JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
KAKINADA - 533 003, Andhra Pradesh, India

DEPARTMENT OF MINING ENGINEERING

COURSE STRUCTURE AND SYLLABUS

For UG – R-20

B. TECH - MINING ENGINEERING

(Applicable for batches admitted from 2020-2021)

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

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DEPARTMENT OF MINING ENGINEERING

COURSE STRUCTURE

I Year – I SEMESTER

S. No	Course Code	Course Title	L	T	P	Credits
1	BSC-1	Mathematics – I (Calculus)	3	0	0	3
2	BSC-2	Engineering Chemistry	3	0	0	3
3	ESC-1	Engineering Mechanics	3	0	0	3
4	HSC-1	Communicative English	3	0	0	3
5	ESC-2	Programming for Problem Solving using C	3	0	0	3
6	BSC-L1	Engineering Chemistry Laboratory	0	0	3	1.5
7	ESC-L1	Programming for Problem Solving using CLaboratory	0	0	3	1.5
8	HSC-L1	English Communication Skills Laboratory	0	0	3	1.5
9	MC -1	Environmental Science	2	0	0	0
Total Credits			**17**	**0**	**11**	**19.5**

I Year – II SEMESTER

S. No	Course Code	Course Title	L	T	P	Credits
1	BSC-3	Mathematics – II (Mathematical Methods)	3	0	0	3
2	BSC-4	Engineering Physics	3	0	0	3
3	ESC-3	Mechanics of Solids	3	0	0	3
4	ESC-4	Basic Electrical and Electronics Engineering	3	0	0	3
5	ESC-5	Engineering Drawing	3	0	0	3
6	ESC-L2	Basic Electrical and Electronics Engineering Lab	0	0	3	1.5
7	BSC-L2	Engineering Physics Laboratory	0	0	3	1.5
8	ESC-L3	Engineering Workshop & IT Workshop Laboratory	0	0	3	1.5
9	MC-2	Constitution of India	2	0	0	0
Total Credits			**17**	**0**	**9**	**19.5**

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II YEAR – I SEMESTER

S. No.	Course Code	Course Title	L	T	P	Credits
1	BSC-5	MATHEMATICS-III(Vector Calculus, Transforms And PDE)	3	0	0	3
2	PCC-1	Development of Mineral Deposits	3	0	0	3
3	PCC-2	Mine Surveying	3	0	0	3
4	PCC-3	Engineering and Economic Geology	3	0	0	3
5	PCC-4	Mineral Processing Technology	3	0	0	3
6	PCC-L1	Mine Surveying Lab	0	0	3	1.5
7	PCC-L2	Engineering and Economic Geology Lab	0	0	3	1.5
8	PCC-L3	Mineral Processing Technology Lab	0	0	3	1.5
9	SOC-1	Numerical Techniques Through Matlab and Python	1	0	2	2
10	MC-3	Essence of Indian Traditional Knowledge	2	0	0	0
		Total Credits	**18**	**0**	**11**	**21.5**

II YEAR – II SEMESTER

S. No	Course Code	Course Title	L	T	P	Credits
1	ESC-6	Fluid Mechanics and Hydraulic Power	3	0	0	3
2	BSC-6	Complex Variables and Statistical Methods	3	0	0	3
3	PCC-5	Rock Mechanics	3	0	0	3
4	PCC-6	Mine Ventilation	3	0	0	3
5	HSC-2	Managerial Economics and Financial Accountancy	3	0	0	3
6	ESC-L4	Fluid Mechanics and Hydraulic Power Lab	0	0	3	1.5
7	PCC-L6	Mine Ventilation Lab	0	0	3	1.5
8	PCC-L7	Rock Mechanics Lab	0	0	3	1.5
9	SOC-2	Data Analytics for Geo-resources using R	1	0	2	2
10	MC-4	Engineering Exploration Project	1	0	0	0
		Total Credits	**17**	**0**	**11**	**21.5**
Honors/Minor courses			**4**	**0**	**0**	**4**

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III YEAR I SEMESTER

S. No.	Course Code	Course Title	L	T	P	Credits
1	PCC-7	Mine Hazards and Rescue	3	0	0	3
2	PCC-8	Underground Coal Mining	3	0	0	3
3	PCC-9	Mine Hoisting and Transportation	3	0	0	3
4	OE-1	1. Introduction to Underground Mining 2. Introduction to Surface Mining 3. Tunneling and Underground Space Design 4. Engineering Survey	3	0	0	3
5	PEC-1	1. Remote Sensing and GIS 2. Resource Evaluation and Geo-statistics 3. Mine Planning and Design 4. Mine Safety & Ergonomics	3	0	0	3
6	PCC-L6	Mine Hoisting and Transportation Lab	0	0	3	1.5
7	PCC-L7	Mine Hazards and Rescue Lab	0	0	3	1.5
8	SOC-3	Soft Skills	0	0	4	2
9	MC-5	Physical Fitness Activities	0	0	4	0
10	Evaluation of Summer Internship, completed after II B. Tech. II Semester					1.5
		Total Credits	**17**	**0**	**10**	**21.5**
Honors/Minor courses			**4**	**0**	**0**	**4**

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III YEAR II SEMESTER

S. No	Course Code	Course Title	L	T	P	Credits
1	PCC-10	Surface Mining	3	0	0	3
2	PCC-11	Mine Legislation and Safety	3	0	0	3
3	PCC-12	Underground Metal Mining	3	0	0	3
3	OE-2	1. Mineral Economics, Business and Trade 2. Landslides & Slope Stability Engineering 3. Remote Sensing and GIS 4. Geostatistics	3	0	0	3
5	PEC-2	1. Computer Applications and Tools 2. Mine Economics 3. Mine Mechanization 4. Mine Automation	3	0	0	3
6	PCC-L8	Mine Mechanization Lab	0	0	3	1.5
7	PCC-L9	Computer Applications in Mining Lab	0	0	3	1.5
8	PCC-L10	Mine Planning and Design Lab	0	0	3	1.5
9	SOC-4	Numerical modeling techniques in Mining Lab	0	0	4	2
10	MC-6	Research Methodologies & IPR	2	0	0	0
		Total Credits	**18**	**0**	**11**	**21.5**
Honors/Minor courses			**4**	**0**	**0**	**4**

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IV YEAR I SEMESTER

S. No	Code	Course Title	L	T	P	Credits
1	PEC-3	1. Operations Research 2. Dimensional Stone Mining 3. Advanced Mining Techniques 4. Planning of Underground Metal mining techniques	3	0	0	3
2	PEC-4	1. Mine closure and Reclamation 2. Surface Mine Environment 3. Sustainable Development for Mining 4. Mineral Economics, Business and Trade	3	0	0	3
3	PEC-5	1. Subsidence Engineering 2. Rock Slope Engineering 3. Advances in Rock Fragmentation 4. Tunneling and Underground Space Technology	3	0	0	3
4	OE-3	1. Mine Waste Management 2. Sustainable Development in Mining Industry 3. Mine Reclamation 4. Environmental Impact of Mining	3	0	0	3
5	OE-4	1. Principles of Mineral Engineering 2. Mine Instrumentation 3. Mine Safety & Ergonomics 4. Numerical Methods in Mining Engineering	3	0	0	3
6	HSC-3	Universal Human Values: Understanding Harmony	3	0	0	3
7	SOC-5	Soft Computing and Applications Lab	0	0	4	2
Evaluation of Summer Internship completed after III B. Tech II Semester						3
Total credits			**19**	**0**	**2**	**23**
Honors/Minor courses			**4**	**0**	**0**	**4**

IV YEAR II SEMESTER

S. No.	Category	Code	Course Title	Hours per week			Credits
				L	**T**	**P**	
1	Major Project	PROJ	Project work*	0	4	16	12
			Total credits	**0**	**4**	**16**	**12**

***Students can complete Project work @ Industries/ Higher Learning Institutions/ APSSDC.**

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MINORS IN MINING ENGINEERING

S. No	SUBJECT	PRE-REQUISTES
1	Development of Mineral Deposits	None
2	Rock Mechanics	Strength of Materials
3	Mine Ventilation	None
4	Underground Coal Mining	Development of Mineral Deposits
5	Mine Hoisting and Transportation	None
6	Surface mining	Development of Mineral Deposits

HONORS IN MINING ENGINEERING

HONORS IN MINING ENGINEERING		Pre-requisites
POOL – 1 (in II-II)		
1.	Optimization Techniques	-
2.	Modern Mining Techniques	-
3.	Mine Power Systems	-
4	Ground Improvement Techniques	-
POOL-2 (in III-I)		
1.	Mine Construction Engineering	-
2.	Grouting Technology	-
3.	Advanced Rock Mechanics	Rock Mechanics
4.	Concrete and Shotcrete Technology	-
POOL-3 (in III-II)		
1.	Rock Fragmentation engineering	-
2.	Mass Production Technology for Underground Coal	Mine Mechanization
3.	Introduction to Robotics and applications to Mining	-
4.	Deep Sea Mining	-
POOL-4 (in IV-I)		
1.	Mining Equipment Reliability, Maintainability and Availability	-
2.	Groundwater Engineering	-
3.	Production planning and control	-
4.	Introduction to Artificial Intelligence and Machine Learning	-

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I Year - I Semester		L	T	P	C
		3	0	0	3
MATHEMATICS-I (BS1101) **(Common to all Branch's for I Year B. Tech)**					

Course Objectives:

- This course will illuminate the students in the concepts of calculus.
- To enlighten the learners in the concept of differential equations and multivariable calculus.
- To equip the students with standard concepts and tools at an intermediate to advanced level mathematics to develop the confidence and ability among the students to handle various real world problems and their applications.

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

- utilize mean value theorems to real life problems (L3)
- solve the differential equations related to various engineering fields (L3)
- familiarize with functions of several variables which is useful in optimization (L3)
- Apply double integration techniques in evaluating areas bounded by region (L3)
- Students will also learn important tools of calculus in higher dimensions. Students will become familiar with 2- dimensional and 3-dimensional coordinate systems (L5)

UNIT I: Sequences, Series and Mean value theorems: (10 hrs)

Sequences and Series: Convergences and divergence – Ratio test – Comparison tests – Integral test – Cauchy's root test – Alternate series – Leibnitz's rule.

Mean Value Theorems (without proofs): Rolle's Theorem – Lagrange's mean value theorem – Cauchy's mean value theorem – Taylor's and Maclaurin's theorems with remainders.

UNIT II: Differential equations of first order and first degree: (10 hrs)

Linear differential equations – Bernoulli's equations – Exact equations and equations reducible to exact form.

Applications: Newton's Law of cooling – Law of natural growth and decay – Orthogonal trajectories - Electrical circuits.

UNIT III: Linear differential equations of higher order: (10 hrs)

Non-homogeneous equations of higher order with constant coefficients – with non-homogeneous term of the type e^{ax}, sin ax, cos ax, polynomials in x^n, e^{ax} V(x) and x^nV(x) – Method of Variation of parameters.

Applications: LCR circuit, Simple Harmonic motion.

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UNIT IV: Partial differentiation: (10 hrs)

Introduction – Homogeneous function – Euler's theorem – Total derivative – Chain rule – Jacobian – Functional dependence – Taylor's and Mc Laurent's series expansion of functions of two variables.

Applications: Maxima and Minima of functions of two variables without constraints and Lagrange's method (with constraints).

UNIT V: Multiple integrals: (8 hrs)

Double and Triple integrals – Change of order of integration – Change of variables.

Applications: Finding Areas and Volumes.

Text Books:

1. **B. S. Grewal,** Higher Engineering Mathematics, 43rd 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. **Joel Hass, Christopher Heil and Maurice D. Weir,** Thomas calculus, 14th Edition, Pearson.
3. **Lawrence Turyn,** Advanced Engineering Mathematics, CRC Press, 2013.
4. **Srimantha Pal, S C Bhunia,** Engineering Mathematics, Oxford University Press.

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I Year - I Semester		L	T	P	C
		3	0	0	3
ENGINEERING CHEMISTRY (BS1110)					

Knowledge of basic concepts of Chemistry for Engineering students will help them as professional engineers later in design and material selection, as well as utilizing the available resources.

Learning Objectives:

- **Importance** of usage of plastics in household appliances and composites (FRP) in aerospace and automotive industries.
- **Outline** the basics for the construction of electrochemical cells, batteries and fuel cells. Understand the mechanism of corrosion and how it can be prevented.
  Express the increase in demand as wide variety of advanced materials are introduced; which have excellent engineering properties.
  Classify and discuss the materials used in major industries like steel industry, metallurgical industries and construction industries and electrical equipment manufacturing industries. Lubrication is also **summarized**.
- **Relate** the need of fuels as a source of energy to any industry, particularly industries like thermal power stations, steel industry, fertilizer industry etc., and hence introduced.
- **Explain** the importance and usage of water as basic material in almost all the industries; **interpret** drawbacks of steam boilers and also how portable water is supplied for drinking purposes.

UNIT I: POLYMER TECHNOLOGY

Polymerisation:- Introduction-methods of polymerization (emulsion and suspension)-physical and mechanical properties.

Plastics: Compounding-fabrication (compression, injection, blown film, extrusion) - preparation, properties and applications of PVC, polycarbonates and Bakelite-mention some examples of plastic materials used in electronic gadgets, recycling of e-plastic waste.

Elastomers:- Natural rubber-drawbacks-vulcanization-preparation, properties and applications of synthetic rubbers (Buna S, thiokol and polyurethanes).

Composite materials: Fiber reinforced plastics-conducting polymers-biodegradable polymers- biopolymers-biomedical polymers.

Learning Outcomes: At the end of this unit, the students will be able to

- **Outline** the properties of polymers and various additives added and different methods of forming plastic materials.
- **Explain** the preparation, properties and applications of some plastic materials.
- **Interpret** the mechanism of conduction in conducting polymers .
- **Discuss** natural and synthetic rubbers and their applications.

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UNIT II: ELECTROCHEMICAL CELLS AND CORROSION

Single electrode potential-Electrochemical series and uses of series-standard hydrogen electrode, calomel electrode-concentration cell-construction of glass electrode-Batteries: Dry cell, Ni-Cd cells, Ni-Metal hydride cells, Li ion battery, zinc air cells–Fuel cells: H_2-O_2, CH_3OH-O_2, phosphoric acid, molten carbonate.

Corrosion:-Definition-theories of corrosion (chemical and electrochemical)-galvanic corrosion, differential aeration corrosion, stress corrosion, waterline corrosion-passivity of metals-galvanic series-factors influencing rate of corrosion-corrosion control (proper designing, cathodic protection)-Protective coatings: Surface preparation, cathodic and anodic coatings, electroplating, electroless plating (nickel). Paints (constituents, functions, special paints).

Learning Outcomes: At the end of this unit, the students will be able to

- **Explain** the theory of construction of battery and fuelcells.
- **Categorize** the reasons for corrosion and study some methods of corrosion control.

UNIT III: CHEMISTRY OF MATERIALS

Part- A:

Nano materials:- Introduction-sol-gel method-characterization by BET, SEM and TEM methods-applications of graphene-carbon nanotubes and fullerenes:Types, preparation and applications

Thermal analysis techniques: Instrumentation and applications of thermogravimetric analysis (TGA), differential thermal analysis (DTA), differential scanning calorimetry (DSC).

Part-B:

Refractories: - Definition, classification, properties (refractoriness, refractoriness under load, porosity and thermal spalling), failure of refractories.

Lubricants: - Definition, mechanism of lubricants and properties (definition and importance).

Cement: - Constituents, manufacturing, parameters to characterize the clinker formation: lime saturation factor (LSF), silica ratio (SR) and alumina ratio (AR), chemistry of setting and hardening, deterioration of cement.

Learning Outcomes: At the end of this unit, the students will be able to

- **Outline** the awareness of materials like nanomaterials and fullerenes and their uses.
- **Explain** the techniques that detect and measure changes of state of reaction.
- **Illustrate** the commonly used industrial materials.

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UNIT IV: FUELS

Introduction-calorific value-HCV and LCV-problems using Dulong's formula-proximate and ultimate analysis of coal sample-significance of these analyses-problems-Petroleum (refining-cracking)-Synthetic petrol (Fischer Tropsch and Bergius)-petrol knocking-diesel knocking-octane and cetane ratings-anti-knock agents-Introduction to alternative fuels (Bio-diesel, ethanol, methanol, Natural gas, LPG, CNG)-Flue gas analysis by Orsat apparatus-Rocket fuels.

Learning Outcomes: At the end of this unit, the students will be able to

- **Differentiate** petroleum, petrol, synthetic petrol and have knowledge how they are produced.
- **Study** alternate fuels.
- **Analyse** flue gases.

UNIT V: WATER TECHNOLOGY

Hardness of water-determination of hardness by complexometric method-boiler troubles (priming and foaming, scale formation, boiler corrosion, caustic embrittlement)-internal treatments-softening of hard water (zeolite processs and related sums, ion exchange process)-treatment of industrial waste water

Portable water and its specifications-steps involved in purification of water-chlorination, break point chlorination-reverse osmosis and electro dialysis.

Learning Outcomes: At the end of this unit, the students will be able to

- **Explain** the impurities present in raw water, problems associated with them and how to avoid them are understood.

Standard Books:

1. Engineering Chemistry by Jain and Jain; Dhanpat Rai Publicating Co. Latest edition
2. Engineering Chemistry by Shikha Agarwal; Cambridge University Press, 2019 edition.
3. A text book of engineering Chemistry by S. S. Dara; S. Chand & Co Ltd., Latest Edition
   Engineering Chemistry by Shashi Chawla; Dhanpat Rai Publicating Co. Latest edition

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I Year - I Semester		L	T	P	C
		3	0	0	3
ENGINEERING MECHANICS (ES1104)					

Objectives: The students completing this course are expected to understand the concepts of forces and its resolution in different planes, resultant of force system, Forces acting on a body, their free body diagrams using graphical methods. They are required to understand the concepts of centre of gravity and moments of inertia and their application, Analysis of frames and trusses, different types of motion, friction and application of work - energy method.

UNIT – I

Objectives: The students are to be exposed to the concepts of force and friction, direction and its application.
Introduction to Engg. Mechanics – Basic Concepts.
Systems of Forces: Coplanar Concurrent Forces – Components in Space – Resultant – Moment of Force and its Application – Couples and Resultant of Force Systems.
Friction: Introduction**,** limiting friction and impending motion, coulomb's laws of dry friction, coefficient of friction, cone of friction

UNIT II
Objectives: The students are to be exposed to application of free body diagrams. Solution to problems using graphical methods and law of triangle of forces.
Equilibrium of Systems of Forces: Free Body Diagrams, , Lami's Theorm, Equations of Equilibrium of Coplanar Systems, Graphical method for the equilibrium, Triangle law of forces, converse of the law of polygon of forces condition of equilibrium, Equations of Equilibrium for Spatial System of forces, Numerical examples on spatial system of forces using vector approach, Analysis of plane trusses.

UNIT – III
Objectives: The students are to be exposed to concepts of centre of gravity. The students are to be exposed to concepts of moment of inertia and polar moment of inertia including transfer methods and their applications.
Centroid: Centroids of simple figures (from basic principles) – Centroids of Composite Figures
Centre of Gravity: Centre of gravity of simple body (from basic principles), centre of gravity of composite bodies, Pappus theorems.
Area moments of Inertia: Definition – Polar Moment of Inertia, Transfer Theorem, Moments of Inertia of Composite Figures, Products of Inertia, Transfer Formula for Product of Inertia. **Mass Moment of Inertia:** Moment of Inertia of Masses, Transfer Formula for Mass Moments of Inertia, mass moment of inertia of composite bodies.

UNIT – IV
Objectives: The students are to be exposed to motion in straight line and in curvilinear paths, its velocity and acceleration computation and methods of representing plane motion.
Rectilinear and Curvilinear motion of a particle: Kinematics and Kinetics- Work Energy method and applications to particle motion- Impulse momentum method.

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UNIT – V

Objectives: The students are to be exposed to rigid motion kinematics and kinetics

Rigid body Motion**:** Kinematics and kinetics of translation, Rotation about fixed axis and plane motion, Work Energy method and Impulse momentum method.

TEXT BOOK:

1. Engg. Mechanics - S.Timoshenko & D.H.Young., 4th Edn - , Mc Graw Hill publications.

Course outcomes:

1. The student should be able to draw free body diagrams for FBDs for particles and rigid bodies in plane and space and problems to solve the unknown forces, orientations and geometric parameters.
2. He should be able to determine centroid for lines, areas and center of gravity for volumes and their composites.
3. He should be able to determine area and mass movement of inertia for composite sections
4. He should be able to analyze motion of particles and rigid bodies and apply the principles of motion, work energy and impulse – momentum.

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I Year - I Semester		L	T	P	C
		3	0	0	3
COMMUNICATIVE ENGLISH (HS1201)					

Introduction

The course is designed to train students in receptive (listening and reading) as well as productive and interactive (speaking and writing) skills by incorporating a comprehensive, coherent and integrated approach that improves the learners' ability to effectively use English language in academic/ workplace contexts. The shift is from learning about the language to using the language. On successful completion of the compulsory English language course/s in B.Tech., learners would be confident of appearing for international language qualification/proficiency tests such as IELTS, TOEFL, or BEC, besides being able to express themselves clearly in speech and competently handle the writing tasks and verbal ability component of campus placement tests. Activity based teaching-learning methods would be adopted to ensure that learners would engage in actual use of language both in the classroom and laboratory sessions.

Course Objectives

- Facilitate effective listening skills for better comprehension of academic lectures and English spoken by native speakers
- Focus on appropriate reading strategies for comprehension of various academic texts and authentic materials
- Help improve speaking skills through participation in activities such as role plays, discussions and structured talks/oral presentations
- Impart effective strategies for good writing and demonstrate the same in summarizing, writing well organized essays, record and report useful information
- Provide knowledge of grammatical structures and vocabulary and encourage their appropriate use in speech and writing

Learning Outcomes

At the end of the module, the learners will be able to

- understand social or transactional dialogues spoken by native speakers of English and identify the context, topic, and pieces of specific information
- ask and answer general questions on familiar topics and introduce oneself/others
- employ suitable strategies for skimming and scanning to get the general idea of a text and locate specific information
- recognize paragraph structure and be able to match beginnings/endings/headings with paragraphs
- form sentences using proper grammatical structures and correct word forms

Unit 1:

Lesson-1: A Drawer full of happiness from "**Infotech English**", Maruthi Publications
Lesson-2: Deliverance by Premchand from "**The Individual Society",** Pearson Publications. (Non-detailed)
Listening: Listening to short audio texts and identifying the topic. Listening to short audio texts and identifying the context and specific pieces of information to answer a series of questions both in speaking and writing.
Speaking: Asking and answering general questions on familiar topics such as home, family, work, studies and interests. Self introductions and introducing others.

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Reading: Skimming text to get the main idea. Scanning to look for specific pieces of information.

