO 1. Describe the concepts of sustainable development.

CO 2. Illustrate the best practices of mining industry towards achieving sustainable development goals.

CO 3. Analyze the environmental, economic, and social impacts of mining activities.

CO 4. Identify and evaluate sustainable mining practices and technologies.

CO 5. Develop strategies for integrating sustainability into mining operations.

Minor	MINOR IN "MINE ENVIRONMENT" MINE HAZARDS AND RESCUE	L	T	P	C
		3	0	0	3

Course Objective: To make students conversant with mine fires, explosions, and their rescue and recovery.

Unit – I:
Mine Fires: Causes of mine fires; spontaneous combustion - mechanism, susceptibility indices, factors affecting spontaneous combustion; detection and prevention of spontaneous heating; accidental fires – causes and prevention; dealing with mine fires - direct and indirect methods, fire stopping: fires in quarries, coal stacks and waste dumps.

Unit – II:
Mine Explosions: Firedamp and coal dust explosions – mechanisms, causes and prevention; stone-dust and water barriers; investigations after an explosion.
Inundation : Causes and prevention, precautions and techniques of approaching old workings; safety boring apparatus, pattern of holes; design and construction of water dams, shaft dams, emergency bulk heads, strengthening of dams

Unit – III:
Rescue and Recovery: Rescue equipment and their uses, rescue stations and rescue rooms; organization of rescue and recovery areas, re-opening of sealed-off workings Illumination in mines- it's effect on safety, efficiency and health ; common types of safety lamps & their uses and limitations, maintenance and examination of lamps, their charging, cleaning, lighting, relighting ; lamp room

Unit – IV:
Design and organization: Lighting from mains – different types of illumination devices; illumination of pit bottoms. main roads, faces, pump houses and haulage rooms; standards of illumination in underground and opencast mines

Unit – V:
Airborne respirable dust in underground mines - generation, dispersion, measurement and control; classification, physiological effects, dust measurement, sampling of air-bone dust

Text Books
1) Mine Fires, Inundation and Rescue: M.A.Ramlu,The Orient Blackswan, 2018
2) Mine Illumination by Trotller, CRC Press, 1988.

References:
1) Spontaneous Combustion: S C Banerjee, Taylor & Francis, 2008.
2) Mine Fires: L C Kaku, Jaipur Oriental Pub. 1985.
3) Mine Fires: Mitchell, Maclean Hunter Publishing Company, 1990 .
4) Mine Ventilation and Air conditioning: Hartman, Wiley-Interscience, 1997.
5) Subsurface Ventilation and Environmental Engineering : McPherson,

Chapman and Hal, 1993.

Course Outcome: Students will be able to explain mine fires, explosions, and their rescue and recovery.

Minor	MINOR IN "MINE ENVIRONMENT" MINE CLOSURE AND RECLAMATION	L	T	P	C
		3	0	0	3

Course objective: To understand the basic concepts and the principles of mine closure and reclamation procedures along with CSR and environmental policies and laws.

UNIT – I
Recent changes in development paradigms; concepts of carrying capacity and sustainable development; environmental problems caused by mining and influencing factors. Environmental aspects of various Mining Machines.

UNIT – II
Land Degradation; land use categories; pre-mining investigations; landscape planning and visual impact; waste disposal, overburden dumps and tailings impoundment.

UNIT – III
Land reclamation procedures; Influence of type of deposit, topography and equipment; top soil characteristics; top soil removal and storage; application of mulches, stabilizing agents and fertilizers;
Land Reclamation: Re-vegetation and restoration methodologies; Plant species selection; Reclamation methods by using different combination of equipment, Case studies of coal and metalliferous mine dumps/spoils.

UNIT – IV
Physical and biological reclamation; afforestation of mine areas, tailing ponds, mine closure and amenity banks; best practices of mined out land reclamation.

UNIT – V
Corporate Social Responsibility towards mine closure and reclamation: Concepts and principles.
Environmental policies and laws: Environmental management systems, environmental impact assessment and environmental management planning; base line studies, environmental audit, ISO 14001, OHSAS.

TEXT BOOKS:
1) Dr. B.B. Dhar, Environmental Management of Mining Operations. Pub
2) Bulk Handling in Open Pit Mines & Quarries: Reinhard H.Wohlbier
3) Coal Mines Regulations, 1957 and Metalliferous Mines Regulations, 1961
4) Introductory Mining Engineering: Howard L. Hartman

REFERENCES:
1) Modern Coal Mining Technology: Samir Kumar Das
2) Opencast Mining – Technology and Integrated Mechanization: V.V. Rzhevsky
3) Opencast Mining – Unit Operations: V.V. Rzhevsky
4) SME Hand Books
5) Surface Mining : G.B. Misra
6) Surface Mining Technology: Samir Kumar Das

7) Proceeding of the National & International Seminars/Symposium organized in concern with mine environment

Course outcome: Students will be able to understand and apply the basic concepts and principles of mine closure and reclamation procedures along with environmental policies and laws.

Minor	MINOR IN "MINE ENVIRONMENT" MINE SAFETY & ERGONOMICS	L	T	P	C
		3	0	0	3

Course Objective: To create awareness among students about the mine safety and human factors and systems along with design.

Unit 1Mine accidents
Causes of Mine accidents, Recommendations of national safety conferences, Accident analysis, Zero harm potential, Accident investigation cases Mine disasters and court of enquiries, Case studies of mine disasters and accidents.

