B. Tech – II Year I Semester

S.No.	Category	Title	L	T	P	Credits
1	BS	Numerical Methods and Transform Techniques	3	0	0	3
2	HSMC	Universal human values – understanding harmony and Ethical human conduct	2	1	0	3
3	Engineering Science	Engineering Geology	3	0	0	3
4	Professional Core	Development of Mineral Deposits	3	0	0	3
5	Professional Core	Mine Surveying	3	0	0	3
6	Professional Core	Mine Surveying Lab	0	0	3	1.5
7	Professional Core	Engineering Geology Lab	0	0	3	1.5
8	Skill Enhancement Course	Soft Computing and Applications Lab	0	1	2	2
9	Audit Course	Environmental Science	2	0	0	-
Total			**16**	**2**	**8**	**20**

B. Tech – II Year II Semester

S.No.	Category	Title	L	T	P	Credits
1	Management Course- I	Managerial Economics and Financial Accountancy	2	0	0	2
2	Engineering Science/Basic Science	Complex Variables, Probability and Statistics	3	0	0	3
3	Professional Core	Rock Mechanics	3	0	0	3
4	Professional Core	Mine Ventilation	3	0	0	3
5	Professional Core	Fluid Mechanics and Hydraulic Power	3	0	0	3
6	Professional Core	Rock Mechanics Lab	0	0	3	1.5
7	Professional Core	Mine Ventilation Lab	0	0	3	1.5
8	Skill Enhancement Course	Fluid Mechanics and Hydraulic Power lab	0	1	2	2
9	Engineering Science	Design Thinking & Innovation	1	0	2	2
Total			**15**	**1**	**10**	**21**
Mandatory Community Service Project Internship of 08 weeks duration during Summer Vacation						

II Year I Semester

L	T	P	C
3	0	0	3

NUMERICAL METHODS AND TRANSFORM TECHNIQUES

Course Objectives:

- To elucidate the different numerical methods to solve nonlinear algebraic equations
- To disseminate the use of different numerical techniques for carrying out numerical integration.
- To furnish the learners with basic concepts and techniques at plus two level to lead them into advanced level by handling various real world applications.

Course Outcomes:

1. Evaluate the approximate roots of polynomial and transcendental equations by different algorithms. Apply Newton's forward & backward interpolation and Lagrange's formulae for equal and unequal intervals (L3)
2. Apply numerical integral techniques to different Engineering problems. Apply different algorithms for approximating the solutions of ordinary differential equations with initial conditions to its analytical computations (L3)
3. Apply the Laplace transform for solving differential equations (L3)
4. Find or compute the Fourier series of periodic signals (L3)
5. Know and be able to apply integral expressions for the forwards and inverse Fourier transform to a range of non-periodic waveforms (L3)

UNIT – I: Iterative Methods:

Introduction – Solutions of algebraic and transcendental equations: Bisection method – Secant method – Method of false position – Iteration method – Newton-Raphson method (Simultaneous Equations)

Interpolation: Newton's forward and backward formulae for interpolation – Interpolation with unequal intervals – Lagrange's interpolation formula

UNIT – II: Numerical integration, Solution of ordinary differential equations with initial conditions:

Trapezoidal rule– Simpson's $1/3^{rd}$ and $3/8^{th}$ rule– Solution of initial value problems by Taylor's series– Picard's method of successive approximations– Euler's method –Runge-Kutta method (second and fourth order) – Milne's Predictor and Corrector Method.

UNIT –III: Laplace Transforms:

Definition of Laplace transform - Laplace transforms of standard functions – Properties of Laplace Transforms – Shifting theorems–Transforms of derivatives and integrals – Unit step

function – Dirac's delta function – Inverse Laplace transforms – Convolution theorem (with out proof).

Applications: Solving ordinary differential equations (initial value problems) and integro differential equations using Laplace transforms.

UNIT – IV: Fourier series:

Introduction– Periodic functions – Fourier series of periodic function –Dirichlet's conditions – Even and odd functions –Change of interval– Half-range sine and cosine series.

UNIT – V: Fourier Transforms:

Fourier integral theorem (without proof) – Fourier sine and cosine integrals – Infinite Fourier transforms – Sine and cosine transforms – Properties– Inverse transforms – Convolution theorem (without proof) – Finite Fourier transforms.

Text Books:

1. **B. S. Grewal,** Higher Engineering Mathematics, 44th Edition, Khanna Publishers.
2. **B. V. Ramana,**Higher Engineering Mathematics, 2007 Edition, Tata Mc. Graw Hill Education.

Reference Books:

1. **Erwin Kreyszig,**Advanced Engineering Mathematics, 10th Edition, Wiley-India.
2. **Steven C. Chapra,** Applied Numerical Methods with MATLAB for Engineering and Science,Tata Mc. Graw Hill Education.
3. **M. K. Jain, S.R.K. Iyengar and R.K. Jain,** Numerical Methods for Scientific and Engineering Computation, New Age International Publications.
4. **Lawrence Turyn,**Advanced Engineering Mathematics, CRC Press.

II Year – I Semester

L	T	P	C
2	1	0	3

UNIVERSAL HUMAN VALUES – UNDERSTANDING HARMONY AND ETHICAL HUMAN CONDUCT

Course Objectives:

- To help the students appreciate the essential complementary between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.
- To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way.
- To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behaviour and mutually enriching interaction with Nature.

Course Outcomes:

- Define the terms like Natural Acceptance, Happiness and Prosperity (L1, L2)
- Identify one's self, and one's surroundings (family, society nature) (L1, L2)
- Apply what they have learnt to their own self in different day-to-day settings in real life (L3)
- Relate human values with human relationship and human society. (L4)
- Justify the need for universal human values and harmonious existence (L5)
- Develop as socially and ecologically responsible engineers (L3, L6)

Course Topics

The course has 28 lectures and 14 tutorials in 5 modules. The lectures and tutorials are of 1-hour duration. Tutorial sessions are to be used to explore and practice what has been proposed during the lecture sessions.

The Teacher's Manual provides the outline for lectures as well as practice sessions. The teacher is expected to present the issues to be discussed as propositions and encourage the students to have a dialogue.

UNIT I Introduction to Value Education (6 lectures and 3 tutorials for practice session)

Lecture 1: Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education)
Lecture 2: Understanding Value Education
Tutorial 1: Practice Session PS1 Sharing about Oneself

Lecture 3: self-exploration as the Process for Value Education
Lecture4: Continuous Happiness and Prosperity – the Basic Human Aspirations
Tutorial 2: Practice Session PS2 Exploring Human Consciousness
Lecture 5: Happiness and Prosperity – Current Scenario
Lecture 6: Method to Fulfill the Basic Human Aspirations
Tutorial 3: Practice Session PS3 Exploring Natural Acceptance

UNIT II Harmony in the Human Being (6 lectures and 3 tutorials for practice session)
Lecture 7: Understanding Human being as the Co-existence of the self and the body.
Lecture 8: Distinguishing between the Needs of the self and the body
Tutorial 4: Practice Session PS4 Exploring the difference of Needs of self and body.
Lecture 9: The body as an Instrument of the self
Lecture 10: Understanding Harmony in the self
Tutorial 5: Practice Session PS5 Exploring Sources of Imagination in the self
Lecture 11: Harmony of the self with the body
Lecture 12: Programme to ensure self-regulation and Health
Tutorial 6: Practice Session PS6 Exploring Harmony of self with the body

UNIT III Harmony in the Family and Society (6 lectures and 3 tutorials for practice session)
Lecture 13: Harmony in the Family – the Basic Unit of Human Interaction
Lecture 14: 'Trust' – the Foundational Value in Relationship
Tutorial 7: Practice Session PS7 Exploring the Feeling of Trust
Lecture 15: 'Respect' – as the Right Evaluation
Tutorial 8: Practice Session PS8 Exploring the Feeling of Respect
Lecture 16: Other Feelings, Justice in Human-to-Human Relationship
Lecture 17: Understanding Harmony in the Society
Lecture 18: Vision for the Universal Human Order
Tutorial 9: Practice Session PS9 Exploring Systems to fulfil Human Goal

UNIT IV Harmony in the Nature/Existence (4 lectures and 2 tutorials for practice session)
Lecture 19: Understanding Harmony in the Nature
Lecture 20: Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature
Tutorial 10: Practice Session PS10 Exploring the Four Orders of Nature
Lecture 21: Realizing Existence as Co-existence at All Levels
Lecture 22: The Holistic Perception of Harmony in Existence
Tutorial 11: Practice Session PS11 Exploring Co-existence in Existence.

UNIT V Implications of the Holistic Understanding – a Look at Professional Ethics (6 lectures and 3 tutorials for practice session)
Lecture 23: Natural Acceptance of Human Values
Lecture 24: Definitiveness of (Ethical) Human Conduct
Tutorial 12: Practice Session PS12 Exploring Ethical Human Conduct
Lecture 25: A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order
Lecture 26: Competence in Professional Ethics
Tutorial 13: Practice Session PS13 Exploring Humanistic Models in Education
Lecture 27: Holistic Technologies, Production Systems and Management Models-Typical Case Studies
Lecture 28: Strategies for Transition towards Value-based Life and Profession
Tutorial 14: Practice Session PS14 Exploring Steps of Transition towards Universal Human Order

Practice Sessions for UNIT I – Introduction to Value Education
PS1 Sharing about Oneself
PS2 Exploring Human Consciousness
PS3 Exploring Natural Acceptance

Practice Sessions for UNIT II – Harmony in the Human Being
PS4 Exploring the difference of Needs of self and body
PS5 Exploring Sources of Imagination in the self
PS6 Exploring Harmony of self with the body

Practice Sessions for UNIT III – Harmony in the Family and Society
PS7 Exploring the Feeling of Trust
PS8 Exploring the Feeling of Respect
PS9 Exploring Systems to fulfil Human Goal

Practice Sessions for UNIT IV – Harmony in the Nature (Existence)
PS10 Exploring the Four Orders of Nature
PS11 Exploring Co-existence in Existence

Practice Sessions for UNIT V – Implications of the Holistic Understanding – a Look at Professional Ethics
PS12 Exploring Ethical Human Conduct
PS13 Exploring Humanistic Models in Education
PS14 Exploring Steps of Transition towards Universal Human Order

READINGS:

Textbook and Teachers Manual

a. The Textbook

R R Gaur, R Asthana, G P Bagaria, *A Foundation Course in Human Values and Professional Ethics*, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1

b. The Teacher's Manual

R R Gaur, R Asthana, G P Bagaria,*Teachers' Manual for A Foundation Course in Human Values and Professional Ethics*, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-53-2

Reference Books

1. *JeevanVidya: EkParichaya,* A Nagaraj, JeevanVidyaPrakashan, Amarkantak, 1999.
2. *Human Values*, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. *The Story of Stuff* (Book).
4. *The Story of My Experiments with Truth* - by Mohandas Karamchand Gandhi
5. *Small is Beautiful* - E. F Schumacher.
6. *Slow is Beautiful* - Cecile Andrews
7. *Economy of Permanence* - J C Kumarappa
8. *Bharat Mein Angreji Raj* – PanditSunderlal
9. *Rediscovering India* - by Dharampal
10. *Hind Swaraj or Indian Home Rule* - by Mohandas K. Gandhi
11. *India Wins Freedom* - Maulana Abdul Kalam Azad
12. *Vivekananda* - Romain Rolland (English)
13. *Gandhi* - Romain Rolland (English)

Mode of Conduct:

Lecture hours are to be used for interactive discussion, placing the proposals about the topics at hand and motivating students to reflect, explore and verify them.

Tutorial hours are to be used for practice sessions.

While analyzing and discussing the topic, the faculty mentor's role is in pointing to essential elements to help in sorting them out from the surface elements. In other words, help the students explore the important or critical elements.

In the discussions, particularly during practice sessions (tutorials), the mentor encourages the student to connect with one's own self and do self-observation, self-reflection and self-exploration.

Scenarios may be used to initiate discussion. The student is encouraged to take up "ordinary" situations rather than" extra-ordinary" situations. Such observations and their analyses are shared and discussed with other students and faculty mentor, in a group sitting.

Tutorials (experiments or practical) are important for the course. The difference is that the laboratory is everyday life, and practical are how you behave and work in real life. Depending on the nature of topics, worksheets, home assignment and/or activity are included.

The practice sessions (tutorials) would also provide support to a student in performing actions commensurate to his/her beliefs. It is intended that this would lead to development of commitment, namely behaving and working based on basic human values.
It is recommended that this content be placed before the student as it is, in the form of a basic foundation course, without including anything else or excluding any part of this content. Additional content may be offered in separate, higher courses. This course is to be taught by faculty from every teaching department, not exclusively by any one department.
Teacher preparation with a minimum exposure to at least one 8-day Faculty Development Program on Universal Human Values is deemed essential.

Online Resources:

1. https://fdp-si.aicte-india.org/UHV-II%20Class%20Notes%20&%20Handouts/UHV%20Handout%201-Introduction%20to%20Value%20Education.pdf
2. https://fdp-si.aicte-india.org/UHV-II%20Class%20Notes%20&%20Handouts/UHV%20Handout%202-Harmony%20in%20the%20Human%20Being.pdf
3. https://fdp-si.aicte-india.org/UHV-II%20Class%20Notes%20&%20Handouts/UHV%20Handout%203-Harmony%20in%20the%20Family.pdf
4. https://fdp-si.aicte-india.org/UHV%201%20Teaching%20Material/D3-S2%20Respect%20July%2023.pdf
5. https://fdp-si.aicte-india.org/UHV-II%20Class%20Notes%20&%20Handouts/UHV%20Handout%205-Harmony%20in%20the%20Nature%20and%20Existence.pdf
6. https://fdp-si.aicte-india.org/download/FDPTeachingMaterial/3-days%20FDP-SI%20UHV%20Teaching%20Material/Day%203%20Handouts/UHV%203D%20D3-S2A%20Und%20Nature-Existence.pdf
7. https://fdp-si.aicte-india.org/UHV%20II%20Teaching%20Material/UHV%20II%20Lecture%2023-25%20Ethics%20v1.pdf
8. https://www.studocu.com/in/document/kiet-group-of-institutions/universal-human-values/chapter-5-holistic-understanding-of-harmony-on-professional-ethics/62490385
9. https://onlinecourses.swayam2.ac.in/aic22_ge23/preview

II Year – I Semester

L	T	P	C
3	0	0	3

ENGINEERING GEOLOGY

Course objectives: Geo means "earth" and logos means "science". Hence geology is the science of the earth or the study of the earth. Geology is a must for mining engineers as they deal with the material of the earth's crust i.e. rocks and minerals. Truly speaking, all the material (rock, mineral, soil etc.) are the outcome of one of the processes viz. igneous, sedimentary and metamorphic. In mining the ore, geology plays an important role. It gives a clear picture about the nature of the material, the attitude of the beds, structures caused by deformed forces, etc. Hence, Geology helps in choosing the method of exploitation, finding the solution for the problems associated.