Reading for Writing: Paragraph writing (specific topics) using suitable cohesive devices; linkers, sign posts and transition signals; mechanics of writing - punctuation, capital letters.

Vocabulary: Technical vocabulary from across technical branches (20) GRE Vocabulary (20) (Antonyms and Synonyms, Word applications) Verbal reasoning and sequencing of words.

Grammar: Content words and function words; word forms: verbs, nouns, adjectives and adverbs; nouns: countables and uncountables; singular and plural basic sentence structures; simple question form - wh-questions; word order in sentences.
Pronunciation: Vowels, Consonants, Plural markers and their realizations

Unit 2:
Lesson-1: Nehru's letter to his daughter Indira on her birthday from "**Infotech English**", Maruthi Publications
Lesson-2: Bosom Friend by Hira Bansode from "**The Individual Society",** Pearson Publications. (Non-detailed)
Listening: Answering a series of questions about main idea and supporting ideas after listening to audio texts, both in speaking and writing.
Speaking: Discussion in pairs/ small groups on specific topics followed by short structured talks. Functional English: Greetings and leave takings.
Reading: Identifying sequence of ideas; recognizing verbal techniques that help to link the ideas in a paragraph together.
Reading for Writing: Summarizing - identifying main idea/s and rephrasing what is read; avoiding redundancies and repetitions.
Vocabulary: Technical vocabulary from across technical branches (20 words). GRE Vocabulary Analogies (20 words) (Antonyms and Synonyms, Word applications)
Grammar: Use of articles and zero article; prepositions.
Pronunciation: Past tense markers, word stress-di-syllabic words

Unit 3:
Lesson-1: Stephen Hawking-Positivity 'Benchmark' from "**Infotech English**", Maruthi Publications
Lesson-2: Shakespeare's Sister by Virginia Woolf from "**The Individual Society",** Pearson Publications. (Non-detailed**)**
Listening: Listening for global comprehension and summarizing what is listened to, both in speaking and writing.
Speaking: Discussing specific topics in pairs or small groups and reporting what is discussed. Functional English: Complaining and Apologizing.
Reading: Reading a text in detail by making basic inferences - recognizing and interpreting specific context clues; strategies to use text clues for comprehension. Critical reading.
Reading for Writing: Summarizing - identifying main idea/s and rephrasing what is read; avoiding redundancies and repetitions. Letter writing-types, format and principles of letter writing. E-mail etiquette, Writing CV's.

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Vocabulary: Technical vocabulary from across technical branches (20 words). GRE Vocabulary (20 words) (Antonyms and Synonyms, Word applications) Association, sequencing of words
Grammar: Verbs - tenses; subject-verb agreement; direct and indirect speech, reporting verbs for academic purposes.
Pronunciation: word stress-poly-syllabic words

Unit 4:
Lesson-1: Liking a Tree, Unbowed: Wangari Maathai-biography from "**Infotech English**", Maruthi Publications
Lesson-2: Telephone Conversation-Wole Soyinka from "**The Individual Society",** Pearson Publications**.** (Non-detailed)
Listening: Making predictions while listening to conversations/ transactional dialogues without video (only audio); listening to audio-visual texts.
Speaking: Role plays for practice of conversational English in academic contexts (formal and informal) - asking for and giving information/directions. Functional English: Permissions, Requesting, Inviting.
Reading: Studying the use of graphic elements in texts to convey information, reveal trends/patterns/relationships, communicative process or display complicated data.
Reading for Writing: Information transfer; describe, compare, contrast, identify significance/trends based on information provided in figures/charts/graphs/tables. Writing SOP, writing for media.
Vocabulary: Technical vocabulary from across technical branches (20 words) GRE Vocabulary (20 words) (Antonyms and Synonyms, Word applications) Cloze Encounters.
Grammar: Quantifying expressions - adjectives and adverbs; comparing and contrasting; degrees of comparison; use of antonyms
Pronunciation: Contrastive Stress

Unit 5:
Lesson-1: Stay Hungry-Stay foolish from "**Infotech English**", Maruthi Publications
Lesson-2: Still I Rise by Maya Angelou from "**The Individual Society",** Pearson Publications. (Non-detailed)
Listening: Identifying key terms, understanding concepts and interpreting the concepts both in speaking and writing.
Speaking: Formal oral presentations on topics from academic contexts - without the use of PPT slides. Functional English: Suggesting/Opinion giving.
Reading: Reading for comprehension. RAP Strategy Intensive reading and Extensive reading techniques.
Reading for Writing: Writing academic proposals- writing research articles: format and style.
Vocabulary: Technical vocabulary from across technical branches (20 words) GRE Vocabulary (20 words) (Antonyms and Synonyms, Word applications) Coherence, matching emotions.
Grammar: Editing short texts – identifying and correcting common errors in grammar and usage (articles, prepositions, tenses, subject verb agreement)
Pronunciation: Stress in compound words
Prescribed text books for theory:

1. "**Infotech English**", Maruthi Publications. (Detailed)
2. "**The Individual Society",** Pearson Publications. (Non-detailed)

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Reference books:

1. Bailey, Stephen. Academic writing: A handbook for international students. Routledge, 2014.
2. Chase, Becky Tarver. Pathways: Listening, Speaking and Critical Thinking. Heinley ELT; 2nd Edition, 2018.
3. Skillful Level 2 Reading & Writing Student's Book Pack (B1) Macmillan Educational. Hewings, Martin. Cambridge Academic English (B2). CUP, 2012.

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DEPARTMENT OF MINING ENGINEERING

I Year - I Semester		L	T	P	C
		3	0	0	3
PROGRAMMING FOR PROBLEM SOLVING USING C (ES1101)					

COURSE OBJECTIVES:

The objectives of Programming for Problem Solving Using C are

1) To learn about the computer systems, computing environments, developing of a computer program and Structure of a C Program
2) To gain knowledge of the operators, selection, control statements and repetition in C
3) To learn about the design concepts of arrays, strings, enumerated structure and union types. To learn about their usage.
4) To assimilate about pointers, dynamic memory allocation and know the significance of Preprocessor.
5) To assimilate about File I/O and significance of functions

UNIT I

Introduction to Computers: Creating and running Programs, Computer Numbering System, Storing Integers, Storing Real Numbers

Introduction to the C Language: Background, C Programs, Identifiers, Types, Variable, Constants, Input/output, Programming Examples, Scope, Storage Classes and Type Qualifiers.

Structure of a C Program: Expressions Precedence and Associativity, Side Effects, Evaluating Expressions, Type Conversion Statements, Simple Programs, Command Line Arguments.

UNIT II

Bitwise Operators: Exact Size Integer Types, Logical Bitwise Operators, Shift Operators.

Selection & Making Decisions: Logical Data and Operators, Two Way Selection, Multiway Selection, More Standard Functions

Repetition: Concept of Loop, Pretest and Post-test Loops, Initialization and Updating, Event and Counter Controlled Loops, Loops in C, Other Statements Related to Looping, Looping Applications, Programming Examples

UNIT III

Arrays: Concepts, Using Array in C, Array Application, Two Dimensional Arrays, Multidimensional Arrays, Programming Example – Calculate Averages

Strings: String Concepts, C String, String Input / Output Functions, Arrays of Strings, String Manipulation Functions String/ Data Conversion, A Programming Example – Morse Code

Enumerated, Structure, and Union: The Type Definition (Type def), Enumerated Types, Structure, Unions, and Programming Application

UNIT IV

Pointers: Introduction, Pointers to pointers, Compatibility, L value and R value

Pointer Applications: Arrays, and Pointers, Pointer Arithmetic and Arrays, Memory Allocation Function, Array of Pointers, Programming Application

Processor Commands: Processor Commands

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UNIT V

Functions: Designing, Structured Programs, Function in C, User Defined Functions, Inter-Function Communication, Standard Functions, Passing Array to Functions, Passing Pointers to Functions, Recursion

Text Input / Output: Files, Streams, Standard Library Input / Output Functions, Formatting Input / Output Functions, Character Input / Output Functions

Binary Input / Output: Text versus Binary Streams, Standard Library, Functions for Files, Converting File Type.

TEXT BOOKS:

1. Programming for Problem Solving, Behrouz A. Forouzan, Richard F.Gilberg, CENGAGE
2. The C Programming Language, Brian W.Kernighan, Dennis M. Ritchie, 2e, Pearson

REFERENCES:

1. Computer Fundamentals and Programming, Sumithabha Das, Mc Graw Hill
2. Programming in C, Ashok N. Kamthane, Amit Kamthane, Pearson
3. Computer Fundamentals and Programming in C, Pradip Dey, Manas Ghosh, OXFORD

COURSE OUTCOMES:

Upon the completion of the course the student will learn

1) To write algorithms and to draw flowcharts for solving problems
2) To convert flowcharts/algorithms to C Programs, compile and debug programs
3) To use different operators, data types and write programs that use two-way/ multi-way selection
4) To select the best loop construct for a given problem
5) To design and implement programs to analyze the different pointer applications
6) To decompose a problem into functions and to develop modular reusable code
7) To apply File I/O operations

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I Year - I Semester		L	T	P	C
		0	0	3	1.5
ENGINEERING CHEMISTRY LABROTARY (BS1111)					

Introduction to Chemistry laboratory – Molarity, normality, primary, secondary standard solutions, volumetric titrations, quantitative analysis

1. Determination of HCl using standard Na_2CO_3 solution.
2. Determination of alkalinity of a sample containing Na_2CO_3 and NaOH.
3. Determination of Mn (II) using standard oxalic acid solution.
4. Determination of ferrous iron using standard $K_2Cr_2O_7$ solution.
5. Determination of copper (II) using standard hypo solution.
6. Determination of temporary and permanent hardness of water using standard EDTA solution.
7. Determination of iron (III) by a colorimetric method.
8. Determination of the concentration of acetic acid using sodium hydroxide (pH-metry method).
9. Determination of the concentration of strong acid vs strong base (by conductometric method).
10. Determination of strong acid vs strong base (by potentiometric method).
11. Determination of Mg^{+2} present in anantacid.
12. Determination of $CaCO_3$ present in an egg shell.
13. Estimation of Vitamin C.
14. Determination of phosphoric content in soft drinks.
15. Adsorption of acetic acid by charcoal.
16. Preparation of nylon-6, 6 and Bakelite (demonstration only).

Of the above experiments at-least 10 assessment experiments should be completed in a semester.

Outcomes: The students entering into the professional course have practically very little exposure to lab classes. The experiments introduce volumetric analysis; redox titrations with different indicators; EDTA titrations; then they are exposed to a few instrumental methods of chemical analysis. Thus at the end of the lab course, the student is exposed to different methods of chemical analysis and use of some commonly employed instruments. They thus acquire some experimental skills.

Reference Books:

1. A Textbook of Quantitative Analysis, Arthur J. Vogel.

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DEPARTMENT OF MINING ENGINEERING

I Year - I Semester		L	T	P	C
		0	0	3	1.5
PROGRAMMING FOR PROBLEM SOLVING USING C LAB (ES1102)					

Course Objectives:

1) Apply the principles of C language in problem solving.
2) To design flowcharts, algorithms and knowing how to debug programs.
3) To design & develop of C programs using arrays, strings pointers & functions.
4) To review the file operations, preprocessor commands.

Exercise 1:

1. Write a C program to print a block F using hash (#), where the F has a height of six characters and width of five and four characters.
2. Write a C program to compute the perimeter and area of a rectangle with a height of 7 inches and width of 5 inches.
3. Write a C program to display multiple variables.

Exercise 2:

1. Write a C program to calculate the distance between the two points.
2. Write a C program that accepts 4 integers p, q, r, s from the user where r and s are positive and p is even. If q is greater than r and s is greater than p and if the sum of r and s is greater than the sum of p and q print "Correct values", otherwise print "Wrong values".

Exercise 3:

1. Write a C program to convert a string to a long integer.
2. Write a program in C which is a Menu-Driven Program to compute the area of the various geometrical shape.
3. Write a C program to calculate the factorial of a given number.

Exercise 4:

1. Write a program in C to display the n terms of even natural number and their sum.
2. Write a program in C to display the n terms of harmonic series and their sum. 1 + 1/2 + 1/3 + 1/4 + 1/5 ... 1/n terms.
3. Write a C program to check whether a given number is an Armstrong number or not.

Exercise 5:

1. Write a program in C to print all unique elements in an array.
2. Write a program in C to separate odd and even integers in separate arrays.
3. Write a program in C to sort elements of array in ascending order.

Exercise 6:

1. Write a program in C for multiplication of two square Matrices.
2. Write a program in C to find transpose of a given matrix.

Exercise 7:

1. Write a program in C to search an element in a row wise and column wise sorted matrix.
2. Write a program in C to print individual characters of string in reverse order.

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Exercise 8:

1. Write a program in C to compare two strings without using string library functions.
2. Write a program in C to copy one string to another string.

Exercise 9:

1. Write a C Program to Store Information Using Structures with Dynamically Memory Allocation
2. Write a program in C to demonstrate how to handle the pointers in the program.

Exercise 10:

1. Write a program in C to demonstrate the use of & (address of) and *(value at address) operator.
2. Write a program in C to add two numbers using pointers.

Exercise 11:

1. Write a program in C to add numbers using call by reference.
2. Write a program in C to find the largest element using Dynamic Memory Allocation.

Exercise 12:

1. Write a program in C to swap elements using call by reference.
2. Write a program in C to count the number of vowels and consonants in a string using a pointer.

Exercise 13:

1. Write a program in C to show how a function returning pointer.
2. Write a C program to find sum of n elements entered by user. To perform this program, allocate memory dynamically using malloc( ) function.

Exercise 14:

1. Write a C program to find sum of n elements entered by user. To perform this program, allocate memory dynamically using calloc( ) function. Understand the difference between the above two programs
2. Write a program in C to convert decimal number to binary number using the function.

Exercise 15:

1. Write a program in C to check whether a number is a prime number or not using the function.
2. Write a program in C to get the largest element of an array using the function.

Exercise 16:

1. Write a program in C to append multiple lines at the end of a text file.
2. Write a program in C to copy a file in another name.
3. Write a program in C to remove a file from the disk.

Course Outcomes:

By the end of the Lab, the student

1) Gains Knowledge on various concepts of a C language.
2) Able to draw flowcharts and write algorithms.
3) Able design and development of C problem solving skills.
4) Able to design and develop modular programming skills.
5) Able to trace and debug a program

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I Year - I Semester		L	T	P	C
		0	0	3	1.5
ENGLISH COMMUNICATION SKILLS LABORATARY (HS1203)					

UNIT I:
Oral Activity: JAM, Hypothetical Situations, Self/Peer Profile Common Errors in Pronunciation, Neutralising Accent

UNIT II:
Oral Activity: Telephonic Etiquette, Role Plays Poster Presentations

UNIT III:
Oral Activity: Oral Presentation skills, Public speaking Data Interpretation

UNIT IV:
Oral Activity: Group Discussions: Do's and Don'ts- Types, Modalities

UNIT V:
Oral Activity: Interview Skills: Preparatory Techniques, Frequently asked questions, Mock Interviews.
Pronunciation: Connected speech (Pausing, Tempo, Tone, Fluency etc.,)

References:

1. Infotech English, Maruthi Publications (with Compact Disc).
2. Exercises in Spoken English Part 1,2,3,4, OUP and CIEFL.
3. English Pronunciation in use- Mark Hancock, Cambridge University Press.
4. English Phonetics and Phonology-Peter Roach, Cambridge UniversityPress.
5. English Pronunciation in use- Mark Hewings, Cambridge UniversityPress.
6. English Pronunciation Dictionary- Daniel Jones, Cambridge University Press.
7. English Phonetics for Indian Students- P. Bala Subramanian, Mac Millan Publications.
8. Technical Communication- Meenakshi Raman, Sangeeta Sharma, Oxford University Press.
9. Technical Communication- Gajendrea Singh Chauhan, Smita Kashiramka, Cengage Publications.

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I Year - I Semester		L	T	P	C
		2	0	0	0
ENVIRONMENTAL SCIENCE (MC1101)					

Learning Objectives:

The objectives of the course are to impart:

- Overall understanding of the natural resources.
- Basic understanding of the ecosystem and its diversity.
- Acquaintance on various environmental challenges induced due to unplanned anthropogenic activities.
- An understanding of the environmental impact of developmental activities.
- Awareness on the social issues, environmental legislation and global treaties.

UNIT-I: Multidisciplinary nature of Environmental Studies: Definition, Scope and Importance – Sustainability: Stockholm and Rio Summit–Global Environmental Challenges: Global warming and climate change, acid rains, ozone layer depletion, population growth and explosion, effects;. Role of information technology in environment and human health.

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 Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems.

UNIT-II: Natural Resources: Natural resources and associated problems.

Forest resources: Use and over – exploitation, deforestation – 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.

Food resources: World food problems, changes caused by non-agriculture activities-effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity.

Energy resources: Growing energy needs, renewable and non-renewable energy sources use of alternate energy sources.

Land resources: Land as a resource, land degradation, Wasteland reclamation, man induced landslides, soil erosion and desertification; Role of an individual in conservation of natural resources; Equitable use of resources for sustainable lifestyles.

UNIT-III: Biodiversity and its conservation: Definition: genetic, species and ecosystem diversity-classification - Value of biodiversity: consumptive use, productive use, social-Biodiversity at national and local levels. India as a mega-diversity nation - Hot-sports of biodiversity - Threats to biodiversity: habitat loss, man-wildlife conflicts. - Endangered and endemic species of India – Conservation of biodiversity: conservation of biodiversity.

UNIT – IV Environmental Pollution: Definition, Cause, effects and control measures of Air pollution, Water pollution, Soil pollution, Noise pollution, Nuclear hazards. Role of an individual in prevention of pollution. - Pollution case studies, Sustainable Life Studies. Impact of Fire Crackers on Men and his well being.

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Solid Waste Management: Sources, Classification, effects and control measures of urban and industrial solid wastes. Consumerism and waste products, Biomedical, Hazardous and e – waste management.

UNIT – V Social Issues and the Environment: Urban problems related to energy -Water conservation, rain water harvesting-Resettlement and rehabilitation of people; its problems and concerns. Environmental ethics: Issues and possible solutions. Environmental 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.

Text Books:

1. Environmental Studies, K. V. S. G. Murali Krishna, VGS Publishers, Vijayawada
2. Environmental Studies, R. Rajagopalan, 2nd Edition, 2011, Oxford University Press.
3. Environmental Studies, P. N. Palanisamy, P. Manikandan, A. Geetha, and K. Manjula Rani; Pearson Education, Chennai

References:

1. Text Book of Environmental Studies, Deeshita Dave & P. Udaya Bhaskar, Cengage Learning.
2. A Textbook of Environmental Studies, Shaashi Chawla, TMH, New Delhi
3. Environmental Studies, Benny Joseph, Tata McGraw Hill Co, New Delhi
4. Perspectives in Environment Studies, Anubha Kaushik, C P Kaushik, New Age International Publishers, 2014

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DEPARTMENT OF MINING ENGINEERING

I Year - II Semester		L	T	P	C
		3	0	0	3
MATHEMATICS - II (BS1102) **(Common to all Branch's for I Year B. Tech)**					

Course Objectives:

- To instruct the concept of Matrices in solving linear algebraic equations
- 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 equip the students with standard concepts and tools at an intermediate to advanced level mathematics to develop the confidence and ability among the students to handle various real world problems and their applications.

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

- develop the use of matrix algebra techniques that is needed by engineers for practical applications (L6)
- solve system of linear algebraic equations using Gauss elimination, Gauss Jordan, Gauss Seidel (L3)
- evaluate approximating the roots of polynomial and transcendental equations by different algorithms (L5)
- apply Newton's forward & backward interpolation and Lagrange's formulae for equal and unequal intervals (L3)
- apply different algorithms for approximating the solutions of ordinary differential equationsto its analytical computations (L3)

Unit I: Solving systems of linear equations, Eigen values and Eigen vectors: (10 hrs)

Rank of a matrix by echelon form and normal form – Solving system of homogeneous and non-homogeneous equations linear equations – Gauss Elimination for solving system of equations – Eigen values and Eigen vectors and their properties.

Unit-II: Cayley-Hamilton theorem and Quadratic forms: (10 hrs)

Cayley-Hamilton theorem (without proof) – Finding inverse and power of a matrix by Cayley-Hamilton theorem – Reduction to Diagonal form – Quadratic forms and nature of the quadratic forms - Reduction of quadratic form to canonical forms by orthogonaltransformation.
Singular values of a matrix, singular value decomposition (Ref. Book – 1).

UNIT III: Iterative methods: (8 hrs)

Introduction – Bisection method – Secant method – Method of false position – Iteration method – Newton-Raphson method (One variable and simultaneous Equations) – Jacobi and Gauss-Seidel methods for solving system of equations.

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UNIT IV: Interpolation: (10 hrs)

Introduction – Errors in polynomial interpolation – Finite differences – Forward differences – Backward differences – Central differences – Relations between operators – Newton's forward and backward formulae for interpolation – Interpolation with unequal intervals – Lagrange's interpolation formula – Newton's divide difference formula.

UNIT V: Numerical integration and solution of ordinary differential equations: (10 hrs)

Trapezoidal rule – Simpson's $1/3^{rd}$ and $3/8^{th}$ rule – Solution of ordinary differential equations by Taylor's series – Picard's method of successive approximations – Euler's method – Runge-Kutta method (second and fourth order).

Text Books:

1. **B. S. Grewal,** Higher Engineering Mathematics, 43^{rd} Edition, Khanna Publishers.
2. **B. V. Ramana,** Higher Engineering Mathematics, 2007 Edition, Tata Mc. Graw Hill Education.

Reference Books:

1. **David Poole,** Linear Algebra- A modern introduction, 4^{th} Edition, Cengage.
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.

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DEPARTMENT OF MINING ENGINEERING

I Year - II Semester		L	T	P	C
		3	0	0	3
ENIGINEERING PHYSICS (BS1208)					

Course Objectives:

Physics curriculum which is re-oriented to the needs of non-circuital branches of graduate engineering courses offered by JNTUniversity:kakinada that serves as a transit to understand the branch specific advanced topics. The course is designed to:

- Impart concepts of mechanics required to identify forces and moments in mechanical systems by vector representation-extend Newton's second law for inertial and non-inertial frames of reference- study different types of harmonic oscillatory motions.
- Tap the Simple harmonic motion and its adaptability for improved acoustic quality of concert halls- impart concepts of flaw detection techniques using ultrasonics.
- Study the structure- property relationship exhibited by solid materials within the elastic limit.
- Impart knowledge in basic concepts of LASERs along with its Engineering applications- Familiarize types of sensors for various engineering applications
- Explore the knowledge of magnetic and dielectric materials and their utility in appliances.