Unit II Safety Management Plan (SMP)
Hazard identification, Risk Assessment, Risk classification, Preparation of safety management plan, Control plan, Review and audit of SMP, Crisis management plan, Occupational health and safety in mines. Safety Education, and Training, Vocational Training Rules.

Unit III
Introduction to Human factors and systems.
Information Input: Information input and processing, Text, Graphics, Symbols, and Codes, Visual displays of dynamic information, Auditory, Tactual, and Olfactory displays, communications
Human Output and Control: Physical Work and Manual Materials Handling, Motor Skills, Human Control of Systems, Controls and Data Entry Devices, Hand Tools and Devices

Unit IV
Workplace Design:
Applied Anthropometry, Work-Space Design and Seating, Arrangement of Components within Physical Space, Interpersonal Aspects of Workplace Design.

Unit V Conditions & Applications
Environmental Conditions: Illumination, Climate, Noise, Motion Human Factors Applications: Human Error. Accidents, and Safety, Human Factors in Systems Design

Text books:
1) B. K. Kejriwal, Safety in Mines, Lovely Prakashan, 2002, Dhanbad
2) L.C. Kaku, A study of Mine Management, Legislation and general safety, Lovely Prakashan, 2020 , Dhanbad

References:
1) Human Factors in Engineering and Design, by Mark S. Sanders and Ernest J. McCormic, Tata McGraw-Hill & McGraw-Hill International Editions.
2) Human Factors Methods: A Practical Guide for Engineering and Design by Paul M. Salmon, Neville A. Ashgate Publishing, Ltd.
3) Ergonomics at Work by David J. Oborne, John Wiely & Sons Ltd.

4) Fitting the Task to the Man – A Text Book of Occupational Ergonomics by Taylor & Francis.
5) A Guide to the Ergonomics of Manufacturing by Martin Helender, Taylor & Francis.
6) Human Factors in Product Design by William H. Cushman and Daniel J. Rosenberg, Elsevier.

Course Outcome: Upon completion of course, students should be able to explain about mine safety and human factors and should be able to design the systems.

Minor	MINOR IN "MINE ENVIRONMENT" NOISE AND VIBRATION CONTROL	L	T	P	C
		3	0	0	3

Course Objective: To impart awareness of vibration, noise and harshness feeling has necessitated the valid design criterion in the design of machines, automobiles, buildings, industrial facilities, etc.

Unit 1
Vibration of structural systems. SDOF, 2-DOF, MDOF and continuous systems. Eigen values and vector estimation methods. Free and Forced vibration analysis. Torsional vibration and applications. Damping estimation methods Structural Vibration control elements: isolation, damping, balancing, resonators, absorption, barriers and enclosures.

Unit 2
Vibration and noise standards. NVH measurement tools and techniques. Modal parameter (natural frequency, mode shape and damping) estimation techniques. Signal and system analysis. Demonstration of vibration and noise experiments – beam, plates, impulse excitation, electro-dynamic shaker excitation, FFT analyzer, stroboscope and mode shape animation, sound level meter, microphones.

Unit 3
Vibration transfer function (VTF) and noise transfer function (NTF) Noise and its effects on man. Acoustic and sound field. Enclosures, shields and barriers-design. Silencer and suppression systems. Noise level interpolation and mapping. Harshness effects and measurements and solutions. NVH Parameters related to vehicle dynamics. Case studies discussion (vibration reduction in passenger car, tiller, tractors, steering column/wheel vibration diagnosis,

Unit 4
Modal analysis of Helicopter, Vibration diagnosis in diesel engine power plant, roto-dynamic analysis of DWR and tracking antenna and engine and compressor noise attenuation and vibration isolation, engine-compressor mount design, vibration diagnosis in power plants, gear shift harshness, newspaper printing cylinder vibration diagnosis, engine filter bracket dynamic analysis, noise reduction for mixer grinders, field audit of industrial chimney for wind induced vibration, stability studies of sports bike, aerodynamic stability derivatives of scaled model of aerospace vehicles)

Unit 5
Common borehole logging techniques such as video, resistivity, natural gamma, electromagnetic induction, 3-arm caliper, spontaneous potential, borehole deviation, and temperature can be deployed and interpreted quickly and cost effectively.

Text books:
1) Ewins, D.J." Modal analysis: Theory and Practice", Research Studies Press Ltd, England, 2014
2) Beranek, L.L," Noise and Vibration Control", Wiley, 2008.
3) David W. North, "Practical Wellbore Geophysics", Springer, 2002.

Reference Books:
1) Gillespie, T.D., "Fundamentals of Vehicle Dynamics", Society of Automotive Engr's., Inc, 2010.
2) Bruce A. Bolt, "Introduction to Borehole Geophysics", Springer, 1993.
3) Darrell M. Boylston, "Well Logging for Earth Scientists", Springer, 1992.
4) Harris, C.W" Shock and vibration handbook" McGraw Hill, New York, 2012.

Course Outcome: On completion of this course, students should be aware of vibration, noise and harshness feeling has necessitated the valid design criterion in the design of machines, automobiles, buildings, industrial facilities, etc.

Minor	MINOR IN "MINE ENVIRONMENT" ENVIRONMENTAL IMPACT ASSESSMENT &MANAGEMENT PLAN	L	T	P	C
		3	0	0	3

Course objective: To create awareness on the concepts of environmental impact and its assessment, acquisition of base line data, operational aspects and methods of EIA, prediction of impacts and environment management plan.

