JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

DEPARTMENT OF MINING ENGINEERING

COURSE STRUCTURE AND SYLLABUS

For

B. TECH MINING ENGINEERING

(Applicable for batches admitted from 2019-2020)

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA

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KAKINADA – 533 003, Andhra Pradesh, India

DEPARTMENT OF MINING ENGINEERING

III Year - I Semester

S.No	Category	Subjects	L	T	P	Credits
1	PCC	Underground Coal Mining Technology	3	--	--	3
2	PCC	Mine Environment Engineering – II	3	--	--	3
3	PCC	Rock Mechanics	3	--	--	3
4		**OPEN ELECTIVE-I** 1. Waste Water Management 2. Environmental impact analysis 3. Disaster Management and Mitigations	3	--	--	3
5	PCC	Mining Machinery & Mechanization-I	3	--	--	3
6	BSC	Advanced English Communication Skills Lab	-	--	3	1.5
7	PCC	Mine Surveying - II Lab	-	--	3	1.5
8	PCC	Rock Mechanics Lab	-	--	3	1.5
9	PCC	Corporate Social Responsibility in mining	1			0.5
10	PCC	Mine Field visit(Mandatory)(internship)	-	--	--	1
		Total Credits				**21**

III Year - II Semester

S.No	Category	Subjects	L	T	P	Credits
1	PCC	Mine Ground Control	3	--	--	3
2	PCC	Mineral processing	3	--	--	3
3	PCC	Under Ground Metal Mining Technology	3	--	--	3
4	PCC	Mining Machinery & Mechanization –II	3	--	--	3
5		**OPEN ELECTIVE - II** 1.Industrial Robotics 2.Artificial intelligence 3.Introduction to Data Base Management System	3	--	--	3
6	PCC	Mineral processing Lab	--	--	3	1.5
7	PCC	Mine Environmental Engineering Lab	--	--	3	1.5
8	PCC	Mining Machinery & Mechanization Lab	--	--	3	1.5
9	PCC	Industrial Training(3-4weeks) or Skill development or Research project	--	--	--	0.5
		Total Credits				**20**

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

DEPARTMENT OF MINING ENGINEERING

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

Objectives:
To Identify and understand the factors contributing to strata control problems in mines, Analyze &design requirement of support system in different workings of mine, To Apply different instruments for evaluation of strata condition and organization of strata control in mines

UNIT-I:
Pit slope stability & subsidence**:** Approach to slope stability, slope parameters, different types of slope failures, factors affecting slope stability, introduction to methods of failure, analysis, determination of factor of safety,. Introduction to different rock slope stabilization techniques.
Theories of subsidence, factors affecting subsidence, subsidence surveys, subsidence prediction techniques, subsidence control – surface and underground measures, pseudo- mining damage.

UNIT -II:
Pillar design and rock burst :Strength of pillars, barrier and shaft pillar design – load estimation, factor of safety, various formulae, rock burst and bumps — phenomena, causes, prediction, monitoring and control, gas outbursts

UNIT -III:
Underground supports**:**
A:Various methods of roof examination, objectives and limitations of supports, ground forces and in situ stresses, pressure arch theory, evolution of supports, conventional supports — timber and steel supports, arches, yielding supports.
B**:** Rock and cable bolting, shotcreting, roof stitching, support of shaft bottoms, galleries, junctions and places of roof falls, freshly exposed roof supports, design of supports, long wall powered supports. Design of systematic support rules for B & P and long wall - development, depillaring, etc.

UNIT -IV:
Instrumentation : Convergence indicators, load cells, strain gauges, flat jacks, LVDT, dial gauges, pressure cells and recorder, anchorage testing equipment, laboratory and in situ measurements, hydraulic fracturing rock mechanics instrumentation for B & P and long wall workings

UNIT -V:
Stowing / filling**:** Selection and preparation of stowing materials, principal methods of stowing, collection, fields of application and limitations, preparation and transport of materials, surface, underground and face arrangements, design of stowing plants.

