Scheme of Instruction, Evaluation

and

Syllabi of

B.E. MINING ENGINEERING

(BATCH 2022-2026)

Vth Semester

With effect from Academic Year 2024-25

DEPARTMENT OF MINING ENGINEERING

UNIVERSITY COLLEGE OF ENGINEERING

(Autonomous)

Osmania University

Hyderabad – 500 007, TG, INDIA

Estd.1917

Estd.1929

Scheme of Instruction for BE (Mining Engineering) - V Semester

S. No.	Course Code	Course Title	Scheme of Instruction			Contact Hrs/ Wk	Scheme of Evaluation			Credits
			L	T	P		Hrs	CIE	SEE	
THEORY										
1	PC501MN	Drilling and Blasting	3	-	-	3	3	40	60	3
2	PC502MN	Underground Coal Mining	3	-	-	3	3	40	60	3
3	PC503MN	Mineral Processing	3	-	-	3	3	40	60	3
4	PC504MN	Applications of Internet of Things to Mining	3	-	-	3	3	40	60	3
5	PC505MN	Mine Environmental Engineering II	3	-	-	3	3	40	60	3
6		PE II	3	-	-	3	3	40	60	3
PRACTICALS										
7	PC551MN	Mine Environmental Engineering Lab	-	-	2	2	3	25	50	1
8	PC552MN	Mineral Processing Lab	-	-	2	2	3	25	50	1
9	PW941MN	Survey Camp (Report)	-	-	-	-	-	50	-	2
			18	**-**	**04**	**22**	**24**	**340**	**460**	**22**

CODE	PROFESSIONAL ELECTIVE-II
PE521MN	Geo-statistics
PE522MN	Surface Mining and Mechanization
PE523MN	Mine Systems Engineering

L : Lectures
P : Practical's
T : Tutorials

SEE : Semester End Examination
CIE : Continuous Internal Evaluation

Course Code	Course title						Core/PE/OE
PC 501 MN	DRILLING AND BLASTING						Core
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	40	60	3

Course Objectives

1. To acquaint with various types of exploratory drilling, core barrels, bore hole surveying, etc.
2. To familiarize with production drilling and its selection and economics, various operating drilling parameters
3. To equip knowledge on various types of the explosives and accessories
4. To illustrate blasting patterns for coal and metal mines used underground
5. To explain blasting techniques in mining and construction sites, and various aspects related to blasting techniques.

Course Outcomes

After completing this course, the student will be able to:

1. Understand the various aspects of exploration drilling, operable parameters, core barrels, directional drilling, etc.
2. Explore various aspects of production drilling, drill machines, drillability, drilling economics, statutory aspects, etc.
3. Recognize the classification and properties of explosives, various types of explosives, mechanics of blasting and blasting agents etc.
4. Discover various aspects of underground blasting techniques, various influencing parameters, rock fragmentation, gallery blasting method, etc.
5. Relate various aspects of open pit blasting- primary and secondary, environmental impacts, blasting for civil constructions, blasting instrumentation, etc.

UNIT-I

Exploratory Drilling: Drilling for exploration and other purposes; diamond drilling-equipment and principle of operation, its merits, demerits and limitations; core recovery — different types of core barrels; fishing tools; borehole surveying; borehole logging; novel and special drilling techniques, horizontal, vertical and directional drilling, and statutory aspects.

UNIT-II

Production Drilling: Various methods and their mechanics, different types of drilling machines for underground and opencast mines - Jack hammer drilling, Top hammer and Down the Hole (DTH) drills.

Drillability: Drillability studies, factors affecting drilling– operating parameters and physico-mechanical properties influencing design and selection of drills and drill bits; bit wear and reconditioning of drill bits; economics of drilling, and statutory aspects. Numerical problems.

UNIT-III

Explosives: Classification and properties of explosives, Types of explosives – Permitted explosives, slurry explosives, SMS, ANFO, boosters, and blasting agents. Mechanics of blasting, alternatives to explosives.