UNIT I: CONCEPTUAL FACTS OF EIA
Introduction, Definition and Scope of EIA, Objectives in EIA, Basic EIA Principles, Classification of EIA: Strategic EIA (SEIA), Regional EIA, Sectoral EIA, Project Level EIA and Life Cycle Assessment, Project Cycle, Grouping of Environmental Impacts: Direct Impacts, Indirect Impacts, Cumulative Impacts and Induced Impacts. Significance of Impacts: Criteria/Methodology to Determine the Significance of the Identified Impacts

UNIT II: BASELINE DATA ACQUISITION, PLANNING AND MANAGEMENT OF IMPACT STUDIES
Environmental Inventory, Data Products and Sources: thematic data, topographical data, collateral data and field data. Environmental Baseline Monitoring (EBM), Preliminary Study to determine impact significance, Environmental Monitoring network Design, Monitoring Stations, Air quality data acquisition, Water Quality data acquisition, soil data, socioeconomic data and biological data acquisition. Impact on Environmental Components: Significance of Impacts, Criteria to determine the significance of the identified Impacts. Conceptual Approach for Environmental Impact Studies, Proposal Development, Interdisciplinary Team Formations, Team Leader Selection and Duties, General Study Management, Fiscal Control

UNIT III: OPERATIONAL ASPECTS OF EIA AND METHODS FOR IMPACT IDENTIFICATION
Screening: Application for Prior Screening for Environmental Clearance, Screening Criteria; Category A Projects, Category B Projects, Criteria for Classification of Category B1 and B2 Projects, Consistency with other Requirements and Siting Guidelines. Scoping: Identification of Appropriate Valued Environmental Components (VEC), Identification of Impacts, Information in Form 1, Structure of a Prefeasibility Report. Public consultation: Appraisal, Decision Making, Post-clearance Monitoring Protocol. Background Information, Interaction-Matrix Methodologies: simple matrices, stepped matrices, development of a simple matrix, other types of matrices, summary observations on matrices, Network Methodologies: Checklist methodologies, simple checklists, descriptive Checklists, summary observations on simple and descriptive Checklists.

UNIT IV: PREDICTION OF IMPACTS (AIR-WATER- NOISE- BIOLOGICAL AND SOCIOECONOMIC)
a) Air Environment: Basic information on air quality, Sources of Pollutants, effects of pollutions, Conceptual approach for addressing air environment impacts, Air quality standards, Impact Prediction, Impact significance.
b) Water Environment: Basic Information on surface-Water Quantity and Quality, Conceptual Approach for Addressing Surface-Water-Environment Impacts, Identification of Surface-Water Quantity or Quality Impacts, Procurement of Relevant

Surface-Water Quantity-Quality Standards, Impact Predictions, Assessment of Impact Significance.

c) Noise Environment: Basic Information on Noise Key Federal Legislation and Guidelines, Conceptual Approach for Addressing Noise-Environment Impacts, Identification of Noise Impacts, Procurement of Relevant Noise Standards and/or Guidelines, Impact Prediction, Assessment of Impact Significance.

d) Biological Environment: Basic Information on Biological Systems, Conceptual Approach for Addressing Biological Impacts, Identification of Biological Impacts, Description of Existing Biological Environment Conditions.

e) Socio-Economic Environment: Procurement of Relevant Legislation and Regulations, Impact Prediction, Assessment of Impact Significance

UNIT V: ENVIRONMENTAL MANAGEMENT PLAN (EMP)

Case Study, identification of Impacts, EMP for Air Environment: Dust Control Plan, Procedural Changes, Diesel Generator Set Emission Control Measures, Vehicle Emission Controls and Alternatives, Greenbelt Development. EMP for Noise Environment, EMP for Water Environment: Water Source Development, Minimizing Water Consumption, Domestic and Commercial Usage, Horticulture, Storm Water Management. EMP for land Environment: Construction Debris, hazardous Waste, Waste from temporary Labour settlements.

Textbooks:
1) Textbook of Environmental Science & Technology by M.Anji Reddy, BS Publications, 2010 2.
2) Technological guidance manuals of EIA. MoEF.
3) Environmental Impact Assessment by Harry W. Canter, McGraw Hill, 1996, 2 nd edition

References:
1) Man and Environment D.H.Carson 1976 Interactions Part I and III.
2) Environmental Impact Assessment, 2003, Y.Anjaneyulu, B.S Publications
3) Erickson, P.A.1979 Environmental Impact Assessment Principles and applications
4) Basic Concepts in Remote Sensing & Arial Photogrammetry Lilles and Keifer. Prentice Hall Intl., 1994.
5) Renewable Energy: environment and development by Maheswar Dayal, Konark Publishers, 1989..

Course outcome: At the end of this course, students will be able to assess the environmental impact and its assessment, acquisition of base line data, operational aspects and methods of EIA, prediction of impacts and environment management plan.

Minor	MINOR IN "MINE ENVIRONMENT" MINE HAZARDS AND RESCUE LAB	L	T	P	C
		0	0	3	1.5

Course Objective: To experiment with various instruments and devices which are used in mines and to avoid mine hazards.