UNIT– I

Introduction: Definition of Geology–Branches of Geology–Importance of Geology in Mining–Interior of the earth – Weathering, Erosion, Denudation, Geological processes. Ground water – Origin and occurrence –Hydrological cycle-Sources of water in Mines-Classification of rocks based on porosity and permeability – Water table and types of Ground water – Geological controls on ground water movement in mines. Crystallography: Characteristics of Crystals – Laws of Crystallography – Classification and study of crystal systems.

UNIT–II

Mineralogy: Definition of mineral – Classification of minerals – Physical and chemical properties of minerals –Study of Silicate structures individual minerals. Study of individual groups – Quartz – Feldspar – Pyroxenes – Amphiboles – Micas –Aluminum silicates–Garnets–Olivine. Identification of minerals, Study of geological maps.

UNIT–III

Optical Mineralogy: Ordinary light and Polarized light – Reflection, refraction, double refraction –Polarizing and Oremicroscopes- Polarizer and analyzer– Thin sections and polisheds ections–Examination of the minerals under the microscope – Optical properties – Pleochroism, Extinction, Interference colors.

UNIT–IV

Structural Geology: Introduction to geological structures – attitudes of beds: strike and dip – Description and classifications of folds, faults, joints and unconformities - recognition of geological structures in the field and their significance in mineral occurrence and exploration.

Paleontology: Definition of fossil, Mode of preservation of fossil, Uses of fossils, Classification of animal and plant kingdom, Morphology and geological range of occurrence of animal fossils - Morphology and geological range of occurrence plant fossils-Glassopteris, gangamopteris, Ptolophillum.

UNIT– V

Petrology: Igneous petrology – Rocks,3-fold classification – Origin, form, structures, textures and classification of igneous rocks – Bowen's reaction principle – Study of rocks – Granite, syenite, gabbro, pegmatite, dolerite.

Sedimentary petrology – Formation, structures, textures and classification of sedimentary rocks – Petrographic characteristics of conglomerate, breccia, sandstone, shale, limestone. Formation of various types of rocks and mineral deposits, engineering rocks.

Metamorphic petrology –Formation, structures, textures and classification of metamorphic rocks – Petrography of gneiss, schist, slate, marble, quartzite, charnockite.

TEXTBOOKS:

1) Engineering and General Geology by Parbin Singh, S.K.Kataria Sons, 8th Edition, 2008.
2) Principles of Engineering Geology by K.M. Bangar,standard publishers and distributers
3) Engineering Geology by D. Venkat Reddy, Vikas Publications, 2nd Edition, 2017.

Reference Books:

1) A text book of Geology–G.B. Mahapathra
2) Billings, M.P. Structural Geology, Third Edition, Pearson Education Limited, 2016.
3) Nanda, H. Indian Stratigraphy, Anmol Publications Pvt. Ltd, 2014
4) Winter J.D. Principles of Igneous and Metamorphic Petrology, Second edition, Pearson
5) Education Limited, 2014.
6) Ford, W.E. Dana's Textbook of Mineralogy (4th edition), CBS Publishers, 2006.
7) Bell F.G. Engineering Geology, Elsevier Publications, 2007
8) Arthur Holmes. Principles of Physical Geology, Thomas Nelson and Sons, USA, 1964.

Course Outcomes: After completion of course, students will be able to:

CO#	Description	Blooms Taxonomy Level
CO1	Understand and explain the concepts such as all the materials (rock, mineral, soil etc.),	L2
CO2	Explain the concepts and processes viz. igneous, sedimentary and metamorphic, nature of the materials,	L2
CO3	Analyze the attitude of the beds,structures caused by deformed forces, etc.	L4
CO4	Analyze and choose the method of exploitation, finding the solution for the problems associated.	L4

II Year – I Semester

L	T	P	C
3	0	0	3

DEVELOPMENT OF MINERAL DEPOSITS

Course Objectives: To make the student learn and understand the ordinary methods of drilling, blasting and special methods of shaft sinking and also to make the student understand the detonators and drivage of drifts.

UNITI:
Various types of openings: shape, size and selection. Development of openings, raises, winzes or passes, orechutes.

UNIT II:
Location of shaft shape and size, incline and vertical shafts. Surface arrangements for sinking shafts, tools and equipment ordinary methods of sinking drilling, blasting removal of debris and water. Ventilation and lighting, temporary and permanent lining, widening and deepening of shafts.

UNITIII:
Special methods of shaft sinking piling, caisson, freezing and cementation method of shaft sinking, Modern techniques of shaft sinking, Raise boring, Design of shafts, inserts, and pit bottoms. Shaft fittings.

UNITIV:
Classification and properties of explosives, detonators. Detonating cords, detonating fuse, noneldetonator and electronic detonators. Blasting systems, electrical and non-electrical methods, delay blasting techniques. Blasting in open pitmines, blasting in underground coal and metal mines. Mechanics of blasting.

UNIT-V:
Drivage of drifts, organization and cycle of operations, drilling, blasting, blasting patterns, loading, transport, support, drainage, ventilation and lighting. Mechanized drifting, road heading and tunnel boring.

Text Books:

1) Surface Mining by Dr.G.B. Mishra, Dhanbad publishers,1978.
2) EMT Volume-I by D.J. Deshmukh (9th edition), Central Technical Publications.
3) Introductory to Mining Engineering by H. L. Hartman, JM Mutmansky, Willey Publishers, 2nd Edition, 2002.
4) Modern Coal Mining by R. D. Singh, New Age International Publishing, 2nd Edition, 2022.

Reference Books:

1) SMEH and Book
2) Blasting Manual-Sandhu & Pradhan.

Course Outcomes: After completion of course, students will be able to:

CO#	Description	Blooms Taxonomy Level
CO1	Explain the concepts such as all the materials (rock, mineral, soil etc.),	L2
CO2	Design the shafts along with surface arrangements, ventilation and lighting.	L4
CO3	Analyze the special methods and modern techniques of shaft sinking.	L4
CO4	Gain knowledge about the classification and properties of various explosives and detonators.	L4
CO5	Understand the electrical and non-electrical methods and different blasting methods.	L3
CO6	Analyze drivage of drifting, organization and cycle of various operations.	L4

II Year – I Semester

L	T	P	C
3	0	0	3

MINE SURVEYING

Course Objectives: To impart the knowledge of measurements of distances and angles, determination of different levels and level difference and computation of areas, volumes which includes determination of capacity of reservoirs, volumes of barrow pits. The knowledge of modern instruments like Theodolite surveying and tachometric surveying, designing & setup of curves and global positioning systems.

UNIT– I

Introduction & distances and direction: Overview of plane surveying (chain, compass and plane table), Objectives, Principles and classifications. Direct and indirect ranging, chaining along sloping ground. Obstacle in chaining, errors and their limination.

Distance measurement conventions and methods; use of chain and tape, Electronic distance measurements, Meridians, Azimuths and Bearings, declination, computation of angle.

UNIT–II

Leveling and contouring: Concept and Terminology, Temporary and permanent adjustments-method of leveling. Characteristics and Uses of contours- methods of conducting contour surveys and their plotting. Intersection, traversing and resection. 2-point and 3-pointproblem.

UNIT–III

Computation of areas and volumes: Area from field notes, computation of areas along irregular boundaries and area consisting of regular boundaries. Embankments and cutting for a level section and two level sections with and without transverse slopes, determination of the capacity of reservoir, volume of barrow pits, Fault and dip problems.

UNIT–IV

Theodolite & tacheometric surveying: Theodolite, description, uses and adjustments – temporary and permanent, measurement of horizontal and vertical angles. Principles of Electronic Theodolite. Trigonometrically leveling, traversing.

Stadia and tangential methods of Tachometry. Distance and Elevation formulae for Staff vertical position. Curves:Types of curves, design and setting out–simple and compoundcurves.

UNIT– V

Introduction to geodetic surveying, Total Station and Global positioning system, Introduction to Geographic information system(GIS), DGPS, Drone Surveying.

Text Books:

1. "Surveying (Vol – 1, 2 & 3), by B.C.Punmia, Ashok Kumar Jain and Arun Kumar Jain – Laxmi Publications (P) ltd., NewDelhi.
2. DuggalSK, "Surveying (Vol–1&2),Tata Mc GrawHill Publishing Co.Ltd. NewDelhi,2004.

Reference Books:

1. Surveying and leveling by R.Subramanian, Oxford university press, New Delhi, 2007.
2. Mine surveying and leveling by S.Gatak, Vol. 1, 2, 3. Lovely Prakasan, 2012.
3. Surveying by Kanetkar, Kulkarni,Vol. 1 and 2, Pune Vidyarthi Griha Prakashan, 2008.

Course Outcomes: After completion of course, students can be able to:

CO#	Description	Blooms Taxonomy Level
CO1	Explain the measurements of distances and angles.	L2
CO2	Determine different levels of and level differences.	L4
CO3	Compute the areas, volumes include determination of capacity of reservoirs.	L4
CO4	Analyze and apply various instruments to survey the mines.	L4
CO5	Design and setup of curves and global positioning systems.	L5

L	T	P	C
0	0	3	1.5

II Year – I Semester

MINE SURVEYING LAB

Course objectives: To Understand different equipment and compare accuracy levels and to study several experiments and conversant with it. To find the importance of latest technology through total station. To be familiar with conventional symbols used in mines. It enables the student to attain good practical knowledge.

List of Experiments:

1. Traversing by compass.
2. Triangulation survey by the odolite
3. Measure horizontal and vertical angles by the odolite
4. Measure horizontal angles by method of repetition and reiteration using the odolite
5. Trigonometric Leveling-Heights and distance problem
6. Study of various plans and sections of open cast and underground mines.
7. Finding heights and distance using Principles of tachometric surveying
8. Curve setting–different methods by total station
9. Setting out works for buildings &pipelines.
10. Traversing, contouring and determination of area using total station
11. Determination of remote height using total station
12. Distance, gradient, Difference, height between two inaccessible points using total station.
13. Traversing and recording position of points by GPS
14. Determination of height of tunnel.
15. Demonstration of DGPS and drone surveying (Call experts from field).

Course outcome: Familiar with equipment and capable to do work independently at anytime (L4).

Equipment to be used:

1. The odolites, and leveling staffs.
2. Tacho meters.
3. Total Station

II Year – I Semester

L	T	P	C
0	0	3	1.5

ENGINEERING GEOLOGY LAB

Course Objectives: To impart exposure on properties of minerals, faults and economic minerals.

List of Experiments:

1) Study of Physical properties in minerals.
2) Study of Silicate structures minerals.
3) Demonstration of Crystal models.
4) Demonstration of Optical properties of minerals.
5) Study of important Igneous rocks.
6) Study of important sedimentary rocks.
7) Study of important metamorphic rocks.
8) Recognition of folds from models and maps.
9) Recognition of faults from models and maps.
10) Recognition of unconformities from models and maps.
11) Simple problems on strike.
12) Simple problems on dip.
13) Study of fossils.

Course Outcomes: Students will be able to identify Megascopic Minerals, Megascopic rocks, their properties and their site parameters such as contour, slope and aspect for topography and to know the occurrence of materials using the strike and dip problems (L4).

II Year – I Semester

L	T	P	C
0	1	2	2

SOFT COMPUTING AND APPLICATIONS LAB

Course objectives: To impart knowledge about basic soft computing tools and model physical systems using Matlab Simulink and Lab view software.

NOTE: Number of experiments should be minimum 2 based on each topic given below and all the experiments should be relevant to Mining Engineering.

1) Introduction to Matlab & Lab view Software.
2) Modeling of physical systems in Matlab and Simulink.
3) Application of different toolbox and modules.
4) Programming using subsystems.
5) Slope stability analysis in pit and dumps.
6) Real-time control and data acquisition (DAQ).

Course Outcomes: Students will be able to model the physical systems in Matlab as well as can discuss real time data acquisition techniques using Lab view (L4).

II Year – I Semester

L	T	P	C
2	0	0	0

ENVIRONMENTAL SCIENCE

Course Objectives:

- To make the students to get awareness on environment
- To understand the importance of protecting natural resources, ecosystems for future generations and pollution causes due to the day-to-day activities of human life
- To save earth from the inventions by the engineers.

UNIT – I

Multidisciplinary Nature of Environmental Studies: – Definition, Scope and Importance – Need for Public Awareness.

Natural Resources : Renewable and non-renewable resources – Natural resources and associated problems – Forest resources – Use and over – exploitation, deforestation, case studies – Timber extraction – Mining, dams and other effects on forest and tribal people – Water resources – Use and over utilization of surface and ground water – Floods, drought, conflicts over water, dams – benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. – Energy resources:

UNIT – II

Ecosystems: Concept of an ecosystem. – Structure and function of an ecosystem – Producers, consumers and decomposers – Energy flow in the ecosystem – Ecological succession – Food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the following ecosystem:

a. Forest ecosystem.
b. Grassland ecosystem
c. Desert ecosystem
d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Biodiversity and Its Conservation : Introduction and Definition: genetic, species and ecosystem diversity – Bio-geographical classification of India – Value of biodiversity: consumptive use, Productive use, social, ethical, aesthetic and option values – Biodiversity at global, National and local levels – India as a mega-diversity nation – Hot-sports of biodiversity – Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – Endangered and endemic species of India – Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

UNIT – III

Environmental Pollution: Definition, Cause, effects and control measures of:

a. Air Pollution.
b. Water pollution
c. Soil pollution
d. Marine pollution
e. Noise pollution
f. Thermal pollution
g. Nuclear hazards

Solid Waste Management: Causes, effects and control measures of urban and industrial wastes – Role of an individual in prevention of pollution – Pollution case studies – Disaster management: floods, earthquake, cyclone and landslides.

UNIT – IV

Social Issues and the Environment: From Unsustainable to Sustainable development – Urban problems related to energy – Water conservation, rain water harvesting, watershed management – Resettlement and rehabilitation of people; its problems and concerns. Case studies – Environmental ethics: Issues and possible solutions – Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies – Wasteland reclamation. – Consumerism and waste products. – Environment Protection Act. – Air (Prevention and Control of Pollution) Act. – Water (Prevention and control of Pollution) Act – Wildlife Protection Act – Forest Conservation Act – Issues involved in enforcement of environmental legislation – Public awareness.

UNIT – V

Human Population And The Environment: Population growth, variation among nations. Population explosion – Family Welfare Programmes. – Environment and human health – Human Rights – Value Education – HIV/AIDS – Women and Child Welfare – Role of information Technology in Environment and human health – Case studies.