Accessories and Tools: Types of detonators like electric, electronic and cordless, etc., delays and their selection, safety fuses, detonating cords, relays, NONEL, exploders, sequential blasting machines and other shot firing tools, testing of explosives, magazines, transportation, handling and destruction of explosives and accessories and statutory aspects.

UNIT-IV

Underground Blasting: Drill patterns for underground excavations (for both coal and metal) and in shafts and tunnels; solid blasting; VCR blasting, smooth blasting, induced blasting, charge ratios, rock fragmentation, dangers associated with underground blasting, blasting gallery, sequential of blasting, computer aided blast design, precautionary measures, misfires, blown out shot and blasting economics, numerical problems and statutory aspects.

UNIT – V

Open Pit Blasting: Blast design, primary and secondary blasting; accidents due to blasting and preventive measures; environmental impacts due to blasting and their control - ground vibrations, fly rocks, dust, fumes, back break, etc. cast blasting.

Misfires, controlled blasting techniques, computer design of opencast blast.

Introduction to blasting and fragmentation analysis, blasting software, blasting economics.

Blasting for civil constructions and trenches. Demolition of buildings, underwater blasting.

Introduction to blasting instruments like seismograph and VOD probe, High speed camera etc., numerical problems and statutory aspects. blast holes, and initiation pattern their merits, demerits, limitation and fields of application.

Text Books:

1. Roy Piyush Pal, Blasting in ground excavations and mines, Oxford and IBH, 1st ed 1993.
2. C.P. Chugh, Drilling technology handbook, Oxford and IBH, 1977.
3. Engineering rock blasting operations, Sushil Bandari, Taylor & Francis, 1997
4. Roy Piyush Pal, Rock blasting effect and operation, A.A. Balkema, 1st ed, 2005.
5. B. Hemphill Gary, Blasting operations, Mc-Graw Hill, 1st ed 1981.

Course Code	Course title						Core/PE/OE
PC 502 MN	UNDERGROUND COAL MINING						Core
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	40	60	3

Course Objectives

1. To explain the theories of coal seam formation, development of bord and pillar panel, manual and mechanized operations, mechanized loading, continuous miners, and selection of equipment.
2. To familiarize with pillar extraction techniques, choice of pillar extraction, caving and stowing methods, and mechanized operations.
3. To demonstrate longwall method of coal mining, mechanized layouts, gate roadways, and selection of machinery.
4. To illustrate the problems of deep, thin, thick seams, method of multiple seam extraction, blasting gallery method and other special situations.
5. To acquaint with special methods of mining like horizon, Wongawalli, Shortwall, Highwall, underground coal gasification, etc.

Course Outcomes

After completing this course, the student will be able to:

1. Understand coal seam formation theories, Bord & Pillar development, and mechanized system of mining and other aspects.
2. Discover various pillar extraction techniques, preparatory arrangements, layout etc.
3. Evaluate longwall mining methods, design of gate roads, and select appropriate machinery while adhering to statutory requirements.
4. Address challenges and apply suitable techniques for working in various difficult seam conditions.
5. Explore and evaluate advanced and specialized coal mining methods and their applications.

UNIT-I
DEVELOPMENT

Theories of coal seam formation, classification and grading of coal, proximate and ultimate analysis. Comparison of U/G and opencast mining. General principle of Bord & Pillar Development, their choice, suitability, advantages and disadvantages, design of size of pillars and galleries, layout of Bord & Pillar panel, percentage of recovery in development, organization and manpower requirement, manual and mechanized system of development: selection of machines, conditions suitable for application of mechanized loader and continuous miners; shuttle cars, factor affecting the selection of equipment, numerical problems and statutory aspects.

UNIT -II
PILLAR EXTRACTION
A: Preparatory arrangement for depillaring operation, statutory provision for depillaring, principle and designing of pillar extraction, size of a district.
B: Factors affecting choice of pillar extraction, depillaring with caving, stowing, mechanized depillaring operation. Types of machines, layout for required outputs, personnel, numerical problems and statutory aspects.

