



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

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

KAKINADA - 533 003, Andhra Pradesh, India



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MINING ENGINEERING

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



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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 differential equations.
- To furnish the learners with basic concepts and techniques at plus two level to lead them into advanced level by handling various real world applications.

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

- Interpret the physical meaning of different 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 Fourier transform 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—
RHS term of the type e^{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, 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. **Dean. G. Duffy**, Advanced Engineering Mathematics with MATLAB, 3rd Edition, CRC Press.
3. **Peter O' Neil**, Advanced Engineering Mathematics, Cengage.
4. **Srimantha Pal, S C Bhunia**, Engineering Mathematics, Oxford University Press.



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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(9th edition),central technipublication.

REFERENCE BOOKS:

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



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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 their elimination.

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 & tachometric 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 various 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 – Petrographic 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.



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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 A Wills, 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 of Geoscience



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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 practical knowledge.

List of Experiments

1. Triangulation survey by theodolite
2. Measure horizontal and vertical angles by theodolite
3. Measure horizontal angles by method of repetition and reiteration using theodolite
4. Trigonometric Leveling - Heights and distance problem
5. Signs and conventions used by GSI, MMR, CMR
6. Finding heights and distance using Principles of tachometric surveying
7. Curve setting – different methods by total station
8. Setting out works for buildings & pipelines.
9. Determine area using total station
10. Traversing using total station
11. contouring using total station
12. Determination of remote height using total station
13. Coordinate measurement by total station and GPS
14. Traversing and recording position of points by GPS
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 leveling staffs.
2. Tachometers.
3. Total Station



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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 properties minerals.
2. Demonstration of Crystal models
3. Demonstration of Optical properties of minerals
4. Study of important Igneous, sedimentary and metamorphic rocks.
5. Recognition of folds, faults, unconformities from maps.
6. Simple problems on strike and dip.

Course Outcomes: To Identify Mega-scope minerals Mega-scope 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 jaw crusher
3. Determination of the grinding characteristics of a given mineral sample using ball mill.
4. Sieve analysis of a given sample and to calculate (a) percentage sample retained on screens (b) to plot sizing curves.
5. Concentration of a given mineral sample using mineral jig.
6. Concentration of a given mineral using Wilfely table.
7. Concentration of a given mineral using froth flotation cell
8. Study of washability characteristic of a coal sample using float and sink test.
9. Study of sedimentation characteristics of a given sample.
10. Estimation of moisture content by Drying of mineral sample.
11. Determining the average size of samples
12. Collection of sample by riffle sample technique.

Course Outcomes:

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

1. Know different sample division techniques.
2. Determine the grinding and crushing characteristics of a given mineral sample.
3. Know the washability characteristic of a coal sample.
4. Determine the moisture content by Drying of mineral sample.
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, PratibhaPrakashan 2012.
3. Traditional Knowledge System in India by Amit Jha Atlantic publishers, 2002
4. "Knowledge Traditions and Practices of India" Kapil Kapoor, Michel Danino

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 pipe bend.

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

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 velocity profiles.

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 radial vanes.

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

Reciprocating pumps: Working, Discharge, slip, indicator diagrams.

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 separation. plot velocity and pressure profiles for any given fluid flow. evaluate the performance characteristics of hydraulic turbines and pumps.

TEXT BOOKS:

1. Hydraulics, fluid mechanics and Hydraulic machinery MODI and SETH.
2. Fluid Mechanics and Hydraulic Machines by Rajput.
3. Fluid Mechanics and Hydraulic Machines/ 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 Age International.
3. Hydraulic Machines by Banga & Sharma, Khanna Publishers.
4. Instrumentation for Engineering Measurements by James W. Dally, William E. Riley, John Wiley & Sons Inc. 2004 (Chapter 12 – Fluid Flow Measurements)
5. Fluid Mechanics and Hydraulic Machines by Domkundwar & Domkundwar, Dhanpatrai & Co.



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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 – Harmonic and conjugate harmonic functions – Milne – Thompson method.
 Complex integration: Line integral – Cauchy's integral theorem – Cauchy's integral formula – Generalized integral formula (all without proofs) and problems on above theorems.

UNIT – II: Series expansions and Residue Theorem: (10 hrs)

Radius of convergence – Expansion in Taylor's series, Maclaurin's series and Laurent 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 I. Devore**, Probability and Statistics for Engineering and the Sciences, 8th Edition, Cengage.
4. **Shron L. 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, 4th Edition, 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 of Rocks, 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, homotropical, anti – tropical 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 their forms.



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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 a product.
- The knowledge of understanding of the Input-Output-Cost relationships and estimation of the least cost combination of inputs.
- 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 Business Units.
- 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 & Company Ltd,
2. J.L Pappas and E.F Brigham, Managerial Economics, Holt, R & W; New edition
3. N.P Srinivasan and M. Sakthivel Murugan, Accounting for Management, S. Chand & Company Ltd,
4. Maheswari S.N, An Introduction to Accountancy, Vikas Publishing House Pvt Ltd
5. I.M Pandey, Financial Management, Vikas Publishing House Pvt Ltd
6. V. Maheswari, Managerial Economics, S. Chand & Company Ltd,



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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 and pumps.

1. Impact of jets on Vanes.
2. Performance Test on Pelton Wheel.
3. Performance Test on Francis Turbine.
4. Performance Test on Kaplan Turbine.
5. Performance Test on Single Stage Centrifugal Pump.
6. Performance Test on Multi Stage Centrifugal Pump.
7. Performance Test on Reciprocating Pump.
8. Calibration of Venturimeter.
9. Calibration of Orificemeter.
10. Determination of friction factor for a given pipeline.
11. Determination of loss of head due to sudden contraction in a pipeline.
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 different methods detectors and multi gas detector, to find flammable index of coal dust and understand the rescue and recovery operations using different rescue apparatus

List of experiments:

1. Determination of CO, CH₄, H₂S, SO₂, O₂, CO₂, Nitrous fumes by corresponding detectors.
2. Study and application of infrared gas analyser.
3. Detection of different gases by Gas –Chromatograph
4. Detection of methane by different types of methane meters & flame safety lamp.
5. Determination index of flammability of coal dust.
6. Study and uses of proto – IV, Proto – V. Dragger – BG – 174 self contained breathing apparatus
7. Study and uses of self rescuer Gas mask, smoke helmet.
8. Study and use of reviving apparatus
9. Study of Born-Side safety boning apparatus.

Course outcomes: The student will be 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 of rocks.
2. Determination of Protodyaknov index of a given rock sample 147
3. Determination of point load index strength of a given rock sample
4. Determination of porosity of rocks.
5. Determination of hardness of rocks
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 of rocks
9. Determination of modulus of elasticity of given rock sample using strain gauge.
10. Determination of triaxial strength of rock and drawing of Mohr's envelope
11. Study of different types of supports used in mines
12. Study of design of mine pillars.

Course Outcomes:

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

- 1: Determine the properties of rocks
- 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, mine safety 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, Mahalanobis 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: Metal price 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 Linear classifiers, Fisher's discriminant analysis; Classification example problems: rock type classification using lithological classification, roof fall diagnostics, rock images classification, machine fault diagnostic through condition 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, Pearson Education 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 analyse data, JKMRRC monograph series in mining and mineral processing, 2014
6. John Lucas, Mines and Mineral statistics, 2013, ISBN- 10: 5518633939