Field Work: Visit to a local area to document environmental assets River/forest grassland/hill/mountain – Visit to a local polluted site-Urban/Rural/Industrial/Agricultural Study of common plants, insects, and birds – river, hill slopes, etc.

Textbooks:

1. Erach Bharucha,Text book of Environmental Studies for Undergraduate Courses,Universities Press (India) Private Limited, 2019.
2. Palaniswamy, Environmental Studies, 2/e, Pearson education, 2014.
3. S.Azeem Unnisa, Environmental Studies, Academic Publishing Company, 2021.
4. K.Raghavan Nambiar, “Text book of Environmental Studies for Undergraduate Courses as per UGC model syllabus”, SciTech Publications (India), Pvt. Ltd, 2010.

Reference Books:

1. Deeksha Dave and E.Sai Baba Reddy, Textbook of Environmental Science, 2/e, Cengage Publications, 2012.
2. M.Anji Reddy, "Textbook of Environmental Sciences and Technology", BS Publication, 2014.
3. J.P. Sharma, Comprehensive Environmental studies, Laxmi publications, 2006.
4. J. Glynn Henry and Gary W. Heinke, Environmental Sciences and Engineering, Prentice Hall of India Private limited, 1988.
5. G.R. Chatwal, A Text Book of Environmental Studies, Himalaya Publishing House, 2018.
6. Gilbert M. Masters and Wendell P. Ela, Introduction to Environmental Engineering and Science, 1/e, Prentice Hall of India Private limited, 1991.

Online Learning Resources:

- https://onlinecourses.nptel.ac.in/noc23_hs155/preview
- https://www.edx.org/learn/environmental-science/rice-university-ap-r-environmental-science-part-3-pollution-and-resources?index=product&objectID=course-3a6da9f2-d84c-4773-8388-1b2f8f6a75f2&webview=false&campaign=AP%C2%AE+Environmental+Science++Part+3%3A+Pollution+and+Resources&source=edX&product_category=course&placement_url=https%3A%2F%2Fwww.edx.org%2Flearn%2Fenvironmental-science
- http://ecoursesonline.iasri.res.in/Courses/Environmental%20Science-I/Data%20Files/pdf/lec07.pdf
- https://www.youtube.com/watch?v=5QxxaVfgQ3k

Course Outcomes:

COs	Statements	Blooms Level
CO1	Grasp multi disciplinary nature of environmental studies and various renewable and non-renewable resources.	L2
CO2	Understand flow and bio-geo- chemical cycles and ecological pyramids.	L2
CO3	Understand various causes of pollution and solid waste management and related preventive measures.	L2
CO4	Understand the rainwater harvesting, watershed management, ozone layer depletion and waste land reclamation.	L2
CO5	Illustrate the causes of population explosion, value education and welfare programmes.	L3

II Year I Semester

L	T	P	C
2	0	0	2

MANAGERIAL ECONOMICS AND FINANCIAL ACCOUNTANCY

Course Objectives:

- To inculcate the basic knowledge of microeconomics and financial accounting
- To make the students learn how demand is estimated for different products, input-output relationship for optimizing production and cost
- To Know the Various types of market structure and pricing methods and strategy
- To give an overview on investment appraisal methods to promote the students to learn how to plan long-term investment decisions.
- To provide fundamental skills on accounting and to explain the process of preparing financial statements.

Course Outcomes:

- Define the concepts related to Managerial Economics, financial accounting and management(L2)
- Understand the fundamentals of Economics viz., Demand, Production, cost, revenue and markets (L2)
- Apply the Concept of Production cost and revenues for effective Business decision (L3)
- Analyze how to invest their capital and maximize returns (L4)
- Evaluate the capital budgeting techniques. (L5)
- Develop the accounting statements and evaluate the financial performance of business entity (L5)

UNIT - I Managerial Economics

Introduction – Nature, meaning, significance, functions, and advantages. Demand-Concept, Function, Law of Demand - Demand Elasticity- Types – Measurement. Demand Forecasting-Factors governing Forecasting, Methods. Managerial Economics and Financial Accounting and Management.

UNIT - II Production and Cost Analysis

Introduction – Nature, meaning, significance, functions and advantages. Production Function– Least- cost combination– Short run and long run Production Function- Isoquants and Is costs, Cost & Break-Even Analysis - Cost concepts and Cost behaviour- Break-Even Analysis (BEA) - Determination of Break-Even Point (Simple Problems).

UNIT - III Business Organizations and Markets

Introduction – Forms of Business Organizations- Sole Proprietary - Partnership - Joint Stock Companies - Public Sector Enterprises. Types of Markets - Perfect and Imperfect Competition - Features of Perfect Competition Monopoly- Monopolistic Competition– Oligopoly-Price-Output Determination - Pricing Methods and Strategies

UNIT - IV Capital Budgeting

Introduction – Nature, meaning, significance. Types of Working Capital, Components, Sources of Short-term and Long-term Capital, Estimating Working capital requirements. Capital Budgeting– Features, Proposals, Methods and Evaluation. Projects – Pay Back Method, Accounting Rate of Return (ARR) Net Present Value (NPV) Internal Rate Return (IRR) Method (sample problems)

UNIT - V Financial Accounting and Analysis

Introduction – Concepts and Conventions- Double-Entry Bookkeeping, Journal, Ledger, Trial Balance- Final Accounts (Trading Account, Profit and Loss Account and Balance Sheet with simple adjustments). Introduction to Financial Analysis - Analysis and Interpretation of Liquidity Ratios, Activity Ratios, and Capital structure Ratios and Profitability.

Textbooks:

1. Varshney & Maheswari: Managerial Economics, Sultan Chand.
2. Aryasri: Business Economics and Financial Analysis, 4/e, MGH.

Reference Books:

1. Ahuja Hl Managerial economics Schand.
2. S.A. Siddiqui and A.S. Siddiqui: Managerial Economics and Financial Analysis, New Age International.
3. Joseph G. Nellis and David Parker: Principles of Business Economics, Pearson, 2/e, New Delhi.
4. Domnick Salvatore: Managerial Economics in a Global Economy, Cengage.

Online Learning Resources:

https://www.slideshare.net/123ps/managerial-economics-ppt
https://www.slideshare.net/rossanz/production-and-cost-45827016
https://www.slideshare.net/darkyla/business-organizations-19917607
https://www.slideshare.net/balarajbl/market-and-classification-of-market
https://www.slideshare.net/ruchi101/capital-budgeting-ppt-59565396
https://www.slideshare.net/ashu1983/financial-accounting

II Year – II Semester

L	T	P	C
3	0	0	3

COMPLEX VARIABLES, PROBABILITY AND STATISTICS

Course Objectives:

- To familiarize the complex variables.
- To familiarize the students with the foundations of probability and statistical methods.
- To equip the students to solve application problems in their disciplines.

UNIT– I: Functions of a complex variable and Complex integration:

Introduction–Continuity –Differentiability–Analyticity –Cauchy-Riemann equations in Cartesian and polar coordinates–Harmonic and conjugate harmonic functions–Milne–Thompson method.

Complex integration: Line integral –Cauchy's integral theorem –Cauchy's integral formula–Generalized integral formula (all without proofs) and problems on above theorems.

UNIT–II: Series expansions and Residue Theorem:

Radius of convergence–Expansion in Taylor's series, Maclaurin's series and Laurent series.

Types of Singularities: Isolated–Essential–Pole of orderm–Residues–Residue theorem (without proof) –Evaluation of realintegral of the types $\int_{-\infty}^{\infty} f(x)dx$ and $\int_C f(\cos\theta, \sin\theta)d\theta$.

UNIT–III: Probability and Distributions:

Review of probability and Baye's theorem – Random variables – Discrete and Continuous random variables – Distribution functions – Probability mass function, Probability density function and Cumulative distribution functions – Mathematical Expectation and Variance – Binomial, Poisson, Uniform and Normal distributions.

UNIT–IV: Sampling Theory:

Introduction – Population and Samples – Sampling distribution of Means and Variance (definition only)–Central limit theorem(without proof)–Representation of the normal theory distributions– Introduction to t, χ^2 and F-distributions- point and interval estimations – maximum error of estimate.

UNIT–V: Tests of Hypothesis:

Introduction – Hypothesis – Null and Alternative Hypothesis – Type I and Type II errors – Level of significance – One tail and two-tail tests – Tests concerning one mean and two means (Large and Small samples)–Tests on proportions.

Text Books:

1. B.S. Grewal, Higher Engineering Mathematics, 44/e, Khanna Publishers.
2. Millerand Freund's, Probability andStatisticsforEngineers,7/e,Pearson,2008.

Reference Books:

1. J. W. Brown and R. V. Churchill, Complex Variables and Applications, 9/e, Mc-Graw Hill, 2013.
2. S.C.GuptaandV.K.Kapoor,FundamentalsofMathematicalStatistics,11/e,Sul an Chand & Sons Publications,2012.
3. Jay l. Devore, Probability and Statistics for Engineering and the Sciences, 8/e, Cengage.
4. ShronL. Myers, Keying Ye, Ronald EWalpole, Probability and Statistics Engineers and the Scientists,8/e,Pearson2007.
5. Sheldon,M.Ross, Introduction to probability and statistics Engineers and the Scientists,4/e,AcademicFoundation,2011.

Online Learning Sources:

- https://archive.nptel.ac.in/courses/111/103/111103070/
- https://biet.ac.in/pdfs/PROBABILITY%20AND%20STATISTICS%20&%20COMPLEX%20VARIABLES.pdf
- https://archive.nptel.ac.in/courses/111/105/111105090/
- http://acl.digimat.in/nptel/courses/video/111102160/L23.html
- https://onlinecourses.nptel.ac.in/noc21_ma57/preview

Course Outcomes:

COs	Statements	Blooms Level
CO1	Apply Cauchy-Riemann equations to complex functions in order to determine whether a given continuous function is analytic	L3
CO2	Make use of the Cauchy residue theorem to evaluate certain integrals	L3
CO3	Infer the statistical inferential methods based on small and large sampling tests	L4
CO4	Find the differentiation and integration of complex functions used in engineering problems	L5
CO5	Design the components of a classical hypothesis test	L6

II Year – II Semester

L	T	P	C
3	0	0	3

ROCK MECHANICS

Course Objectives:

- To study about application of Rock Mechanics in mining and allied engineering.
- To study Physico-Mechanical properties of rocks, non-destructive testing methods, time-dependent properties of rock.
- To study the theories of failure and approaches used for open pit and underground designs.

UNIT-I:

Introduction: Definition of some important terms used in rock mechanics, application of rock mechanics in mining, introduction to stress analysis, stresses in two and three dimensions, Mohr's circle.

UNIT-II:

Physical properties of rocks and rock indices: Physical properties of rocks — density, porosity, moisture content, permeability, water absorption various indices of rocks like swell index, slake durability index, impact strength index, Protodyakonov index, etc., thermal conductivity, hardness, durability, rock mass classification.

UNIT-III:

Mechanical properties of rocks:

A: Preparation of test specimens, laboratory determination of mechanical properties of rocks - compressive strength, tensile strength, flexural strength, shear and triaxial strength,

B**:** Modulus of elasticity, Poisson's ratio, Mohr's envelope, effect of various parameters on the strength of rocks, in-situ strength, post failure behavior of rocks.

UNIT-IV:

Non-destructive testing methods and time dependent properties of rocks: Dynamic wave velocities, dynamic elastic constants, their determination in the laboratory, application in mining, time dependent properties of rocks, creep, mechanism of creep of rocks — different stages, rheological models.

UNIT-V:

Theories of failure of rocks &Design of underground workings**:** Different theories of failure of rocks, modes of failure - Griffith, Coulomb-Navier, Mohr's, Mohr's-Coulomb, Hoek-Brown, Drucker-Prager empirical criteria, etc. and their field of applications. Stress distribution in underground openings.

Text Books:

1. Fundamentals and applications of Rock Mechanics by Deb. D and Verma. A.K. PHI, 2016.
2. Hand book on Mechanical Properties of Rocks by Vutukuri, V.S., and Lama, R.D, Vol.I, II, III and IV, Transtech Publication,Berlin,1974/78.
3. Peng, S.S., Ground Control, Wiley Inter Science, New York,1987.
4. Engineered rock structures in mining and civil construction/ by R.N. Singh and A.K. Ghose, Taylor & Francis, 2006.

Reference Books:

1. Obert, L. and Duvall, W.I., Rock Mechanics and Design of Structure in Rock John Wiley and Sons Inc., New York, 1967.
2. Brady, B.H.G. and Brown, S.T., Rock Mechanics, Wiley Interscience,1985.
3. Hoek,E.,andBrown,S.T.,UndergroundExcavationsinRocks,InstituteofMining

Course Outcomes: After completion of course, Students will be able to:

CO#	Description	Blooms Taxonomy Level
CO1	Understand the application of Rock Mechanics in mining and allied engineering	L2
CO2	Gain knowledge about Physico-Mechanical properties of rocks, non-destructive testing methods, time dependent properties of rock.	L4
CO3	Explain the theories of failure and approaches used for open pit and underground designs.	L2

II Year – II Semester

L	T	P	C
3	0	0	3

MINE VENTILATION

Course objectives: 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 mine air: 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 air flow, resistance of airways, equivalent orifice, 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 characteristics, factors 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, Ascensional, descensional, 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 ventilatinga mine. Introduction to Network analysis, Hardy–Cross method, Ventilation survey. Case studies.

Text Books:

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

Reference Books:

1) Mine ventilation and air conditioning–Howard L.Hartman.WileyInternational, 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.
4) Vivek Publications, Varanasi1999.
5) Mine Ventilation Vol.–II, S.Ghatak, Coalfield Publishers, 1993.

Course Outcomes: After completion of course, students will be able to:

CO#	Description	Blooms Taxonomy Level
CO1	To understand the composition and comparison of mine air and its effects	L2
CO2	To understand the mine climate	L2
CO3	To analyze various types of mine ventilation systems	L3
CO4	To analyze and apply different types of mechanical ventilation systems.	L4
CO5	To plan and design a ventilation system.	L5

II Year – II Semester

L	T	P	C
3	0	0	3

FLUID MECHANICS AND HYDRAULIC POWER

Course Objectives: The students completing this course are expected to understand the properties of fluids, its kinematic and dynamic behavior through various laws of fluids like continuity, Euler's, Bernoulli's equations, energy and momentum equations. Further, the student shall be able to understand the theory of boundary layer, working and performance characteristics of various hydraulic machines like pumps and turbines.

UNITI

Fluid statics: Dimensions and units: physical properties of fluids- specific gravity, viscosity and its significance, surface tension, capillarity, vapor pressure. Atmospheric gauge and vacuum pressure –measurement of pressure. Manometers- Piezometer, U-tube, inverted and differential manometers. Pascal'slaw, hydrostatic law.