UNIT -III
LONG WALL MINING
Longwall methods of working, their choice, suitability, advantages and disadvantages. Mechanized layouts, orientation, gate roads. Design and maintenance of gate roadways and faces, selection of machines and their use and statutory aspects.

UNIT -IV
SPECIAL METHODS - 1
Problems of working deep, thin, thick and gassy seams, seams liable to outbursts, working steeply inclined seams, and seams liable to spontaneous heating, bumps, etc. multiple seams, multi slice, sublevel caving, blasting gallery method, working under surface structures.

UNIT -V
SPECIAL METHODS - 2
Hydraulic mining, Horizon mining, Wongawalli, Shortwall, Highwall mining, Underground coal gasification, Coal bed methane and Shield mining.

TEXT BOOKS/ REFERENCES:
1. Principles and Practices of Modern Coal Mining, R.D. Singh, New Age International Publication.
2. Advanced Coal Mining, Volume 1 & 2, B. M. Vorobjev & R T Deshmukh, Asia Publishing House, Bombay.
3. Underground Mining & Coal, Singh, T.N. Singh – Oxford Publication.
4. Longwall Mining, S.S Peng, Chiang H/S. – John Willey Publication.
5. Mine Planning for Coal, S.P. Mathur– M.J Consultant Publications.

E RESOURCES:
1. https://www.nap.edu/read/18766/chapter/5
2. http://www.canoseco.com/general-description/technologies-and-practices/modernunderground-coal-mining-technologies.html
3. https://link.springer.com/article/10.1007/s40789-014-0043-0

Course Code	Course title						Core/PE/OE
PC 503 MN	MINERAL PROCESSING						Core
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	40	60	3

Course Objectives

1. To build a foundation on the principles of operation of mineral processing techniques, sampling methods, comminution, and various crushers and ball mills.
2. To explain various laboratory sizing techniques, movement of solids and fluids- Stoke's and Newton's laws and related aspects.
3. To illustrate various types of classification techniques, classifiers, jigging and tabling machines.
4. To familiarize with heavy media, magnetic and electrostatic separation techniques, coal washing and washability curves.
5. To demonstrate floatation technique, various factors, classification agents and application of floatation for various minerals.

Course Outcomes

After completing this course, the student will be able to:

1. Understand the mineral processing fundamentals, including ore sampling techniques, theories of mineral liberation, and the operation of various crushing and grinding equipment.
2. Analyse sizing data, describe the functioning of industrial sizing units, and apply principles of solid movement in fluids.
3. Understand the theory and operation of jigging and tabling equipment, including the design considerations for different jig types.
4. Understand the principles and procedures of heavy media separation, magnetic separation, and electrostatic separation.
5. Understand the principles of flotation, factors influencing its efficiency, and the classification of flotation reagents, along with their application.

UNIT - I

Comminution

Sampling of ores by different methods in field and laboratory/plant; Theory of liberation of minerals; Comminution laws - Rittinger's laws, Kick's law and Bond's law. Crushers - Jaw, Gyratory, Cone, Rolls and Toothed Roll crushers; Grinding - Types of grinding operations like batch and continuous grinding, dry and wet grinding, Grinding Mills - Ball mills, Theory of ball mill operation, Rod and Tube mills; Case studies, pot mill, flowcharts and numerical problems.

UNIT - II

Sizing

Study of laboratory sizing techniques and reporting of sizing data; Industrial sizing units – Types of screen surfaces, Grizzlies, Trommels, Vibrating and Shaking screens; dry and wet screening.

Movement of solids in fluids –Stokes' and Newton's laws, Terminal velocity and its

relation with size and density, Relation between time and velocity, Equal settling ratio, Free and hindered settling ratios.
Quantifying concentrating operations - Ratio of concentration, Recovery, Selectivity Index and Economic Recovery;

UNIT - III
Classification, Jigging and Tabling
Classification – Types of classifiers, Study of Settling Cones, Rake Classifier, Spiral Classifier and Cyclones.
Jigging: - Theory of jigging, types of jigs, working principle of various jigs, selection of jigs.
Tabling - Study of classification on a table. Shaking tables, Wilfley table and flow charts.