List of Experiments:
1) Study of constructional features & working of self contained breathing apparatus.
2) Study of various types of Fire Extinguishers used in Mines.
3) Study of constructional features & working of self Rescuer.
4) Study of constructional features & working of Gas Mask.
5) Study of constructional features & working of Reviving apparatus.
6) Study of working of Burn Side Safety Boring Machine.
7) Study of constructional features & working of Stone Dust Barriers.
8) Study of constructional features & working of Water barrier
9) Design of underground water dams
10) First aid training to be explained and conducted.
11) Emergency organization in underground mines

TEXT & REFERENCE BOOKS:
1) P.Seshagiri Rao, Law of Mines & Minerals. Pub: Asia Law House, Hyderabad
2) Rakesh & Prasad, Legislation in Indian Mines Vol. I & II. Pub:Mrs. Asha Lata Varanasi
3) Classified Mine Circulars Issued by DGMS (Compiled)
4) Relevant Act, Rules and Regulations, Published by Govt. of India
5) Elements of Mining Technology Vol-2, D. J. Deshmukh
6) Mine Disasters and Mine Rescue – M.A. Ramlu, Oxford & IBH, New Delhi.
7) Hand book on First Aid, Published by Multi Disciplinary Centre on Safety, Health & Environment, Bhubaneswar
8) Mine Safety & Legislation, by S.K.Das, Lovely Prakashan, Dhanbad.

Course Outcome: Students will be to distinguish various instruments and devices which are used in mines and apply the knowledge to avoid mine hazards.

Minor	MINOR IN "MINE ENVIRONMENT" MINE VENTILATION LAB	L	T	P	C
		0	0	3	1.5

Course objective: To be familiar with detection of different gases using deferent methods detectors and multi gas detector, to find flammable index of coal dust and understand the rescue and recovery operations using different rescue apparatus.

List of experiments:

1. Determination of CO, CH4, H2S, SO2,O2,CO2,Nitrous fumes by corresponding detectors.

2. Study and application of infrared gas analyzer.

3. Detection of different gases by Gas–Chromatograph

4. Detection of methane by different types of methanolmeters.

5. Determination of various gases by flame safety lamp.

6. Determination index of flammability of coal dust.

7. Study and uses of proto–IV, Proto–V. Dragger–BG–174self-contained breathing apparatus

8. Study and uses of Self-rescuer Gas mask, smoke helmet.

9. Study and use of reviving apparatus

10. Study of Born-Side safety boring apparatus.

Course outcome: The student will familiar with rescue and recovery operations from different disasters in mines.

HONORS

Honors	**SURFACE MINE PLANNING AND DESIGN**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objective: Students will be able to learn the concepts related to mine life, production planning, design of blast, high wall slopes, waste dumps along with computer applications.

UNIT-I Introduction:
Stages/Phases of mine life; Preliminary evaluation of surface mining prospects; Mine planning and its importance; Mining revenues and costs, and their estimation; Mine planning components, planning steps and planning inputs. Pit Planning: Development of economic block model; Pit Cut-off grade and its estimation; Ultimate pit configuration and its determination – hand method, floating cone technique, Lerchs-Grossmann algorithm, and computer assisted hand method. Planning: Open-pit optimization techniques for mine geometry and output, mine development phases, quality control and conservation. Output and manpower planning; calendar planning, mine scheduling, production scheduling. Feasibility Report - Contents and preparation.

UNIT-II Production planning:
Determination of optimum mine size and Taylor's mine life rule; Sequencing by nested pits; Cash flow calculations; Mine and mill plant sizing, Lanes algorithm for estimation of optimum mill cut of grade; Introduction to production scheduling. Equipment management: Selection of mining system vis-à-vis equipment system. Machine availability, productivity, maintenance, maintenance scheduling, preventive maintenance, control and monitoring inventory. Workshops for HEMM. Power supply arrangements in opencast mines.

UNIT-III Blast Design:
Large dia holes, small dia holes, deep hole blasting, fragmentation, throw, noise, fly rock and dust. Blast patterns for various blasts, dragline blasting, monitoring of the blast undesired effects and controlling techniques.

UNIT-IV Design of highwall slopes and waste dumps:
Influence of pit slope on mine economics; Highwall slope stability analysis and design methodology; Stability analysis and design methodology for waste dumps. Design of haul roads: Design of road cross section; Design of road width, curves and gradient; Haul road safety features and their design. Design of drainage system

UNIT - V Recent advances in surface mine:
Drilling, Blasting, Loading and Transport Operations. Selective extraction and dumping. Extraction of seams developed/extracted by underground methods. Highwall mining. Computer applications in surface mine: Design of pit, Internal dump and external dump and embankments and others.

Text Books:
1) Cummings AB and Given IV. SME mining engg. hand book volume I and II, New York. 1994.
2) Das SK. Surface mining technology. Lovely prakashan, Dhanbad. 1994.

References:

1) Das SK. Modern coal mining technology. Lovely prakashan, Dhanbad. 1994.
2) Hustrulid W and Kuchta M. Fundamentals of open pit mine planning and design, Elsevier. 1995.

Course Outcome: On completion of this course, students will be explain the concepts related to mine life, production planning, design of blast, highwall slopes, waste dumps along with computer applications.

Honors	ADVANCED EXPLORATION TECHNIQUES	L	T	P	C
		3	0	0	3

Course objective: The aim of this course is to gain knowledge about the ore deposits, geophysical exploration techniques, geological settings for deposits, underground sampling, hydrocarbon indicators.