Buoyancy and floatation: Meta center, stability of floating body. Submerged bodies. Calculation of meta center height. Stability analysis and applications.

UNITII

Fluid kinematics: Introduction, flow types. Equation of continuity for one dimensional flow. Circulation and vorticity. Stream line, path line and streak lines and stream tube. Stream function and velocity potential function, differences and relation between them. Condition for irrotational flow, flow net, source and sink, doublet and vortex flow.

Fluid dynamics: surface and body forces –Euler's and Bernoulli's equations for flow along a stream line, momentum equation and its applications, force on pipe bend.

Closed conduit flow: Reynold's experiment- Darcy Weisbach equation- Minor losses in pipes- pipes in series and pipes in parallel-total energy line-hydraulic gradient line.

UNITIII

Boundary Layer Theory: Introduction, momentum integral equation, displacement, momentum and energy thickness, separation of boundary layer, control of flow separation, Stream lined body, Bluff body and its applications, basic concepts of velocity profiles.

Dimensional Analysis: Similitude and modeling–Dimensionless numbers.

UNITIV

Basics of turbo machinery: Hydrodynamic force of jets on stationary and moving flat, inclined, and curved vanes, jet striking centrally and at tip, velocity diagrams, work done and efficiency, flow over radial vanes.

Centrifugal pumps: classification, working, work done – manometric head- losses and efficiencies-specific speed-pumps in series and parallel-performance characteristic curves, cavitation & NPSH. Reciprocating pumps: Working, Discharge, slip, indicator diagrams.

UNITV

Hydraulic Turbines: classification of turbines, impulse and reaction turbines, Pelton wheel, Francis turbine and Kaplan turbine-working proportions, work done, efficiencies, hydraulic design –draft tube-theory-functions and efficiency.

Performance of hydraulic turbines: Geometric similarity, Unit and specific quantities, characteristic curves, governing of turbines, Hydraulic systems-hydraulicram, hydrauliclift, hydraulic coupling.

Text Books:

1) Hydraulics, fluid mechanics and Hydraulic machinery, MODI and SETH.
2) Fluid Mechanics and Hydraulic Machines by Rajput.
3) Fluid Mechanics and Hydraulic Machines/RKBansal/Laxmi Publications (P)Ltd.

Reference Books:

1) Fluid Mechanics and Fluid Power Engineering by D.S.Kumar, Kotaria& Sons.
2) Fluid Mechanics and Machinery by D.Rama Durgaiah, New Age International.
3) Hydraulic Machines by Banga & Sharma, Khanna Publishers.
4) Instrumentation for Engineering Measurements by James W. Dally, William E. Riley, John Wiley & Sons Inc.2004(Chapter12–FluidFlow Measurements)
5) Fluid Mechanics and Hydraulic Machines by Domkundwar & D omkundwar, Dhanpatrai & Co.

Course Outcomes: After completion of this course, students will be able to:

CO#	Description	Blooms Taxonomy Level
CO1	To gain knowledge about the concepts of fluid statics, buoyancy and flotation	L2
CO2	To understand the concepts of fluid kinematics and fluid dynamics	L2
CO3	To understand the dimensional analysis and to apply boundary layer theory	L3
CO4	To analyze the basics of turbo-machinery along with centrifugal and reciprocating pumps	L4
CO5	To analyze the hydraulic systems and turbines	L4

II Year – II Semester

L	T	P	C
0	0	3	1.5

ROCK MECHANICS LAB

Course Objectives:

To study the various of methods to determine the properties of rocks and to study the operation of various instruments and equipment.

List of experiments:

1. Determination of Core recovery and RQD of rocks.
2. DeterminationofProtodyakonovindexofagivenrocksample.
3. Determination of point load index strength of a given rock sample
4. Determination of Density, porosity and void ratio o frocks.
5. Determination of slake durability index of a given rock sample.
6. Determination of uniaxial compressive strength, young's modulus and Poisson's ratio of a given rocks ample
7. Determination of tensile strength of a given rocks ample.
8. Determination of shear strength of rocks
9. Determination of cohesion, angle of internal friction using triaxial test of a given sample.
10. Determination of permeability of a given rock or soil sample.
11. Determination of RMR for a coal seams and other strata.
12. Study of different types of supports used in mines.
13. Study of design of mine pillars.

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

1) Determine the properties of rocks (L3)
2) Knowledge of various instruments and equipment (L3)
3) Design the supports for mine openings (L4).
4) Design mine pillars (L4).
5) Knowledge of various equipment (L3).

II Year – II Semester

L	T	P	C
0	0	3	1.5

MINE VENTILATION LAB

Course objectives: Students to understand various mine ventilation instruments and to detect different gases and properties of gases.

List of experiments:

1. Determination of CO, CH_4, H_2S, SO_2, O_2, CO_2, Nitrousfumes by various detectors.
2. Study and application of in fraredgas analyzer.
3. Detection of different gases by Gas–Chromatograph.
4. Detection of methane by different types of methanometers.
5. Detection of methane, CO_2 and O_2byflamesafety lamp.
6. Determination of air quantity by Anemometer.
7. Determination of air pressure by manometer.
8. Determination of cooling power of air by kata-thermometer.
9. Measurement of air velocity by Velometer.
10. Determination of relative humidity using whirling Hygrometer.
11. Study of mine ventilation plans.
12. Study of various mine fans.

Course outcomes: After completion, **s**tudents will be able to understand various mine ventilation instruments and to detect different gases and properties of gases (L4).

II Year – II Semester

L	T	P	C
0	1	2	2

FLUID MECHANICS AND HYDRAULIC POWER LAB

Course Objectives: To impart practical exposure on the performance evaluation methods of various flow measuring equipment and hydraulic turbines and pumps.

1) Impact of jetson Vanes.
2) Performance Teston Pelton Wheel.
3) Performance Test on Francis Turbine.
4) Performance Test on Kaplan Turbine.
5) Performance Test on Single Stage Centrifugal Pump.
6) Performance Test on Multi Stage Centrifugal Pump.
7) Performance Test on Reciprocating Pump.
8) Calibration of Venturi meter.
9) Calibration of Orifice meter.
10) Determination of friction factor for a given pipeline.
11) Determination of loss of head due to sudden contract ion in a pipe line.
12) Turbine flow meter.

Course Outcomes:

Students will be able to utilize the knowledge in the design of water supply pipe networks and measure the rate of flow in pipes and channels. Students will have confidence in the hydraulic design of turbine **s** and should be able to identify suitable pumps and turbines for different working conditions (L5).

II Year II Semester

L	T	P	C
1	0	2	2

DESIGN THINKING & INNOVATION

Course Objectives: The objectives of the course are to

- Bring awareness on innovative design and new product development.
- Explain the basics of design thinking.
- Familiarize the role of reverse engineering in product development.
- Train how to identify the needs of society and convert into demand.
- Introduce product planning and product development process.

UNIT – I Introduction to Design Thinking

Introduction to elements and principles of Design, basics of design-dot, line, shape, form as fundamental design components. Principles of design. Introduction to design thinking, history of Design Thinking, New materials in Industry.

UNIT - II Design Thinking Process

Design thinking process (empathize, analyze, idea & prototype), implementing the process in driving inventions, design thinking in social innovations. Tools of design thinking - person, costumer, journey map, brainstorming, product development

Activity: Every student presents their idea in three minutes, Every student can present design process in the form of flow diagram or flow chart etc. Every student should explain about product development.

UNIT - III Innovation

Art of innovation, Difference between innovation and creativity, role of creativity and innovation in organizations. Creativity to Innovation. Teams for innovation, Measuring the impact and value of creativity.

Activity: Debate on innovation and creativity, Flow and planning from idea to innovation, Debate on value-based innovation.

UNIT - IV Product Design

Problem formation, introduction to product design, Product strategies, Product value, Product planning, product specifications. Innovation towards product design Case studies.

Activity: Importance of modeling, how to set specifications, Explaining their own product design.

UNIT – V Design Thinking in Business Processes

Design Thinking applied in Business & Strategic Innovation, Design Thinking principles that redefine business – Business challenges: Growth, Predictability, Change, Maintaining Relevance, Extreme competition, Standardization. Design thinking to meet corporate needs. Design thinking for Startups. Defining and testing Business Models and Business Cases. Developing & testing prototypes.

Activity: How to market our own product, about maintenance, Reliability and plan for startup.

Textbooks:

1. Tim Brown, Change by design, 1/e, Harper Bollins, 2009.
2. Idris Mootee, Design Thinking for Strategic Innovation, 1/e, Adams Media, 2014.

Reference Books:

1. David Lee, Design Thinking in the Classroom, Ulysses press, 2018.
2. Shrrutin N Shetty, Design the Future, 1/e, Norton Press, 2018.
3. William lidwell, Kritinaholden, &Jill butter, Universal principles of design, 2/e, Rockport Publishers, 2010.
4. Chesbrough.H, The era of open innovation, 2003.

Online Learning Resources:

- https://nptel.ac.in/courses/110/106/110106124/
- https://nptel.ac.in/courses/109/104/109104109/
- https://swayam.gov.in/nd1_noc19_mg60/preview
- https://onlinecourses.nptel.ac.in/noc22_de16/preview

Course Outcomes:

COs	Statements	Blooms Level
CO1	Define the concepts related to design thinking.	L1
CO2	Explain the fundamentals of Design Thinking and innovation.	L2
CO3	Apply the design thinking techniques for solving problems in various sectors.	L3
CO4	Analyse to work in a multidisciplinary environment.	L4
CO5	Evaluate the value of creativity.	L5

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

Minor in "Mine Environment" (Any 5 theory and 2 Labs)					
S.No.	**Title**	**L**	**T**	**P**	**Credits**
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

Honors (Any 5 theory and 2 Labs)					
S. No.	**Title**	**L**	**T**	**P**	**Credits**
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– I Semester	MINE HAZARDS AND RESCUE	L	T	P	C
		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– I Semester	UNDERGROUND COAL MINING	L	T	P	C
		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– I Semester	MINING MACHINERY	L	T	P	C
		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– I Semester	RESOURCE EVALUATION AND GEO-STATISTICS	L	T	P	C
		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– I Semester	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, **s**tudents should be able to explain about mine safety and human factors and should be able to design the systems.

III Year– I Semester	INTRODUCTION TO UNDERGROUND MINING	L	T	P	C
		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, 2nd edition, 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, 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– I Semester	MINING MACHINERY-I LAB	L	T	P	C
		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– I Semester	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) 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.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
B.Tech. Course Structure (w.e.f. AY 2023-24)
B.Tech MINING ENGINEERING
(R23 – III[rd] YEAR COURSE STRUCTURE & SYLLABUS)

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.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
B.Tech. Course Structure (w.e.f. AY 2023-24)
B.Tech MINING ENGINEERING
(R23 – IIIrd YEAR COURSE STRUCTURE & SYLLABUS)

III Year– II Semester	COMPUTER APPLICATIONS IN MINING	L	T	P	C
		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 IoT, 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– II Semester	DIMENSIONAL STONE MINING	L	T	P	C
		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– II Semester	ADVANCED MINING TECHNIQUES	L	T	P	C
		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– II Semester	TUNNELLING & UNDERGROUND SPACE TECHNOLOGY	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– II Semester	MINERAL ECONOMICS	L	T	P	C
		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– II Semester	REMOTE SENSING AND GIS	L	T	P	C
		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– II Semester	GEOSTATISTICS	L	T	P	C
		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– II Semester	MINING MACHINERY-II LAB	L	T	P	C
		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– II Semester	MINE PLANNING AND DESIGN LAB	L	T	P	C
		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– II Semester	TECHNICAL PAPER WRITING AND IPR	L	T	P	C
		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, **s**tudents 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.

		L	T	P	C
Minor	**MINOR IN "MINE ENVIRONMENT"** **ENVIRONMENTAL IMPACT ASSESSMENT &MANAGEMENT PLAN**	**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, **s**tudents 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.

B. Tech IV Year I Semester

S.No.	Category	Title	L	T	P	C
1	Professional Core	Mine Legislation and Safety	3	0	0	3
2	Management Course- II	Industrial Management	2	0	0	2
3	Professional Elective-IV	1. Ground control 2. Surface Mine Environment 3. Sustainable Development for Mining 4. Mineral Economics, Business and Trade 5. Mine Management	3	0	0	3
4	Professional Elective-V	1. Mineral Processing Technology 2. Mine Economics 3. Advances in Rock Fragmentation 4. Planning of Underground Metal mining techniques	3	0	0	3
5	Open Elective - III	1. Mine Waste Management 2. Sustainable Development in Mining Industry 3. Mine Reclamation 4. Environmental Impact of Mining	3	0	0	3
6	Open Elective-IV	1. Principles of Mineral Engineering 2. Mining Instrumentation 3. Mine Safety & Ergonomics 4. Mineral Exploration 5. Quantum Science and Technology	3	0	0	3
7	Skill Enhancement Course	Mineral Processing Technology Lab	0	1	2	2
8	Audit Course	Constitution of India	2	0	0	-
9	Internship	Evaluation of Industry Internship	-	-	-	2
		Total	**16**	**1**	**02**	**21**

B. Tech.– IV Year II Semester

S.No.	Category	Title	L	T	P	Credits
1	PR	Internship and Project work	-	-	**24**	**12**

Minors and Honors in Mining Engineering

Minor in "Mine Environment" (Any 5 theory and 2 Labs)					
S.No.	**Title**	**L**	**T**	**P**	**Credits**
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

Honors in "Mine Planning" (Any 5 theory and 2 Labs)					
S. No.	**Title**	**L**	**T**	**P**	**Credits**
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

IV Year	**MINE LEGISLATION AND SAFETY**	**L**	**T**	**P**	**C**

I Semester		**3**	**0**	**0**	**3**

Course Objectives:

1) To provide an understanding of the history and evolution of mine legislation in India.
2) To familiarize students with the key provisions of the Mines Act and related mineral concession rules.
3) To impart knowledge about various safety and operational regulations like Indian Electricity Rules and Mine Rescue Rules.
4) To introduce important workplace welfare rules including V-T Rules, Pit Head Bath Rules, and DGMS circulars.
5) To develop understanding of accident causes, classifications, and procedures for investigation and reporting in mines.

UNIT – I

History and development of mine legislation in India, General principles of mining laws, mines & Minerals (Regulation & Development), Act, payment of wages act,

UNIT – II

Mineral concession rules, principle provision of mine act. Rules & regulation framed there under (CMR - 2017, MMR - 1961)

UNIT – III

Indian Electricity rule, Mine rescue rule, industrial dispute Act.

UNIT – IV

V-T rules, Pit Head Bath Rules, cretche rules, DGMS circulars.