UNIT-I: (10hrs)

MECHANICS: Basic laws of vectors and scalars, rotational frames-conservative and non – conservative forces , F = - grad V, Newton's laws in inertial and linear accelerating non-inertial frames of reference, rotating frame of reference with constant angular velocity, Harmonic oscillator ; damped harmonic motion ; Forced oscillations and resonance.

Outcome:

The students will be able to

- Identify forces and moments in mechanical systems using scalar and vector techniques
- extend Newton's second law for inertial and non-inertial frame of reference
- explain simple harmonic motion and damped harmonic motions

UNIT-II: (10hrs)

ACOUSTICS & ULTRASONICS: Introduction – Reverberation - Reverberation time - Sabine's formula (Derivation using growth and decay method)–absorption coefficient and its determination-factors affecting acoustics of buildings and their remedies.

Production of ultrasonics by Magnetostriction and piezoelectric methods – Detection of ultrasonics - acoustic grating - Non-Destructive Testing- pulse echo system through transmission and reflection modes - Applications.

Outcome:

The students will be able to

- explain how sound is propagated in buildings
- analyze acoustic properties of typically used materials in buildings
- recognize sound level disruptors and their use in architecturalacoustics
- Use of ultrasonics in flaw detection using NDT technique

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UNIT-III: (9hrs)

ELASTICITY:, stress, strain, Hooke's law, stress-strain curve, generalized Hooke's law with and without thermal strains for isotropic materials, different types of moduli and their relations, bending of beams – Bending moment of a beam – Depression of cantilever.

Outcome:

The students will be able to

- Understand the elasticity and plasticity concepts
- Study different types of moduli and their relation
- Analyze the concepts of shearing force and moment of inertia

UNIT-IV: (9hrs)

LASERS & SENSORS: Characteristics–Spontaneous and Stimulated emission of radiation – population inversion - Einstein's coefficients & Relation between them and their significance - Pumping Mechanisms - Ruby laser – Helium Neon laser – Applications.

SENSORS (qualitative description only): Different types of sensors and applications; Strain and Pressure sensors- Piezoelectric, magnetostrictive sensors, Temperature sensor - bimetallic strip, pyroelectric detectors.

Outcome:

The students will be able to

- **Understand** the basic concepts of LASER light Sources
- Study Different types of laser systems
- Identify different types of sensors and their working principles

UNIT-V: (10hrs)

MAGNETISM & DIELECTRICS: Introduction – Magnetic dipole moment – Magnetization-Magnetic susceptibility and permeability – Origin of permanent magnetic moment – Bohr Magneton - Classification of magnetic materials (Dia, Para and Ferro) – Domain concept of Ferromagnetism - Hysteresis – soft and hard magnetic materials – Applications of Ferromagnetic materials.

Introduction - Dielectric polarization – Dielectric polarizability, Susceptibility and Dielectric constant-types of polarizations: Electronic and Ionic (Quantitative), Orientational polarizations (qualitative)-Lorentz internal field – Claussius_Mossoti equation- Frequency dependence of polarization - Applications of dielectrics.

Outcome:

The students will be able to

- **explain** the concept of dielectric constant and polarization in dielectric materials.
- **summarize** various types of polarization of dielectrics .
- **interpret** Lorentz field and Claussius_Mosotti relation in dielectrics.
- **classify** the magnetic materials based on susceptibility and their temperature dependence.
- **explain** the applications of dielectric and magnetic materials .
- **Apply** the concept of magnetism to magnetic devices.

Text Books:

1. "Engineering Mechanics" by Manoj K Harbola, Cengage Publications 2nd Eds.
2. "A text book of Engineering Physics" by P G Kshirsagar & M N Avadhanulu, S Chand & Company Ltd.
3. "Engineering Physics" by R K Gaur and S L Gupta, Dhanpat Rai Publications.
4. "Sensor and Transducers" by Ian R Sinclair, Elsevier (Newnes) 3rd Eds.

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Reference Books:

1. "Engineering Physics" by M R Srinivasan, New Age International Publishers.
2. "Lectures on Physics" by Richard P Feynman, Pearson Publishers, New Millennium Eds.
3. "Lasers and Non-linear Optics" by B B Laud, New Age International Publishers (3rd Eds.).

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I Year - II Semester		L	T	P	C
		3	0	0	3
MECHANICS OF SOLIDS					

Course Objectives:
The objective of this subject is to provide the basic concepts of mechanical behaviour of the materials under various loads, provides knowledge on shear force and bending moment diagrams of beams and knowledge about stress distribution across various cross sections of beams.

UNIT I: Simple Stresses & Strains
Elasticity and plasticity – Types of stresses & strains – Hooke's law – stress–strain diagram for ductile and brittle material–Working stress–Factor of safety–Lateral strain, Poisson's ratio & volumetric strain.
Elastic Module & the relationship between them–Bars of varying section–composite bars–Temperature stresses. Strain energy – Resilience–Gradual, sudden, impact and shock loadings

UNIT II: Shear Force and Bending Moment
Definition of beam –Types of beams–Concept of shear force and bending moment–SF and BM diagrams for cantilever, simply supported and overhanging beams subjected to point loads, UDL, UVL and combination of these loads–Point of contra flexure–Relation between SF and BM and rate of loading at section of a beam

UNIT III: Bending Stresses & Shear Stresses
A: Bending Stresses: Theory of simple bending– Assumptions– Neutral axis – Derivation of bending equation: M/I=f/y=E/R –Determination bending stresses– section modulus of rectangular and circular sections (Solid and Hollow), I, T, Angle and Channel sections–Design of simple beam sections.
B: Shear Stresses: Derivation of formula – Shear stress distribution across various beam sections – rectangular, circular, triangular, I, T and angle sections.

UNIT IV: Deflection of Beams &Torsion
Deflection of Beams**:** Bending into a circular arc–slope, deflection and radius of curvature – Differential equation for the elastic line of a beam– Double integration and Macaulay's methods– Determination of slope and deflection for cantilever and simply supported beams subjected to point loads- UDL – uniformly varying load.
Torsion: Theory of pure torsion – Assumptions – Derivation of torsion equation, polar section modulus – power transmitted by shafts – combined bending and torsion.

UNIT V: Analysis of Pin Jointed Plane Frames & Thin Cylinders
Analysis of Pin- Jointed Plane Frames**:** Determination of forces in the members of various types of cantilever & simply supported trusses using (i) Method of Joints (ii) Method of Sections.
Thin Cylinders**:** Thin seamless cylindrical shells–Derivation of formula for longitudinal and circumferential stresses– hoop, longitudinal and volumetric strains– changes in diameter and volume of thincylinder.

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Course Outcomes:

1) to understand the theory of elasticity including strain/displacement and Hooke's law relationships.
2) to analyze solid mechanics problems using classical methods and energy methods.
3) to solve torsion problems in bars and thin walled members.
4) to solve for stresses and deflections of beams under unsymmetrical loading.
5) to locate the shear center of thin wall beams.
6) to obtain stresses and deflections of beams on elastic foundations.
7) to obtain solutions to column buckling and plate problems.
8) to apply various failure criteria for general stress states at points.

TEXT BOOKS

1. S.Timshenko **"**Strength of Materials**",** D. Van Nostr and Company, inc., 3rd edition,1983
2. Ramamrutham **"**Strength of materials**",** Dhanpat Rai Publishing, 18th edition, 2014

REFERENCES

1. R..K. Rajput, **"**Strength of Materials" S. Chand company Pvt, 5th edition, 2014
2. R K Bansal "Strength of Materials" Lakshmi – publications, 6th edition, 2015
3. Bhavikatti "Strength of materials" Lakshmi publications, 4th edition, 2014.
4. R S Khurmi, "Strength of Materials" S Chand, revised edition, 2013.
5. D. S. Kumar, "Strength of Materials, S K Kataria & Sons, Reprint 2013.

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I Year - II Semester		L	T	P	C
		3	0	0	3
BASIC ELECTRICAL & ELECTRONICS ENGINEERING (ES1206)					

Preamble:
This course covers the topics related to analysis of various electrical circuits, operation of various electrical machines and electronic components to perform well in their respective fields.

Learning Objectives:

- To learn the basic principles of electrical circuital law's and analysis ofnetworks.
- To understand principle of operation and construction details of DC machines.
- To understand principle of operation and construction details of transformers, alternator and 3-Phase induction motor.
- To study operation of PN junction diode, half wave, full wave rectifiers and OP-AMPs.
- To learn operation of PNP and NPN transistors and various amplifiers.

Unit - I

Electrical Circuits

Basic definitions – types of network elements – Ohm's Law – Kirchhoff's Laws – inductive networks – capacitive networks – series – parallel circuits – star-delta and delta-star transformations.- Numerical Problems.

Unit - II

DC Machines

Principle of operation of DC generator – EMF equation – types of DC machines – torque equation characteristics of DC motors – applications – three point starter – speed control methods of DC motor - Swinburne's Test-Brake test on DC shunt motor-Numerical problems.

Unit - III

AC Machines:

Transformers

Principle of operation and construction of single phase transformers – EMF equation – Losses – OC & SC tests – efficiency and regulation-Numerical Problems.

AC Rotating Machines

Principle of operation and construction of alternators – types of alternators Regulation of alternator by synchronous impedance method – principle of operation of synchronous motor – principle of operation of 3-Phase induction motor – slip-torque characteristics – efficiency – applications-Numerical Problems.

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Unit IV

Rectifiers & Linear ICs

PN junction diodes – diode applications (half wave and bridge rectifiers). Characteristics of operation amplifiers (OP-AMP) – application of OP-AMPs (inverting, non-inverting, integrator and differentiator)-Numerical Problems.

Unit V

Transistors

PNP and NPN junction transistor, transistor as an amplifier– frequency response of CE amplifier – Basic concepts of feedback amplifier-Numerical problems.

Learning Outcomes:

The student should be able to:

- Analyse various electrical networks.
- Understand operation of DC generators,3-point starter and DC machine testing by Swinburne's Test and Brake test.
- Analyse performance of single-phase transformer and acquire proper knowledge and working of 3-phase alternator and 3-phase induction motors.
- Analyse operation of half wave, full wave bridge rectifiers and OP-AMPs.
- Understanding operations of CE amplifier and basic concept of feedback amplifier.

Text Books:

1. Electrical Technology by Surinder Pal Bali, Pearson Publications.
2. Electronic Devices and Circuits by R.L. Boylestad and Louis Nashelsky, 9th edition, PEI/PHI 2006.

Reference Books:

1. Electrical Circuit Theory and Technology by John Bird, Routledge Taylor &Francis Group
2. Basic Electrical Engineering by M.S.Naidu and S.Kamakshiah, TMH Publications
3. Fundamentals of Electrical Engineering by Rajendra Prasad, PHI Publications,2nd edition
4. Basic Electrical Engineering by Nagsarkar, Sukhija, Oxford Publications,2nd edition
5. Industrial Electronics by G.K. Mittal, PHI

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DEPARTMENT OF MINING ENGINEERING

I Year - II Semester		L	T	P	C
		3	0	0	3
ENGINEERING DRAWING (ES1203)					

Course Objective: Engineering drawing being the principal method of communication for engineers, the objective is to introduce the students, the techniques of constructing the various types of polygons, curves and scales. The objective is also to visualize and represent the 3D objects in 2D planes with proper dimensioning, scaling etc.

Unit I
Objective: To introduce the students to use drawing instruments and to draw polygons, Engg. Curves.
Polygons: Constructing regular polygons by general methods, inscribing and describing polygons on circles.
Curves: Parabola, Ellipse and Hyperbola by general and special methods, cycloids, involutes, tangents & normals for the curves.
Scales: Plain scales, diagonal scales and vernier scales

Unit II
Objective: To introduce the students to use orthographic projections, projections of points & simple lines. To make the students draw the projections of the lines inclined to both the planes.
Orthographic Projections: Reference plane, importance of reference lines, projections of points in various quadrants, projections of lines, line parallel to both the planes, line parallel to one plane and inclined to other plane.
Projections of straight lines inclined to both the planes, determination of true lengths, angle of inclination and traces.

Unit III
Objective: The objective is to make the students draw the projections of the plane inclined to both the planes.
Projections of planes: regular planes perpendicular/parallel to one reference plane and inclined to the other reference plane; inclined to both the reference planes.

Unit IV
Objective: The objective is to make the students draw the projections of the various types of solids in different positions inclined to one of the planes.
Projections of Solids – Prisms, Pyramids, Cones and Cylinders with the axis inclined to both the planes.

Unit V
Objective: The objective is to represent the object in 3D view through isometric views. The student will be able to represent and convert the isometric view to orthographic view and vice versa.
Conversion of isometric views to orthographic views; Conversion of orthographic views to isometric views.
Computer Aided Design, Drawing practice using Auto CAD, Creating 2D&3D drawings of objects using Auto CAD
Note: In the End Examination there will be no question from CAD.

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TEXT BOOKS:

1. Engineering Drawing by N.D. Bhatt, Chariot Publications
2. Engineering Drawing by Agarwal & Agarwal, Tata McGraw Hill Publishers

REFERENCE BOOKS:

1. Engineering Drawing by K.L.Narayana & P. Kannaiah, Scitech Publishers
2. Engineering Graphics for Degree by K.C. John, PHI Publishers
3. Engineering Graphics by PI Varghese, McGrawHill Publishers
4. Engineering Drawing + AutoCad – K Venugopal, V. Prabhu Raja, New Age

Course Outcome: The student will learn how to visualize 2D & 3D objects.

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I Year - II Semester		L	T	P	C
		0	0	3	1.5
BASIC ELECTRICAL & ELECTRONICS ENGINEERING LAB (ES1208)					

Learning Objectives:

- To predetermine the efficiency of dc shunt machine using Swinburne's test.
- To predetermine the efficiency and regulation of 1-phase transformer with O.C and S.C tests.
- To obtain performance characteristics of DC shunt motor &3-phase induction motor.
- To find out regulation of an alternator with synchronous impedance method.
- To control speed of dc shunt motor using Armature voltage and Field flux control methods.
- To find out the characteristics of PN junction diode & transistor
- To determine the ripple factor of half wave & full wave rectifiers.

Section A: Electrical Engineering:

The following experiments are required to be conducted as compulsory experiments:

1. Swinburne's test on D.C. Shunt machine (predetermination of efficiency of a given D.C. shunt machine working as motor and generator).
2. OC and SC tests on single phase transformer (predetermination of efficiency and regulation at given power factors).
3. Brake test on 3-phase Induction motor (determination of performance characteristics)
4. Regulation of alternator by Synchronous impedance method.
5. Speed control of D.C. Shunt motor by
   a) Armature Voltage control b) Field flux control method
6. Brake test on D.C. Shunt Motor.

Section B: Electronics Engineering:

The following experiments are required to be conducted as compulsory experiments:

1. PN junction diode characteristics a) Forward bias b) Reverse bias (Cut in voltage and resistance calculations)
2. Transistor CE characteristics (input and output)
3. Half wave rectifier with and without filters.
4. Full wave rectifier with and without filters.
5. CE amplifiers.
6. OP- amp applications (inverting, non inverting, integrator and differentiator)

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Learning Outcomes:

The student should be able to:

- Compute the efficiency of DC shunt machine without actual loading of the machine.
- Estimate the efficiency and regulation at different load conditions and power factors for single phase transformer with OC and SC tests.
- Analyse the performance characteristics and to determine efficiency of DC shunt motor &3- Phase induction motor.
- Pre-determine the regulation of an alternator by synchronous impedance method.
- Control the speed of dc shunt motor using Armature voltage and Field flux control methods.
- Draw the characteristics of PN junction diode & transistor
- Determine the ripple factor of half wave & full wave rectifiers.

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I Year - II Semester		L	T	P	C
		0	0	3	1.5
ENGINEERING PHYSICS LABORATARY(BS1209)					

(Any 10 of the following listed 15 experiments)

LIST OF EXPERIMENTS:

1. Determination of Rigidity modulus of a material- Torsional Pendulum.
2. Determination of Young's modulus by method of single cantilever oscillations.
3. Determination of Acceleration due to Gravity and Radius of Gyration - Compound Pendulum.
4. Verification of laws of vibrations in stretched strings – Sonometer.
5. Determination of spring constant of springs using coupled oscillators.
6. Magnetic field along the axis of a current carrying coil – Stewart and Gee's apparatus
7. Study the variation of B versus H by magnetizing the magnetic material (B-H curve).
8. Measurement of magnetic susceptibility by Gouy's method.
9. Determination of ultrasonic velocity in liquid (Acoustic Grating)
10. Determination of dielectric constant by charging and discharging method
11. Determination of wavelength of Laser by diffraction grating
12. Determination of particle size using Laser.
13. Determeination of Pressure variation using strain Gauge sensor.
14. Determination of Moment of Inertia of a Fly Wheel.
15. Determination of Velocity of sound –Volume Resoantor.

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I Year - II Semester		L	T	P	C
		0	0	3	1.5
ENGINEERING WORKSHOP & IT WORKSHOP (ES1220)					

Course Objective: To impart hands-on practice on basic engineering trades and skills.
Note: At least two exercises to be done from each trade.

Trade:

1. **Carpentry**
   1. T-Lap Joint
   2. Cross Lap Joint
   3. Dovetail Joint
   4. Mortise and Tenon Joint
2. **Fitting**
   1. Vee Fit
   2. Square Fit
   3. Half Round Fit
   4. Dovetail Fit
3. **Black Smithy**
   1. Round rod to Square
   2. S-Hook
   3. Round Rod to Flat Ring
   4. Round Rod to Square headed bolt
4. **House Wiring**
   1. Parallel / Series Connection of three bulbs
   2. Stair Case wiring
   3. Florescent Lamp Fitting
   4. Measurement of Earth Resistance
5. **Tin Smithy**
   1. Taper Tray
   2. Square Box without lid
   3. Open Scoop
   4. Funnel
6. **IT Workshop**
   1. Assembly & Disassembly of Computer

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IT Workshop

COURSE OBJECTIVES:

The objective of IT Workshop is to

1. Explain the internal parts of a computer, peripherals, I/O ports, connecting cables
2. Demonstrate basic command line interface commands on Linux
3. Teach the usage of Internet for productivity and self paced lifelong learning
4. Describe about Compression, Multimedia and Antivirus tools
5. Demonstrate Office Tools such as Word processors, Spreadsheets and Presentation tools

Computer Hardware:

Experiment 1: Identification of peripherals of a PC, Laptop, Server and Smart Phones: Prepare a report containing the block diagram along with the configuration of each component and its functionality, Input/ Output devices, I/O ports and interfaces, main memory, cache memory and secondary storage technologies, digital storage basics, networking components and speeds.

Operating Systems

Experiment 2: Internet Services:

- Web Browser usage and advanced settings like LAN, proxy, content, privacy, security, cookies, extensions/ plugins
- Antivirus installation, configuring a firewall, blocking pop-ups
- Email creation and usage, Creating a Digital Profile on LinkedIn
- Source control on Github, Hackerrank, Codechef, HackerEarth, etc
- Google hangout/ Skype/ gotomeeting video conferencing
- archive.org for accessing archived resources on the web

Productivity Tools:

Experiment 3: Demonstration and Practice on archival and compression tools

- scanning and image editing tools
- OCR and text extraction
- audio players, recording using Mic, editing, podcast preparation
- video players, recording using webcam/camcorder, editing
- podcast, screencast, vodcast, webcasting

Office Tools:

Experiment 4: Demonstration and Practice on Text Editors like Notepad++, Sublime Text, Atom, Brackets, Visual code, etc

Experiment 5: Demonstration and practice on Microsoft Word, Power Point

Experiment 6: Demonstration and practice on Microsoft Excel.

Experiment 7: Demonstration and practice on LaTeX and produce professional pdf documents.

Experiment 8: Cloud based productivity enhancement and collaboration tools:

- Store, sync, and share files with ease in the cloud using Google Drive
- Document creation and editing text documents in your web browser using Google docs
- Handle task lists, create project plans, analyze data with charts and filters using Google Sheets

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- Create pitch decks, project presentations, training modules using Google Slides
- Manage event registrations, create quizzes, analyze responses using Google Forms
- Build public sites, internal project hubs using Google Sites
- Online collaboration through cross-platform support using Jamboard
- Keep track of important events, sharing one's schedule, and create multiple calendars using Google Calendar

TEXT BOOKS:

1. Computer Fundamentals, Anita Goel, Pearson Education, 2017
2. PC Hardware Trouble Shooting Made Easy, TMH

REFERENCES:

1. Essential computer and IT Fundamentals for Engineering and Science Students, Dr. N.B.Venkateswarlu, S. Chand

WEB RESOURCES:

1. https://explorersposts.grc.nasa.gov/post631/2006-2007/computer_basics/ComputerPorts.doc
2. https://explorersposts.grc.nasa.gov/post631/2006-2007/bitsnbyte/Digital_Storage_Basics.doc
3. https://www.thegeekstuff.com/2009/07/linux-ls-command-examples
4. https://www.pcsuggest.com/basic-linux-commands/
5. https://www.vmware.com/pdf/VMwarePlayerManual10.pdf
6. https://geek-university.com/vmware-player/manually-install-a-guest-operating-system/
7. https://gsuite.google.com/learning-center/products/#!/

COURSE OUTCOMES:

Students should be able to:

1. Assemble and disassemble components of a PC
2. Construct a fully functional virtual machine, Summarize various Linux operating system commands,
3. Secure a computer from cyber threats, Learn and practice programming skill in Github, Hackerrank, Codechef, HackerEarth etc.
4. Recognize characters & extract text from scanned images, Create audio files and podcasts
5. Create video tutorials and publishing, Use office tools for documentation, Build interactive presentations, Build websites, Create quizzes & analyze responses.

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DEPARTMENT OF MINING ENGINEERING

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

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 andhigh courtcontroller 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 and constitutional 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- State relationship, President: Role, power and position, PM and Council of ministers, Cabinet and Central Secretariat, 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 of ministers,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 ZilaPanchayat: Block level Organizational Hierarchy - (Different departments), Village level - Role of Elected and Appointed officials - Importance of grass root democracy

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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 Zillapanchayat block level organisation

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 Commissiononerate
- 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 andPolitics 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 thefollowing:

- Understand historical background of the constitution making and its importance for building ademocratic India.
- Understand the functioning of three wings of the government ie., executive, legislative andjudiciary.
- Understand the value of the fundamental rights and duties for becoming good citizen of India.
- Analyze the decentralization of power between central, state and local self-government.
- Apply the knowledge in strengthening of the constitutional institutions like CAG, Election Commission and UPSC for sustaining democracy.

1. Know the sources, features and principles of Indian Constitution.
2. Learn about Union Government, State government and its administration.
3. Get acquainted with Local administration and Pachayati Raj.
4. Be aware of basic concepts and developments of Human Rights.
5. Gain knowledge on roles and functioning of Election Commission

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DEPARTMENT OF MINING ENGINEERING

II Year - I Semester		L	T	P	C
		3	0	0	3
MATHEMATICS-III (VECTOR CALCULUS, TRANSFORMS AND PDE)					

Course Objectives:

- To familiarize the techniques in partial differentialequations.
- Tofurnishthelearners withbasicconceptsandtechniques atplus twoleveltoleadthemintoadvanced level by handling various real worldapplications.