UNIT - IV
Heavy Media, Magnetic and Electrostatic separation
Principles, flow chart, different media used, Heavy media separation using heavy liquids and heavy suspensions, washability curves for different coals; coal washing, flowcharts;
Magnetic separation and Electrostatic separation, flowcharts.

UNIT - V
Flotation
Flotation - principles of flotation, factors affecting flotation, classification of agents like, collectors, frothers, modifiers, regulators, etc., and factors affecting their efficiency, Application of flotation process for Cu, Pb, Zn, Graphite, etc., Flow charts.

TEXT BOOKS:
1. Mineral processing technology - B. A. Wills
2. Principles of Mineral Dressing - A.M. Gaudin
3. Introduction to Mineral Processing by V. Malleswara Rao, Indian Academy of Geoscience
4. Mineral processing by S.K. Jain
4. Textbook of Mineral Processing – D.V.S Rao, Scientific Publishers
5. Mineral Processing: Including Mineral Dressing, Experiments and Numerical Problems, Vandana Rao, TechSar Pvt. Ltd; First Edition

REFERENCE BOOKS:
1. Ore Processing - S. K. Jain
2. Elements of Ore Dressing - A. F. Taggart

Course Code	Course title						Core/PE/OE
PC 504 MN	APPLICATIONS OF INTERNET OF THINGS TO MINING						Core
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	40	60	3

Course Objectives

1. To provide students with a comprehensive understanding of the Internet of Things (IoT) technology and its relevance in the mining industry.
2. To equip students with the knowledge of IoT data collection, communication, and edge computing techniques specific to mining environment
3. To explain smart mining operations with IoT, autonomous mining vehicles, robotics in IoT driven mining operations
4. To familiarize with IoT usage in safety in mining, safety enhancement, accident reduction, devices and protective equipment, risk assessment and management with IoT data analytics
5. To demonstrate IoT practical application with Arduino Boards in mining, Arduino programming, Arduino boards troubleshooting and optimization of the IoT system for mining operations

Course Outcomes

After completing this course, the student will be able to:

1. Understand the Internet of Things (IoT) technology and its application in the mining industry.
2. Acquire the knowledge of IoT data collection, communication, and edge computing techniques specific to mining environments and various other aspects.
3. Achieve proficiency in smart mining operations with IoT, real-time monitoring, robotics, and environmental monitoring sustainability.
4. Explore IoT usage in mine safety, smart personal protective equipment safety enhancement, accident reduction, devices and protective equipment, risk assessment and management with IoT data analytics.
5. Gain practical experience with Arduino Boards in mining, Arduino programming, Arduino boards troubleshooting and optimization of the IoT system for mining operations.

UNIT I

Introduction to Internet of Things (IoT) in mining

Understanding the concept of the Internet of Things (IoT) and its relevance in the mining industry, Overview of IoT architecture and components, IoT-enabled devices and sensors in the mining environment, Benefits and challenges of implementing IoT in mining operations

UNIT II

IoT Data Collection and Communication in Mining

Data acquisition and collection techniques in mining using IoT sensors, Communication protocols and networks for IoT in mining, Edge computing and fog computing in mining IoT systems, Security and privacy considerations in IoT data transmission in mining

UNIT III

Smart Mining Operations with IoT

Real-time monitoring and control of mining equipment through IoT, Predictive maintenance and condition monitoring using IoT data, Autonomous mining vehicles and robotics in IoT-driven mining operations, Environmental monitoring and sustainability through IoT in mining

UNIT IV

IoT and Safety in Mining

IoT applications for enhancing safety and reducing accidents in mining, Wearable devices and smart personal protective equipment (PPE) for miners, Emergency response systems and remote monitoring in hazardous areas, Risk assessment and management with IoT data analytics in mining