UNIT – V

Coal mines regulations and metalliferous mines regulations. Introduction to rescue rules, vocational training rules, maternity benefit act and rules. Causes & Classification of Accidents, accidents statistics, Accidents investigation & Reports.

TEXT BOOKS:

1. Mine Act - 52 by B. K. Kejriwal
2. DGMS Circulars

REFERENCE BOOKS:

1. Mines Act, Mine regulations, Mine rules Govt. of India Publication
2. Legislation In Indian Mines - Critical Appraisal by Prasad & Rakesh

Course Outcomes: Upon completion of this course, students will be able to:

1) Explain the legislative framework governing mining operations in India.
2) Interpret and apply provisions from CMR 2017, MMR 1961, and related mining rules.
3) Comprehend safety regulations including electricity and rescue rules applicable in mines.
4) Demonstrate knowledge of welfare provisions and directives issued by DGMS.
5) Analyze accident data, identify causes, and understand legal reporting procedures and preventive measures.

IV Year I Semester	INDUSTRIAL MANAGEMENT	L	T	P	C
		2	0	0	2

Course Objectives:

1. To introduce the fundamentals of Industrial Engineering, its development, and its role in modern industries.
2. To provide knowledge on plant layout design, location factors, and maintenance strategies.
3. To develop an understanding of work study techniques including method study, time study, and ergonomics.
4. To impart knowledge on quality control tools and techniques including control charts and Total Quality Management concepts.
5. To familiarize students with resource management, value analysis, and modern enterprise systems.

UNIT – I

INTRODUCTION: Definition of industrial engineering (I.E), development, applications, role of an industrial engineer, differences between production management and industrial engineering, quantitative tools of IE and productivity measurement. concepts of management, importance, functions of management, scientific management, Taylor's principles, theory X and theory Y, Fayol's principles of management.

UNIT – II

PLANT LAYOUT: Factors governing plant location, types of production layouts, advantages and disadvantages of process layout and product layout, applications, quantitative techniques for optimal design of layouts, plant maintenance, preventive and breakdown maintenance.

UNIT – III

WORK STUDY: Importance, types of production, applications, work study, method study and time study, work sampling, PMTS, micro-motion study, rating techniques, MTM, work factor system, principles of Ergonomics, flow process charts, string diagrams and Therbligs,

UNIT – IV

STATISTICAL QUALITY CONTROL: Quality control, Quality assurance and its importance, SQC, attribute sampling inspection with single and double sampling, Control charts - $\bar{X}$ bar and R bar charts X and S charts and their applications, numerical examples.
TOTAL QUALITY MANAGEMENT: zero defect concept, quality circles, implementation, applications, ISO quality systems. six sigma – definition, basic concepts

UNIT – V

RESOURCE MANAGEMENT: Concept of human resource management, personnel management and industrial relations, functions of personnel management, Job-evaluation, its

importance and types, merit rating, quantitative methods, wage incentive plans, types.
VALUE ANALYSIS: Value engineering, implementation procedure, enterprise resource planning and supply chain management.

TEXT BOOKS:

1. Industrial Engineering and management / O.P Khanna/ Khanna Publishers.
2. Industrial Engineering and Production Management/ Martand Telsang/ S. Chand & Company Ltd. New Delhi

Reference Books:

1. Industrial Management / Bhattacharya DK/ Vikas publishers
2. Operations Management / J.G Monks/McGraw Hill Publishers.
3. Industrial Engineering and Management Science/T.R. Banga, S.C.Sharma, N. K. Agarwal /Khanna Publishers
4. Principles of Management /Koontz O' Donnel/ McGraw Hill Publishers.
5. Statistical Quality Control /Gupta/Khanna Publishers
6. Industrial Engineering and Management /NVS Raju/ Cengage Publishers

Course outcomes: Upon successful completion of this course, students should be able to:

1) Explain the role and significance of Industrial Engineering in various industrial applications.
2) Analyze and design effective plant layouts and maintenance systems for efficient production.
3) Apply work study methods to improve productivity and ergonomic efficiency in the workplace.
4) Implement statistical quality control techniques and Total Quality Management practices.
5) Demonstrate knowledge in human resource management, job evaluation, value engineering, and enterprise systems.

IV Year I Semester	GROUND CONTROL Professional Elective-IV	L 3	T 0	P 0	C 3

Course Objectives:

1) To introduce the fundamental concepts and practices of ground control in mining.
2) To study strata pressure redistribution and its manifestations in underground workings.
3) To provide knowledge of various roof support systems and ground reinforcement techniques.
4) To understand the design principles for underground and surface mining structures.
5) To explore subsidence phenomena, its prediction, measurement, and mitigation methods.

UNIT - I

Definition and concept of ground control in Mines. Ground control practice in Mines. Constraints on ground control design; characteristics of coal measure strata.

UNIT - II

Modern concept of strata pressure redistribution. Manifestation of strata pressure, convergence, load on prop, creep, heave, roof fall and facture systems due to mining. Insitu stress measurement, instrumentation.

UNIT - III

Roof support: Timber and steel supports, friction and hydraulic prop Arches, shotcrete, roof truss, roof bolts. Cable bolts Powered supports stowing caving strip packing pump packing rock reinforcement.

UNIT - IV

Design of structures in rock; design of underground openings. Design of pillars, design of open pit slopes, waste dumps and embankments. Design of stopes.

UNIT - V

Subsidence: Theories of subsidence, factors affecting subsidence, prediction and measurement of subsidence. Damage and prevention of damage due to subsidence. Bumps and rock bursts-causes, occurrence and control.

TEXT BOOKS:

1) Rock Mechanics and Design of structures in rock, L. Obert and W. I. Duvall, New York, NY, USA: John Wiley & Sons, 1967, 650 pp. ISBN: 0-471-65235-0.
2) Peng, S. S. (2008). *Coal mine ground control* (3rd ed.). West Virginia University, Dept. of Mining Engineering.

REFERENCE BOOKS:

1. Jaeger, J. C., Cook, N. G. W., & Zimmerman, R. W. (2007). *Fundamentals of Rock Mechanics* (4th ed.). Malden, MA & Oxford, UK: Blackwell-Wiley. ISBN 978-0-632-05759-7.
2. Rock Mechanics and Ground Control, V. Singh & B.P. Khare.

Course Outcomes: Upon completion of this course, students will be able to:

1. Explain ground control issues related to underground and open cast mines can get adequate exposure to ground control practices in mines
2. Acquire knowledge on strata pressure redistribution, manifestation and insitu stresses measurement.
3. Students will understand about different types of roof supports and design of support system to manage roof pressure
4. Gain knowledge about design of underground structures and design of stable structures for safe mining in the future complex geo-mining situations
5. Acquire knowledge on subsidence, influencing parameters, prediction methods and preventing measures

IV Year I Semester	SURFACE MINE ENVIRONMENT Professional Elective-IV	L 3	T 0	P 0	C 3

Course objectives:

1. To provide an understanding of environmental management principles and policies related to mining.
2. To study various types of environmental pollution caused by mining activities and their control measures.
3. To introduce land pollution management, mine closure planning, and impact on human health.
4. To develop knowledge of environmental management systems, standards, audits, and impact assessments.
5. To familiarize students with national and international environmental laws, regulations, and clearance procedures.

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 – Greenhouse 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. (2006). Environmental Science and Technology: A Sustainable Approach to Green Science and Technology (2nd ed.). CRC Press.
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, Addison Wesley Longman Ltd, Singapore, 1997.

Course outcomes: Upon completion of this course, students will be able to:

1) Explain environmental goals, strategies, and global issues related to mining operations.
2) Identify sources and effects of air, water, noise, and vibration pollution and apply control techniques.
3) Apply effective land pollution management, mine reclamation, and mine closure strategies.
4) Evaluate and implement environmental management plans, impact assessments, and audits.
5) Interpret and apply relevant environmental legislations and regulatory frameworks in mining projects.

IV Year I Semester	SUSTAINABLE DEVELOPMENT FOR MINING	L	T	P	C
		3	0	0	3

Course objectives:

1) To introduce the concept and importance of sustainable development in the mining industry.
2) To understand current mining practices and their alignment with national and international sustainability goals.
3) To explore clean coal technologies, metal recovery techniques, and recycling methods for sustainability.
4) To study water conservation, pollution control, waste management, biodiversity, and mine closure practices.
5) To analyze best practices and case studies that demonstrate innovative approaches to sustainable mining.

UNIT – I

Concept of Sustainable development for mining industry- Sustainable development –a perspective of mineral professional community. International sustainability reporting and tools for measurement of sustainability. Milos statement on Sustainable mineral industry. Legislative measures for sustainable development- MMRD Act- star rating of Indian mines (Non-coal), Environmental responsibility – Corporate social responsibility. District mineral fund, its collection, utilization etc.

UNIT – II

Current status of mining practices and their impact on sustainability. Mining and environmental frame work, National mineral policies in mineral based countries. Indian national mineral policy, its historical development with the changing goals and sustainable practices. Issues of leases, auctions for mineral development in India.

UNIT-III

Clean coal technologies, Coal bed methane, abandoned coal mine methane, Underground gasification of coal. Leaching of old dumps and recovery of metals. Recycling of metals. Application of new techniques for sustainable development.

UNIT-IV

Mine water- Water conservation Acts and rules in India. New Initiatives in mines. Underground mine water, Water pollution and control measures, Phyto-remediation, Sewage and effluent treatment plants, their use and benefits. Waste management- processing of overburden material for underground stowing and innovative methods for utilization of waste from mines. Air quality in open pit mines, dust control measures, noise levels- pollution, monitoring, and control. Bio-diversity- Land reclamation and plantation. Mine closure plan- Collection and disbursement of Mine closure fund for both open pit and underground mines in India.

UNIT-V

Best mining practices for Sustainable mining. - Case studies. Innovative practices for achievement of sustainability, benefits of sustainability.

TEXT BOOKS:

1) Rajaram, V., Parameswaran, K., & Dutta, S. (2005). *Sustainable mining practices: A global perspective.* Taylor & Francis. https://doi.org/10.1201/9780367803490
2) Aswathanarayana, U. (2003). *Mineral resources management and the environment.* A.A. Balkema.
3) Lodhia, S. K. (Ed.). (2018). *Mining and sustainable development: Current issues.* Routledge. https://doi.org/10.4324/9781351003608

REFERENCES:

1) Guidelines of MOEF and Climate change, - Annual reports of MOEF&CC, Ministry of Mines, Ministry of Coal in India,
2) Sustainable mining practices –A global perspective by Vasudevan Rajaram, Subijoy Dutta, Krishna Paremeswaran, ISBN-90-5809-689-0.
3) MMRD Act 2015 and amendments, Ministry of Mines
4) Mineral concession Rules.
5) Government of India. (2019). *National Mineral Policy 2019.* Ministry of Mines. https://mines.gov.in/

Course outcomes: Upon completion of this course, students will be able to:

1) Explain the principles of sustainable development and relevant legislative frameworks in the mining sector.
2) Assess the impact of mining practices on sustainability and interpret national mineral policies.
3) Apply clean technologies and metal recovery techniques to promote sustainable resource utilization.
4) Implement environmental protection methods including water management, air quality control, and biodiversity conservation.
5) Evaluate and adopt best practices and innovations for achieving sustainability in mining operations.

IV Year I Semester	MINERAL ECONOMICS, BUSINESS AND TRADE	L	T	P	C
		3	0	0	3

Course Objectives:

1) To understand the economic significance of the mineral industry and the fundamentals of mineral pricing and policies.
2) To study concepts related to mineral resources/reserves, inventory, and market demand analysis.
3) To explore conservation techniques, mine sampling methods, and evaluation of mineral properties.
4) To learn the principles of mine valuation, investment appraisal, cost estimation, and mine finance.
5) To examine the taxation system, trade practices, and the role of mineral information systems in the mining sector.

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 Geo-statistics.

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 outcomes: Upon completion of this course, students will be able to:

1) Analyze the economic and policy aspects influencing the mineral industry, including pricing and demand-supply dynamics.
2) Classify and estimate mineral reserves and apply geo-statistical and market survey methods.
3) Apply mineral conservation practices and perform sampling and evaluation for effective resource utilization.
4) Evaluate mining projects using valuation techniques, investment appraisal methods, and budgeting tools.
5) Interpret mineral taxation structures, trade policies, and utilize mineral information systems for decision-making.

IV Year I Semester	MINE MANAGEMENT	L	T	P	C
		3	0	0	3

Course Objectives:

1) To provide foundational knowledge of management principles and organizational structures in mining enterprises.
2) To understand concepts of industrial psychology and industrial relations for effective workforce management.
3) To develop skills in personnel management, communication, leadership, and manpower planning.
4) To study production, office, and materials management practices including inventory control in mining operations.
5) To apply behavioural science concepts to enhance motivation, conflict resolution, and control processes in organizations.

Unit 1

Introduction: Evolution of management, theory and practice, principles of scientific management; elements of management functions - planning, organization, staffing and controlling organization; structuring organization for mining enterprises.

Unit 2

Industrial Psychology: Definitions, objectives and applications; study or individual differences — traits and personality theories; job satisfaction and morale - determining factors, and steps for improvement; study of work groups — characteristics and types; psychological tests and their uses.

Industrial Relations: Industrial disputes - definitions and causes; industrial discipline, grievance — causes, and grievance procedure; trade union movement, trade unions collective bargaining; adjudication - adjudicating authorities and their subject matters: workers' participation in management.

Unit 3

Personnel Management: Selection, training and development of human resource; job evaluation and performance appraisal, and incentives, standard of performance. Manpower Planning in mines.

Communication skills: types and its importance, two way personal communications; transmission of facts and feelings; directing and disciplining. **Leadership** - study of traditional leader behaviours - autocratic, democratic and Laissez-Faire behaviour.

Unit 4

Production Management: Determination of norms and standards of operations by work study; analysis of mine capacities and capabilities; production planning, scheduling and control - short and long term; productivity - its concept and measurement. **Office management**-types of accounts, Financial Management, accounting procedures, book keeping

Materials Management: Introduction; purchase and stores management; Inventory Management: Introduction; components, scope and limitations; nature of inventory; classical E. O. Q. model; E. O. Q. model with quantity discount; an E. O. Q. problem with safety stock; inventory optimization.

Unit 5

Behavioral Sciences for Management: Human needs, theory of motivation and organization design; conflicts in organization, sources of conflicts, dealing with conflicts, organizing for conflict resolution, conflict and growth; individual motivation;; behavioral view of controlling; eliciting positive response to controls; efficient control process through leadership actions.