TEXT BOOKS:
1. Strata Control in Mineral Engineering, T. Bieniawski Ziti, John Wiley & Sons, 1987
2. Underground winning of Coal, T.N. Singh, Oxford and IBH New Delhi,1992
REFERENCE BOOKS:

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KAKINADA – 533 003, Andhra Pradesh, India

DEPARTMENT OF MINING ENGINEERING

1. Engineering Rock Mass Classifications, Bieniawski Z.T. 1989, Wiley, New York
2. Longwall mining, Peng S S and Chiang HS, Wiley, New York, 708p.

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

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KAKINADA – 533 003, Andhra Pradesh, India

DEPARTMENT OF MINING ENGINEERING

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**,** Ore sorters
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. Subba rao
2. Introduction to Mineral Processing – V. Malleswar Rao, Indian Academy of Geoscience

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

Course objectives: Understand peculiarities and limitations of metal mining, familiar with different stoping methods, design and planning of stoping methods.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

DEPARTMENT OF MINING ENGINEERING

UNIT – I:

Introduction to Metal Mining: Peculiarities of Metallic ferrous deposit. Scope and limitations of underground mining, Opening up of underground deposits, choice of entry shaft and combination and their applicability, limitations.

UNIT – II:

Mine Developments:Methods of developments, Factors effecting choice of level interval, Cross cuts, Drive, shape and size of drive, winzes, Raises, block size, shaft station, ore bin, ore pass and their position in relation to ore body and general scheme of its development.Division of mining area into working units and level pattern, dimensions of panels and blocks.

UNIT –III:

Stoping:Classification of stoping methods, applicability, limitations, merits and demerits, Factors affecting choice of stopping methods like depth, dip, Width grade / value of deposit, physio mechanical characteristics of the ore and wall rocks. Stope design and production planning in various methods of stoping. Production and cycle time estimates. Stope and development support, mining cycles, shift times, estimating equipment's requirements

Stoping Methods:Stoping without supports**:** Open stopping, overhand, underhand, breast stoping. Stoping with Supports: shrinkage stopping cut and fill stopping, square set stopping. Caving methods: Top Slicing, sublevel caving and block caving.

UNIT –I V:

Special Stoping methods:Sublevel stoping, long-hole stoping, blast hole stoping, raise stoping, V.C.R Stoping, in-situ leaching, bio-mineral engineering, hydraulic mining, blast hole stoping, underground bench blasting, Extraction of remnant pillars, shaft pillars and contiguous reefs, their supporting system and special precautions during extraction.

UNIT – V:

Deep mining: concept of deep mining, special problems of deep mining, , salt potash and sulphur mining and their special problems, stoping practices in rock burst prone mines.Under sea mining, novel mining methods, application of tunnel and shaft boring machines and their applications.

Course outcome: Stope design and planning is essential in various stoping methods for effective production.

TEXT BOOKS:

1. Introductory Mining Engineering, Harman, John Wiley and sons,2002
2. Elements Of Mining Technology Vol 2, Dj Deshmukh, Denett& Co publisher,2014

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".

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

DEPARTMENT OF MINING ENGINEERING

III Year - II Semester		L	T	P	C
		3	0	0	3
MINING MACHINERY AND MECHANIZATION-II					

Course Objectives:
To understand the functioning of winding engines and other winding accessories. To study surface and pit bottom layouts, various coal face machinery. To study the design and construction details of excavating & transporting equipment's used in surface mines. To know the various statutory aspects like CMR, MMR and the relevant DGMS circulars related to this course.

UNIT – I:

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KAKINADA – 533 003, Andhra Pradesh, India

DEPARTMENT OF MINING ENGINEERING

Winding engines**:** Winding systems, drum winders, drives, mechanical braking of winders, safety devices in winding, overwind 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., signalling systems, winding calculations relating to rope size & numbers, capacity & power requirement for cages, skips, drum and 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 mine mechanization.