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

- Interpret the physical meaning ofdifferent operators such as gradient, curl and divergence (L5)
- Estimate the work done against a field, circulation and flux using vector calculus(L5)
- Apply the Laplace transform for solving differential equations(L3).
- Find or compute the Fourier series of periodic signals(L3)
- Know and be able to apply integral expressions for the forwards and inverse Fouriertransform to a range of non-periodic waveforms(L3)
- Identify solution methods for partial differential equations that model physical processes(L3)

UNIT I: Vector calculus: (10hrs)

Vector Differentiation: Gradient — Directional derivative — Divergence — Curl — Scalar Potential. Vector Integration: Line integral — Work done — Area — Surface and volume integrals — Vector integral theorems: Greens, Stokes and Gauss Divergence theorems (without proof).

UNIT II: Laplace Transforms: (10hrs)

Laplace transforms of standard functions — Shifting theorems — Transforms of derivatives and integrals —
Unit step function — Dirac's delta function — Inverse Laplace transforms — Convolution theorem (without proof).
Applications: Solving ordinary differential equations (initial value problems) using Laplace transforms.

UNIT III: Fourier series and Fourier Transforms: (10hrs)

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.

Fourier Transforms: Fourier integral theorem (without proof) — Fourier sine and cosine integrals — Sine and cosine transforms — Properties — inverse transforms — Finite Fourier transforms.

UNIT IV: PDE of first order: (8hrs)

Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions — Solutions of first order linear (Lagrange) equation and nonlinear (standard types) equations.

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UNIT V: Second order PDE and Applications: (10 hrs)

Second order PDE: Solutions of linear partial differential equations with constant coefficients—RHStermofthetypee^{ax+by} ,sin(ax+by),cos(ax+by),$x^m y^n$

Applications of PDE: Method of separation of Variables — Solution of One dimensional Wave, Heat and two-dimensional Laplace equation.

Text Books:

1. **B.S. Grewal,** Higher Engineering Mathematics, 43rd Edition, KhannaPublishers.
2. **B. V. Ramana**, Higher Engineering Mathematics, 2007 Edition, Tata Mc. Graw Hill Education.

Reference Books:

1. **Erwin Kreyszig**, Advanced Engineering Mathematics, 10thEdition,Wiley-India.
2. **Dean. G. Duffy**, Advanced Engineering Mathematics with MATLAB, 3rdEdition, CRCPress.
3. **Peter O' Neil**, Advanced Engineering Mathematics, Cengage.
4. **Srimantha Pal, S C Bhunia,** Engineering Mathematics, Oxford UniversityPress.

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DEPARTMENT OF MINING ENGINEERING

II Year - I Semester		L	T	P	C
		3	0	0	3
DEVELOPMENT OF MINERAL DEPOSITS					

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

UNIT I:
Various types of development openings shape and size, Selection of suitable type for actual situations raises, winzes or passes, ore chutes.

UNIT II:
Location of shaft shape and size, incline and vertical shafts. Surface arrangements for sinking shafts, tools and equipments ordinary methods of sinking drilling, blasting removal of debris and water.

UNIT III:
Ventilation and lighting, temporary and permanent lining, widening and deepening of shafts.

UNIT IV
Special methods of shaft sinking piling, caisson, freezing and cementation method of shaft sinking Modern techniques of shaft sinking. Design of shafts inserts and pit bottoms

UNIT -V:
Classification and properties of explosives, detonators. Detonating cords, and detonating fuse and nonel detonator. Blasting systems, electrical and non electrical methods, delay blasting techniques. Blasting in open pit mines, blasting in underground coal and metal mines. Mechanics of blasting.
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.

Course Outcomes:
Students can design procedure for shaft sinking ;drilling and blasting for various mining operations.

TEXT BOOKS:
1. Surface Mining by Dr. G.B.Mishra,Dhanbadpublishers,1978
2. EMT Volume-I by D.J.Deshmukh(9^{th} edition),central technipublication.

REFERENCE BOOKS:
1. SME Hand Book
2. Blasting Manual- Sandhu &Pradhan.

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DEPARTMENT OF MINING ENGINEERING

II Year - I Semester		L	T	P	C
		3	0	0	3
MINE SURVEYING – I					

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 theirelimination.
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. Methods of plane table, radiations. Intersection, traversing and resection. 2-point and 3-point problem. Adjustment and common error in plane table survey.

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.

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.

UNIT – V
Curves: Types of curves, design and setting out – simple and compound curves.
Introduction to geodetic surveying, Total Station and Global positioning system, Introduction to Geographic information system (GIS).

Course Outcomes: Students can perform surveying of mine areas with variopous instruments such **as** Theodolite , plane table , total station etc,.

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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 .Duggal S K, "Surveying (Vol – 1 & 2), Tata Mc.Graw Hill Publishing Co. Ltd. New Delhi, 2004.

REFERENCE BOOKS:

1. Surveying and levelling by R. Subramanian, Oxford university press, New Delhi
2.Mine surveying and levelling by S. Gatak (vol-i,ii,iii)
3. Surveying by Kanetkar

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II Year - I Semester		L	T	P	C
		3	0	0	3
ENGINEERING AND ECONOMIC 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
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.

UNIT – III
Mineralogy: Study of individual groups – Quartz – Feldspar – Pyroxenes – Amphiboles – Micas – Aluminum silicates – Garnets – Olivine.

UNIT – IV
Optical Mineralogy : Ordinary light and Polarized light – Reflection, refraction, double refraction – Polarizing and Ore microscopes - Polarizer and analyzer – Thin sections and polished sections – Examination of the minerals under the microscope – Optical properties – Pleochroism, Extinction, Interference colors.

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 – Petro graphic characteristics of conglomerate, breccia, sandstone, shale, limestone – Metamorphic petrology – Formation, structures, textures and classification of metamorphic rocks – Petrography of gneiss, schist, slate, marble, quartzite, charnockite.

TEXT BOOKS :
1. Engineering and general Geology by ParbinSingh,kataria ,S.k.sonspublishers.
2. Principles of Engineering Geology by K.M.Bangar , standard publishers anddistributers

REFERENCE BOOKS:
1. A text book of Geology –G.B.Mahapathra

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

Course Objectives: This course introduces Objectives of mineral processing, characteristics of minerals and coal, crushing methods, separation methods, methods of concentration, fields of application and limitations.

UNIT-I
Introduction**:** Scope, objectives and limitations of mineral processing, liberation and beneficiation. Combinations: Theory and practices of crushing and grinding; different types of crushing and grinding equipment's – their applications and limitations.

UNIT -II
Size Separation: Laboratory size analysis and interpretation; settling of solids in fluids; industrial screens, mechanical classifiers and hydro cyclones.
Gravity Concentration Methods: Jigging, Heavy media separation, flowing film concentrators–theory, applications and limitations.

UNIT -III:
Froth Floatation:
A: Physico-chemical principles, reagents.
B**:** Machines, floatation of sulphides, oxides and coal.

UNIT -IV:
Applications and Limitations of concentrating technique: Applications and limitations of magnetic concentration, high tension concentration**,** Oresorters
Dewatering: Thickeners, filters, thermal drying.

UNIT -V:
Flow Sheets: Simplified flow sheets for coal, zinc, iron, and manganese ores.
Magnetic methods of concentration Principles, Fields of Application and Limitation.

TEXT BOOKS:
1. Mineral Processing – S.K. Jain, CBS Publishers &Distributors,2018
2. Mineral Processing – Barry AWills,Elsevier,2006

REFERENCE BOOKS:
1. Mineral beneficiation a concise basic course by D.V. Subbarao
2. Introduction to Mineral Processing – V. Malleswar Rao, Indian Academy ofGeoscience

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II Year - I Semester		L	T	P	C
		0	0	3	1.5
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 practicalknowledge.

List of Experiments

1. Triangulation survey bytheodolite
2. Measure horizontal and vertical angles bytheodolite
3. Measure horizontal angles by method of repetition and reiteration usingtheodolite
4. Trigonometric Leveling - Heights and distanceproblem
5. Signs and conventions used by GSI, MMR,CMR
6. Finding heights and distance using Principles of tachometricsurveying
7. Curve setting – different methods by totalstation
8. Setting out works for buildings & pipelines.
9. Determine area using totalstation
10. Traversing using totalstation
11. contouring using totalstation
12. Determination of remote height using total station
13. Coordinate measurement by total station andGPS
14. Traversing and recording position of points byGPS
15. Distance, gradient, Difference, height between two inaccessible points using total stations.

Course outcome: Familiar with equipment and capable to do work independently at any time if you get chance

EQUIPMENT TO BE USED:

1. Theodolites, and levelingstaffs.
2. Tachometers.
3. TotalStation

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II Year - I Semester		L	T	P	C
		0	0	3	1.5
ENGINEERING AND ECONOMIC GEOLOGY LAB					

Objectives: To impart exposure on properties of minerals, faults and economic minerals List of Experiments

1. Study of Physical propertiesminerals.
2. Demonstration of Crystalmodels
3. Demonstration of Optical properties ofminerals
4. Study of important Igneous, sedimentary and metamorphicrocks.
5. Recognition of folds, faults, unconformities frommaps.
6. Simple problems on strike anddip.

Course Outcomes: To Identify Mega-scopic minerals Mega-scopic 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 & dip problems.

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II Year - I Semester		L	T	P	C
		0	0	3	1.5
MINERAL PROCESSING TECHNOLOGY LAB					

Course objectives: To study various mineral processing technique to enrich minerals.

List of experiments:

1. Different sample division techniques like coning and quartering, riffle sampling techniques,etc.
2. Determination of crushing characteristics of a given mineral sample using jawcrusher
3. Determination of the grinding characteristics of a given mineral sample using ballmill.
4. Sieve analysis of a given sample and to calculate (a) percentage sample retained onscreens (b) to plot sizing curves.
5. Concentration of a given mineral sample using mineraljig.
6. Concentration of a given mineral using Wifelytable.
7. Concentration of a given mineral using froth flotationcell
8. Study of wash ability characteristic of a coal sample using float and sinktest.
9. Study of sedimentation characteristics of a givensample.
10. Estimation moisture content by Drying of mineralsample.
11. Determining the average size ofsamples
12. Collection of sample by riffle sampletechnique.

Course Outcomes:

At the end of the course, students will be able to

1. Know different sample divisiontechniques.
2. Determine the grinding and crushing characteristics of a given mineralsample.
3. Know the wash ability characteristic of a coalsample.
4. Determine the moisture content by Drying of mineralsample.
5. Determine the average size of samples.

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II Year - I Semester		L	T	P	C
		1	0	2	2
NUMERICAL TECHNIQUES THROUGH MATLAB AND PYTHON					

1. To find the roots of non-linear equation using Bisection method
2. To find the roots of non-linear equation using Newton Raphson's method.
3. Curve fitting by least – square approximations
4. To solve the system of linear equations using Gauss - elimination method
5. To solve the system of linear equations using Gauss - Siedal method
6. To solve the system of linear equations using Gauss - Jordan method
7. To integrate numerically using Trapezoidal rule
8. To integrate numerically using Simpsons rule
9. To find the largest eigen value of a matrix by Power – method
10. To find numerical solution of ordinary differential equations by Euler's method
11. To find numerical solution of ordinary differential equations by Runge-Kutta method
12. To find numerical solution of ordinary differential equations by Milne's method
13. To find the numerical solution of Laplace equation
14. To find the numerical solution of Wave equation
15. To find the solution of a tri-diagonal matrix using Thomas algorithm
16. To fit a straight using least square technique

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II Year - I Semester		L	T	P	C
		2	0	0	0
ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE					

Course Objectives:

To facilitate the students with the concepts of Indian traditional knowledge and to make them understand the Importance of roots of knowledge system

- The course aim of the importing basic principle of third process reasoning and inference sustainability is at the course of Indian traditional knowledgesystem
- To understand the legal framework and traditional knowledge and biological diversity act 2002 and geographical indication act2003
- The courses focus on traditional knowledge and intellectual property mechanism of traditional knowledge andprotection
- To know the student traditional knowledge in differentsector

Course Outcomes:

After completion of the course, students will be able to:

- Understand the concept of Traditional knowledge and itsimportance
- Know the need and importance of protecting traditionalknowledge
- Know the various enactments related to the protection of traditionalknowledge
- Understand the concepts of Intellectual property to protect the traditionalknowledge

UNIT I

Introduction to traditional knowledge: Define traditional knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, the physical and social contexts in which traditional knowledge develop, the historical impact of social change on traditional knowledge systems. Indigenous Knowledge (IK), characteristics, traditional knowledge vis-à-vis indigenous knowledge, traditional knowledge Vs western knowledge traditional knowledge vis-à-vis formal knowledge

UNIT II

Protection of traditional knowledge: the need for protecting traditional knowledge Significance of TK Protection, value of TK in global economy, Role of Government to harness TK.

UNIT III

Legal framework and TK: A: The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, Plant Varieties Protection and Farmers Rights Act, 2001 (PPVFR Act);B:The Biological Diversity Act 2002 and Rules 2004, the protection of traditional knowledge bill, 2016.Geographical indications act 2003.

UNIT IV

Traditional knowledge and intellectual property: Systems of traditional knowledge protection, Legal concepts for the protection of traditional knowledge, Certain non IPR mechanisms of traditional knowledge protection, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge, global legal FORA for increasing protection of Indian Traditional Knowledge.

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UNIT V

Traditional knowledge in different sectors: Traditional knowledge and engineering, Traditional medicine system, TK and biotechnology, TK in agriculture, Traditional societies depend on it for their food and healthcare needs, Importance of conservation and sustainable development of environment, Management of biodiversity, Food security of the country and protection of TK.

REFERENCE BOOKS:

1. Traditional Knowledge System in India, by Amit Jha,2009.
2. Traditional Knowledge System and Technology in India by Basanta Kumar Mohanta and Vipin Kumar Singh, PratibhaPrakashan2012.
3. Traditional Knowledge System in India by Amit Jha Atlantic publishers,2002
4. "Knowledge Traditions and Practices of India" Kapil Kapoor, MichelDanino

e-Resources:

1) https://www.youtube.com/watch?v=LZP1StpYEPM
2) http://nptel.ac.in/courses/121106003/

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II Year - II Semester		L	T	P	C
		3	0	0	3
FLUID MECHANICS AND HYDRAULIC POWER					

Course Objective: 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.

UNIT I

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's law, hydrostatic law.

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

UNIT II

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 pipebend.

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.

UNIT III

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 velocityprofiles.

Dimensional Analysis: Similitude and modeling – Dimensionless numbers

UNIT IV

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 radialvanes.

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, indicatordiagrams.

UNIT V

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- hydraulic ram, hydraulic lift, hydraulic coupling.

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Course Outcomes: Identify importance of various fluid properties at rest and in transit. understand the concept of boundary layer theory and flow seperation. plot velocity and pressure profiles for any given fluid flow. evaluate the perfomance characteristics of hydraulic turbines andpumps.

TEXT BOOKS:

1. Hydraulics, fluid mechanics and Hydraulic machinery MODI andSETH.
2. Fluid Mechanics and Hydraulic Machines byRajput.
3. Fluid Mechanics and Hydraulic Machines/ RK Bansal/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 AgeInternational.
3. Hydraulic Machines by Banga & Sharma, KhannaPublishers.
4. Instrumentation for Engineering Measurements by James W. Dally, William E. Riley ,John Wiley & Sons Inc. 2004 (Chapter 12 – Fluid FlowMeasurements)
5. Fluid Mechanics and Hydraulic Machines by Domkundwar & Domkundwar, Dhanpatrai&Co.

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DEPARTMENT OF MINING ENGINEERING

II Year - II Semester		L	T	P	C
		3	0	0	3
COMPLEX VARIABLES AND STATISTICAL METHODS					

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.

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

- apply Cauchy-Riemann equations to complex functions in order to determine whether a given continuous function is analytic (L3)
- find the differentiation and integration of complex functions used in engineering problems (L5)
- make use of the Cauchy residue theorem to evaluate certain integrals (L3)
- apply discrete and continuous probability distributions (L3)
- design the components of a classical hypothesis test (L6)
- infer the statistical inferential methods based on small and large sampling tests (L4)

UNIT – I: Functions of a complex variable and Complex integration: (10 hrs)
Introduction – Continuity – Differentiability – Analyticity –Cauchy-Riemann equations in Cartesian and polar coordinates –Harmonicand 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: (10 hrs)
Radius of convergence – Expansion in Taylor's series, Maclaurin's series andLaurent series.
Types of Singularities: Isolated – Essential –Pole of order m– Residues – Residue theorem (without proof) – Evaluation of real integral of the types $\int_{-\infty}^{\infty} f(x)dx$ and $\int_{c}^{c+2\pi} f(\cos\theta,\sin\theta)d\theta$.

UNIT – III: Probability and Distributions: (10 hrs)
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: (8 hrs)
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: (10 hrs)
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.

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Text Books:

1. **B. S. Grewal,** Higher Engineering Mathematics, 44th Edition, Khanna Publishers.
2. **Miller and Freund's,** Probability and Statistics for Engineers,7/e, Pearson, 2008.

Reference Books:

1. **J. W. Brown and R. V. Churchill**, Complex Variables and Applications, 9th edition, Mc-Graw Hill, 2013.
2. **S.C. Gupta and V.K. Kapoor**, Fundamentals of Mathematical Statistics, 11/e, Sultan Chand & Sons Publications, 2012.
3. **Jay l. Devore,** Probability and Statistics for Engineering and the Sciences, 8thEdition,Cengage.
4. **ShronL.Myers, Keying Ye, Ronald E Walpole,** Probability and Statistics Engineers and the Scientists,8th Edition, Pearson 2007.
5. **Sheldon, M. Ross**, Introduction to probability and statistics Engineers and the Scientists, 4thEdition, Academic Foundation,2011

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DEPARTMENT OF MINING ENGINEERING

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, protodynakov 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, Coulumb-Navier, Mohr's, Hoek-Brown, empirical criteria, etc. and their field of applications. Stress distribution in underground workings

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TEXT BOOKS:

1. Vutukuri, V.S., and Lama, R.D., Handbook on Mechanical Properties ofRocks, Vol. I, II, III and IV, Transtech Publication, Berlin,1974/78.
2. Peng, S.S., Ground Control, Wiley Interscience, New York,1987.

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 Inter science, 1985.
3. Hoek, E., and Brown, S.T., Underground Excavations in Rocks, Institute of Mining

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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-gasdetector.

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 naturalventilation

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.

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UNIT – V

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

Course Outcomes: 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.

TEXT BOOKS:

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 – Howard L. 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. Vivek Publications, Varanasi 1999.
4. Mine Ventilation Vol. – II, S. Ghatak, Coalfield Publishers, 1993.

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II Year - II Semester		L	T	P	C
		3	0	0	3
MANAGERIAL ECONOMICS AND FINANCIAL ACCOUNTANCY					

Course Objectives:

- The Learning objectives of this paper are to understand the concept and nature of Managerial Economics and its relationship with other disciplines and also to understand the Concept of Demand and Demand forecasting.
- To familiarize about the Production function, Input Output relationship, Cost-Output relationship and Cost-Volume-Profit Analysis.
- To understand the nature of markets, Methods of Pricing in the different market structures and to know the different forms of Business organization and the concept of Business Cycles.
- To learn different Accounting Systems, preparation of Financial Statement and uses of different tools for performance evaluation.
- Finally, it is also to understand the concept of Capital, Capital Budgeting and the techniques used to evaluate Capital Budgeting proposals.

Unit-I

Introduction to Managerial Economics and demand Analysis:

Definition of Managerial Economics –Scope of Managerial Economics and its relationship with other subjects – Concept of Demand, Types of Demand, Determinants of Demand-Demand schedule, Demand curve, Law of Demand and its limitations- Elasticity of Demand, Types of Elasticity of Demand and Measurement- Demand forecasting and Methods of forecasting, Concept of Supply and Law of Supply.

Unit – II:

Theories of Production and Cost Analyses:

Theories of Production function- Law of Variable proportions-Isoquants and Isocosts and choice of least cost factor combination-Concepts of Returns to scale and Economies of scale-Different cost concepts: opportunity costs, explicit and implicit costs-Fixed costs, Variable Costs and Total costs –Cost –Volume-Profit analysis- Determination of Breakeven point(problems)-Managerial significance and limitations of Breakeven point.

Unit – III:

Introduction to Markets, Theories of the Firm & Pricing Policies:

Market Structures: Perfect Competition, Monopoly, Monopolistic competition and Oligopoly – Features – Price and Output Determination – Managerial Theories of firm: Marris and Williamson's models – other Methods of Pricing: Average cost pricing, Limit Pricing, Market Skimming Pricing, Internet Pricing: (Flat Rate Pricing, Usage sensitive pricing) and Priority Pricing, Business Cycles : Meaning and Features – Phases of a Business Cycle. Features and Evaluation of Sole Trader, Partnership, Joint Stock Company – State/Public Enterprises and theirforms.

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DEPARTMENT OF MINING ENGINEERING

Unit – IV:
Introduction to Accounting & Financing Analysis:
Introduction to Double Entry System, Journal, Ledger, Trail Balance and Preparation of Final Accounts with adjustments – Preparation of Financial Statements-Analysis and Interpretation of Financial Statements-Ratio Analysis – Preparation of Funds flow and cash flow analysis (Problems)

Unit – V:
Capital and Capital Budgeting: Capital Budgeting: Meaning of Capital-Capitalization-Meaning of Capital Budgeting-Time value of money- Methods of appraising Project profitability: Traditional Methods(pay back period, accounting rate of return) and modern methods(Discounted cash flow method, Net Present Value method, Internal Rate of Return Method and Profitability Index)

Course Outcomes:
- The Learner is equipped with the knowledge of estimating the Demand and demand elasticities for aproduct.
- The knowledge of understanding of the Input-Output-Cost relationships and estimation of the least cost combination ofinputs.
- The pupil is also ready to understand the nature of different markets and Price Output determination under various market conditions and also to have the knowledge of different BusinessUnits.
- The Learner is able to prepare Financial Statements and the usage of various Accounting tools for Analysis.
- The Learner can able to evaluate various investment project proposals with the help of capital budgeting techniques for decisionmaking.

TEXT BOOKS:
A R Aryasri, Managerial Economics and Financial Analysis, The McGraw – Hill companies.