Text Books:

1. Principles of Management by Kulkarni
2. D. A. Sloan, Finance for Mine Management, Chapman and Hall, London, 1983.

Reference Books:

1) Sloan, D. A. (1983). *Mine management*. Chapman and Hall, London.
2) Blight, G. E. (2010). *Geotechnical engineering for mine waste storage facilities*. Boca Raton, FL: CRC Press.
3) Bhattacharya, J. (2013). *Principles of mine planning: Volume II – Enterprise building*. New Delhi, India: Engineering Press.
4) Darling, P. (Ed.). (2011). *SME Mining Engineering Handbook* (3rd ed., Vols. 1–2). Littleton, CO: Society for Mining, Metallurgy & Exploration.
5) Jain, S. K. (2021). *Mine management, legislation and safety*. New Delhi, India.
6) Galvin, J. M. (2016). *Ground engineering: Principles and practices for underground coal mining*. Cham, Switzerland: Springer.
7) Hall, R. D. (1913). *Mine management*. New York, NY: Coal Age.

Course Outcomes: Upon completion of this course, students will be able to:

1) Apply management principles to effectively structure and operate mining organizations.
2) Analyze psychological and relational aspects influencing employee behavior and industrial harmony.
3) Manage human resources through efficient selection, training, performance appraisal, and communication.
4) Plan and control mining production and apply accounting, financial, and inventory management techniques.
5) Utilize behavioural science approaches for motivation, conflict management, and organizational efficiency.

IV Year I Semester	MINERAL PROCESSING TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1) To understand the economic significance, pricing, and policy aspects of the mineral industry.
2) To study the concepts, classification, and estimation techniques for mineral resources and reserves.
3) To learn demand analysis, market survey techniques, and conservation strategies for mineral resources.
4) To gain knowledge of mine sampling, mineral examination, and estimation of extraction parameters.
5) To introduce principles of comminution, sizing, sampling, and mineral processing techniques.

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 Geo-statistics.
Mineral inventory: concept, characteristic features, composition and economic significance; Estimation of life index.

UNIT-III

Demand analysis and Market survey: Meaning and law of demand; methodology of demand analysis, Market survey.
Conservation of mineral resources – Means of conservation and limitations in the scope of Conservation

UNIT-IV

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-V

Comminution: Introduction to comminution, reduction ratio, primary/secondary/tertiary crushing, purpose, theory of crushing, types of crushers and comparison, general crushing and grinding flow sheet.
Laboratory & Industrial Sizing and Sampling: Comparisons of different sampling techniques. Collecting sample on site (mine face); Purpose, factors governing particle behaviour – Sampling. stream analysis, automatic control in mineral processing, laboratory

and industrial screens, trommels, vibrating screens, etc. wet and dry screening, classification, classifiers. Mineral dressing, concentration methods, solid-liquid separation.

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. Wills, B. A., & Finch, J. (2016). Wills' mineral processing technology: An introduction to the practical aspects of ore treatment and mineral recovery (8th ed.). Amsterdam, Netherlands: Butterworth-Heinemann. ISBN 978-0-08-097053-0.
4. 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 outcomes: Upon completion of this course, students will be able to:

1. Analyze the economic, pricing, and policy-related aspects of the mineral industry.
2. Classify and estimate mineral reserves using geo-statistical and inventory analysis methods.
3. Conduct demand analysis, market surveys, and apply conservation methods for sustainable mining.
4. Apply sampling techniques and evaluate mineral properties for effective resource estimation.
5. Understand and implement crushing, screening, and concentration processes in mineral processing.

IV Year I Semester	MINE ECONOMICS	L	T	P	C
		3	0	0	3

Course objectives:

1) To understand the role of the mineral industry in the national economy and the investment environment in mining.
2) To learn methods of ore reserve estimation and classification using sampling and geo-statistical techniques.
3) To study mine valuation principles including financial concepts like NPV, depreciation, and rate of return.
4) To evaluate mining projects using standard appraisal techniques and understand factors affecting profitability.
5) To gain knowledge of mine financing, accounting practices, and cost estimation in mining operations.

UNIT I

Introduction: Mineral industry and its role in national economy; world and national mineral resources; Mining –A unique investment environment; special risk factors in mine investment and evaluation; national mineral policy.

UNIT II

Ore reserve estimation: Methods of sampling, sampling frequency; analysis of sampling data, estimation of reserves, introduction to geo-statistical methods, classification of reserves.

UNIT III

Mine valuation: Time value of money; annuity; redemption of capital, net present value; depletion allowance; depreciation; inflation; escalation; rates of return; Hoskold's Two rate method.

Economic evaluation: Capital and operating cost including wages, incentives, material, etc.; assets; liabilities; cash flows and discounted cash flow; profitability index – their implications in mine economic evaluation.

UNIT IV

Project appraisal: Methods of project evaluation–payback, annual value, benefit/cost ratio, ERR and IRR, etc., evaluation of exploratory mining areas and operating mines; mine project financing, its risks and constraints; mine taxation; critical impact of depreciation, depletion ,type of funding, reserves, life, etc. on mine profitability.

UNIT V

Finance and accounting: Sources of mine funds–shares, debentures, fixed deposit, sinking fund, capital gearing, P& L account, balance sheet, typical case studies of mine feasibility. Cost estimation of individual mining operations and overall mining cost, cost control methods.

TEXTBOOKS:

1) Deshmukh, R.T., Mineral and Mine Economics, Mira Publications, Nagpur, 1986.
2) Arogyaswamy, R.N.P. Courses in Mining Geology,Oxford and IBH Publishing Co.,1994.

REFERENCE BOOKS:

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 outcomes: Upon completion of this course, students will be able to:

1) Explain the economic significance of the mineral industry and assess investment risks in mining.
2) Apply appropriate methods for ore reserve estimation and analyze sampling data.
3) Perform mine valuation and economic evaluation using financial analysis techniques.
4) Evaluate mining projects through various appraisal methods and understand their financial implications.
5) Analyze mining costs, interpret financial statements, and apply cost control measures in mine operations.

IV Year I Semester	ADVANCES IN ROCK FRAGMENTATION	L	T	P	C
		3	0	0	3

Course Objectives:

1) To understand the theory of rock cutting and drilling mechanics for various rock formations.
2) To study rock fragmentation techniques using explosives and design efficient blasting rounds.
3) To explore computational models related to blasting and analyze common blasting failures.
4) To learn controlled blasting techniques and assess their impact on safety and environment.
5) To introduce blasting instrumentation and evaluate environmental impacts of blasting operations.

UNIT-I

General theory of rock cutting, selection of cutting tools for optimum penetration and wear characteristics. Mechanics of rotary, percussive and rotary-percussive drilling, short and long hole drilling equipment, different types of bits, bit wear, drilling in difficult formations, drillibality of rocks, drilling performance and costs.

UNIT- II

Mechanism of rock breaking machines, Pneumatic and Hydraulic rock hammers. Mechanics of rock fragmentation and fracture by explosive action, Types of explosives, Blasting accessories, blasting parameters, design of blasting rounds for opencast and underground mines, Blastability of rocks, blasting efficiency, mean fragment size, Fragmentation analysis and software.

UNIT- III

Computational models of blasting, transient ground motion, misfires, blown out shots, incomplete detonation – their cases and remedial measures.

UNIT- IV

Controlled blasting techniques, perimeter blasting, safety precautions, ground vibrations and air over pressure from blasting.

UNIT- V

Instrumentation in blasting, Borehole pressure transducer, V.O.D probe, vibration monitor, high speed video camera. Impact of ground vibration and sound on the neighboring structures and communities and mitigative measures.

TEXT BOOKS:

1) P. Pal Roy, Rock Blasting effect and operation, A A Barkolna, 2005
2) S. K. Das, Explosive and Blasting Practices in Mines Lordy Prakashan, 1993

REFERENCE BOOKS:

1) B. H. Garg, Blasting Operation, McGraw Hill, 1981
2) C.P. Chugh, Drilling Technology Handbook, Oxford & IBH, 1977

Course outcomes: Upon completion of this course, students will be able to:

1) Select appropriate rock cutting tools and analyze drilling performance and cost.
2) Design effective blasting patterns and evaluate fragmentation using explosives.
3) Identify causes of blasting failures and apply suitable remedial measures.
4) Implement controlled blasting techniques ensuring safety and minimal environmental impact.
5) Use blasting instrumentation to monitor vibrations and mitigate impacts on nearby structures.

IV Year I Semester	PLANNING OF UNDERGROUND METAL MINING TECHNIQUES	L	T	P	C
		3	0	0	3

Course Objectives:

1) To understand planning and scheduling principles for underground transport, shaft bottoms, and winding systems.
2) To learn design and layout considerations for surface mine installations, mills, and concentrator plants.
3) To develop skills in determining stope dimensions and planning stoping operations effectively.
4) To study operation cycle planning, scheduling techniques, and resource allocation for mining activities.
5) To explore ore blending concepts and integrate mine planning and scheduling for optimum production and sustainability.

UNIT I:

Planning and scheduling of insets, shaft bottoms, Winding and transport system- Introduction to mine planning and scheduling principles, Detailed design and layout of shaft bottoms, Planning inset development and stope access, Winding system: types of hoists, capacity calculations, safety considerations, Transport systems: haulage, conveyors, rail and road transport inside mines, Ventilation planning in relation to shaft and transport layout, Maintenance scheduling for winding and transport equipment, Case studies on transport optimization in underground mines.

UNIT II:

Surface layouts including mill and concentrator plants-Surface mine layouts: dumps, stockyards, workshops, offices, Design considerations for mill location and plant layout, Process flow and integration of concentrator units (crushing, grinding, flotation), Infrastructure planning: power supply, water management, tailings disposal, Environmental considerations in surface layouts, Material handling systems on surface: conveyors, trucks, feeders, Plant capacity planning and bottleneck analysis, Safety planning for surface installations.

UNIT III:

Determination of number and dimensions of stops-Fundamentals of stoping methods and their planning, Factors influencing number of stopes: ore body geometry, mining method, production rate, Calculation of stope dimensions for optimal ore extraction, Stability and ground control considerations in stop design, Scheduling and sequencing of stopes, Equipment selection and workforce allocation for stoping, Risk assessment and contingency planning for stopes, Examples of stope dimensioning in various ore deposits.

UNIT IV:

Planning and scheduling of a cycle of operations-Definition and analysis of mining operation cycles, Breakdown of operation cycles: drilling, blasting, loading, hauling, Time and motion study techniques for cycle optimization, Critical path method (CPM) and Gantt charts in scheduling, Resource allocation: labor, machinery, and materials, Cost estimation and budgeting for mining cycles, Monitoring and control of operation cycles for productivity, Case studies on cycle time reduction and efficiency improvement.

UNIT V:

Ore blending, Mine planning and Scheduling-Concept of Ore blending, Importance and objectives of ore blending, Blending techniques: manual, mechanical, and computerized methods, Impact of blending on processing efficiency and metal recovery, Overall planning and scheduling of activities in metal mining and processing, Integration of mining and processing schedules for optimum output, Long-term and short-term mine production planning, Coordination between mining, processing, maintenance, and logistics, Sustainability and environmental considerations in integrated planning, Case studies of planning of Mining operations.

Text Book:

1. Agoshkov M.et al., Mining of ores and non-metallic minerals, Mir publishers, Moscow.
2. Introductory Mining Engg: Harman, John Wiley and sons;
3. EME-D.J Deshmukh

Reference Books:

1. Deep Mining-jack Spalding, mining publications;
2. Peele: ”Mineral engineers hand book” Vol.I&II
3. U/G Mining Method-Hustrulid, society for mining, metallurgy & Exploration
4. Wood-roof S.C: ”Methods of working coal and metal mines”, Vol.III
5. Shevyaov:” Mining and mineral deposits”.
6. Popov: ”Working of mineral deposits”.

Course Outcomes: Upon completion of this course, students will be able to:

1) Design and optimize underground transport systems and shaft layouts considering safety and maintenance.
2) Plan surface mine layouts including processing plants, infrastructure, and material handling systems.
3) Calculate and schedule stope dimensions ensuring stability, efficiency, and risk management.
4) Apply scheduling tools like CPM and Gantt charts to optimize mining operation cycles and resource use.
5) Integrate ore blending techniques and coordinate mining and processing schedules for improved production and environmental compliance.

IV Year I Semester	MINE WASTE MANAGEMENT	L	T	P	C
		3	0	0	3

Course Objectives:

1) To introduce terminologies, types, and characteristics of mining wastes and their management strategies.
2) To understand handling, transportation, and management techniques of waste rock dumps in surface and underground mines.
3) To study tailings storage facilities, their types, properties, design principles, and regulatory frameworks.
4) To learn site selection, material characterization, stability assessment, and monitoring of waste dumps and tailing dams.
5) To explore reuse, reclamation, and closure practices for mine waste with environmental considerations.

Unit I

Introduction: Basic introduction to Terminologies, Sources, Nature and Characteristics of different types of waste generated during mining.

Types of waste dumps: Based on i) material types, ii) construction method iii) overall configuration and topographic constraints iv) Location (Internal/External) v) Geo-chemical properties. Method of design & construction. Introduction to Life of mine (LoM) mine waste management plans and handling strategy.

Unit II

Mine Waste Rock Dumps (WRDs): Nature and Type of coarse waste generated from surface mines. Methods and Practices of overburden waste handling, management and storage in open cast and open pit mines. Waste sources and management in underground mines

Handling and Transportation of waste rocks: Methods, Techniques (dumper/draglines), Cost-benefit analysis, Dumping methods (top-down/bottom-up).

Unit III

Tailing Storage Facilities (TSFs): Key Terminologies, Sources of mine tailings, Physical & Chemical properties. Mode of tailings material handling (slurry transportation)

Type of TSFs: Upstream/Downstream/Centreline/Modified centreline

Washery rejects: Types, Nature and Characteristics of washery rejects, fly ash/bottom ash Basic design principle of Tailing dams and ash pond/dykes, Governing standards and Indian regulations

Unit IV

Site selection & Material characterization for waste dumps and tailing dams: factor affecting site selection, site investigation and material testing (physical, geotechnical, geochemical) in WRDs & TSFs, sample collection, testing and analysis

Stability assessment in mine waste & tailing dams: Different modes of failures in waste dumps and tailing dams, Risk assessment and hazard classification

Stability analysis: Acceptance criteria, Stability requirement and risk involved. Numerical techniques and methods for stability assessment, Basics of Dam Run-out/Breach modelling

Instrumentation and monitoring in WRDs & TSFs structures: Requirements, Types, Advantages and Limitations, Introduction to state-of-the-art monitoring practices.

Unit V

Re-use and utilization of mine waste: Possible re-use of mine waste for civil, domestic purpose, notable examples of waste to wealth (India & Abroad). Introduction to Tailings re-mining practices.

Closure of WRDs and TSFs: Closure requirements (technical/environmental), Reclamation at waste dumps, Short-to-long-term environmental challenges and mitigation.