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

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

DEPARTMENT OF MINING ENGINEERING

III Year - II Semester		**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
(OPEN ELECTIVE-II) **INDUSTRIAL ROBOTICS**					

Course Objectives:

1. The student will be exposed to the concepts of automation
2. The students will be exposed to the concepts of robot kinematics, Dynamics, Trajectory planning.
3. Mathematical approach to explain how the robotic arm motion can be described.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

DEPARTMENT OF MINING ENGINEERING

4. The students will understand the functioning of sensors and actuators and their applications
5. The student will be exposed to the applications of robotics in manufacturing.

UNIT-I

INTRODUCTION: Automation and Robotics, types of automation, assembly automation equipment,
material handling systems, feed systems, Automated Guided Vehicles, Automated storage and retrieval
systems, Flexible Manufacturing Systems, Computer Aided Process Planning Systems, Computer Aided
manufacturing. CAD/CAM and Robotics – An over view of Robotics – present and future applications –
classification by coordinate system and control system.
COMPONENTS OF THE INDUSTRIAL ROBOTICS: Function line diagram representation of robot
arms, common types of arms. Components, Architecture, number of degrees of freedom – Requirements
and challenges of end effectors, determination of the end effectors, comparison of Electric, Hydraulic and
Pneumatic types of locomotion devices.

UNIT – II

MOTION ANALYSIS: Homogeneous transformations as applicable to rotation and translation – problems.
MANIPULATOR KINEMATICS: Specifications of matrices, D-H notation joint coordinates and world
coordinates Forward and inverse kinematics – problems.

UNIT – III

Differential transformation and manipulators, Jacobians – problems
Dynamics: Lagrange – Euler and Newton – Euler formulations – Problems.

UNIT IV

General considerations in path description and generation. Trajectory planning and avoidance of obstacles, path planning, Skew motion, joint integrated motion –straight line motion – Robot programming,
languages and software packages-description of paths with a robot programming language.

UNIT V

ROBOT ACTUATORS AND FEED BACK COMPONENTS:
Actuators: Pneumatic, Hydraulic actuators, electric & stepper motors.
Feedback components: position sensors – potentiometers, resolvers, encoders – Velocity sensors.
ROBOT APPLICATIONS IN MANUFACTURING: Material Transfer - Material handling, loading and unloading-

Course outcomes:

Upon successful completion of this course you should be able to:

1. Identify various robot configuration and components,
2. Select appropriate actuators and sensors for a robot based on specific application
3. Carry out kinematic and dynamic analysis for simple serial kinematic chains

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KAKINADA – 533 003, Andhra Pradesh, India

DEPARTMENT OF MINING ENGINEERING

Perform trajectory planning for a manipulator by avoiding obstacles

TEXTBOOKS:

1. IndustrialRobotics/GrooverMP/Pearson Edu, 2008
2. RoboticsandControl /MittalR K &NagrathI J /TMH,2003

REFERENCE BOOKS:

1. Robotics/Fu KS/ McGrawHill.
2. RoboticEngineering /RichardD. Klafter, PrenticeHall
3. Robot AnalysisandControl/ H. Asada and J.J.E. Slotine/BSP Books Pvt.Ltd.
4. IntroductiontoRobotics/John JCraig/PearsonEdu.