REFERENCES:
1. Varshney R.L, K.L Maheswari, Managerial Economics, S. Chand & CompanyLtd,
2. JL Pappas and EF Brigham, Managerial Economics, Holt, R & W; New editionedition
3. N.P Srinivasn and M. SakthivelMurugan, Accounting for Management, S. Chand & CompanyLtd,
4. MaheswariS.N,AnIntroduction to Accountancy, Vikas Publishing House PvtLtd
5. I.M Pandey, Financial Management , Vikas Publishing House PvtLtd
6. V. Maheswari, Managerial Economics, S. Chand & CompanyLtd,

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II Year - II Semester		L	T	P	C
		0	0	3	1.5
FLUID MECHANICS AND HYDRAULICS POWER LAB					

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

1. Impact of jets onVanes.
2. Performance Test on PeltonWheel.
3. Performance Test on FrancisTurbine.
4. Performance Test on KaplanTurbine.
5. Performance Test on Single Stage CentrifugalPump.
6. Performance Test on Multi Stage CentrifugalPump.
7. Performance Test on ReciprocatingPump.
8. Calibration ofVenturimeter.
9. Calibration of Orificemeter.
10. Determination of friction factor for a given pipeline.
11. Determination of loss of head due to sudden contraction in apipeline.
12. Turbine flowmeter.

Course Outcomes:

Student 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.

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II Year - II Semester		L	T	P	C
		0	0	3	1.5
MINE VENTILATION LAB					

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 rescueapparatus

List of experiments:

1. Determination of CO, CH4, H2S, SO2, O2, CO2, Nitrous fumes by corresponding detectors.
2. Study and application of infrared gasanaliser.
3. Detection of different gases by Gas –Chromatograph
4. Detection of methane by different types of methano meters &flame safetylamp.
5. Determination index of flammability of coaldust.
6. Study and uses of proto – IV, Proto – V. Dragger – BG – 174 self contained breathingapparatus
7. Study and uses of self rescuer Gas mask, smokehelmet.
8. Study and use of revivingapparatus
9. Study of Born-Side safety boningapparatus.

Course outcomes: The student will familiar with rescue and recovery operation from different disasters in mine

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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. To study the operation of various instruments and equipment.

List of experiments:
1. Determination of RQD ofrocks.
2. Determination of Protodyaknov index of a given rocksample 147
3. Determination of point load index strength of a given rocksample
4. Determination of porosity ofrocks.
5. Determination of hardness ofrocks
6. Determination of uniaxial compressive strength of a given rock sample
7. Determination of tensile strength of a given rock sample using Brazilian method
8. Determination of shear strength ofrocks
9. Determination of modulus of elasticity of given rock sample using straingauge.
10. Determination of triaxial strength of rock and drawing of Mohr'senvelope
11. Study of different types of supports used inmines
12. Study of design of minepillars.

Course Outcomes:
At the end of the course, students will be able to
1: Determine the properties of rocks
2: Knowledge of various instruments and equipment.
3: Design the supports for mine openings.
4: Design mine pillars.
5**:** Knowledge of various equipments.

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II Year - II Semester		L	T	P	C
		0	0	3	1.5
DATA ANALYTICS FOR GEO-RESOURCES USING R					

MODULE-I

Introduction: Data types: qualitative and quantitative, Data sources- geo-spatial, geo-environment, geomechanics, and mine safety; Grade attribute and lithological data, rock testing, minesafety data, well-logs. Sensor data from different georesources applications.

MODULE-II

Data visualization: Univariate data: Descriptive statistics; inferential statistics- t test, chi-square test, F test,ANOVA; **Multivariate data:** Scatter plot, P-P plot, Q-Q plot, multivariate distribution, Mahanalobis distance, Test of association.

MODULE-III

Regression of georesources data: Introduction to regression; Simple regression and multiple regressions; ordinary least square and generalized least-square algorithms.
Spatial regression: variogram modeling and Kriging; Dimension

MODULE-IV

Reduction techniques: principal component analysis, factor analysis. Regression problems examples: Metalprice forecasting using historical price data, spatial regression for grade estimation, environmental quality parameters, PCA and factor analysis using mine safety data

MODULE-V

Classification of Georesources Data: Introduction to classification; Bayes classifier; Different Liner classifiers, Fisher's discriminant analysis; Classification example problems: rock type classification using lithological classification, roof fall diagnostics, rock images classification, machine fault diagnostic throughcondition monitoring.

Suggested Books:

1. Johnson, R.A. and Wichern, D.W., Applied Multivariate Statistical Analysis, PHI, Delhi, 2013.
2. Ross, S.M., Introduction to Probability Models, Elsevier, New Delhi, 2010
3. Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., Multivariate Data Analysis, PearsonEducation Limited, United Kingdom, 2013
4. Stern, R. Good Statistical Practice for Natural Resources Research, Statistical Services Centre,University of Reading, UK, 2004
5. T J Napier-Munn, Statistical methods for mineral engineers- how to design experiments and analysedata, JKMRC monograph series in mining and mineral processing, 2014
6. John Lucas, Mines and Mineral statistics, 2013, ISBN- 10: 5518633939

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

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.
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, 1991
2. Mine Illumination by Trotller

References:
3. Spontaneous Combustion: S C Banerjee
4. Mine Fires: L C Kaku
5. Mine Fires: Mitchell
6. Mine Ventilation and Air conditioning: Hartman
7. Subsurface Ventilation and Environmental Engineering : McPherson

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

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DEPARTMENT OF MINING ENGINEERING

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

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

Modern coal mining methods: applicability, limitations, merits and demerits of Inseam Mining and Horizon Mining, Hydraulic Mining, plough methods, chirimiri caving method, shield mining, 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.

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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
4. Modern Coal mining Technology: Samir Kumar Das
5. Underground winning of coal: T.N Singh

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

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III Year - I Semester		L	T	P	C
		3	0	0	3
MINE HOISTING AND TRANSPORTATION					

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, tippers, 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

Heat Treatment: 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, construction and safety devices.

UNIT – IV

Conveyors: Construction and operation of belt, chain and cable belt conveyors. Conveyor computations. High angle conveyors, shiftable conveyors, Head frames; 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, selection
and 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 : Walker
2) SME Mining Engineer's Handbook : Hustrulid
3) Underground Mining Methods Handbook : Hustrulid
4) Mine Hoisting : M.A.Ramlu, Oxford & IBH, 1996

Course Outcomes:

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

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III Year - I Semester	OPEN ELECTIVE - 1	L	T	P	C
		3	0	0	3
INTRODUCTION TO UNDERGROUND MINING					

Course objectives: To understand the methods of underground coal mining.

UNIT – I

Introduction: status of coal reserves, grade and rank of coals available in India, status of coal mining in India, mining conditions in Indian coalfields; choice of mining methods

UNIT – II

Development: Bord and Pillar, and Room and Pillar Mining; design of bord & pillar workings, the panel system, panels and inter-panel barriers, size of pillars and galleries; methods of driving galleries; layouts for different combinations of loading and transport systems including continuous systems

UNIT – III

Depillaring: preparatory arrangements for depillaring; sequence and manner of extraction of pillars; mechanized pillar extraction, setting and withdrawal of supports; air blasts; partial extraction

UNIT – IV

Longwall Mining: Evolutionary development of long wall mining, its application, layouts, development and extraction by conventional and mechanised methods; design of long wall workings - face length and panel length; salvaging of long wall faces.

UNIT – V

Thick seam mining: multi-section mining, slicing methods, sublevel caving, integrated sublevel caving, blasting gallery method, thick seam extraction by cable bolting, hydraulic mining

Contiguous seam working: working under surface structures and water bodies, harmonic mining; shaft pillar extraction; horizon mining Gasification of coal

Text Books:

1. Introductory Mining Engineering: H L Hartman

References:

1. Coal Mining Methods: S K Das
2. SME Mining Engineer's Handbook: Hustrulid

Course Outcomes: Students will be able to learn various coal mining methods.

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III Year - I Semester	OPEN ELECTIVE - 1	L	T	P	C
		3	0	0	3
INTRODUCTION TO SURFACE MINING					

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, cut off 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 strata, deep mining problems

UNIT – V

Dump Formation: Types of waste dump - internal and external; dump formation methods and equipment. Reclamation methods by using different combination of equipment.

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

Course Outcomes: Students will be able to explain the concepts of surface mining, mineral deposits and

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dump formation.

III Year - I Semester	OPEN ELECTIVE - 1	L	T	P	C
		3	0	0	3
TUNNELING AND UNDERGROUND SPACE DESIGN					

Course Objectives:
Students will acquire knowledge about tunneling methods, mechanized tunneling and tunneling design.

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, defence 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 tunnelling, hard rock tunnelling, shallow tunnelling, deep tunnelling; 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 tunnelling; 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 behaviour of tunnelling 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.

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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 gain knowledge on tunneling methods and tunneling design.

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III Year - I Semester	OPEN ELECTIVE - 1	L	T	P	C
		3	0	0	3
ENGINEERING SURVEY					

Course Objectives: To gain knowledge about the concepts of surveying and leveling using various instruments along with advanced surveying techniques.

UNIT - I

Introduction: overview of Plane Surveying (Chain, compass, and plane table-in brief): Objectives, Principles and classifications; electronic distance measurements; Types of compasses, different types of meridians and bearings, local attraction and closed traversing with compass; computation of angles from bearings; declination.

Total Station: Description, uses, types of surveys by total station, mapping of sites by total station surveys – elementary exercises only.

UNIT - II

Levelling: Different types leveling instruments and description of parts; Temporary and Permanent adjustments; methods of levelling – fly levelling, differential levelling, and reciprocal levelling. Problems on leveling. Permissible error and distribution of error.

Contouring: Characteristics and uses of contour; contour interval; methods of establishing contours.

UNIT - III

Theodolite – construction and operation, tests and adjustments, angle measurement, traversing, balancing of traverse, calculation of coordinates and plotting.

Triangulation: Principles and methods of triangulation: classification of triangulation system, signals and towers; base line measurement; calculations of length of base- tape corrections,

UNIT – IV

Tacheometric Surveying: – Principles, Stadia and tangential methods, measurements of heights and distances by tacheometry, distance and elevation formulae for staff vertical and normal;

anallactic lens. Curves: Definitions and types of curves; simple curves by linear and angular method (Rankine's method); setting of underground curve.

UNIT – V

ADVANCED SURVEYING

Introduction to Global Information System (GIS), Remote Sensing, Total Station, GPS, DGPS, Laser scanning and 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., New Delhi.
2. Surveying (Vol 1 & 2) – Kanetkar
3. mine surveying and leveling- (Vol-1,2, and 3) by S.Ghatak

REFERENCE BOOKS:

1. Arthur R. Benton and Philip J Taetly, Elements of Plane Surveying, McGraw Hill-2000
2. Arora K R Surveying Vol 1 & 2 & 3, Standard Book House, Delhi, 2004.
3. Chandra A M, Plane Surveying, New age International Pvt. Ltd., Publishers, New Delhi, 2002.
4. Chandra A M, Higher Surveying, New age International Pvt. Ltd, Publishers, New Delhi, 2002.

Course Outcome: Students will learn about leveling and surveying methods.

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III Year - I Semester	PROGRAM ELECTIVE CORE - 1	L	T	P	C
		3	0	0	3
REMOTE SENSING & GIS					

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, electromagnetic radiation, electromagnetic spectrum, interaction with atmosphere, energy interaction with the earth surfaces, characteristics of remote sensing systems, types of resolutions - advantages & limitations, 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

RS and GIS 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.

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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 outcomes

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

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III Year - I Semester	PROGRAM ELECTIVE CORE – 1	L	T	P	C
		3	0	0	3
RESOURCE EVALUATION AND GEO-STATISTICS					

Course Objectives: To gain knowledge about mineral exploration and the principles and applications of Geo-statistics.

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, nonstationarities, regularisation, presence of nugget effect and presence of trend. Extension, estimation and dispersion variance; calculation by discretisation 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 Geostatistics.

UNIT - IV
Advanced Geo-statistics: Practical difficulties associated with semi-variography, viz. anisotropy, non-stationarity, regularisation, 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 Outcomes: Students will be able learn various Geo-statistics techniques and their applications.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
KAKINADA - 533 003, Andhra Pradesh, India

DEPARTMENT OF MINING ENGINEERING

III Year - I Semester	PROGRAM ELECTIVE CORE – 1	L	T	P	C
		3	0	0	3
MINE PLANNING AND DESIGN					

Course Objectives: To acquire knowledge about the principles of surface mining and underground coal and metal mining.

UNIT-1

Mine planning process, component of mine planning. Exploration strategy and planning, exploratory drilling, management of exploration data, Concept of cut-off grade, compositing, resource estimation techniques, resource classification system-UNFC.

UNIT-II

SURFACE MINING SYSTEM

Pit geometry, stripping ratios and their significance, Pit layouts, pit expansion and push back, Ultimate pit configuration, Production scheduling, Classification of methods and factors governing choice of mining methods.

UNIT-III

UNDERGROUND COAL MINING SYSTEM:

Pillar mining systems: Design, development, manpower, coal handling, equipment, essential services, production scheduling, time and work study for improvement of production, Optimization of mine size (mine production capacity) based on techno-economic considerations, Equipment and face scheduling against targeted production.

UNIT-IV

Longwall mining System: layouts for thin and medium thick seams, design, development, manpower, coal handling, equipment, essential services, production scheduling, time and work study for improvement of production, Optimization of mine size based on technoeconomic considerations, Equipment and face scheduling against targeted production, Planning and design for contiguous seams, hydraulic mining, other applicable methods.

UNIT-V

Underground Metal Mining System

General engineering design; design methods in mining; input parameter for design - geological and other rock mass parameters; empirical, observational and analytical methods of design; design of excavations in massive elastic, stratified and jointed rocks. Stope planning: Evaluate stope boundaries, selection of a stoping methods, Design of stoping layouts for mining of different types of ore deposits and application of computer in stope design, economics of each stope. Production planning: Stope reserve, development, manpower, ore/waste handling, equipment, essential services, production scheduling, time and work study for improvement of production, Optimization of mine size (mine production capacity) based on techno-economic considerations; Planning and design for deep deposit, hydraulic, thermal, hydro-chemical and biochemical methods, and nuclear device mining systems.

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Text Books:

1) Open Pit Mine Planning and Design-W. Hustrulid and M. Kuchta
2) SME Mining Engineering Hand book-H.L. Hartman

Reference Books:

1) Surface and underground excavations – R. R. Tatiya
2) Principles and practices of modern coal mine-R. D. Singh
3) Mineral Deposit Evaluation: A practical approach by Alwyn E. Annels

Course Outcomes:

Students will be able to learn the principles of surface mining and underground coal and metal mining.

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DEPARTMENT OF MINING ENGINEERING

III Year - I Semester	PROGRAM ELECTIVE CORE – 1	L	T	P	C
		3	0	0	3
MINE SAFETY & ERGONOMICS					

Course Objectives:
To understand the concepts and various methods of risk management and safety of mines along with the ergonomics aspects.

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.

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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

References:

1. Safety Engineering by B. S. Dhillon, Springer
2. Mine Safety by B. S. Dhillon, Springer

Course Outcomes:

Students will be able to learn about various methods of risk management and safety of mines along with the ergonomic aspects.

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DEPARTMENT OF MINING ENGINEERING

III Year - I Semester	PROGRAM ELECTIVE CORE – 1	L	T	P	C
		0	0	3	1.5
MINE HOISTING AND TRANSPORTATION LAB					

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 longwall faces.
11. Study of aerial rope ways.
12. Study of various types of head gear-fleet angle, Study of shaft fittings-signal systems, guides, safety dogs and protective roofing, study of guides– methods of support and tensioning arrangements.

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

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DEPARTMENT OF MINING ENGINEERING

III Year - I Semester	PROGRAM ELECTIVE CORE – 1	L	T	P	C
		0	0	3	1.5
MINE HAZARDS AND RESCUE LAB					

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

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DEPARTMENT OF MINING ENGINEERING

III Year - I Semester		L	T	P	C
		0	0	4	2
SOFT SKILLS					

Course objective: To introduce various concepts of soft skills to improve the personality of students.

UNIT – I

Getting Started

Soft Skills: An Introduction – Definition and Significance of Soft Skills; Process, Importance and Measurement of Soft Skill Development.

Self-Discovery: Discovering the Self; Setting Goals; Beliefs, Values, Attitude, Virtue.

Positivity and Motivation: Developing Positive Thinking and Attitude; Driving out Negativity; Meaning and Theories of Motivation; Enhancing Motivation Levels.

UNIT – II

Interpersonal Communication: Interpersonal relations; communication models, process and barriers; team communication; developing interpersonal relationships through effective communication; listening skills; essential formal writing skills; corporate communication styles – assertion, persuasion, negotiation.

Public Speaking: Skills, Methods, Strategies and Essential tips for effective public speaking.

Group Discussion: Importance, Planning, Elements, Skills assessed; effectively disagreeing, Initiating, Summarizing and Attaining the Objective.

Non-Verbal Communication: Importance and Elements; Body Language.

Teamwork and Leadership Skills: Concept of Teams; Building effective teams; Concept of Leadership and honing Leadership skills.

UNIT – III

Interview Skills: Interviewer and Interviewee – in-depth perspectives. Before, During and After the Interview. Tips for Success.

Presentation Skills: Types, Content, Audience Analysis, Essential Tips – Before, During and After, Overcoming Nervousness.

UNIT-IV

Etiquette and Manners – Social and Business.

Time Management – Concept, Essentials, Tips.

Personality Development – Meaning, Nature, Features, Stages, Models; Learning Skills; Adaptability Skills.

UNIT-V

Decision-Making and Problem-Solving Skills: Meaning, Types and Models, Group and Ethical Decision-Making, Problems and Dilemmas in application of these skills.

Conflict Management: Conflict - Definition, Nature, Types and Causes; Methods of Conflict Resoultion.

Stress Management: Stress - Definition, Nature, Types, Symptoms and Causes; Stress Analysis Models and

Impact of Stress; Measurement and Managemet of Stress

Leadership and Assertiveness Skills: A Good Leader; Leaders and Managers; Leadership Theories; Types of Leaders; Leadership Behaviour; Assertivness Skills.

Emotional Intelligence: Meaning, History, Features, Components, Intrapersonal and Management Excellence; Strategies to enhance Emotional Intelligence.

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Reference Books:

1. Managing Soft Skills for Personality Development – edited by B.N.Ghosh, McGraw Hill India, 2012.
2. English and Soft Skills – S.P.Dhanavel, Orient Blackswan India, 2010.

Course outcome: Students are expected to implement various concepts of soft skills to improve their personality.

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III Year - I Semester		L	T	P	C
		0	0	4	0
PHYSICAL FITNESS ACTIVITIES					

This would involve a daily routine of physical activity with games and sports. It would start with all students coming to the field at 6 am for light physical exercise or yoga. There would also be games in the evening or at other suitable times according to the local climate. These would help develop team work. Each student shall pick one game and learn it for three weeks. There could also be gardening or other suitably designed activity where labour yields fruits from nature.

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DEPARTMENT OF MINING ENGINEERING

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

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, cut off grade, different mining costs and preliminary evaluation of surface mining prospects.

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 strata, deep mining problems

UNIT – V

Dump Formation: Types of waste dump - internal and external; dump formation methods and equipment. Reclamation methods by using different combination of equipment.

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
4) Modern Coal Mining Technology : Samir Kumar Das

REFERENCES:

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

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

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DEPARTMENT OF MINING ENGINEERING

III Year -II Semester		L	T	P	C
		3	0	0	3
MINE LEGISLATION AND SAFETY					

Course Objectives: Students will be able to gain insight to various laws, rules and acts related to mines safety and mining legislation.

UNIT – I
Histroy 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 circular,

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 Outcome:
Students will be able to discuss and apply various laws, rules and acts related to mines safety and mining legislation.

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DEPARTMENT OF MINING ENGINEERING

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

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
Basics: Metal Mining 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 mining/ stoping methods.

UNIT - II
General Mine Design: 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.

UNIT – III
Stoping – General Concepts: Techno-economic characteristics impacting choice of method; typical unit 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.

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. Case studies of Indian and foreign underground metal mines. Comparison of various methods of stoping and costs.

UNIT – V
Novel & Innovative Techniques and Special Applications: 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: CMR, MMR, DGMS circulars and other relevant 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.

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DEPARTMENT OF MINING ENGINEERING

III Year - II Semester	OPEN ELECTIVE-II	L	T	P	C
		3	0	0	3
MINERAL ECONOMICS, BUSINESS AND TRADE					

Course Objectives: To understand the principles of mine economics, valuation, finance, taxation, trade and mineral 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 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.

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REFERENCES:

1) Deshmukh R.T. Mine and Mineral Economics, Emdee Publishers, 1986.

Course Outcomes: Students will be able to learn and apply the principles of mine economics, valuation, finance, taxation, trade and mineral information systems.

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DEPARTMENT OF MINING ENGINEERING

III Year - II Semester	OPEN ELECTIVE-II	L	T	P	C
		3	0	0	3
LANDSLIDES & SLOPE STABILITY ENGINEERING					

Course Objectives: 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, discontinuum 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.

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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 Outcomes: 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.

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DEPARTMENT OF MINING ENGINEERING

III Year - II Semester	OPEN ELECTIVE-II	L	T	P	C
		3	0	0	3
REMOTE SENSING & GIS					

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, electromagnetic radiation, electromagnetic spectrum, interaction with atmosphere, energy interaction with the earth surfaces, characteristics of remote sensing systems, types of resolutions - advantages & limitations, 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

RS and GIS 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.

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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 outcomes

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

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DEPARTMENT OF MINING ENGINEERING

III Year - I Semester	OPEN ELECTIVE – 2	L	T	P	C
		3	0	0	3
GEO-STATISTICS					

Course Objectives: 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, nonstationarities, regularisation, presence of nugget effect and presence of trend. Extension, estimation and dispersion variance; calculation by discretisation 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, regularisation, 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 Outcomes: Students will be able to explain various Geo-statistics techniques and their applications to mineral industry.

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DEPARTMENT OF MINING ENGINEERING

III Year -II Semester	PROGRAM ELECTIVE CORE-II	L	T	P	C
		3	0	0	3
COMPUTER APPLICATIONS AND TOOLS					

Course Objective: To learn about the computer tools and software used for mining.

UNIT-I
Introduction to structure terminology and peripherals, algorithms, flow charts, programs, dedicated systems, applications in mining.

UNIT-II
Exploration, rocket topographic models, bore hole compositing, ore reserve calculation, interpolation, geo-statistical models, open pit design, ultimate pit design, introductory process control, underground mine design.

UNIT-III
Production scheduling: Operational simulation: Introduction, simulation overview, objective, understand the role of modeling. Understanding the basic concept in simulation, example of simulation in mining aspects, simulation of machine repair problem.