TEXTS BOOKS:

1) P. Mark Hawley, John Cunning, Guidelines for Mine Waste Dump and Stockpile Design, CRC Press , ISBN 9781138197312
2) Vick, Steven G, Planning, Design, and Analysis of Tailings Dams, BiTech Publisher , ISBN 0-921095-12-0

REFERENCES:

1) Lottermoser, Bernd, Mine Wastes-Characterization, Treatment and Environmental Impacts, Springer , ISBN 978-3-642-12418-1
2) Geoffrey E. Blight, Geotechnical Engineering for Mine Waste Storage Facilities, CRC Press , ISBN 9780367577216
3) Environmental Geology, Ghosh R. & Chatterjee D. S., Capital Publishing Co. New Delhi.
4) Water Resources Engineering Larry W. M., Publisher John Wiley and Sons
5) Water Resources Engineering - Ray K. L., Franzini J.B., Freyberg D.L., George Tchobanoglous G. & Hill M.G., 4th Ed.
6) Hydrology and Water Resources Engineering, Garg S.K., Khanna Publishers
7) Hydrology- Das M.M. & Saikia M.D., PHI Learning Pvt. Ltd., New Delhi.
8) SME Mining Reference Handbook, Lowrie R., SME Publication 2002.
9) Mining engineers Handbook, Peele R.

Digital Material

1. https://youtu.be/X14OTkdPUPs – Mine Waste Management

Course Outcomes: Upon completion of this course, student will be able to:

1) Identify and classify different types of mining wastes and develop appropriate waste management plans.
2) Apply efficient methods for handling and transporting waste rock dumps in mining operations.
3) Design and evaluate tailings storage facilities complying with safety standards and environmental regulations.
4) Conduct site investigations, stability assessments, and implement monitoring systems for waste structures.
5) Implement waste reuse, reclamation, and closure strategies for sustainable mine waste management.

IV Year I Semester	SUSTAINABLE DEVELOPMENT IN MINING INDUSTRY	L	T	P	C
		3	0	0	3

Course objectives:

1) To understand the concept of sustainable development specific to the mining industry and related legislative frameworks.
2) To analyze current mining practices and their environmental impacts within national and international policy contexts.
3) To study clean coal technologies, methane recovery, and innovative techniques promoting sustainable mining.
4) To examine water conservation, pollution control, and environmental management practices in mining operations.
5) To explore biodiversity conservation, land reclamation, mine closure planning, and best practices for sustainable mining.

UNIT – I

Concept of Sustainable development for mining industry-Sustainable development –a perspective of mineral professional community. International sustainability reporting and tools for measurement of sustainability. Milos statement on Sustainable mineral industry. Legislative measures for sustainable development- MMDR Act- star rating of Indian mines (Non-coal), Environmental responsibility – Corporate social responsibility. District mineral fund, its collection, utilization etc.

UNIT – II

Current status of mining practices and their impact on sustainability. Mining and environmental frame work, National mineral policies in mineral based countries. Indian national mineral policy, its historical development with the changing goals and sustainable practices. Issues of leases, auctions for mineral development in India.

UNIT-III

Clean coal technologies, Coal bed methane, abandoned coal mine methane, Underground gasification of coal. Leaching of old dumps and recovery of metals. Recycling of metals. Application of new techniques for sustainable development.

UNIT-IV

Mine water- Water conservation Acts and rules in India. New Initiatives in mines. Underground mine water, Water pollution and control measures, Phyto-remediation, Sewage and effluent treatment plants, their use and benefits. Air quality in open pit mines, dust control measures, noise levels- pollution, monitoring and control.

UNIT-V

Bio-diversity- Land reclamation and plantation. Mine closure plan- Collection and disbursement of Mine closure fund for both open pit and underground mines in India.
Best mining practices for Sustainable mining. - Case studies. Innovative practices for achievement of sustainability. Benefits of sustainability.

TEXT BOOKS:

1) MMRD Act 2015 and amendments, Ministry of Mines
2) Mineral concession Rules

REFERENCES:

1) Guidelines of MOEF and Climate change - Annual reports of MOEF&CC, Ministry of Mines, Ministry of Coal in India,
2) Sustainable mining practices –A global perspective by Vasudevan Rajaram, Subijoy Dutta, Krishna Paremeswaran, ISBN-90-5809-689-0

Course outcomes: Upon completion of this course, students will be able to:

1) Explain sustainable development principles and regulatory requirements applicable to the mining sector.
2) Evaluate mining policies and their influence on sustainable mining practices nationally and globally.
3) Apply clean technologies and resource recovery methods to enhance mining sustainability.
4) Implement water and air pollution control measures and monitor environmental quality in mining operations.
5) Develop and manage mine closure plans, land reclamation projects, and promote biodiversity conservation in mining areas.

IV Year I Semester	MINE RECLAMATION	L	T	P	C
		3	0	0	3

Course objectives:

1) To understand recent development paradigms, carrying capacity, and environmental impacts of mining activities.
2) To study land degradation, land use, and planning for waste disposal and tailings management in mining.
3) To learn land reclamation techniques, including soil management and vegetation restoration in mining areas.
4) To explore engineering and biological reclamation methods, afforestation, and mine closure practices.
5) To analyze corporate social responsibility, environmental policies, and management systems related to mine closure and reclamation.

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

Engineering 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 outcomes: Upon completion of this course, students will be able to:

1) Describe environmental problems caused by mining and assess the impact of mining machinery on the environment.
2) Evaluate land degradation and plan for effective waste disposal and tailings impoundment.
3) Apply land reclamation techniques, including soil conservation and vegetation restoration for disturbed mining sites.
4) Implement engineering and biological reclamation methods for mine closure and land restoration.
5) Develop environmental management plans and ensure compliance with environmental laws, standards, and corporate social responsibility practices in mining.

IV Year I Semester	ENVIRONMENTAL IMPACT OF MINING	L	T	P	C
		3	0	0	3

Course objectives:

1) To introduce concepts, goals, and tools for environmental management related to mining activities and sustainable development.
2) To study various types of environmental pollution (air, water, noise), their sources, effects, and control measures.
3) To understand land pollution, tailing management, mine closure planning, and their impact on health and environment.
4) To learn environmental management systems, standards, impact assessment, and economic valuation of environmental resources.
5) To familiarize with environmental laws, regulations, and procedures applicable to mining projects.

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 – Greenhouse 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.

REFERENCES:

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, Addison Wesley Longman Ltd, Singapore, 1997

Course outcomes: Upon completion of this course, students will be able to:

1) Explain environmental management principles and global/local environmental issues affecting mining.
2) Identify types of pollution, assess their impacts, and recommend control and preventive measures.
3) Analyze land pollution challenges, tailing management techniques, and implement mine closure plans.
4) Apply environmental management tools including EIA, audits, and economic analysis for mining operations.
5) Demonstrate knowledge of key environmental legislation and regulatory compliance for mining projects.

IV Year I Semester	PRINCIPLES OF MINERAL ENGINEERING	L	T	P	C
		3	0	0	3

Course objectives:

1) To understand the scope, objectives, and limitations of mineral dressing and microscopic study and learn the theory and practice of comminution including crushing and grinding.
2) To gain knowledge about the sizing and classification methods
3) To study sizing and classification methods and their industrial applications.
4) To explore gravity concentration and froth flotation techniques, their principles and uses.
5) To gain knowledge of electrical concentration methods, dewatering, drying, coal washing, and beneficiation flow sheets.

UNIT - I

Scope, objectives and limitations of Mineral Dressing; Role of microscopic study.
Comminution and Liberation: Theory and practice of crushing & grinding; Conventional units used-their fields of application and limitation

UNIT – II

Sizing and Classification: Laws of setting of solids in fluid; Laboratory methods of sizing and interpretation of sizing data; Industrial sizing by screens; Types of classifiers; Classification as means of sizing by screens.

UNIT – III

Gravity concentration Methods- Jigging, Flowing film concentration like spirals and shaking table, Heavy Media separation; Theory, applications and limitations of each method; Introductory Froth Flotation, physico-chemical, principles underlying flotation-reagents, flotation machines; Flotation of sulphides, oxides and non-metals.

UNIT – IV

Electrical Methods of Concentration: Electrostatic and magnetic methods, their principles of operation, fields of application and limitations.
Dewatering and drying: Thickening, filtration and drying.

UNIT – V

Coal washing: Coal washability, crushing, sizing and cleaning of coal.
Sampling: Importance and methods used in ore-dressing.
Beneficiation and flow sheet of common minerals like copper, lead, zinc, gold, chromium, Aluminium etc.

TEXT BOOKS:

1) Gaudin, A. M. (1939). Principles of mineral dressing. McGraw-Hill Book Company.
2) H.G. Vijendra, Handbook on Mineral Dressing. Pub: Vikas Publishing house New-Delhi

REFERENCES:

1) Jain, S. K. (2018). ***Mineral processing*** (2nd ed.). CBS Publishers & Distributors.
2) Rao, G. S. R. (2017). Mineral processing: Including mineral dressing, experiments and numerical problems**.** I.K. International Publishing House Pvt. Ltd.

Course outcomes: Upon completion of this course, students will be able to:

1) Describe the fundamentals and limitations of mineral dressing and microscopic analysis.
2) Apply crushing and grinding methods for effective mineral liberation.
3) Perform sizing and classification to analyze particle size distribution.
4) Select appropriate gravity concentration and flotation methods for mineral processing.
5) Develop beneficiation flow sheets and apply sampling and coal washing techniques.

IV Year I Semester	MINING INSTRUMENTATION	L	T	P	C
		3	0	0	3

Course objectives:

1) To understand the principles and characteristics of electrical instruments used in mining applications.
2) To study various pressure and flow measurement techniques and devices.
3) To learn methods for measuring vibration, humidity, velocity, sound, and material levels in mining environments.
4) To explore different types of analysers used for gas, water, and dust quality monitoring.
5) To understand rock mechanics instrumentation and its applications in various mining methods.

UNIT I

Electrical Instruments: Basic Concepts: Sensitivity, range, reproducibility and accuracy, drift, absolute and relative measurements, error, environmental factors and planning for instrumentation. Accuracy, precision, resolution, sensitivity, linearity, span and range - Dynamic characteristics. Ammeters (MI & MC), Volt meters, Watt meters (Dynami), Energy Meters, Megger, Power Factor meters, Earth resistance measurement. and thermocouples, Inclinometers.

UINT II

Pressure Measurements and Flow Measurements: Unit of Pressure – Manometers Different types, - Elastic type pressure gauges and sensors– Bourdon tube – Bellows – Diaphragm – Elastic elements with LVDT and strain gauge, deformation gauge – Capacitive type pressure gauge – Measurement of vacuum – McLeod gauge – Thermal conductivity gauge – Ionisation gauge. Piezometer, Flow meters – Variable head type flow meter – Orifice plate – Venture tube – Positive displacement flow meter: Nutating disc, Reciprocating piston, oval gear and helix type flow meter – Rotameter – Mass flow meters.

UNIT III

Vibration, Humidity, Velocity and Level Measurements: Mechanical type vibration measuring instruments – Seismic instruments as an accelerometer – Vibrometers – Geo-phones. Humidity – Hot wire electro type hygrometer – Dew cell – Electrolysis type hygrometer. Anemometer, Velometer, Pitot static tube, Sound level meter, microphone, Lux meter; Level measurements: – Float gauges - Displacer type – D/P methods -Bubbler system Load cell – Electrical types – Conductivity sensors – Capacitive sensors – Nucleonic gauge - Ultrasonic gauge – Boiler drum level measurement – Differential pressure method and Hydrastep method -Solid level measurement.

UNIT IV

Analyzers: Dissolved Analyzer: Conductivity meter – pH meter – Dissolved oxygen analyzer – Sodium analyzer – Silica analyzer – Turbidity meter – Gas analyzer – O2, NOx – H2S analyzer – CO and CO2 monitor, Dust & Smoke measurement. IR analyzers, thermal conductivity analyzers, analysis based on ionization of gases. hydrocarbons, nitrogen oxides, Sulphur dioxide estimation - Calibration methods.

UNIT V

Rock Mechanics Instrumentation: Different types of Load cells, stress capsules, Flat jack, tape extensor meters, convergence indicators and recorders, borehole deformation gauges of different types, depth indicators. Seismic measurements, Applications in Mining: Coal mining – bord and pillar development, depillaring and Longwall, Metal mining and opencast mining applications, rock slope instrumentation.

TEXT BOOKS:

1. De, N.K. and Sen, P.K. 'Electric Drives' Prentice Hall of India Private Ltd, 2002.
2. Subramaniam, V. 'Electric Drives' Tata McGraw Hill , New Delhi,2007

REFERENCE BOOKS:

1) Dubey, G.K. 'Fundamentals of Electrical Drives' Narosa, Second Edition.
2) Morrris, A.S. Principles of Measurement and Instrumentation, Print ice-Hall of India Pvt., Ltd. New Delhi, 1999.
3) Doeblin, E.O. Measurement Systems Application & Design, Tata McGraw Hill Publishing Co., New. Delhi, 1999.

Course outcomes: Upon completion of this course, students will be able to:

1) Identify and apply electrical instruments for accurate measurement and monitoring in mining systems.
2) Use appropriate pressure and flow measurement devices for different operational needs.
3) Measure vibration, velocity, humidity, and level parameters using relevant instruments.
4) Operate and interpret readings from analysers for environmental and process control.
5) Implement rock mechanics instrumentation techniques in both underground and surface mining operations.

IV Year I Semester	MINE SAFETY & ERGONOMICS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To introduce the historical evolution and global perspective of mine safety practices.
2. To develop understanding of risk management, its processes, and HIRA methodology in mining operations.
3. To explore statistical and analytical tools used for evaluating and mitigating mining risks.
4. To study system safety engineering concepts and models for accident causation and prevention.
5. To understand ergonomic principles, posture analysis, and physiological factors impacting mine workers.

UNIT-I

Introduction: Historical Developments of Mine Safety in India and Abroad; Need for Approving, Safety Engineering Approach in Mining, Industry; Engineering Safety Goals; Mine Safety Facts and Figures; Worldwide Major Mine Disasters.

UNIT-II

Risk Management: Risk Management Related Terms and Definitions; Basic Concept of Risk, Reliability and Hazard Potential; Risk Components and Types; Risk Management Objectives; Risk Management Process; Functions of a Risk Manager; Common Errors in Risk Management; Risk Estimates for Selective, Events; Hazards Identification and Risk Assessment (HIRA) Methodology; Implementation of HIRA and its Controls & Review; Advantages of Risk Management.