UNIT V

IoT Practical Applications with Arduino Boards in Mining

Introduction to Arduino boards and their capabilities for IoT applications, Selection and integration of sensors relevant to mining scenarios (e.g., temperature, humidity, gas), Hands-on experience with Arduino programming for data acquisition and control, Design and implementation of a mining-specific IoT application using Arduino boards, Troubleshooting and optimization of the IoT system for mining operations

REFERENCE BOOKS

1. Internet of Things for Architects" by Perry Lea
2. IoT Solutions in Microsoft's Azure IoT Suite" by Scott Klein and Paolo Patierno
3. Smart Mining: Resources for a Connected World" by William M. Bajjali
4. IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things" by David Hanes and Gonzalo Salgueiro
5. IoT for Intelligent Mining and Agriculture" edited by Saraju P. Mohanty, Elias Kougianos, and Sudip Misra
6. Industrial Internet of Things: Cyber-Manufacturing Systems" by Sabina Jeschke, Christian Brecher, Houbing Song, and Danda B. Rawat
7. Mining Equipment Reliability, Maintainability, and Safety" by Balbir S. Dhillon
8. IoT Projects with Arduino" by Marco Schwartz and Olivier Engler

Course Code	Course title						Core/PE/OE
PC 505 MN	MINE ENVIRONMENTAL ENGINEERING – II						Core
	Contact Hours Per Week				CIE	SEE	Credits
Mine Environmental Engineering – I	L	T	D	P			
	3	-	-	-	40	60	3

Course Objectives

1. To explain various aspects of spontaneous combustion in mines, causes, prevention and control.
2. To familiarize with mine fires, detection and prevention, firefighting techniques, reopening of sealed off areas.
3. To illustrate different inflammable gases, fire damp and coal dust explosions, various factors affecting explosions, prevention and control of explosions.
4. To provide knowledge on mine inundation, causes, approaching of water-logged areas; noise pollution, causes, measurement, prevention and control.
5. To equip with the knowledge of mine illumination and rescue, illumination standards, mine rescue and recovery operations, rescue apparatus, etc.

Course Outcomes

After completing this course, the student will be able to:

1. Understand various aspects of spontaneous combustion in mines, factors, causes of fire, prevention and control.
2. Appreciate mine fires, detection and prevention, firefighting techniques, different types of fire extinguishers, reopening of sealed off areas, etc
3. Comprehend different inflammable gases, fire damp and coal dust explosions, causes, various factors affecting explosions, prevention and control of explosions, and preventive measures, stone dust barriers
4. Recognize various aspects of mine inundation, causes, prevention; noise pollution, its causes, measurement, prevention and control
5. Acquire knowledge on mine illumination and rescue, flame safety lamps, lamp room layout, illumination of opencast and underground workings, mine rescue and recovery operations, rescue apparatus, etc

UNIT-I:

Spontaneous Combustion

Various theories, factors affecting the liability of coal seams to spontaneous heating, experimental methods to determine relative tendencies of coal seams to spontaneous combustion, detection, prevention and dealing in U/G mines.

Numerical problems and statutory aspects. Spontaneous heating in coal benches in OCMs, their preventions and their detection and dealing.

UNIT –II:

Mine Fires:

Causes of fires in surface coal stocks, precautions against fire in coal stocks on surface, fighting the surface coal stock fires. Accidental fires, various methods to combat fires and detection, prevention.

Fire Fighting and Reopening of sealed-off areas

Advances in firefighting techniques, different inert gases used for firefighting, their advantages and disadvantages, different types of fire extinguishers, fields of application and limitations.

Reopening of sealed-off areas

Factors to be considered, methods and their suitability, and precautions to be taken to reopen the areas sealed off due to fires. Numerical problems and statutory aspects.

UNIT –III:

Mine Explosions

Different inflammable gases are likely to be present in underground coal mines and explosibility triangles, fire tetrahedron. Fire damp explosion, causes different sources of ignition of firedamp, prevention of firedamp explosions, characteristics of firedamp explosions. Coaldust explosion, causes, factors affecting the coal dust explosion, dust explosion pentagon and preventive measures against coal dust explosion. Stone dusting; stone dust, water and triggered barriers. Comparison of Coal dust explosions and Fire damp explosions. Water gas explosions, Numerical problems and statutory aspects.