Unit 1
Distribution of ore deposits in space and time; stages of exploration and objectives; prospecting criteria and selection of areas for exploration during reconnaissance and initial follow-up;

Unit 2
Introduction to geophysical exploration techniques, gravity and magnetic methods, principles and methods of gravity and magnetic prospecting, Modern borehole logging techniques such as Gamma Ray logging technique, Electromagnetic induction, etc.

Unit 3
Geological setting and prospecting criteria for important deposits; petroleum resources, gold deposits, massive sulfide deposits, porphyry copper deposits;

Unit 4
Underground sampling and calculation of blocked reserves; seismic exploration theory and geometry of seismic waves, seismic sources and equipment, reflection and refraction field method, seismic stratigraphy, seismic interpretation,

Unit 5
Hydrocarbon indicators, resistivity methods; well logging techniques and data processing, applications and limitations of various geophysical techniques in solving geological, hydrogeological, geotechnical, and environmental problems, with an emphasis on mineral and hydrocarbon exploration

Text Books:
1) Moon, C.J., Whateley, M.K., Evans, G., 2006. Introduction to Mineral Exploration, Blackwell Science, Oxford.
2) Telford, W.M., Geldart, L.P., Sheriff, R.E., 1990. Applied Geophysics, Cambridge University Press, Cambridge.
3) Peters, W.C., 1987. Exploration and Mining Geology, 2nd Edition, John Wiley & Sons, New York.
4) Chugh, C.P., 1992. High Technology in Drilling and Exploration, Oxford & IBH, New Delhi.
5) Sheriff, R.E., Geldart, L.P., Exploration Seismology, Cambridge University Press, Cambridge.

Course Outcome: Upon completion of this course students will be able to describe the concepts of ore deposits, geophysical exploration techniques, geological settings for deposits, underground sampling, hydrocarbon indicators.

Honors	**MINE SAFETY & ERGONOMICS**	L	T	P	C
		3	0	0	3

Course Objective: To create awareness among students about the mine safety and human factors and systems along with design.

Unit 1Mine accidents
Causes of Mine accidents, Recommendations of national safety conferences, Accident analysis, Zero harm potential, Accident investigation cases Mine disasters and court of enquiries, Case studies of mine disasters and accidents.

Unit II Safety Management Plan (SMP)
Hazard identification, Risk Assessment, Risk classification, Preparation of safety management plan, Control plan, Review and audit of SMP, Crisis management plan, Occupational health and safety in mines. Safety Education, and Training, Vocational Training Rules.

Unit III
Introduction to Human factors and systems.
Information Input: Information input and processing, Text, Graphics, Symbols, and Codes, Visual displays of dynamic information, Auditory, Tactual, and Olfactory displays, communications
Human Output and Control: Physical Work and Manual Materials Handling, Motor Skills, Human Control of Systems, Controls and Data Entry Devices, Hand Tools and Devices

Unit IV Workplace Design:
Applied Anthropometry, Work-Space Design and Seating, Arrangement of Components within Physical Space, Interpersonal Aspects of Workplace Design.

Unit V Conditions & Applications
Environmental Conditions: Illumination, Climate, Noise, Motion
Human Factors Applications: Human Error. Accidents, and Safety, Human Factors in Systems Design

Text books:
1) B. K. Kejriwal, Safety in Mines, Lovely Prakashan, 2002, Dhanbad
2) L.C. Kaku, A study of Mine Management, Legislation and general safety, Lovely Prakashan, 2020 , Dhanbad

References:
1) Human Factors in Engineering and Design, by Mark S. Sanders and Ernest J. McCormic, Tata McGraw-Hill & McGraw-Hill International Editions.
2) Human Factors Methods: A Practical Guide for Engineering and Design by Paul M. Salmon, Neville A. Ashgate Publishing, Ltd.
3) Ergonomics at Work by David J. Oborne, John Wiely & Sons Ltd.
4) Fitting the Task to the Man – A Text Book of Occupational Ergonomics by Taylor & Francis.

5) A Guide to the Ergonomics of Manufacturing by Martin Helender, Taylor & Francis.
6) Human Factors in Product Design by William H. Cushman and Daniel J. Rosenberg, Elsevier.

Course Outcome: Upon completion of course, students should be able to explain about mine safety and human factors and should be able to design the systems.

Honors	ADVANCED COAL AND METAL MINING	L	T	P	C
		3	0	0	3

Course objective: To gain knowledge about advanced concepts of coal and metal mining such as Bord and Pillar methods, Long wall method, Development of metal mine, stoping methods and special methods in coal and metal mining.

UNIT - I
Bord and Pillar Method: Design and development of a district / panel, sizes and shapes of galleries and pillars, bord and pillar, room and pillar methods, development of panel with semi mechanized equipment like LHD, SDL, Gathering Arm Loader with shuttle car and continuous miner. Pillar extraction by caving and stowing methods; mechanized extraction of pillars, shaft pillar extraction, systematic supports, surface, underground and face arrangements for stowing. Partial extraction.

UNIT- II
Long wall Method: Longwall advancing and retreating methods, development of panel, extraction of coal longwall mining with different machines-plough and shearer, design of longwall workings-optimum length of face, size of panel, gates, support system, personnel, organization and safety measures, salvaging and relocations of equipment.