III Year - II Semester		L	T	P	C
		3	0	0	3
(OPEN ELECTIVE-II) **ARTIFICIAL INTELLIGENCE**					

Course Objectives:

- To have a basic proficiency in a traditional AI language including an ability to write simple to intermediate programs and an ability to understand code written in that language

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

DEPARTMENT OF MINING ENGINEERING

 To have an understanding of the basic issues of knowledge representation and blind and heuristic search, as well as an understanding of other topics such as minimax, resolution, etc. that play an important role in AI programs

 To have a basic understanding of some of the more advanced topics of AI such as learning, natural language processing, agents and robotics, expert systems, and planning

Course Outcomes:

 Outline problems that are amenable to solution by AI methods, and which AI methods may be suited to solving a given problem

 Apply the language/framework of different AI methods for a given problem

 Implement basic AI algorithms- standard search algorithms or dynamic programming

 Design and carry out an empirical evaluation of different algorithms on problem formalization, and state the conclusions that the evaluation supports

UNIT I
Introduction, history, intelligent systems, foundations of AI, applications, tic-tac-toe game playing, development of AI languages, current trends.

UNIT II
Problem solving: state-space search and control strategies: Introduction, general problem solving, characteristics of problem, exhaustive searches, heuristic search techniques, iterative deepening A*, constraint satisfaction.
Problem reduction and game playing: Introduction, problem reduction, game playing, alpha beta pruning, two-player perfect information games.

UNIT III
Logic concepts: Introduction, propositional calculus, proportional logic, natural deduction system, axiomatic system, semantic tableau system in proportional logic, resolution refutation in proportional logic, predicate logic.

UNIT IV
Knowledge representation: Introduction, approaches to knowledge representation, knowledge representation using semantic network, extended semantic networks for KR, knowledge representation using frames.
Advanced knowledge representation techniques: Introduction, conceptual dependency theory, script structure, CYC theory, case grammars, semantic web

UNIT V
Expert system and applications: Introduction phases in building expert systems, expert system versus traditional systems

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

DEPARTMENT OF MINING ENGINEERING

Uncertainty measure: probability theory: Introduction, probability theory, Bayesian belief networks, certainty factor theory, dempster-shafer theory
Fuzzy sets and fuzzy logic: Introduction, fuzzy sets, fuzzy set operations, types of membership, functions, multi valued logic, fuzzy logic, linguistic variables and hedges, fuzzy propositions, inference rules for fuzzy propositions, fuzzy systems.

Text Books:

1) Artificial Intelligence- Saroj Kaushik, CENGAGE Learning

2) Artificial intelligence, A modern Approach , 2nded, Stuart Russel, Peter Norvig, PEA

Reference Books:

1) Artificial Intelligence- Deepak Khemani, TMH, 2013

2) Introduction to Artificial Intelligence, Patterson, PHI

3) Atificial intelligence, structures and Strategies for Complex problem solving, -George F Lugar, 5thed, PEA

e-Resources:

1) https://nptel.ac.in/courses/106/105/106105077/

2) http://aima.cs.berkeley.edu/

III Year - II Semester		L	T	P	C
		3	0	0	3
(OPEN ELECTIVE-II) **INTRODUCTION TO DATA BASE MANAGEMENT SYSTEM**					

Course Objectives:

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

DEPARTMENT OF MINING ENGINEERING

 To introduce about database management systems

 To give a good formal foundation on the relational model of data and usage of Relational Algebra

 To introduce the concepts of basic SQL as a universal Database language

 To demonstrate the principles behind systematic database design approaches by covering conceptual design, logical design through normalization

 To provide an overview of physical design of a database system, by discussing Database indexing techniques and storage techniques

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

 Describe a relational database and object-oriented database

 Create, maintain and manipulate a relational database using SQL

 Describe ER model and normalization for database design

 Examine issues in data storage and query processing and can formulate appropriate solutions

 Outline the role and issues in management of data such as efficiency, privacy, security, ethical responsibility, and strategic advantage

UNIT I
Introduction: Database system, Characteristics (Database Vs File System), Database Users(Actors on Scene, Workers behind the scene), Advantages of Database systems, Database applications. Brief introduction of different Data Models; Concepts of Schema, Instance and data independence; Three tier schema architecture for data independence; Database system structure, environment, Centralized and Client Server architecture for the database.