UNIT –IV: Mine Inundation and Noise Pollution

Surface and underground mine inundations, causes, precautions against inundation, approaching of old water-logged areas, dewatering of water-logged areas.

Noise pollution, its causes and measurement of noise levels. Precautions, prevention and reduction of noise levels. Numerical problems and statutory aspects.

UNIT –V:

Mine Illumination and Rescue

Illumination standards, common types of flame safety lamps, their use and limitations, cap lamp, and lamp room layout. Illumination of opencast and underground workings including Illumination surveys and instruments used for the same. Rescue and recovery work, rescue apparatus, rescue stations, rooms, layouts. Numerical problems and statutory aspects.

TEXT BOOKS:

1. Mine Fires, Explosion, Rescue, Recovery and Inundation – M.A. Ramulu, Mukharjee Publishers
2. Mine Environment & Ventilation – G.B. Misra, Oxford University Press.
3. Environmental Engineering in Mines – R.D Lama, V.S Vutukuri, Cambridge University Press

REFERENCES:

1. Fires in Coal Mines – L.C. Kaku, Oriental Publishers.
2. Mine Environment Engineering- M. Sengupta
3. Mining Ventilation – 2 Volumes - by D.C.Panigrahi

E RESOURCES:

1. https://sites.google.com/site/mineventilationiitkgp/mine-hazards-and-rescue
2. http://www.edumine.com/courses/online-courses/mine-safety-and-rescue-2-underground-irehazards/

Course Code	Course title						Core/PE/OE
PE 521 MN	GEO-STATISTICS						PE
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	40	60	3

Course Objectives

1. To make the students familiar with the basics of Geo-Statistics, applications of geostatistics and its advantages.
2. To illustrate exploratory borehole data, statistical analysis, correlation and regression model.
3. To equip the students with the knowledge of computation of experimental variograms, mathematical models and validation.
4. To familiarize with resource estimation by kriging, kriging analysis and other related aspects.
5. To provide the knowledge of geostatistical applications, case studies, resource modelling and introduction to Surpac mine planning software.

Course Outcomes

After completing this course, the student will be able to:

1. Understand the concepts of geo-statistics, regionalized variables, applications of geo-statistics, and geo-statistical estimation methods.
2. Comprehend the basics of exploratory data analysis, regression models, measures of dispersion and grade distribution and other statistical analysis.
3. Recognize the structural analysis (variograms), computation of experimental variograms, fitting of mathematical models and validation.
4. Acquire knowledge on resource estimation by kriging, discretization, variance analysis, grade control and bench plan of opencast mines.
5. Discover knowledge on geostatistical applications, optimization of exploration drilling, resource modelling and mine panning software.

UNIT-I

Introduction to Geo-statistics and prerequisites

Definition, Origin of Geo-statistics, Theory of Regionalized Variables, Introduction and Applications of Geo-statistics, Conventional Methods of estimations with its limitations and advantages of Geo-statistical Estimation Methods.

UNIT-II

Exploratory Data Analysis

Exploratory Borehole Data and its attributes, Measures of Central Tendency, Measures of Dispersion, Grade Distributions, Correlations and Regression Model and Borehole Plan,

UNIT-III

Structural Analysis (Variograms)

Definitions, Computation of Experimental Variograms in one, two, and three dimensions, Regularization, Variogram Cloud, Fitting of Mathematical models, Nugget Effect, Nested Models, Anisotropy and Validation of Variogram Models.

UNIT-IV

Resource Estimation by Kriging

Overview of Conventional methods of Estimation, Introduction to Kriging, Point Kriging and Block Kriging Estimations Block Discretization, Block Variance, Extension Variance and Estimation Variance, Neighborhood Analysis, Kriging Efficiency. Screen Effect, Categorization of Resources. Establishment of Grade Tonnage relations, Grade Control Plans, Bench Plans.