UNIT - III
Development of Metal Mine: Mode of mine and stope entry; Layouts; Determination of optimum production level; sequence of extraction, production scheduling; Basic design – Level Intervals, ore pass, common ore pass, size of blocks ore handling in stope and other openings, overview of constructional features – X cuts, Raises, Winzes etc. equipment selection, production cycle; unit cost calculation.

UNIT - IV
Stoping Methods: Unsupported methods – Stope and pillar, room and pillar, shrinkage, sublevel stoping etc. supported stoping– cut and fill, stull, square set, rill, etc. caving methods – Top slicing, sublevel caving, block caving. VCR; Ring drilling; Large Blast hole stoping. Case studies of Indian and foreign underground metal mines. comparison of various methods of stoping and costs.

UNIT - V
Special methods for metal: Hydraulic mining, slurry mining, solution mining, nuclear mining; Rapid excavation; Radial – axial splitter; Thermal fragmentation; shock wave breaking; Deep mining; narrow contiguous veins; shaft and remnant pillars.
Special Methods for coal: Sublevel caving, Horizon mining, blasting gallery method, working of contiguous seams, working steeply inclined seams, working under surface structures and seams liable to spontaneous heating, outburst and bumps, etc. Hydraulic mining, Wongawalli mining method, shortwall, underground coal gasification, coal bed methane, shield mining; Thick seam mining methods- slice mining methods- Inclined slice mining with mechanized longwall mining.

TEXT BOOKS:
1) Principles and Practices of Modern Coal Mining, Singh, R.D. New Age International (P) Ltd., Chennai, 1994.
2) Longwall Mining, Peng S.S., and Chiang, H.S., John Willey and Sons, New York, 1992.
3) Introductory Mining Engineering, Hartman, H.L., John Wiley and Sons, New York, 1987.
4) Underground Mining Methods Handbook Society of Mining Engineering, Hustrulid, W.A. Ed., AMIE, New York, 1990.

REFERENCE BOOKS:
1) Underground Winning of Coal – Singh, T.N. Singh, Oxford & IBH Publishing Co. Ltd.,1992.
2) Coal Mining in India, Mathur, S.P., M.S. Enterprises, Bilaspur, 1999.
3) Modern Coal Mining Technology Das S.K., Lovely Prakashan, Dhanbad 1994.
4) Thick Seam Mining, Problems and Issues, Singh T.N., Dhar, B.B. Oxford & IBH Publishers, 1992.
5) Mining Planning for Coal., Mathur, S.P., M.G. Consultants, Bilaspur, 1993.
6) Underground Mining Methods and Technology, Szwilski and Richards M.J., 1987.
7) Internet: www.miningindia.com.
8) Gold mining in Witwatersrand, The Transvaal chamber of mines, Volume I, II, BICCARD J C, 1946.
9) SME Mining Engineering Handbook, 3rd edition, Vol I & II, Hartman, H. L. (Editor), Society of Mining Engineers, New York, 2011.

Course outcome: On completion of this course, students will be able to explain and implement advanced concepts of coal and metal mining such as Bord and Pillar methods, Longwall method, Development of metal mine, stoping methods and special methods in coal and metal mining.

Honors	**GEO-INFORMATICS**	L	T	P	C
		3	0	0	3

Course Objective: The aim of this course is to create awareness among students about the concepts of Geoinformatics, acquiring the geodata, visualization, analysis and applications.

Unit 1
Meaning and Scope of Geoinformatics–Science and Technologies involved: Cartography- Geodesy- Geology- Remote Sensing- Geographical Information System Photo grammetry - Information & Communication Technologies- Global Positioning System- Digital Image Processing - Map as decision tool.

Unit 2
Geodata: Earth – Origin, Interior, Age, size, shape and Physiography of the Earth - Sources and methods of acquiring geodata Atmosphere: Origin and nature, Composition and layers of the atmosphere. Fundamental principles of acquiring earth related information: geodetic information - lat - long - time - altimetry – bio-physical and bio-chemical information.

Unit 3
Basic principles of surveying – Classification and applications- Scales - Conventional signs - Survey instruments, their care and adjustment - traversing, trilateration and triangulation - conventional, electronic (total station) - Aerial and Satellite based survey techniques (Photogrammetry, RADAR, LiDAR) - Survey by GPS.

Unit 4
Geodata visualization and analysis - two – three – fourth dimension viewing - viewing by animation - Visualization by hyper map - virtual images – web GIS.

Unit 5
Application of Geoinformatics: Rural Development, Geosciences, Agriculture, Forestry, Soil Studies, Meteorology, Military, Transport, Environmental studies, Banking and Health Civil Engineering etc.

Text Book:
1) LO. C.P., and Albert K.W.Yeung, Concepts and Techniques of Geographic Information Systems, Prentice-Hall of India, New Delhi, 2006.

Reference Books:
1) Peter A. Burrough and Rachael A. Mc. Donnell, Principles of Geographical Information System, Oxford University Press Inc., New York, 2004.
2) Ian Heywood, Sarah Cornelivs and Steve Carver, An Introduction to Geographical Information System, Pearson Education Pvt .Ltd., New Delhi, 2007.
3) Arthur H. Robinson et al. Elements of Cartography, V Edition, John Wiley & Sons, New Delhi, 2002.
4) Misra, R.P.and Ramesh, A, Fundamentals of Cartography, Concept Publishing Company, New Delhi, 2002.
5) Lillesand M. Thomas and Ralph W.Kiefer, Remote Sensing and Image Interpretation, John Wiley & Sons, New York, 2007.