UNIT-III

Statistical Methods of Risk analysis: Basic Risk Analysis Methods based on Frequency Rates and Severity of Accidents Appraisal of advanced techniques - Preliminary Hazards Analysis (PHA); Hazards and Operability Analysis (HAZOP); Failure Mode and Effect Analysis (FMEA); Failure Mode Effect and Critical Analysis (FMECA); Job Safety Analysis (JSA); Fault Tree Analysis (FTA); Markov Model (MM) – An Important Risk analysis Tool.

UNIT-IV

System Safety Engineering Concept in Mine Safety: An Introduction to Systems Safety Engineering; Different School of Thoughts in Accident Causations - Domino Model; Behavioral Accident Model based on the human perception; Epidemiological Accident Models, Normal Accident Theory; The Swiss Cheese Model; Systems-Theoretic Accident Modeling and Process (STAMP); In-depth Study of Accidents Due to Various Causes; Application of Structural Equation Modelling (SEM) and Artificial Neural Network (ANN) in Determining the Accident Causation in Mines.

Safety audits and control: Objectives of safety audit in mines; Different steps in safety audit; Risk control procedures.

UNIT-V

Mine Ergonomics: Domain, Philosophy and Objective of Mine Ergonomics; Ergonomics/ human, Factors fundamentals; Work physiology, and stress; Human body- structure and, function, anthropometrics; Posture and movement; Posture and Job Relation – Work Posture Analysis using OWAS, Method; Oxygen Consumption and Workload Analysis of Mine Workers.

Text Books:

1) Engineering Safety: Fundamentals, Techniques and Applications by B. S. Dhillon; World Scientific Publisher.
2) Mine Health and Safety Management – Edited by Michael Karmis.
3) Kejriwal, B. K., Safety in mines, Lovely Prakashan.

References:

1) Dhillon, B. S. (2008). Mining equipment reliability, maintainability, and safety (Springer Series in Reliability Engineering). Springer.
2) Dhillon, B. S. (2010). Mine safety: A modern approach (Springer Series in Reliability Engineering). Springer..

Course Outcomes: Upon completion of this course, students will be able to:

1. Demonstrate knowledge of historical safety practices and major global mining disasters.
2. Apply risk assessment techniques and HIRA methodology in identifying and controlling mining hazards.
3. Utilize advanced risk analysis methods such as FMEA, HAZOP, FTA, and Markov Models.
4. Analyze mine accidents using safety engineering theories, ANN, and SEM tools.
5. Evaluate and implement ergonomic principles to improve safety and productivity in mining environments.

IV Year I Semester	MINERAL EXPLORATION	L	T	P	C
		3	0	0	3

Course Objectives:

1. To understand the basic principles and methods of geological prospecting and exploration.
2. To learn various sampling techniques and orebody evaluation methods.
3. To introduce geochemical exploration concepts and the role of pathfinder elements.
4. To study the dispersion of elements and interpretation of geochemical anomalies.
5. To analyze exploration data in relation to geological, feasibility, and economic factors.

UNIT - I

Geological Prospecting and Exploration: Definitions and Principles; Methods of Prospecting; Methods of Exploration.

UNIT - II

Sampling: theory and methods; Geological plans and sections for orebody evaluation; Exploration drilling, drill core logging and sampling Cut-off grade concepts and applications; Resources and Reserves. Estimation of reserves – methods and practice.

UNIT - III

Geochemical Exploration: Introduction, Geochemical cycle, geochemical mobility and association of elements. Pathfinder and target elements for geochemical exploration. Principles of geophysical exploration methods.

UNIT - IV

Primary and secondary dispersions of elements; Determination of background, and geochemical anomalies; Geo-chemical methods of mineral exploration: Procedures for geochemical sampling; Interpretation of geochemical surveys. Indian case studies.

UNIT - V

Collection of data along Geological (G), Feasibility (F) and Economic (E) axes during various stages of exploration.

TEXT BOOKS:

1) Techniques in Mineral Exploration: Reedman, J H., 1979. Applied Science Publishers Ltd, UK
2) Exploration and Mining Geology (2nd Ed.), Peters, W.C. 1987. John Wiley & Sons, New York.

REFERENCE BOOKS:

1) Tables for Mineral Identification, Sharma, N L and Agarwal Y K.
2) Ore Geology and Industrial minerals- An introduction (III edn.) Geo-science, A.M. Evans. 1997, Texas.

Course Outcomes: Upon completion of this course, students will be able to:

1. Explain fundamental concepts of geological prospecting and exploration techniques.
2. Apply appropriate sampling and ore reserve estimation methods in exploration.
3. Identify geochemical cycles and pathfinder elements used in mineral exploration.
4. Interpret geochemical survey results and recognize geochemical anomalies.
5. Evaluate exploration data across geological, feasibility, and economic dimensions.

IV Year – I Semester	QUANTUM SCIENCE AND TECHNOLOGY	L	T	P	C
		3	0	0	3

Prerequisites: Basic Physics, Linear Algebra, and Introduction to Modern Physics

Course Objectives:

1. To introduce fundamental concepts of quantum mechanics and its mathematical formalism.
2. To explore quantum computing and communication principles and technologies.
3. To understand the physical implementation and limitations of quantum systems.
4. To enable students to relate quantum theory to practical applications in computing, cryptography, and sensing.
5. To familiarize students with the emerging trends in quantum technologies.

Course Outcomes:

After completing this course, students will be able to:

CO1. Explain core principles of quantum mechanics and their technological implications.
CO2. Analyze quantum phenomena like superposition and entanglement.
CO3. Apply mathematical tools to model and solve quantum systems.
CO4. Demonstrate understanding of quantum algorithms and quantum circuits.
CO5. Evaluate potential applications and challenges in quantum communication and sensing.

Unit 1: Fundamentals of Quantum Mechanics: Historical background: Blackbody radiation, photoelectric effect, and Compton scattering; Dual nature of light and matter; De Broglie hypothesis; Schrödinger equation; Free particle, infinite potential well, step potential; Operators and observables: position, momentum, Hamiltonian; Commutation relations and uncertainty principle; Quantum postulates and measurement theory; Eigenvalues, eigenfunctions.

Unit 2: Quantum Information Theory: Classical vs. quantum information; Qubit representation using Bloch sphere; Quantum superposition and quantum entanglement; Dirac notation (bra-ket), tensor products, and composite systems; Bell states and EPR paradox; Quantum gates: Pauli-X, Y, Z; Hadamard; Phase; T; CNOT; Quantum circuit models and notation; Measurement in computational basis; Quantum teleportation and no-cloning theorem; Quantum state tomography (introductory)

Unit 3: Quantum Computing: Classical computing review and limitations; Quantum parallelism and interference; Deutsch and Deutsch-Jozsa algorithms; Grover's search algorithm, Oracle and amplitude amplification; Shor's factoring algorithm (overview and significance); Quantum Fourier Transform (QFT); Quantum error correction: Bit-flip, phase-flip, and Shor's 9-qubit code; Introduction to quantum programming: Qiskit, Cirq, IBM Quantum Experience (overview)

Unit 4: Quantum Communication: Introduction to quantum cryptography; Quantum key distribution (QKD): BB84 protocol; Entanglement-based QKD: Ekert protocol (E91); Eavesdropping and security of QKD; Quantum teleportation (circuit and protocol); Quantum dense coding; Quantum networks and entanglement swapping; Role of quantum repeaters; Single-photon sources and detectors; Implementation challenges (loss, decoherence, noise)

Unit 5: Quantum Technologies and Applications: Quantum sensors: magnetometry, gravimetry; Quantum metrology: standard time, atomic clocks; Quantum imaging and lithography; Quantum materials: topological insulators, graphene, quantum dots; NV centers in diamonds for sensing; Hardware platforms: Superconducting qubits, Trapped ions, Photonic quantum processors; Quantum supremacy and NISQ era; Global initiatives: IBM, Google, D-Wave, IonQ, India's NQM; Ethical concerns and future prospects

Text Books:

1. **"Quantum Computation and Quantum Information"** by Michael A. Nielsen and Isaac L. Chuang
2. **"Quantum Mechanics: Concepts and Applications"** by Nouredine Zettili

Online Learning Resources:

1. https://nptel.ac.in/courses/104104082
2. https://nptel.ac.in/courses/115104096
   https://nptel.ac.in/courses/122106034

IV Year I Semester	MINERAL PROCESSING TECHNOLOGY LAB	L	T	P	C
		0	1	2	2

Course Objectives:

1. To familiarize students with different sampling techniques used in mineral processing.
2. To develop practical skills in crushing, grinding, and size analysis of minerals.
3. To understand and perform various mineral concentration techniques.
4. To evaluate washability and sedimentation characteristics of mineral and coal samples.
5. To assess grindability indices (HGI and Bond's Work Index) for various ores and minerals.

LIST OF EXPERIMENTS:

1) Different types of sampling techniques like Grab sampling, coning and quartering, riffle sampling techniques, etc.
2) Determination of crushing characteristics of a given mineral sample using jaw crusher.
3) Determination of the grinding characteristics of a given mineral sample using ball mill.
4) Sieve analysis of a given sample and to calculate (a) percentage retained and percentage passed through on screens (b) average size of sample material and (c) to plot sizing curves.
5) Concentration of a given mineral using Wilfley table.
6) Concentration of a given mineral using froth flotation cell.
7) concentration of a given mineral using magnetic separator.
8) Washability characteristic of coal samples using sink-float tests.
9) Sedimentation characteristics of a given mineral sample.
10) Determination of Hard Grove Grind-ability Index of ore or mineral or coal.
11) Determination of Bonds work index for rock or ore or mineral.
12) Mineral concentration using jigging.

Course Outcomes: Upon completion of this lab course, students will be able to:

1. Demonstrate proficiency in applying appropriate sampling techniques for mineral processing.
2. Operate and analyze crushing and grinding equipment for mineral size reduction.
3. Conduct and evaluate mineral concentration using gravity, flotation, and magnetic methods.
4. Analyze coal washability and sedimentation behavior of mineral samples.
5. Determine and interpret grindability indices essential for equipment and process selection.

IV Year I Semester	CONSTITUTION OF INDIA	L	T	P	C
		2	0	0	-

Course Objectives:

- To Enable the student to understand the importance of constitution
- To understand the structure of executive, legislature and judiciary
- To understand philosophy of fundamental rights and duties
- To understand the autonomous nature of constitutional bodies like Supreme Court and highcourt controller and auditor general of India and election commission of India.
- To understand the central and state relation financial and administrative.

UNIT-I

Introduction to Indian Constitution: Constitution meaning of the term, Indian Constitution - Sources andconstitutional history, Features - Citizenship, Preamble, Fundamental Rights and Duties, Directive Principles of State Policy.

Learning outcomes:

After completion of this unit student will

- Understand the concept of Indian constitution
- Apply the knowledge on directive principle of state policy
- Analyze the History, features of Indian constitution
- Evaluate Preamble Fundamental Rights and Duties

UNIT-II

Union Government and its Administration Structure of the Indian Union: Federalism, Centre- Staterelationship, President: Role, power and position, PM and Council of ministers, Cabinet and CentralSecretariat, LokSabha, RajyaSabha, The Supreme Court and High Court: Powers and Functions; **Learning outcomes:**-After completion of this unit student will

- Understand the structure of Indian government
- Differentiate between the state and central government
- Explain the role of President and Prime Minister
- Know the Structure of supreme court and High court

UNIT-III

State Government and its Administration Governor - Role and Position - CM and Council ofministers, State Secretariat: Organisation, Structure and Functions

Learning outcomes: After completion of this unit student will

- Understand the structure of state government
- Analyze the role Governor and Chief Minister
- Explain the role of state Secretariat
- Differentiate between structure and functions of state secretariat

UNIT-IV

A. Local Administration - District's Administration Head - Role and Importance, Municipalities – Mayor and role of Elected Representative - CEO of Municipal Corporation PachayatiRaj: Functions PRI: ZilaPanchayat, Elected officials and their roles, CEO Zilla Panchayat: Block level Organizational Hierarchy - (Different departments), Village level - Role of Elected and Appointed officials - Importance of grass root democracy

Learning outcomes: - After completion of this unit student will

- Understand the local Administration
- Compare and contrast district administration role and importance
- Analyze the role of Myer and elected representatives of Municipalities
- Evaluate Zilla Panchayat block level organization

UNIT-V

Election Commission: Election Commission- Role of Chief Election Commissioner and Election Commissionerate State Election Commission: Functions of Commissions for the welfare of SC/ST/OBC and women

Learning outcomes: - After completion of this unit student will

- Know the role of Election Commission apply knowledge
- Contrast and compare the role of Chief Election commissioner and Commissionerate
- Analyze role of state election commission
- Evaluate various commissions of viz SC/ST/OBC and women

References:

1) Durga Das Basu, Introduction to the Constitution of India, Prentice – Hall of India Pvt. Ltd..NewDelhi.
2) SubashKashyap, Indian Constitution, National Book Trust
3) J.A. Siwach, Dynamics of Indian Government & Politics
4) D.C. Gupta, Indian Government and Politics
5) H.M.Sreevai, Constitutional Law of India, 4th edition in 3 volumes (Universal Law Publication)
6) J.C. Johari, Indian Government and Politics Hans
7) J. Raj IndianGovernment and Politics
8) M.V. Pylee, Indian Constitution Durga Das Basu, Human Rights in Constitutional Law, Prentice–Hall of India Pvt. Ltd.. New Delhi
9) Noorani, A.G., (South Asia Human Rights Documentation Centre), Challenges to Civil Right),Challenges to Civil Rights Guarantees in India, Oxford University Press 2012

E-resources:

1. nptel.ac.in/courses/109104074/8
2. nptel.ac.in/courses/109104045/
3. nptel.ac.in/courses/101104065/
4. www.hss.iitb.ac.in/en/lecture-details
5. www.iitb.ac.in/en/event/2nd-lecture-institute-lecture-series-indian-constitution

Course Outcomes:

At the end of the semester/course, the student will be able to have a clear knowledge on the following:

1) Understand historical background of the constitution making and its importance for building a democratic India.
2) Understand the functioning of three wings of the government i.e., executive,legislative and judiciary.
3) Understand the value of the fundamental rights and duties for becoming good citizen of India.
4) Analyze the decentralization of power between central, state and local self-government.

5) Apply the knowledge in strengthening of the constitutional institutions like CAG, Election Commission and UPSC for sustaining democracy.
6) Know the sources, features and principles of Indian Constitution.
7) Learn about Union Government, State government and its administration.
8) Get acquainted with Local administration and Pachayati Raj.
9) Be aware of basic concepts and developments of Human Rights.
10) Gain knowledge on roles and functioning of Election Commission

IV Year I Semester	EVALUATION OF INDUSTRY INTERNSHIP	L	T	P	C
		-	-	-	2

B.Tech. – IV Year II Semester

S.No.	Category	Title	L	T	P	Credits
1	Internship & Project Work	Full semester Internship &Project Work	0	0	24	12