UNIT-IV
Concept of variability and prediction, example with dumping time problem, fitting distribution with chi-square test, random number generation, properties of random number, pseudorandom number, random variants generation.
Methods of random variants generation, inverse transform method, acceptance rejection method, composition method, empirical method and rectangular approximation

UNIT-V
Simulation languages, GPPS and SLAM, logical flow diagram of different mining activities, coding with GPSS and SLAM of different mining problems. Computer control, remote control, automatic, applications and limitations of control, IoT in mining.
Mining Software: Basic introduction, salient features, planning by different mining software like DATAMINE, SURPAC. Software for various applications: Basic introduction, salient features and application of software like BLASTWARE, FRAGLYST, GALENA, FLAC/ FLAC3D, VENT.

TEXT BOOKS:

1. T.C. Bartee, digital computer fundamental, Mc Graw Hill, 4th edition 1984.
2. P. Malvino and D.P.leach digital principals and applications Mc Graw Hill 5th edition 1994.

REFERENCE BOOKS:

1. R.V. Ramani, application of computer methods in the mineral industry,published by society of mining engineers of AMIE, New York city ,U.S.A, 1977.

Course Outcome: Students will be able to gain knowledge on various computer tools and software used in mining.

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DEPARTMENT OF MINING ENGINEERING

III Year - II Semester		L	T	P	C
		3	0	0	3
MINE ECONOMICS					

Course objectives: To understand the mineral industry and gain knowledge about the concepts of estimation, valuation of ore reserves and mineral deposits along with project appraisals, finance and accounting.

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 objectives: Students will be able to understand the concepts of estimation, valuation of ore reserves and mineral deposits along with project appraisals, finance and accounting.

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DEPARTMENT OF MINING ENGINEERING

III Year - II Semester		L	T	P	C
		3	0	0	3
MINE MECHANISATION					

Course Objectives: To understand the concepts of winding engines, accessories and layouts, coal face machinery, excavation and loading machinery in surface mines.

UNIT - I
WINDING ENGINES: Winding systems, drum winders, drives, mechanical braking of winders, safety devices in winding, over wind and over speed protection, Koepe and multi-rope friction winding, electrical layouts. Duty cycles of drum winders of different drum cross-sections. Special problems of deep shaft winding.

UNIT – II
WINDING ACCESSORIES AND LAYOUTS-I:
Head gear and their design, head sheave, cages and skips, suspension gear, shaft fittings and appliances – guides, keps, etc., signalling systems, winding calculations relating to rope size & numbers, capacity & power requirement for cages, skips, drum and Koepe winding systems.

UNIT – III
WINDING ACCESSORIES AND LAYOUTS-II:
Surface and Pit-bottom layouts - Mine car circuits at the surface and pit bottom, creepers, skip winding – loading and discharge arrangements. Case studies, railway sidings and layouts.

UNIT – IV
COAL FACE MACHINERY:
Construction, salient mechanical and electrical features and operations of coal drills and their control panels, coal cutters, different types of mechanical loaders coal ploughs, cutter loaders and continuous miners; development road headers in face mechanisation, longwall mining equipment, electrical and hydraulic layouts; condition monitoring of mining machinery for underground and opencast mines and ore handling plants, modern concepts in underground mine mechanisation.

UNIT – V
EXCAVATION AND LOADING MACHINERY IN SURFACE MINES:
Classification. Hydraulic system diagram. Under carriage. Design and Constructional details of Front end loaders, Hydraulic excavators and Electric Rope shovel, Backhoe, Dragline, Bucket Wheel Excavator. Bucket Chain Excavator and Surface Miners.

TEXT BOOKS:
1. Amitosh Dey, Heavy Earth Moving Machinery, Lovely Prakashan Publications, Dhanbad, 2000.
2. Walker, S.C., Mine Winding and Transport, Elsevier, 1988. 3. Ramlu, M.A. Mine Hoisting, CRC Press, 1996

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REFERENCE BOOKS:

1) Hartman, H. L. (Editor), SME Mining Engineering Handbook, 3rd edition, Vol I & II, Society of Mining Engineers, New York, 2011.
2) Cherkassky, B.M., Pumps, Fans, Compressors, MIR Publishers, 1980.
3) Deshmukh, D.J., Elements of Mining Technology, Vol. I, II and III, EMDEEE Publishers, Nagpur, 1979.
4) Alemgren G., Kumar U., and Vagenas N., Mine Mechanisation and Automation, A.A., Balkema Publication, 1993.
5) Mason, E., Coal Mining Series, Surveying, Vol I and II Virtue and Company Limited, London, 1985.

Course Outcomes: Students will be able to understand and apply the concepts of winding engines, accessories and layouts, coal face machinery, excavation and loading machinery in surface mines.

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DEPARTMENT OF MINING ENGINEERING

III Year - II Semester	PROFESSIONAL ELECTIVE COURSE-II	L	T	P	C
		3	0	0	3
MINE AUTOMATION					

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.

UNIT - II
Data communication and modern computerized control systems -data formats and IREDES, mine process data, AGV technology.

UNIT – III
Basic foundations for automation of mining equipment- navigation, surface navigation and GNSS (satellite navigation), mine planning tools etc

UNIT - IV
Automation of drilling and drill rig, drilling process - Automation of underground loading and transportation systems - Automation in tunnelling projects.

UNIT – V
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.

TEXT BOOKS:
1) Society of Mining Engineering Handbooks –Vol –I and II

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.

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DEPARTMENT OF MINING ENGINEERING

III Year - II Semester		L	T	P	C
		0	0	3	1.5
MINE MECHANIZATION LAB					

Course Objectives: 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. Friction prop, close-circuit hydraulic prop, multi leg chock support (in long wall gallery).

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

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DEPARTMENT OF MINING ENGINEERING

III Year - II Semester		L	T	P	C
		0	0	3	1.5
COMPUTER APPLICATIONS IN MINING LAB					

Course Objectives: To acquire knowledge on CAD packages.

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, Pedit, 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 SUPRAC.

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

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DEPARTMENT OF MINING ENGINEERING

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

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

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DEPARTMENT OF MINING ENGINEERING

III Year - II Semester		L	T	P	C
		0	0	4	2
NUMERICAL MODELING TECHNIQUES IN MINING LAB					

Course Objective: To perform numerical modeling of various aspects of surface and underground mining.

LIST OF EXPERIMENTS:

1. Design of pillars
2. Blast design
3. Subsidence prediction.
4. Mine ventilation network analysis.
5. Modeling of airflow through underground workings using CFD.
6. Ore body modeling.
7. Slope stability analysis in soil and rocks.
8. Fragmentation Analysis
9. Truck dispatch system optimization
10. Digital Terrain and Wire-frame modeling
11. Surface Mine Design using MPD Software
12. Underground Mine Design using MPD Software
13. Pit optimization using MPD Software
14. Production scheduling for grade control
15. Design of experiments.

Course Outcome: Students will able to use the numerical modeling software for surface and underground mining.

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DEPARTMENT OF MINING ENGINEERING

III Year - II Semester		L	T	P	C
		3	0	0	3
RESEARCH METHODLOGIES & IPR					

Course Objectives: To acquire knowledge about research methodologies and IPR.

UNIT-I
Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.

UNIT II:
Effective literature studies approaches, analysis Plagiarism, Research ethics, Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.

UNIT III:
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 IV:
Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

UNIT-V:
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) Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
2) Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"

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

Course Outcomes: Students will be able to learn the concepts of research methodology and intellectual property rights

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DEPARTMENT OF MINING ENGINEERING

IV Year - I Semester	PROFESSIONAL CORE COURSE-III	L	T	P	C
		3	0	0	3
OPERATIONS RESEARCH					

Course Objectives: To provide knowledge of solving of different operational problems for their optimal solutions.

UNIT -I: Introduction
Introduction to optimization techniques, Introduction to linear programming, problem formulations, graphical solutions, unbounded solution, infeasible solution, unique solution, multiple solutions. Mining examples

UNIT -II: LPP
Simplex method with different combinations of constraints, Big M method, Duality of linear programming, importance of dual problems, interpretations of solutions of primal from dual.

UNIT -III: Transportation & Assignment problems
A: Transportation problem: Formulation–Optimal solution, unbalanced transportation problem–Degeneracy, mining examples.
B: Assignment problem – Formulation – Optimal solution - Variants in assignment problems, Mining examples.

UNIT -IV: Inventory and Waiting line models
Importance of Inventory, Introduction to inventory, basic assumptions in EOQ model, EOQ (Economic Order Quantity): Introduction to waiting line theory, basic assumptions in waiting line, determination of waiting time in queue, waiting time in system, Single channel queue systems – arrivals Poisson distributed, service time exponential distribution

UNIT-V: Project management
Introduction to CPM, Importance of CPM, Determination of Early start times, Early finish times, Latest finish times, Critical path, Project duration, Crashing of a network, Importance of PERT, Probability of project completion time, Assumptions in PERT

TEXT BOOKS:
1. Introduction to O.R /Taha/PHI Publishers
2. Operations Research / S.D.Sharma/Kedarnath Publisher

REFERENCE BOOKS:
1) Operations Research /A.M.Natarajan, P.Balasubramani,A. Tamilarasi/Pearson Education.
2) Operations Research: Methods & Problems / Maurice Saseini, ArhurYaspan& Lawrence Friedman/ Literary Licensing
3) Operations Research / R.Pannerselvam,PHI Publications.

Course Outcomes: Students will get knowledge to find the optimal solutions for a variety of problems.

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DEPARTMENT OF MINING ENGINEERING

IV Year -I Semester	PROFESSIONAL CORE COURSE-III	L	T	P	C
		3	0	0	3
DIMENSIONAL STONE MINING					

Course Objectives: 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 project proposal.

UNIT- II
Mining: Conventional mining of Sandstone, Limestone, 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.

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 Outcomes: Students will learn about the important concepts of dimensional mining.

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DEPARTMENT OF MINING ENGINEERING

IV Year -I Semester	PROFESSIONAL CORE COURSE-III	L	T	P	C
		3	0	0	3
ADVANCED MINING TECHNIQUES					

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. The various underground coal mining techniques: bord and pillar, blasting gallery, continuous miner, longwall and other special techniques. Criteria for selection of different mining equipment.

UNIT – III

Design of underground coal mining methods: Pillar mining systems: design of panels, rooms and pillars; design and methods of pillar extraction with bord and pillar, blasting gallery and longwall 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 gassification 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: General engineering design; design methods in mining; input parameter for design - geological and other rock mass parameters; empirical, observational and analytical methods of design; 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 Outcomes:

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

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DEPARTMENT OF MINING ENGINEERING

IV Year -I Semester	PROGRAM ELECTIVE-3	L	T	P	C
		3	0	0	3
PLANNING OF UNDERGROUND METAL MINNING TECHNIQUES					

Course Objectives:
To understand the basic concepts and principles of underground metal mining methods and practices.

UNIT I:
Planning and scheduling of insets, shaft bottoms. Winding and transport system.

UNIT II:
Surface layouts including mill and consentrator plants.

UNIT III:
Determination of number and dimentions of stops.

UNIT IV:
Planning and scheduling of a cycle of operations.

UNIT V:
Concept of Ore blending. Overall planning and scheduling of activities in metal mining and processing. Case studies of planning of Mining operations.

Text Book:
1. 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". 5. Popov:"Working of mineral deposits".

Course Outcome: Student will be able to discuss the concepts and principles of underground metal mining methods.

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DEPARTMENT OF MINING ENGINEERING

IV Year -I Semester	PROFESSIONAL CORE COURSE-IV	L	T	P	C
		3	0	0	3
MINE CLOSURE AND RECLAMATION					

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.

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DEPARTMENT OF MINING ENGINEERING

IV Year -I Semester	PEC -4	L	T	P	C
		3	0	0	3
SURFACE MINE ENVIRONMENT					

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.

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DEPARTMENT OF MINING ENGINEERING

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

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DEPARTMENT OF MINING ENGINEERING

IV Year -I Semester	PEC-4	L	T	P	C
		3	0	0	3
SUSTAINABLE DEVELOPMENT FOR MINING					

Course objective: To understand the concepts of sustainable development for mining industry and know about the current status of mining practices and their impact on sustainability, clean coal technologies and mine water conservation practices.

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, utilisation 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, Abondoned coal mine methane, Underground gasification of coal. Leaching of old dumps and recovery of metals. Recyling 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 benfits.Waste management- processing of overburden material for underground stowing and innovative methods for utilisation 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) 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) Sustaianble mining practices –A global perspective by Vasudevan Rajaram, Subijoy Dutta, Krishna Paremeswaran, ISBN-90-5809-689-0.

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Course outcome: Students will be able to come across sustainable development in mining industry, clean coal technologies, mine water conservation and the best mining practices.

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DEPARTMENT OF MINING ENGINEERING

IV Year -I Semester	PEC-4	L	T	P	C
		3	0	0	3
MINERAL ECONOMICS, BUSINESS AND TRADE					

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.

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DEPARTMENT OF MINING ENGINEERING

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.

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DEPARTMENT OF MINING ENGINEERING

IV Year -I Semester	PEC-5	L	T	P	C
		3	0	0	3
SUBSIDENCE ENGINEERING					

Course Objectives: To understand subsidence mechanisms, prediction, control of subsidence due to underground mining, time influence and impact on structures along with the governing laws.

UNIT-1
Introduction: Strata movement at the mining horizon, convergence in mine working, factors influencing convergence in mine working.

UNIT- II
Subsidence Mechanism**:** Zones of movement in the overlaying beds, vertical and horizontal movement, subsidence trough, angle of draw, angle of break, sub-surface subsidence.

UNIT- III
Subsidence Prediction: Different methods of surface subsidence prediction – graphical, analytical, profile function, empirical and theoretical models, software and instrumentation, subsidence survey.

UNIT- IV
Time Influence and Impact on Structures: Influence of time on subsidence, example from long wall and bord and pillar working. Calculation of ground movement over time. Types of stress on structures, stress-strain behaviour of soils, mining damage to buildings, industrial installations, railway lines, pipes, canals, etc.,

UNIT- V
Subsidence Control, Governing Laws and Standards: Measures to reduce mining damage, mining methods to minimize damage. Laws governing mining damage, different standards suggested for mining and building ground in respect of subsidence. Case studies of mine subsidence.

TEXT BOOKS:
1. Whiltaker B.N. Reddish D.J. - Subsidence occurrence prediction and control
2. Kratzsch. H, Mine Subsidence Engineering.

REFERENCE BOOKS:
1. B. Singh – Mine Subsidence
2. Peng.S. – Surface subsidence Engineering
3. Debasis Deb and A.K. Verma -Fundamentals and applications of rock mechanics, PHI.

Course outcomes: Students will be able to learn subsidence mechanisms, prediction, control of subsidence due to underground mining, time influence and impact on structures along with the governing laws.

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DEPARTMENT OF MINING ENGINEERING

IV Year -I Semester	PROGRAM ELECTIVE-5	L	T	P	C
		3	0	0	3
ROCK SLOPE ENGINEERING					

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
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.

UNIT IV Circular and toppling failure:
Conditions for circular failure; derivation of circular failure analysis; effect of ground water; circular failure charts; Bishop's and Janbu's methods of failure analysis; case studies. Types of toppling failure; secondary toppling modes; analysis of toppling failure; limit equilibrium analysis of toppling failures; 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.

UNIT V Rock slope failure monitoring and slope 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 rock reinforcement & rock removal; protection measures against rock falls. design of the slope using numerical modelling software.

TEXT BOOKS:

1. Hoek, EandBray,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.

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DEPARTMENT OF MINING ENGINEERING

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.

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DEPARTMENT OF MINING ENGINEERING

IV Year -I Semester	PROGRAM ELECTIVE-5	L	T	P	C
		3	0	0	3
ADVANCES IN ROCK FRAGMENTATION					

Course Objectives: To acquire the knowledge about rock breaking techniques and computational models of blasting.

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.

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

REFERENCE BOOKS:
1. B. H. Garg: Blasting Operation, McGraw Hill, 1981
2. CP Chugh, Drilling Technology Handbook, Oxford & IBH, 1977

Course outcome: Students will be able to learn rock breaking techniques and also the computational models of blasting and the instrumentation used for blasting.

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DEPARTMENT OF MINING ENGINEERING

IV Year -I Semester	PROGRAM ELECTIVE-5	L	T	P	C
		3	0	0	3
TUNNELING AND UNDERGROUND SPACE TECHNOLOGY					

Course Objectives: To understand drilling and blasting methods of tunnels, mechanized tunneling 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 behaviour 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.

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DEPARTMENT OF MINING ENGINEERING

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

Course Objective: To understand various issues related to waste management, environment pollution due to mine wastes and their impact.

UNIT-1
Introduction Chemical aspects of environmental pollution by mine wastes and their impact.

UNIT-2
Production and Solid Waste Management Production and characterization of solid wastes in different types of mines.

UNIT-3
Mine Effluents Generation and characterization of mine effluents and leachate.

UNIT-4:
Tailings Disposal – characterization, technical issues, sampling and analysis, site selection and design of tailings impoundment, tailings dam failure.

UNIT-5:
Mine Waste Handling Management of different types of mine wastes.

TEXTS BOOKS:
1. SME Mining Reference Handbook, Lowrie R., SME Publication 2002.
2. Mining engineers Handbook, Peele R.

REFERENCES:
1) Environmental Geology, Ghosh R. & Chatterjee D. S., Capital Publishing Co. New Delhi.
2) Water Resources Engineering Larry W. M., Publisher John Wiley and Sons
3) Water Resources Engineering - Ray K. L., Franzini J.B., Freyberg D.L., George Tchobanoglous G. & Hill M.G., 4th Ed.
4) Hydrology and Water Resources Engineering, Garg S.K., Khanna Publishers
5) Hydrology- Das M.M. & Saikia M.D., PHI Learning Pvt. Ltd., New Delhi.

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

Course outcome: Students will be able to explain various issues related to waste management, environment pollution due to mine wastes and their impact.

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DEPARTMENT OF MINING ENGINEERING

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

Course objectives: To understand the concepts of sustainable development for mining industry and know about the current status of mining practices and their impact on sustainability, clean coal technologies and mine water conservation practices.

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, utilisation 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, Abondoned coal mine methane, Underground gasification of coal. Leaching of old dumps and recovery of metals. Recyling 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 benfits.Waste management- processing of overburden material for underground stowing and innovative methods for utilisation of waste from mines. Air quality in open pit mines, dust control measures, noise levels- pollution, monitoring and control. Bio-divrsity- 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) 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) Sustaianble mining practices –A Global perspective by Vasudevan Rajaram, Subijoy Dutta, Krishna Paremeswaran,ISBN-90-5809-689-0

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Course outcome: Students will be able to come across sustainable development in mining industry, clean coal technologies, mine water conservation and the best mining practices.

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DEPARTMENT OF MINING ENGINEERING

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

Course objective: To impart knowledge about basic concepts and 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.

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DEPARTMENT OF MINING ENGINEERING

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

Course objectives: 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.

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DEPARTMENT OF MINING ENGINEERING

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, Addision Wesley Longman Ltd, Singapore, 1997

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

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DEPARTMENT OF MINING ENGINEERING

IV Year -I Semester	OPEN ELECTIVE-4	L	T	P	C
		3	0	0	3
PRINCIPLES OF MINERAL ENGINEERING					

Course objective: To understand the principles of mineral dressing, sizing and classification, concentration methods, and sampling methods.

UNIT - I
Scope, object 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.
Coal washing: Coal washability, crushing, sizing and cleaning of coal.

UNIT – V
Sampling: Importance and methods used in ore-dressing

TEXT BOOKS:
1) M.A. Gaudin, Mineral Dressing
2) H.G. Vijendra, Handbook on Mineral Dressing. Pub: Vikas Publishing house New-Delhi

REFERENCES:
1) S.K.Jain, Mineral Dressing
2) Rao, Mineral Dressing

Course outcome: Students will be able to learn the principles of mineral engineering.

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DEPARTMENT OF MINING ENGINEERING

IV Year -I Semester	OPEN ELECTIVE-4	L	T	P	C
		3	0	0	3
MINE INSTRUMENTATION					

Course objectives: To understand and classify various instruments to measure pressure, flow, vibration, humidity, velocity, sensitivity, energy along with analyzers and rock mechanics instrumentation.

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 – ManometersDifferent 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 systemLoad 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
Analysers: Dissolved Analyzer: Conductivity meter – pH meter – Dissolved oxygen analyser – Sodium analyser – Silica analyser – Turbidity meter – Gas analyser – O2, NOx – H2S analyser – 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 Long wall, 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

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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 outcome: Students will be able to explain and classify various instruments to measure pressure, flow, vibration, humidity, velocity, sensitivity, energy along with analysers and rock mechanics instrumentation.

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DEPARTMENT OF MINING ENGINEERING

IV Year -I Semester	OPEN ELECTIVE-4	L	T	P	C
		3	0	0	3
MINE SAFETY & ERGONOMICS					

Course Objective: To understand the concepts and various methods of risk management and safety of mines along with ergonomic aspects.

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; Behavioural 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

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REFERENCE BOOKS:

1) Safety Engineering by B. S. Dhillon, Springer
2) Mine Safety by B. S. Dhillon, Springer.

Course outcome: Students will be able to learn the various methods of risk management and safety of mines along with ergonomic aspects.

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IV Year -I Semester	OPEN ELECTIVE-4	L	T	P	C
		3	0	0	3
NUMERICAL METHODS IN MINING ENGINEERING					

Course Objectives: To gain knowledge about the finite element methods, finite difference methods and boundary element methods and analyze practical applications of numerical methods in mining field.

UNIT-I: Introduction to Elastic and Plastic Models, Fundamentals, elastic, plastic, homogeneous and isotropic, non-linear elastic and elasto-plastic models.

UNIT -II: Finite Difference Methods:
Concept, formation of mesh element, finite difference patterns, solutions, application to mining.

UNIT -III: Finite Element Methods
A: Concept, discretization, element configuration, element stiffness, assemblage and solutions, two and three dimensional solutions.
B: Linear and non-linear analysis, applications in geomechanics; simulation of joints in strata.

UNIT -IV: Boundary Element Method
Concept, discretization, different methods of solution for isotropic and infinite media.

UNIT -V: Practical Applications in Mining and Rock Mechanics
Practical Applications in stress analysis, slope stability, subsidence prediction, and pillar design, rock burst, etc.

TEXT BOOKS:

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

REFERENCE BOOKS:

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 outcomes: Students will be able to learn finite element methods, finite difference methods and boundary element methods and their applications to mining.

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DEPARTMENT OF MINING ENGINEERING

IV Year -I Semester		L	T	P	C
		3	0	0	3
UNIVERSAL HUMAN VALUES: UNDERSTANDING HARMONY					

Course objective: To develop a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence, to understand (or developing clarity) of the harmony in the human being, family, society and nature/existence, to strengthen self-reflection and to develop the commitment and courage to act.

UNIT-1:

Course Introduction - Need, Basic Guidelines, Content and Process for Value Education

1) Purpose and motivation for the course, recapitulation from Universal Human Values-I
2) Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration
3) Continuous Happiness and Prosperity- A look at basic Human Aspirations
4) Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority
5) Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario
6) Method to fulfill the above human aspirations: understanding and living in harmony at various levels. Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking.