UNIT-V

Geostatistical applications – Case Studies

Optimization of exploration drilling, Case study on 2D data, Practical Applications of Geostatistics in Resource Modelling of a Mineral Deposit using 3D data. Case study showing a 3D Orebody Modelling and Resource Estimation using Surpac Mine Planning Software. Overview of Non-linear Geostatistics and simulations.

TEXT BOOKS:

1. An Introduction to Applied Geostatistics, Issacks and Srivastava Oxford, JBH, 1990
2. Geostatistics for Beginners – Anil Kumar Mehrotra, Zorba Books Pvt. Ltd.
3. Mining Geostatistics – Andre G Journel, The Blackburn Press

REFERENCES:

1. An Introduction to Geostatistical methods of Mineral Exploration, Rendu J.M John Wileyand Sons, 1981
2. Geostatistical Ore Reserve Estimation, David, Michel, Mc Graw Hill, 1977

E RESOURCES

1. http//www.springer.com/in/book/9781402093791
2. https//link.springer.com/chapter/10.1007%2F978-3-319-39264-6_17

Course Code	Course title						Core/PE/OE
PE 522 MN	SURFACE MINING AND MECHANIZATION						PE
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	40	60	3

Course Objectives

1. To provide knowledge about open pit planning, cutoff grade and pit configuration, design of haul roads, optimization of mine geometry and feasibility report, DPR contents and preparation, etc.
2. To acquaint with the knowledge of geo-technical parameters of pit slope, stability analysis, design of waste dumps, and numerical problems, etc.
3. To impart the knowledge of mine size determination, mine and mill plant size, stack piling and blending, production scheduling, computerized truck dispatch system, calculation of mine production and power supply arrangement in opencast mine, etc.
4. To familiarize with, health, safety and environmental management, hazards due to mine dust, poor lighting and ventilation, mine accidents, drainage requirements, water pollution, and socio-economics factors, etc.
5. To illustrate the knowledge of modern trends in opencast mines, mining methods and layouts, in-pit crushing and conveying, continuous surface mining, and special opencast mining methods, etc.

Course Outcomes

After completing this course, the student will be able to:

1. To acquire knowledge about surface mine planning, block modelling, open pit design, various parameters, design of haul roads, pit layouts, mine scheduling, feasibility report, DPR contents and preparation, etc.
2. To understand the knowledge of geo-technical parameters, pit slope economics, high wall stability, slope stability analysis including rock dumps and tailing dumps, etc.
3. Comprehend to concepts of production and equipment panning, determination of mine size, cash flow calculations, HEM machines like, spreaders and reclaimers, computerized truck dispatch systems, inventory, and preventive maintenance, etc.
4. Recognize health, safety and environmental occupation health hazards, mine dust, noise and vibration, water pollution, impact of surface subsidence and mine reclamation, etc.
5. Appreciate modern trends in opencast mines like in-pit crushing, conveying, continuous surface miner and other special opencast mining methods, etc.

UNIT-I

Pit Planning

Development of economic block model; Pit cut-off grade and its estimation; Ultimate pit configuration and its determination – graphical method, floating cone technique, Lerchs-Grossmann algorithm, and computer aided method. Design of haul roads; Pit layouts. Optimization of mine geometry, mine development phases, quality control output and manpower planning; calendar planning, mine scheduling, production scheduling, Feasibility Report, DPR-contents and preparation.

UNIT –II

Geotechnical Parameters

Influence of pit slope on mine economics; High wall slope stability analysis and design methodology; stability analysis and design methodology for waste dumps; Application of geotechnical investigation for design of ultimate pit slope and other design parameters. Numerical problems on slope stability analysis including mine waste rock dumps and tailing dumps.