Honors	ADVANCED ROCK ENGINEEERING	L	T	P	C
		3	0	0	3

Course Objective: The aim of this course is to provide a comprehensive understanding of physio-mechanical properties of intact rock, rock masses, failure criteria, rock discontinuities, deformations around the excavation, in-situ stresses, and its measurement.

Unit 1: Introduction
Concept, Scope, field of application & its relationship with other subjects, Index properties of rock materials and its laboratory determination: porosity, density, permeability, specific gravity, hydraulic conductivity, strength, slaking and durability, sonic velocity as an index to degree of fissuring, hardness, elasticity, and stress-strain coefficient.

Unit 2: Rock Mass classification
Intact rock classification: rock material, classification of rock material, class I and II rocks, Uniaxial compression, stability in water, classification based on Slake durability Index, Classification of Rock masses: Rock Quality Designation (RQD) and its measurement, Terzaghi's Rock Load Theory, Modified Terzaghi's Theory for tunnels and Caverns, Rock Mass Rating (RMR), Rock Mass Quality (Q-System), Rock Mass Number, Rock Mass Index, Geological Strength Index (GSI).

Unit 3: Rock Slopes Engineering
Strength of Discontinuities: Joint Wall Roughness Coefficient, Joint Wall compressive strength, Joint Matching Coefficient, Internal Friction Angle, Shear Strength, Shear Strength of Rock Masses in Slopes (Mohr-Coulomb Yield Criterion, Drucker-Prager Criterion, Hoek-Brown Criterion, Tensile Yield Criterion, Mohr's Coulomb strength parameters, Non-linear failure envelops), Types of Rock Slope failure (Planar, 3D wedge, circular, toppling failure), Effect of Height and Groundwater Condition on Safe Slope Angle, Slope Mass Rating (SMR), Kinematic Analysis of Slopes, Landslide Hazard Zonation (Landslide hazard zonation maps-The methodology, A case study).

Unit 4: In-situ Stresses
In- situ stresses, need for in-situ stress measurement, classification of geological conditions and stress regimes, variation of in-situ stresses with depth.

Unit 5: Tunneling
Tunnels- types, investigations for tunnel alignment, tunnel support design, tunnel linings, TBM, problems due to underground water and fault-shear zones, tunneling in hard and soft grounds, Rate of Tunneling, Strength enhancement of Rock mass in Tunnels (causes of strength enhancement, reason for strength enhancement in Tunnels and suggested new failure theory), Case study.
Miscellaneous: Allowable Bearing Pressure for Building Foundation, Rock Drillability, Method of Excavation, Rock Bolting, Gouge Material.

TEXT BOOKS:
1) Bieniawski, Z. T. (1989): Engineering Rock Mass Classification, John Wiley. • Goodman, R.E. (1980): Introduction to rock mechanics.

2) Jagger, J. C. and Cook, N. G. W. (1979): Fundamental of rock Mechanics, Champman & Hall.

REFERENCES:
1) Bell, F. G. (1999): Geological Hazards, Routledge, London.
2) Bieniawski, Z. T. (1989): Engineering Rock Mass Classification, John Wiley.
3) Goodman, R.E. (1980): Introduction to rock mechanics.

Course Outcome: Upon completion of course, students will be able to explain physio-mechanical properties of intact rock, rock masses, failure criteria, rock discontinuities, deformations around the excavation, in-situ stresses, and its measurement along with tunneling.

Honors	**NUMERICAL METHODS IN GEOMECHANICS**	L	T	P	C
		3	0	0	3

Course Objective :The course is taught with the objectives of enabling the student to study the finite element methods and finite difference methods and to understand the practical applications of numerical methods in mining field.

Unit - I
INTRODUCTION TO ELASTIC AND PLASTIC MODELS PRACTICAL APPLICATIONS IN MINING
Fundamentals, elastic, plastic, homogeneous and isotropic, non-linear elastic and elastoplastic models. Need for numerical modelling in design of excavations in mines; Domain and boundary conditions; Discretisation of domain and boundary; Methods of numerical simulation for excavations in mining. Practical Applications in stress analysis, slope and dump stability, pillar design.

Unit - II
INTRODUCTION TO FINITE DIFFERENCE METHODS
Concept, formation of mesh element, finite difference patterns, solutions, application to mining. Commercial Software for application in mining.

Unit - III
APPLICATION OF FINITE DIFFERENCE METHODS
Explicit finite difference method; Finite difference equation; Mechanical damping, mechanical time-step determination, solution stability, advantages and their limitations. Non-linear solution methods Introduction to Numerical Modelling Packages: Strand – 7 and FLAC.

Unit - IV
INTRODUCTION TO FINITE ELEMENT METHODS
Concept, discretisation, element configuration, element stiffness, Assembling elements to form a structural stiffness matrix; Imposing boundary conditions and solving structural equations Elements on assumed displacements, constant strain triangle, isoperimetric formulation.

Unit - V
APPLICATION OF FINITE ELEMENT METHODS
Advantages and their limitations, two and three dimensional solutions, linear and non-linear analysis, applications in geomechanics; simulation of joints in strata. Commercial Software for application in mining.

TEXT BOOKS:
1) Desai, C.S. and Abel, J.F., Introduction to the finite Element Method, Van NostrandRiehokl Co., New York, 1983.
2) Zienkiewicz, O.C., The Finite Element Method in Engineering Science, Tata McGraw Hill 1972.