UNIT- 2:

Understanding Harmony in the Human Being - Harmony in Myself!

1) Understanding human being as a co-existence of the sentient 'I' and the material 'Body'
2) Understanding the needs of Self ('I') and 'Body' - happiness and physical facility
3) Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer)
4) Understanding the characteristics and activities of 'I' and harmony in 'I'
5) Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail
6) Programs to ensure Sanyam and Health. Include practice sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease.

UNIT-3:

Understanding Harmony in the Family and Society- Harmony in Human Relationship

1) Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfillment to ensure mutual happiness; Trust and Respect as the foundational values of relationship
2) Understanding the meaning of Trust; Difference between intention and competence
3) Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship
4) Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals
5) Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family. Include practice sessions to reflect on relationships in family, hostel and institute as

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extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives.

UNIT-4:

Understanding Harmony in the Nature and Existence - Whole existence as Coexistence

1) Understanding the harmony in the Nature
2) Interconnectedness and mutual fulfilment among the four orders of nature recyclability and self regulation in nature
3) Understanding Existence as Co-existence of mutually interacting units in allpervasive space
4) Holistic perception of harmony at all levels of existence. Include practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

UNIT-5:

Implications of the above Holistic Understanding of Harmony on Professional Ethics

1) Natural acceptance of human values
2) Definitiveness of Ethical Human Conduct
3) Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order
4) Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems.
5) Case studies of typical holistic technologies, management models and production systems
6) Strategy for transition from the present state to Universal Human Order: a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers b. At the level of society: as mutually enriching institutions and organizations
7) Include practice: Exercises and Case Studies will be taken up in Practice (tutorial) Sessions eg. To discuss the conduct as an engineer or scientist etc.

TEXT BOOKS:

1) Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010

REFERENCE BOOKS:

1) Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, 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).

Course outcome: Students will be able to discuss a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence, to explain (or developing clarity) of the harmony in the human being, family, society and nature/existence, to strengthen self-reflection and to judge the commitment and courage to act.

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IV Year -I Semester		L	T	P	C
		0	0	4	2
SOFT COMPUTING AND APPLICATIONS LAB					

Course objective: To impart knowledge about basic soft computing tools and model physical systems using Matlab Simulink and Labview software.

NOTE: Number of experiments should be minimum 10 based on each topic given below and all the experiments should be relevant to Mining Engineering.

1) Introduction to Matlab & Labview Software.
2) Modeling of physical systems in Matlab and Simulink.
3) Application of different toolbox and modules.
4) Programming using subsystems.
5) Real-time control and data acquisition (DAQ).

Course Outcome: Student will be able to model the physical systems in Matlab as well as he can discuss real time data acquisition techniques using Labview.

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MINOR IN MINING ENGINEERING:

S. NO	SUBJECT	PRE-REQUISTES
1	Development of Mineral Deposits	None
2	Rock Mechanics	Strength of Materials
3	Mine Ventilation	None
4	Underground Coal Mining	Development of Mineral Deposits
5	Mine Hoisting and Transportation	None
6	Surface Mining	Development of Mineral Deposits

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		L	T	P	C
		3	0	0	3
DEVELOPMENT OF MINERAL DEPOSITS					

Course Objectives: To impart the knowledge of mineral deposits and understand the methods of drilling, blasting, special methods of shaft sinking and drivage of drifts.

UNIT I:
Introduction to methods of development of mineral deposits. Various types of development openings shape and size, Selection of suitable type for actual situations raises, winzes or passes, ore chutes.
Location of shaft shape and size, incline and vertical shafts.

UNIT II:
Surface arrangements for sinking shafts, tools and equipment's ordinary methods of sinking drilling, blasting removal of debris and water.
Ventilation and lighting, temporary and permanent lining, widening and deepening of shafts.

UNIT III
Special methods of shaft sinking piling, caisson, freezing and cementation method of shaft sinking Modern techniques of shaft sinking. Design of shafts inserts and pit bottoms.
Modern methods of underground tunneling and caverns

UNIT -IV:
Classification and properties of explosives, detonators. Detonating cords, and detonating fuse and nonel detonator. Blasting systems, electrical and non electrical methods, delay blasting techniques. Blasting inopen pit mines, 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,Dhanbadpublishers,1978
2. Elements Mining Technology Volume-I by D.J.Deshmukh (9^{th} edition),central techno publication.

REFERENCE BOOKS:
1. SME Hand Book
2. Blasting Manual- Sandhu &Pradhan.

Course Outcomes: Students will be able to explain the knowledge of mineral deposits and understand the methods of drilling, blasting, special methods of shaft sinking and drivage of drifts.

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DEPARTMENT OF MINING ENGINEERING

		L	T	P	C
		4	0	0	4
ROCK MECHANICS					

Course Objectives: To acquire knowledge about the concepts of rock mechanics and properties ocks along with non-destructive testing methods.

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, protodynakov 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 thestrength 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, Coulumb-Navier, Mohr's, Hoek-Brown, empirical criteria, etc. and their field of applications. Stress distribution in underground workings

TEXT BOOKS:

1. Vutukuri, V.S., and Lama, R.D., Handbook on Mechanical Properties ofRocks, Vol. I, II, III and IV, Transtech Publication, Berlin,1974/78.
2. Peng, S.S., Ground Control, Wiley Interscience, New York, 1987.

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REFERENCE BOOKS:

1. Obert, L. and Duvall, W.I., Rock Mechanics and Design of Structure in Rock John Wiley andSons Inc., New York, 1967.
2. Brady, B.H.G. and Brown, S.T., Rock Mechanics, Wiley Interscience,1985.
3. Hoek, E., and Brown, S.T., Underground Excavations in Rocks, Institute of Mining

Course Outcomes: Student will be able to learn the concepts of rock mechanics, properties of rocks along with the non-destructive testing methods.

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		L	T	P	C
		4	0	0	4
MINE VENTILATION					

Course objectives: To understand the mine atmosphere conditions, heat and humidity levels, ventilation in mines and their controlling methods.

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-gasdetector.

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 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, Accenssional, 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 ventilating a mine. Introduction to Network analysis, Hardy – Cross method, Ventilation survey. Case study

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TEXT BOOKS:

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

REFERENCE BOOKS:

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

Course outcomes: Students will be able to learn the mine atmosphere conditions, heat and humidity levels, ventilation in mines and their controlling methods.

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DEPARTMENT OF MINING ENGINEERING

		L	T	P	C
		4	0	0	4
UNDERGROUND COAL MINING					

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, 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 withlayout.

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.

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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 CompanyLtd. Inc.1958.
3. Elements of Mining technology- D.J DeshmukhVol.1
4. Modern Coal mining Technology: Samir kumarDas
5. Underground 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.

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		L	T	P	C
		4	0	0	4
MINE HOISTING AND TRANSPORTATION					

Course Objectives:
To gain knowledge about various mine hoisting and transportation systems.

UNIT – I:
Winding engines: Winding systems, drum winders, drives, mechanical braking of winders, safety devices in winding, over wind and over speed protection, Koepe and multi-rope friction winding, electrical layouts. Duty cycles of drum winders of different drum cross-sections. Special problems of deep shaft winding.

UNIT – II:
Winding accessories and layouts: Head gear and their design, head sheave, cages and skips, suspension gear, shaft fittings and appliances – guides, keps, etc., signaling systems, winding calculations relating to rope size & numbers, capacity & power requirement for cages, skips, drumand Koepe winding systems. Surface and Pit-bottom layouts - Mine car circuits at the surface and pit bottom, creepers, skip winding – loading and discharge arrangements. Case studies, railway sidings and layouts.

UNIT –III:
Coal face machinery:
A: Construction, salient mechanical and electrical features and operations of coal drills and their control panels, different types of mechanical loaders, coal ploughs, and continuous miners.
B**:** Development road headers in face mechanization, longwall mining equipment, electrical and hydraulic layouts; condition monitoring of mining machinery for underground and opencast mines and ore handling plants, modern concepts in underground minemechanization.

UNIT – IV:
Excavation and loading machinery in surface mines: Classification. Hydraulic system diagram. Under carriage. Design and Constructional details of Front end loaders, Hydraulic excavators and Electric Rope shovel, Backhoe, Dragline, and Bucket Wheel Excavator. Bucket Chain Excavator and Surface Miners.

UNIT – V:
Other machinery in surface mines: Classification of transport equipments; Construction and technical specifications of Dumpers of different types including multi-axial dumpers,, Tractors, trailers, dump trucks, Rippers (types), Motor Graders, Bull Dozers, Rock breakers, Road Compactors, Water Tankers.

TEXT BOOKS:
1. Elements of Mining Technology Vol. I & II, Deshmukh D.J., Denett &Company,2014
2. Pumps Focus Compressors Walkar, winding & Transport, Cherkasky B.M.

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REFERENCE BOOKS:

1. Mine Mechanisation and Automation, Alemgren G,U.Kumar.
2. Coal Mining Series, Ernest Mason, London,1952.

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

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DEPARTMENT OF MINING ENGINEERING

		L	T	P	C
		4	0	0	4
SURFACE MINING					

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

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

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: Drillability, 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, flyrocks 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 surface miners.

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

TEXT BOOKS:

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

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DEPARTMENT OF MINING ENGINEERING

REFERENCE BOOKS:

1. Elements of Mining Technology, Vol. – I, D. J. Deshmukh, 6th Edition, 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, the Institution of Mining and Metallurgy,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.

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DEPARTMENT OF MINING ENGINEERING

	HONORS	L	T	P	C
		4	0	0	4
OPTIMIZATION TECHNIQUES					

Course objectives: To understand and apply various techniques to optimize systems.

UNIT – 1
INTRODUCTION TO OPTIMIZATION: Engineering applications of optimization- statement of an optimization problem- classification of optimization problem- optimization techniques.
CLASSICAL OPTIMIZATION TECHNIQUES: Single variable optimization- multivariable optimization with equality constraints - multivariable optimization with inequality constraints.

UNIT – 2
UNCONSTRAINED OPTIMIZATION TECHNIQUES: pattern search method - Rosenbrock's method of rotating coordinates- the simplex method - Descent methods- gradient of function- steepest descent method.

UNIT – 3
CONSTRAINED OPTIMIZATION TECHNIQUES: characteristics of a constrained problem- methods of feasible directions - basic approach in the penalty function method- interior penalty function method- convex programming problem- exterior penalty function method.

UNIT – 4
GEOMETRIC PROGRAMMING (G.P): Solution of an unconstrained geometric programming, differential calculus method and arithmetic method. Primal dual relationship and sufficiency conditions. Solution of a constrained geometric programming problem (G.P.P).Complimentary geometric programming (C.G.P).

UNIT – 5
DYNAMIC PROGRAMMING (D.P): Multistage decision processes. Concepts of sub optimization, computational procedure in dynamic programming calculus method and tabular methods. Linear programming as a case of D.P., Continuous D.P.

Text Book:
1. Optimization Theory and Applications, by S.S.Rao, Wiley Eastern Limited, New Delhi.

References:
1. Engineering Optimization by Kalyanmanai Deb, Prentice Hall of India, New Delhi.
2. Optimization Techniques, C.Mohan, Kusum Deep.
3. Operations Research by S.D.Sharma.

Course outcomes: Students will be able to apply various techniques to optimize systems.

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DEPARTMENT OF MINING ENGINEERING

	HONORS	L	T	P	C
		4	0	0	4
MODERN MINING TECHNIQUES					

Course Objectives: To make students conversant with modern mining methods

UNIT - I

Experimental mining procedures: Review of various experimental mining procedures, including a critical evaluation of their potential applications. Mining methods covered include deep sea nodule mining, in situ gasification of coal, in situ retorting of oil shale, solution mining of soluble minerals, in situ leaching of metals, geothermal power generation, oil mining, nuclear fragmentation, slope caving, electro-thermal rock penetration and fragmentation.

UNIT - II

Borehole mining: Borehole mining of coal, uranium, sulphur Drilling , maintenance services, Jet Cavitations, fracturing, Solution Mining of important minerals, leaching

Coal bed methane: Coal Fundamentals and Geology, Key Coal Properties, Coal Permeability, Measurement of Coal bed Gas Content, Elements of a CBM, Isotherms, and Recovery Factor, Development Considerations, Well Design and Drilling, Gas Recovery & Well Performance

UNIT - III

Coal gasification: Introduction to gasification: Chemical reactions, Process technologies: Coal Liquefaction, Underground gasification – principles and potential, Conversion of coal to syngas, Impact of coal properties on gasification, Production of coal for gasification: mining and beneficiation perspective, Conversion of syngas to a variety of chemical products, Conversion of coal to syngas via the Sasol process, Environmental aspects around a gasification plant, relevance of coal gasification and its future potential as an environmentally sound technology in the co-production of energy and chemicals with CO_2 minimisation.

UNIT - IV

Hydraulic mining: Introduction, Process of hydraulic mining, hydro monitors, water jets, surface and underground layouts, merits and impacts

Dimensional Stone mining: Introduction and stone mining in India, cutting and control blasting technology, damage measurement during mining, marble and granite mining, cobbles and building stone mining

UNIT - V

Ocean floor mining : Deep ocean exploration, sea bed mining, ocean floor nodules mining, technology, dredgers and other machines for mining and transport

Mining in the space : Lunar mining, asteroid mining, automatic and robotic machines, future of space mining, Impacts.

Text Books:

1. Underground Mining Methods by SME publication Hustrilid
2. Introductory Mining Engineering : Hartman 2nd Edition
3. Society of Mining Engineering Handbooks –Vol –I and II

Course outcomes: Students will learn about modern mining methods.

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DEPARTMENT OF MINING ENGINEERING

	HONORS-POOL	L	T	P	C
		4	0	0	4
MINE POWER SYSTEMS					

Course objectives: To impart knowledge on electrical power supply system in mines, its distribution, control & fault detection, Power economics with emphasis on energy conservation, electric drives & their solid-state control,
transformers, circuit breakers, relays & safety measures and principles of basic electronics in mines.

UNIT I
Mine Power Supply System: Performance of short transmission lines, radial & ring-main distribution system, substation arrangements for opencast & underground mines (OC&UG), voltage selection & power distribution in OC&UG mines. Mining cables, their construction, ratings, selection & application, fault detection & cable joint. Importance & significance of insulation resistance & its testing.

UNIT II
Power Economics: Understanding standard energy bills, importance of parameters therein & calculation of energy charges, types of power tariffs, importance of power factor & its improvement in mines.

UNIT III
Electrical Drives and their Control: Group & individual drive, selection of motors & starters for mining applications like haulage, ventilation fans, pumps, compressors, locomotives, winders. Introduction to power semiconductor devices, thyristor & its applications, basic principle of operation of thyristor controlled variable speed drive, electrical braking.

UNIT IV
Transformers, Switchgears & Electrical Safety in Mine Applications: Principle of working, construction & applications of mining type transformers & lighting transformer, ratings & their selection, thermal & overload relays, their applications. Circuit breakers, introduction of working principle, rating calculation & applications of OCB, ACB, & MCCB, gate end boxes, drill panel, field switch, & trans switch. Equipment earthing practice in mines, principle of flameproof enclosures, intrinsic safety, IE rules as applied to mines.

UNIT V
Basic Electronics & Instrumentation: Transistor as amplifier in CE, CB & CC modes, bridge rectifiers & filters, working principle of feedback sinusoidal oscillators. Working principle of electronic voltmeter, digital frequency counter, CRO stroboscope, transducers & sensors used in measurement of strain, flow & displacement.
Communication: Different types of communication systems in mines, wired telephone system, fibre optics applications in mines, signalling systems in mines, data transmission systems.

Text and Reference Book/s:
1. Electrical equipments in mines by H. Cotton
2. A course in Electrical Power By Soni, Gupta and Bhatnagar
3. Electrical power by S L Uppal
4. Principles of Power Systems by V K Mehta
5. Principles of electrical engineering by V K Mehta & Rohit Mehta
6. Electric drives by N K Dey & P K Sen
7. Electric drives by Vedam Subramaniam

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8. Electronic Principles by Malvino
9. Integrated Electronics by Millman & Halkias
10. Communication systems by B P Lathi
11. A course in Electrical Engineering By B L Thereja
12. Legislation in Indian Mines: A critical Appraisal by Prasad & Rakesh
13. Underground Mining Methods Handbook, SME, 1982
14. SME Mining Engineers Handbook, SME

Course outcomes: Students at the end of the course will gain knowledge on Electrical power supply system and control & fault detection, Power economics with emphasis on energy conservation, Electric drives & their solid-state control, Transformers, circuits breakers and relays & safety measures and Principles of basic electronics, Electronic measurements and communication systems in mines.

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DEPARTMENT OF MINING ENGINEERING

	HONORS-POOL	L	T	P	C
		4	0	0	4
GROUND IMPROVEMENT TECHNIQUES					

Course objectives:
To understand the profiles of soils and various of methods of ground improvement.

UNIT – I
General: Formation of rock, soils and soil profiles, soil distribution in India and other countries - marine, black cotton soils (expansive)., lateritic, alluvial, desert soils peat etc., factors affecting the alteration of ground after formation – natural and man-made – reclaimed soils – methods of geotechnical processes.

UNIT – II
Compaction methods: moisture density relations – compactive efforts – field methods – surface compaction, deep compactions- vigor compaction methods, vibro-probes, stone columns, sand compaction, stone column piles, selection of methods – quality control – specifications for compaction process for solving field problems.

UNIT – III
Drainage methods: seepage, ground water seepage control – filter requirements methods of dewatering – well point methods of discharge computations – design of steps for dewatering – design of well screens – selection of pumps and accessories – deep bored wells. Pre compression methods: compressibility and consolidation properties of soils estimation of rate of consolidation settlements – accelerating methods – monitoring compressions – design of vertical drains – consolidation by electro osmosis and vacuum compression methods.

UNIT – IV
Grouting and injection methods: principles, design methods, selection of methods and requirements. Aspects of grouts, types of grouts and chemical applications, seepage control, solidification and stabilization – equipment and accessories used – quality control – specifications for achieving satisfactory results.

UNIT – V
Stabilization methods: Mechanical, cement, lime, chemical methods of stabilization of soils – use of admixtures – polymers – geo synthesis – reinforcements thermal slurry trenches, void filling – prewetting – improving rock stability methods – exercise quality control to achieve desired results.

TEXT BOOKS
1. J.E. Bowles – Foundation Design & Analysis.McGraw-Hill Edition 1995.
2. Ground improvement techniques by P. Purushottam Raj, Laxmi Pub., 1999.

REFERENCE BOOKS
1. F. S. Fang Handbook of Foundation Engg. CBS Pub., 1985.

Course outcomes:
Students will be able to learn about the profiles of soils and various of methods of ground improvement.

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DEPARTMENT OF MINING ENGINEERING

	HONORS-POOL	L	T	P	C
		4	0	0	4
MINE CONSTRUCTION ENGINEERING					

Course Objective: To gain knowledge about the concepts of mine construction.

UNIT I
Size of mine: Environment and ecology, selection criteria for site of the openings geological investigations. Underground mine shaft sinking methods through alluvium, soft and had rock,

UNIT II
Mechanization: Consolidation of loose ground shaft lining; ground pressure, thickness of lining, design and procedure of laying the lining, Construction of shaft collar heap stead.

UNIT III
Design and construction of insets: shaft bottom, excavation for mechanized decking of cages; skip loading, pit bottom lay outs, installation of main haulages. Main sump size, construction under ground substation; first aid room and office.

UNIT IV
Surface inclines: Drivage through soft and hard rock, construction of portals and lining of inclines, literal and vertical pressures. Underground developments, drivage of roads in stone and coal, mechazation support systems opening of faces. Surface layouts pit top circuits and coal handling and coal preparation plant, railway siding and weigh bridges, surface and underground coal bunkers winding house substation, lamp room.

UNIT V
Pit head bath, crèche dispensary: office, work-shop; material handling. Stowing installation, bunkers, water tanks, mixing chamber. Open pit mines opening out trenches, haul roads, construction of benches. Assembling and transporting of draglines, shovels etc. Scheduling for mine constructions PERT/CPM.

Text books:
1. Pazdziora J. “Design of Underground hard coal mine”.
2. Popov “Working of Mineral Deposits”.
3. Bokey “Mining” 4. “Rzhevsky Unit operations in open cast mines”

Course Outcome: Students will be able to learn various concepts of mine constrcution.

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	HONORS-POOL	L	T	P	C
		4	0	0	4
GROUTING TECHNOLOGY					

Course objective: - To make student conversant about the application of different types of grouts and grouting equipment

UNIT-I
Principles, purpose and application of grouting, viscosity and thixotropy of grout, flow of grout in cracks, pressures for grouting, utility for control of water movement, strengthening of both soil and rock, and structural applications.

UNIT-II
Grouts: Types of grout: cement, chemical, cellular grout, silica fume modified grouts and microfine cement, additives: properties, application, setting of grout, durability.

UNIT-III
Grouting: Grouting techniques: injection techniques, jet, displacement, and permeation. Mix preparation, grout quality. Procedure of grouting assessment during and after grouting, Water testing in grout holes, Monitoring and control methods. Grouting in surface and sub-surface excavations.

UNIT-IV
Grouting equipment: drilling and grouting equipment, grouting mixers, agitators, pumps, valves, pressure gauges, fittings on grout holes, grouting arrangement.
Site investigation, geology, permeability and grouting design Grouting in stressed rock, computer aided grouting.

UNIT-V
Compaction, Remediation, and Testing of grout: field and laboratory studies related to grouting materials, Grouting verification methods and related technologies. Compaction grouting: mechanisms; theories, practice; effect of fines in compaction grouts. Remediation grouting: mine subsidence, cement grouting.

TEXT BOOKS:
1) C. Houlsby; Construction and Design of Cement Grouting : A Guide to Grouting in Rock Foundations(April 1990) John Wiley & Sons (Sd); ISBN: 0471516295.

REFERENCES:
1) Robert Bowen, Grouting in engineering practice

Course outcome: - Student will be able to explain the application of different types of grouts and grouting equipment.

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DEPARTMENT OF MINING ENGINEERING

	HONORS-POOL	L	T	P	C
		4	0	0	4
ADVANCED ROCK MECHANICS					

Course objective: To understand the concepts of ground control of mines, stress concepts, design of structure and supports, and estimation of damage due to bursts and bumps.

UNIT – I
Stress: State of stress in underground openings- premining and induced stresses, influence of water, time, temperature on stress behaviour.
Stress- strain relationships and elastic constants, physico- mechanical properties of rocks

UNIT – II
Measurement of rock loads and displacements, Failure criteria, Influence of anisotropy and discontinuity on rock behaviour. Stress distributions around single and multiple openings in rocks. Rock mass classifications. Rock mass damage criteria. Field instrumentation.