UNIT II
Relational Model: Introduction to relational model, concepts of domain, attribute, tuple, relation, importance of null values, constraints (Domain, Key constraints, integrity constraints) and their importance BASIC SQL: Simple Database schema, data types, table definitions (create, alter), different DML operations (insert, delete, update), basic SQL querying (select and project) using where clause, arithmetic & logical operations, SQL functions(Date and Time, Numeric, String conversion).

UNIT III
Entity Relationship Model: Introduction, Representation of entities, attributes, entity set, relationship, relationship set, constraints, sub classes, super class, inheritance, specialization, generalization using ER Diagrams. SQL: Creating tables with relationship, implementation of key and integrity constraints, nested queries, sub queries, grouping, aggregation, ordering, implementation of different types of joins, view(updatable and non-updatable), relational set operations.

UNIT IV

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KAKINADA – 533 003, Andhra Pradesh, India

DEPARTMENT OF MINING ENGINEERING

Schema Refinement (Normalization): Purpose of Normalization or schema refinement, concept of functional dependency, normal forms based on functional dependency(1NF, 2NF and 3 NF), concept of surrogate key, Boyce-codd normal form(BCNF), Lossless join and dependency preserving decomposition, Fourth normal form(4NF), Fifth Normal Form (5NF).

UNIT V

Transaction Concept: Transaction State, Implementation of Atomicity and Durability, Concurrent Executions, Serializability, Recoverability, Implementation of Isolation, Testing for Serializability, Failure Classification, Storage, Recovery and Atomicity, Recovery algorithm.

Indexing Techniques: B+ Trees: Search, Insert, Delete algorithms, File Organization and Indexing, Cluster Indexes, Primary and Secondary Indexes , Index data Structures, Hash Based Indexing: Tree base Indexing ,Comparison of File Organizations, Indexes and Performance Tuning

Text Books:

1) Database Management Systems, 3/e, Raghurama Krishnan, Johannes Gehrke, TMH

2) Database System Concepts,5/e, Silberschatz, Korth, TMH

Reference Books:

1) Introduction to Database Systems, 8/e C J Date, PEA.

2) Database Management System, 6/e Ramez Elmasri, Shamkant B. Navathe, PEA

3) Database Principles Fundamentals of Design Implementation and Management, Corlos Coronel, Steven Morris, Peter Robb, Cengage Learning.

e-Resources:

1) https://nptel.ac.in/courses/106/105/106105175/

2) https://www.geeksforgeeks.org/introduction-to-nosql/

III Year - II Semester		**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**
MINERAL PROCESSING LAB					

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

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

DEPARTMENT OF MINING ENGINEERING

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 Wifely table.
7. Concentration of a given mineral using froth flotation cell
8. Study of wash ability characteristic of a coal sample using float and sink test.
9. Study of sedimentation characteristics of a given sample.
10. Estimation 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 wash ability characteristic of a coal sample.
4. Determine the moisture content by Drying of mineral sample.
5. Determine the average size of samples.

III Year - II Semester		**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**
MINE ENVIRONMENTAL ENGINEERING LAB					

Course objective:

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

DEPARTMENT OF MINING ENGINEERING

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

List of experiments:

1. Determination of CO, CH4, H2S, SO2, O2, CO2, Nitrous fumes by corresponding detectors.
2. Study and application of infrared gas analiser.
3. Detection of different gases by Gas – Chromatograph
4. Detection of methane by different types of methano 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 familiar with rescue and recovery operation from different disasters in mine

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

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

DEPARTMENT OF MINING ENGINEERING

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

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:

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

1: Understand the safety and efficiency of various haulage layouts and devices
2: Understand the safety and efficiency of various Winding arrangements and devices
3: Understand the safety and efficiency of various Pit top layouts and devices
4: Understand the safety and efficiency of various Pit bottom layouts and devices
5: Understand the safety and efficiency of various machineries used at coal faces.

IV Year - I Semester		L	T	P	C
		3	0	0	3
COMPUTER APPLICATIONS IN MINING					