REFERENCES:
1) Segerlind, L.J., Applied Finite Element Analysis, John Wiley and Sons, New York, 1987.
2) Mukhopadyay, M., Matrix Finite Element – Computer and Structural Analysis, Oxford and IBH Publishing co., 1984.
3) Brown, E.T., (Ed) Analytical and Computational Methods in Engineering and Rock Mechanics, Allen and Unwin, London, 1987.

Course Outcome : On completion of this course, the students will be able to explain and implement the concepts of finite element models, methods and finite difference method and its practical applications in mining.

Honors	**ADVANCED MINE SURVEYING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objective: The objective of the course is to introduce different types of modern survey equipment and methods for precision survey.

UNIT 1: **Remote sensing**
Remote sensing, Photogrammetry, satellite imaging, GIS application to mining, Computer aided drawings of plans and section.

UNIT 2: **Advances in Surveying Instrumentation**
GPS & DGPS, Principle, operation, application to mine survey and face monitoring. Laser profilers, EDM, Total Station, principle, techniques and application in mines.

UNIT 3: **Underground Surveying**
Methods of correlation - direct traversing in inclined shaft, correlation in vertical, single and two shafts.Gyrotheodolite & its application. Stope Surveying: Purpose, methods of survey in moderately and steeply inclined ore bodies, flat and vertical ore bodies/seams. Relevant provisions and requirements as per the Regulations. Subsidence survey.

UNIT 4: **Opencast surveying**
Slope monitoring Survey, Bench & Ramp Layout survey, Joint boundary survey, Problems based on Dip-Strike, boreholes, faults, Area and Volume calculations. Relevant provisions and requirements as per the Regulations.

UNIT 5: **National Grid**
Map Projections; Cassini, Lambert's Polyconic, UTM, transformation of coordinates. Geodesy: Geoid, spheroid and ellipsoid, geocentric, geodetic and astronomical coordinates, orthometric and dynamic heights.

Text books
1. Ghatak, S., Mine Surveying and Levelling – Vol I, II & III, Coal Field Publishers, Asansol, 2005
2. Punmia, B. C., Surveying Vol- I & II, Laxmi Publishers, New Delhi, 2008.
3. Kanetkar, T.P., Suveying, Vol- I & II, Tata McGraw Hill, New Delhi, 2007

Reference Books
1) Fundamentals of Remote Sensing, by George Joseph &C. Jeganathan, 3rd Edition
2) Advanced Surveying: Total Station, GPS, GIS & Remote Sensing by Pearson, by Gopi Satheesh, R. Sathikumar, N. Madhu, 2 nd Edition

Course Outcome: Students will be able to explain and utilize different types of modern survey equipment and methods for precision survey.

Honors	**MINING GEOMECHANICS LAB**	L	T	P	C
		0	0	3	1.5

Course Objective: To identify minerals, rocks, ores and geological structures and to learn geological mapping, remote Sensing.

List of experiments:

1) Identification and physical properties of important rock-forming and ore-forming minerals.
2) Identification and distinguishing characteristics of important igneous, sedimentary and metamorphic rocks.
3) Determination of strike and dip of planar features using brunton compass.
4) Study of models pertaining to folds, faults and unconformities.
5) Study and interpretation of Topographic Maps.
6) Study of Geological Maps of Telangana, Andhra Pradesh & India.
7) Study of Geomorphologic Map of India and Tectonic Map of India.
8) Study of Seismotectonic Atlas of India.
9) Vertical Electrical Sounding Survey to determine depth to water table & bed rock.
10) Determination of strike and dip of the deposits.

Course Outcomes: At the end of the course, students will be able to:
1) Identify the properties of rock forming and ore forming minerals
2) Determine the strike and dip planar features by clinometer compass. Mine Surveying
3) Identify the folds, faults and unconformities
4) Knowledge of geology mapping
5) Determine the unconfined compressive strength of important rocks, techniques and geophysical methods

Honors	COMPUTER APPLICATIONS IN MINING ENGINEERING LAB	L	T	P	C
		0	0	3	1.5

Course Objective: To gain knowledge in design and analysis of various mining systems using software.

List of Experiments
1) LEM: Stability analysis of a highwall slope using limit equilibrium method.
2) LEM: Stability analysis of a dump slope using limit equilibrium method.
3) LEM: Design of a highwall slope using limit equilibrium method.
4) LEM: Design of a dump slope using limit equilibrium method.
5) FEM: Stability analysis of pillars of coal mine using numerical modelling.
6) FEM: Design of pillars of coal mine using numerical modelling.
7) FEM: Stability analysis of stope pillars of metal mine using numerical modelling.
8) FEM: Design of stope pillars of metal mine using numerical modelling.
9) FEM: Design of support system for underground mine using numerical modelling.
10) Design of a ventilation system for coal mine using VENTSIM software.
11) Design of a ventilation system for metal mine using VENTSIM software.
12) FEM: Prediction of subsidence for long wall panel of coal mine.
13) FEM: Prediction of subsidence for bord and pillar panel of coal mine.
14) FEM: Prediction of subsidence for sublevel caving of metal mine.
15) FEM: Prediction of subsidence for cut and fill method of metal mine.
16) Design of safe explosive charge for opencast coal mine.

Course Objective: On completion of this course, students will be able to design and analysis of various mining systems using software.