UNIT - III
Design of structure and supports: Design of structure in rock, Design of pillars, Cavability characteristics and cavability index, design of supports.

UNIT - IV
Subsidence: Concept, prediction and determination, measurement techniques, subsidence damage and its prevention.

UNIT - V
Prediction mechanisms: Rock bursts and bumps – mechanisms, prediction and estimation of damage.

TEXT BOOKS
1) Obert L. and Duvall W.I. – Rock Mechanics and The Design of Structures In Rocks; John Wiley & Sons, New York, 1967.
2) Peng, S.S. Coal Mine Ground Control ; John Wiley & Sons, New York, 1978.
3) Biron C. and Arioglue E- Design of Supports in Mines; John Wiley & Sons, New York, 1983.

Course outcome: Students will be able to understand the concepts of measurement of rock loads and displacements, design of structures and supports, subsidence and prediction mechanism.

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	HONORS-POOL	L	T	P	C
		4	0	0	4
CONCRETE AND SHOTCRETE TECHNOLOGY					

Course Objective: - To understand the design principles and concepts of concrete and shotcrete.

UNIT – I: Concrete Making Materials: Aggregates classification, IS Specifications, Properties, Grading, Methods of combining aggregates, specified, grading, Testing of aggregates, Fibers. Cement, Grade of cement, Chemical composition, Testing of concrete, Hydration of cement, Structure of hydrated cement, Special cements - Water Chemical admixtures, Mineral admixture.

UNIT – II: Mix Design: Principles of concrete mix design, Methods of concrete mix design, Testing of concrete. Aggregates, Mixing water and admixtures, Formwork, Reinforcement, Concrete production (including ready-mixed concrete).

UNIT – III: Concrete: Properties of fresh concrete, Hardened concrete, Strength, Elastic properties, Creep and shrinkage, Variability of concrete strength. Materials for concrete, Receiving and storing materials, Batching, mixing. Transporting, placing and compacting, Finishing and surface preparation, Protection and curing, Formwork and reinforcement, Sand-cement mixes, durability of concrete.

UNIT – IV: Special Concrete: Light weight concrete, Fly ash concrete, Fibre refinforced concrete, Polymer Concrete, Super plasticised, concrete, Epoxy resins and screeds for rehabilitation - Properties and Applications - High performance, Mass concrete, Hot and cold weather concreting, Defects and repairs, Concrete pavements, Introduction to prestressed concrete, Vaccum dewatering - underwater concrete.

UNIT – V: Concrete Floors on the Ground: Design philosophy, Subgrades and subbases, Joints. Shotcrete technology: Introducing sprayed concrete, Materials for shotcrete including fibres, Properties of shotcrete (fresh and hardened), Mix design, Batching and mixing, Quality control, Equipment selection and maintenance, Planning and logistics.

Books::

1. Neville, A.M., Properties of Concrete , Pitman Publishing Limited, London.
2. Shetty M.S., Concrete Technology, S.Chand and Company Ltd. Delhi.
3. Rudhani G., Light Weight Concrete Academic Kiado, Publishing Home of Hungarian Academy of Sciences, 1963.

Course Outcome: - Students at the end of the course will be able to gain the fundamental concepts of concrete and shotcrete technology.

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DEPARTMENT OF MINING ENGINEERING

	HONORS-POOL	L	T	P	C
		4	0	0	4
ROCK FRAGMENTATION ENGINEERING					

Course Objectives: To understand the basic concepts of blasting, fragmentation measurement methods, blasting nuisances, special blasting techniques and alternative methods for rock fragmentation.

UNIT-1

Fragmentation by Blasting

Mechanism of rock fragmentation by blasting. Explosives – trends and selection. Principles and application of explosives. Casting of rocks. Controlled blasting methods. Design of multi-row blast rounds. Design of blast rounds for tunnels and drifts.

UNIT-2

Fragmentation Measurement Methods

Application of high speed videography and image analysis techniques for measurement of rock fragmentation by blasting, blast surveys, audits and documentation for monitoring of fragmentation. Computational methods.

UNIT-3

Blasting Nuisances Blasting damages, ground vibrations, airblasts and flyrocks. Mitigation of damages due to blasting, mechanical methods of Fragmentation by water jets, shearers and ploughs, roller and disc cutters.

UNIT-4

Special Blasting Techniques Underwater blasting, demolition blasting, smooth blasting and hot hole blasting.

UNIT-5

Alternative Methods for Rock Fragmentation

Physical, chemical and nuclear methods.

Text Books:

1. Explosives and Blasting Practices in Mines, S.K. Das, Lovely Prakashan, Dhanbad, 1993. (Modules I-V)
2. Explosives and Blasting Techniques, G.K. Pradhan, Minetech Publication, 1996. (Modules I-V)

Reference Books:

1. Surface Mining, G.B. Mishra, Module.1, Dhanbad Publishers, Dhanbad, 1978.
2. Rock Fragmentation by Blasting, B.Mohanty, Module.4, A.A. Balkema, Rotterdam, 1996.
3. Advances in Drilling and Blasting V.R. Sastry, Modules 1 and 2, Allied Publishers Ltd., 1993.
4. Principles of Rock Drilling U.M. Rao Karanam and B.Mishra, Modules 1 and 2 Oxford and IBH, 1998.
5. Drilling and Blasting of Rocks, Carlopez Jimeno, etal. Module.7, A.A. Balkema, Rotterdam, Brook fields, 1995.
6. Engineering Rock Blasting operations, Sushil Bhandari, Modules 3 and 6, A.A. Balkema, Rotterdam, Brook fields, 1997

Course outcomes: Students at will be able to learn blasting, fragmentation measurement methods, blasting nuisances, special blasting techniques and alternative methods for rock fragmentation.

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DEPARTMENT OF MINING ENGINEERING

		L	T	P	C
		4	0	0	4
MASS PRODUCTION TECHNOLOGY FOR UNDERGROUND COAL					

Course objectives:
To gain knowledge about the essential concepts of mass production technology for underground coal mining

UNIT-1
Mass production technology: concepts and applicability, system design, cycle of operation etc., Infrastructure for underground mass production technologies: Features of high-capacity underground coal mining equipment; High capacity,hoisting / conveying of coal; Mass inertization plant; Pre-drainage of methane; conveyance of man; Heavy material handling – multi-utility,vehicle, Air chilling plant.

UNIT-2
Room and pillar mining: Integrated mining and haulage systems, The "Archveyor" automated mining and continuous haulage unit. The long-airdox full dimension continuous haulage system, Powered support longwall mining, Longwall top coal caving, Short longwall method for extraction of standing pillars, Shortwall method,Wongawilli method

UNIT-3
Highwall mining: introduction, applicability and method; Punch longwall: applicability condition, layout, advantages and problems.

UNIT-4
Surface loader dumper combination with creeper dumper haulers: with high angle conveyors/inclined skips, Shovel dumper/in-pit crusher/ conveyor combination, with creeper dumper haulers, with high angle conveyors/inclined skips

UNIT-5
Shovel-dumper /surface miner/rock breaker-tipper combination: Bucket wheel excavator/ conveyor combination (specially for lignite mining), Case studies of underground mines of capacity 1-5 Mty, Case studies of opencast mines of capacity 25-50 Mty

Text Books:
1. Principles and Practices of Modern Coal Mining by R. D. Singh
2. Underground Wining of Coal by T N Singh

Reference Books:
1. Coal Mining by I C F Statham
2. Coal Mining by T C Cantrill
3. SME Mining Engineering Hand Book by Howard L Hartman
4. Introductory Mining Engineering by Howard L Hartman
5. Introduction to Mining Engineering by Ratan Raj Tatia

Course objectives: Students at the end of the course will be able to gain knowledge on various mass production techniques used in underground mining.

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DEPARTMENT OF MINING ENGINEERING

		L	T	P	C
		4	0	0	4
INTRODUCTION TO ROBOTICS AND APPLICATION TO MINING					

Course Objectives: To understand the basic concepts associated with the design and functioning of robots

UNIT-I
Introduction: Automation and Robotics, CAD/CAM and Robotics – An over view of Robotics – present and future applications. Components of the Industrial Robotics: common types of arms. Components, Architecture, number of degrees of freedom – Requirements and challenges of end effectors, Design of end effectors, Precision of Movement: Resolution, Accuracy and Repeatability, Speed of Response and Load Carrying Capacity.

UNIT – II
Motion Analysis: Basic Rotation Matrices, Equivalent Axis and Angle, Euler Angles, Composite Rotation Matrices. Homogeneous transformations as applicable to rotation and translation – problems. Manipulator Kinematics-H notation-H method of Assignment of frames-H Transformation Matrix, joint coordinates and world coordinates, Forward and inverse kinematics – problems on Industrial Robotic Manipulation.

UNIT – III
Differential transformation of manipulators: Jacobians – problems. Dynamics: Lagrange – Euler and Newton – Euler formations – Problems. Trajectory planning and avoidance of obstacles, path planning, Slew motion, joint interpolated motion – straight line motion.

UNIT – IV
Robot actuators and Feedback components: Actuators: Pneumatic, Hydraulic actuators, electric & stepper motors, comparison of Actuators, Feedback components: position sensors – potentiometers, resolvers, encoders – Velocity sensors, Tactile and Range sensors, Force and Torque sensors.

UNIT – V
Robot Application in Mining: Mining cycles such as drilling, blasting, loading, transportation in opencast mines; and its application in underground mining methods board and pillar, blasting gallery, continuous miner and long wall, Mine ventilation: mine gas monitoring, ventilation survey and others. Rescue and recovery works.

Text Books:
1. Mikell PG, Mitchel W, Roger NN, Nicholas GO and Ashish D. Industrial Robotics: Technology, Programming and Applications. Pearson Edu.
2. Mittal R K and Nagrath I J. Robotics and Control. Tata McGraw-Hill Education Pvt Ltd. 2003.

References Books:
1. Richard DK, Thomas AC and Michael N. Robotic Engineering: An Integrated Approach. Prentice Hall. 1989.

Course Outcomes:
The students will be able to learn the basic concepts of design of robots for mining applications.

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	HONORS-POOL	L	T	P	C
		4	0	0	4
DEEP SEA MINING					

Course objectives: To understand marine environment, profile of sea, exploration of inland water, offshore exploration and deep sea bed mining.

UNIT – I: Introduction to Marine environment. Characteristics of the ocean floor.

UNIT – II: Profile of the sea. Shelf, slope and rise Nature of the deposits of environments.

UNIT – III: Exploration and characterization of inland water. Mineralogical studies of marine sediments and continental slope. Continental shelf and deep sea bed mineral resources. Exploration systems of dissolved and un dissolved mineral deposits;

UNIT – IV: Off shore exploration of oil and gas and sub-sea systems.

UNIT – V: Deep sea bed Mining . Wells and algae for extraction of minerals, Economic & Technologies. Environmental impact of ocean mining. Law of the sea, legal considerations in ocean mining.

Text books:

1. Hartman HL “Introductory Mining Engg” Willey Eastern.
2. Issues of “MARINE MINING” Manjula R.Shyam “Metals fom sea bed Prospects of mining poly matallic nodules of India “Oxfod & IBH”.

Course outcome: Students will be able to learn about marine environment, profile of sea, exploration of inland water, offshore exploration and deep sea bed mining.

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	HONORS-POOL	L	T	P	C
		4	0	0	4
MINING EQUIPMENT RELIABILITY, MAINTAINABILITY AND AVAILABILITY					

Course Objective: To gain knowledge about the concepts of reliability, maintainability and availability of mining equipment.

UNIT-1

Introduction: What is Reliability Engineering? Its Importance-a birth to death process, Reasons for Product failure; Non-maintained, Maintained Items and their failure patterns, Need for Improving Mining Equipment Reliability, Maintainability, and Availability; Mining-equipment-related Facts and Figures; Reliability, Maintainability, Availability.

UNIT 2

Reliability Mathematics and Probability Distributions: Basic statistics – mean, mode, median, standard deviation, variance, etc. Correlation and regression, Boolean Algebra Laws and Probability Definition and Properties; Useful Mathematical Definitions – Cumulative Distribution Function, Probability Density Function, Reliability Function Expected Value, Variance; Probability Distributions: Discrete and Continuous Distribution, Binomial Distribution, Exponential Distribution, Rayleigh Distribution, Weibull Distribution, Normal Distribution, Lognormal Distribution, Case studies.

UNIT 3

Mining Equipment Reliability: Concept of Reliability and its Tools: Need for Reliability and Bathtub Hazard Rate Curve; General Reliability, Hazard Rate, and Mean Time to Failure Functions - General Reliability Function, Hazard Rate Function, Mean Time to Failure; Reliability Networks - Series Configuration, Parallel Configuration, k-out-of-m Configuration, Standby System, Bridge Configuration; Commonly Used Methods in Reliability Analysis – FMEA, FMECA, Markov Method, Fault Tree Analysis, etc. Application in Mining Equipment: Reasons for Improving Mining Equipment, Reliability, Factors Impacting Mining System Reliability, and Useful Mining Equipment-Reliability-Related Measures; Open-Pit-System Reliability Analysis; Programmable Electronic Mining System Failures; Designing Reliable Conveyor Belt Systems; Fault Tree Analysis of Shovel; Dump-truck Tire Reliability and the Factors Affecting Their Life, Case studies, Mining Equipment Maintainability

UNIT-4

Concept of Maintainability and its Tools: Need for Maintainability of Surface Mining Equipment and Maintainability Versus Reliability; Maintainability Functions, - Maintainability Function I: Exponential Distribution, Maintainability Function II: Weibull Distribution; Maintainability Design Factors and Maintainability Analysis Tools - Total Quality Management (TQM), Cause and Effect Diagram; Maintainability-Management-Related Tasks During the Equipment Life Cycle Application in Mining Equipment: Design-induced Maintainability Problems of Mining Equipment; Mining Equipment Maintainability Design Characteristics; Maintenance Engineering Objectives, Total Productive Maintenance, and Reasons for Its Performance; Factors Contributing to Equipment Maintenance Cost in Mines; Maintenance of Explosion-protected Switchgear in Mines; Useful Maintenance, Measures for Mines; Mathematical Models for Performing Mining Equipment

UNIT-5

Concept of Availability and its Application in Mining Equipment: Availability; Types of Availability; approaches to increase equipment Availability. Maintenance; Case studies.

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DEPARTMENT OF MINING ENGINEERING

Text Book:

1. Mining Equipment Reliability, Maintainability, and Safety by B. S. Dhillon, Springer, 1st Edition, 2008.

Reference Books:

1. Mine Health and Safety Management – Edited by Michael Karmis
2. Reliability Engineering - Theory and Practice by A. Birolini, Springer
3. Engineering Maintenance: A Modern Approach by B. S. Dhillon, CRC Press, Boca Raton, Florida
4. Case Studies in Reliability and Maintenance by W.R. Blischke. and D.N.P.Murthy, John Wiley & Sons, USA

Course Outcome: At the end of the course, students will be able to learn the concepts of reliability, maintainability and availability of mining equipment.

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
KAKINADA - 533 003, Andhra Pradesh, India

DEPARTMENT OF MINING ENGINEERING

	HONORS-POOL	L	T	P	C
		4	0	0	4
GROUNDWATER ENGINEERING					

Course objectives:
To understand the basic physical principles of groundwater flow, differential equations, boundary conditions, groundwater quality and various aspects of recharge of groundwater.

UNIT-I
Introduction: Ground water in hydrologic cycle, Distribution of subsurface water, ground water potential, occurrence of groundwater in hydro geologic formations, components of groundwater studies, Darcy‘s law and its validity.
Governing equations of groundwater flow in aquifers: 3-D Ground water flow equations in Cartesian and polar coordinates, equations for steady radial flow into a well in case of confined and unconfined aquifers, equations for effect of uniform recharge in a fully penetrating unconfined aquifer, well flow near aquifer boundaries.

UNIT-II
Unsteady radial flow of confined aquifer: Equations for unsteady radial flow into a well in case of confined aquifer, determination of Storage coefficient and Transmissibility(S and T) by Theis‘s graphical method, CooperJacob‘s and Chow‘s method. Image well theory, partial penetration of wells, multiple well system.

UNIT-III
Artificial recharge of aquifers: Introduction, current trends in artificial recharge, spreading methods, injection wells, technical feasibility and economic viability. Geophysical methods in groundwater Exploration: surface geophysical methods: electrical resistivity method, seismic method, magnetic method, determination of aquifer thickness.

UNIT-IV
Quality of groundwater and seawater intrusion in coastal aquifers: Dissolved constituents in groundwater and their effects, fluctuations in groundwater, mechanism of salt water intrusion, Ghyben-Herzberg relation, slope and shape of the interface, prevention and control of seawater intrusion, case studies involving sea water intrusion.

UNIT-V
Models in ground water analysis: Major applications of ground water models, sand models, viscous fluid models, membrane models, thermal models, electric-Analog models, numerical modeling of ground water systems.

TEXT BOOKS:
1. Ven-Te-Chow, (1964) _Hand book of Applied Hydrology‘, McGraw-Hill Book Company, New York.
2. Todd, D.K. (1980) _Groundwater Hydrology‘, John Wiley and Sons, New York.
3. Karanth, K. R. (1987) _Groundwater Assessment, development and Management‘, Tata McGraw – Hill publishing company New Delhi.
4. Raghunath H.M,(1982), _Ground water‘ Wiley Eastern Ltd, New Delhi.
5. Wang Herbert. F. and Anderson Mary. P.(1995), _Introduction to groundwater modeling; FDM and FEM‘, Academic Press, New York.

6. Rastogi, A.K. (2007) _Numerical Groundwater Hydrology‘, Penram International publishing (India) Pvt Ltd.

Course outcomes:
Students will be able to gain knowledge on the basic physical principles of groundwater flow, differential equations, boundary condition, groundwater quality and various aspects of recharge of groundwater.

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DEPARTMENT OF MINING ENGINEERING

	HONORS-POOL	L	T	P	C
		4	0	0	4
PRODUCTION PLANNING AND CONTROL					

Course Objectives: To gain knowledge about the objectives and functions of PPC, forecasting techniques, inventory management, routing and dispatching**.**

UNIT – 1
Introduction: Definition – objectives and functions of production planning and control – elements of production control – types of production – organization of production planning and control department – internal organization of department.

UNIT – 2
Forecasting – Importance of forecasting –types of forecasting, their uses – general principles of forecasting – forecasting techniques – qualitative methods and quantitative methods.

UNIT – 3
Inventory management – functions of inventories – relevant inventory costs – ABC analysis – VED analysis – EOQ model – Inventory control systems – P–Systems and Q-Systems Introduction to MRP I, MRP II, ERP, LOB (Line of Balance), JIT and KANBAN system.

UNIT – 4
Routing –definition – routing procedure –route sheets – bill of material – factors affecting routing procedure, schedule –definition – difference with loading. Scheduling policies – techniques, standard scheduling methods.
Line Balancing, aggregate planning, chase planning, expediting, controlling aspects.

UNIT – 5
Dispatching – activities of dispatcher – dispatching procedure – follow up – definition – reason for existence of functions – types of follow up, applications of computer in production planning and control.

Text Books:
1. Elements of Production Planning and Control / Samuel Eilon/Universal Book Corp.
2. Manufacturing, Planning and Control/Partik Jonsson Stig - Arne Mattsson /Tata McGraw Hill

References:
1. Inventory Control Theory and Practice / Martin K. Starr and David W.Miller/Prentice-Hall
2. Production Planning and Control/Mukhopadyay/PHI.
3. Production Control A Quantitative Approach / John E.Biegel/Prentice-Hall
4. Production Control / Franklin G Moore & Ronald Jablonski/Mc-GrawHill
5. Production and Operations Management/Shailendra Kale/McGraw-Hill
6. Production and Operations Management/Ajay K Garg/McGraw-Hill

Course Outcomes: Students will be able to learn about the objectives and functions of PPC, forecasting techniques, inventory management, routing and dispatching.

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DEPARTMENT OF MINING ENGINEERING

IV Year -I Semester	HONORS-POOL	L	T	P	C
		4	0	0	4
INTRODUCTION TO ARTIFICIAL INTELLIGENCE & MACHINE LEARNING					

Course Objectives: To understand the various tools used in artificial intelligence and machine learning

UNIT – 1
Introduction: Definition of Artificial Intelligence, Evolution, Need, and applications in realworld. Intelligent Agents, Agents and environments; Good Behavior-The concept of rationality,the nature of environments, the structure of agents.
Neural Networks and Genetic Algorithms: Neural network representation, problems,perceptrons, multilayer networks and back propagation algorithms, Genetic algorithms.

UNIT – 2
Knowledge–Representation and Reasoning: Logical Agents: Knowledge based agents, the Wumpus world, logic. Patterns in Propositional Logic, Inference in First-Order Logic-Propositional vs first order inference, unification and lifting.

UNIT – 3
Bayesian and Computational Learning: Bayes theorem , concept learning, maximum likelihood, minimum description length principle, Gibbs Algorithm, Naïve Bayes Classifier, Instance Based Learning- K-Nearest neighbour learning
Introduction to Machine Learning (ML): Definition, Evolution, Need, applications of ML in industry and real world, classification; differences between supervised and unsupervised learning paradigms.

UNIT – 4
Basic Methods in Supervised Learning: Distance-based methods, Nearest-Neighbors, Decision Trees, Support Vector Machines, Nonlinearity and Kernel Methods.
Unsupervised Learning: Clustering**,** K-means, Dimensionality Reduction, PCA and kernel PCA.

UNIT – 5
Machine Learning Algorithm Analytics: Evaluating Machine Learning algorithms, Model,Selection, Ensemble Methods (Boosting, Bagging, and Random Forests).
Modeling Sequence/Time-Series Data and Deep Learning: Deep generative models, Deep Boltzmann Machines, Deep auto-encoders, Applications of Deep Networks.

TEXT BOOKS:

1. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, 2/e, Pearson Education, 2010.
2. Tom M. Mitchell, Machine Learning, McGraw Hill, 2013.
3. Ethem Alpaydin, Introduction to Machine Learning (Adaptive Computation and Machine Learning), The MIT Press, 2004.

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DEPARTMENT OF MINING ENGINEERING

REFERENCE BOOKS:

1. Elaine Rich, Kevin Knight and Shivashankar B. Nair, Artificial Intelligence, 3/e, McGraw Hill Education, 2008.
2. Dan W. Patterson, Introduction to Artificial Intelligence and Expert Systems, PHI Learning, 2012.
3. T. Hastie, R. Tibshirani, J. H. Friedman, The Elements of Statistical Learning, 1/e, Springer, 2001.
4. Bishop, C. ,M., Pattern Recognition and Machine Learning, Springer, 2006.
5. M Narasimha Murty, Introduction to Pattern Recognition and Machine Learning, World Scientific Publishing Company, 2015

Course outcomes: Students at the end of the course will be able to learn the tools and apply them to real world problems.