UNIT –III

Production and Equipment Planning

Determination of mine size and sequencing by nested pits; Cash flow calculations; mine and mill plant sizing; Production scheduling. Stockpiling and blending, Spreaders and Reclaimers; computerized truck dispatch system. Selection of mining system vis-à-vis equipment system; Computations for the capacity and number of machines vis-à-vis mine production. Machine availability, productivity, maintenance scheduling, preventive maintenance, control and monitoring inventory. Workshops for HEMM. Power supply arrangements in opencast mines. Truck dispatch system;

UNIT –IV

Health, Safety and Environmental Management

Occupational health hazards due to mine dust, poor lighting and ventilation, noise and vibration, radioactive emission; Impact of surface subsidence; Accidents in Surface mining and their prevention; Sources of water, assessment of drainage requirements, sump design and drainage patterns – pumping systems. Pre-drainage through diversion channels and boreholes; Water pollution, Methods of reclamation of mined out areas, dumps and tailing ponds, environmental audit. Socioeconomic factors in surface mines.

UNIT –V

Modern Trends in Opencast Mines

Recent developments in mining methods and layouts. In pit crushing & conveying, continuous surface mining. Selective extraction and dumping. Extraction of seams developed/extracted by underground methods. Deep Open pit Mining; Placer mining and solution mining – scope of applicability, sequence of development and machinery; Closure of surface mines.

TEXT BOOKS:

1. Hartman, H. L. (Editor), SME Mining Engineering Handbook, 3rd edition, Vol I & II, Society of Mining Engineers, New York, 2011.
2. Hustrulid, W. and Kuchta, M., (eds)., Fundamentals of Open Pit Mine Planning & Design, Elsevier, 1995

REFERENCES:

1. Proceedings of National Seminar on Surface Mining, IME Publications/ Calcutta, 1995
2. Das, S.K., Surface Mining Technology, Lovely Prakashan, Dhanbad, 1994
3. Das, S.K., Modern Coal Mining Technology, Lovely Prakashan, Dhanbad, 1994
4. Kennedy, B.A., Surface Mining – 2nd Edition, SME, New York, 1990

E RESOURCES:

1. www.eolss.net/sample-chapters/c05/e6-37-06-01.
2. https://link.springer.com/book/10.10

Course Code	Course title						Core/PE/OE
PE 523 MN	MINE SYSTEMS ENGINEERING						PE
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	40	60	3

Course Objectives

1. To explain introduction to optimization techniques, linear programming and other mine systems engineering aspects with mining examples, etc.
2. To impart knowledge on simplex method of linear programming, dual programming with mining examples, etc.
3. To provide knowledge on transportation problem, assignment problems, optimization techniques with mining examples, etc.
4. To familiarize the importance of inventory, EOQ model, waiting line theory, and queuing systems, etc.
5. To illustrate PERT and CPM systems, Network analysis with mining examples, etc.

Course Outcomes

After completing this course, the student will be able to:

1. Understand the concept of optimizations techniques, linear programming, problem formulation and graphical solutions.
2. Comprehend linear programming techniques such as simplex method, Big M method, duality, etc.
3. Recognize the application of transportation problems, problem formulation, assignment problems with mining examples, etc.
4. Appreciate the knowledge of inventory, EOQ models, waiting line theory, Queuing systems and their mining applications, etc.
5. To acquire knowledge about CPM and PERT techniques, network analysis, determination of project completion time with related to mining and mining case studies, etc.

UNIT – I –Introduction

Introduction to optimization techniques, linear programming, problem formulations, graphical solutions, unboundedness, infusibility, unique solution, multiple solutions. Mining examples

UNIT – II Linear programming

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 Problem

Formulation–Optimal solution, unbalanced transportation problem–Degeneracy, variants in assignment problems, mining examples. Assignment problem – Formulation – Optimal solution – Mining examples

UNIT – IV –Inventory and Waiting line

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 queuing systems – arrivals Poisson distributed, service time exponential distribution

UNIT – V – PERT and CPM

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. Mining examples.

TEXT BOOKS:

1. Introduction to O.R /Taha/PHI Publishers
2. Operations Research / S.D.Sharma/Kedarnath Publisher
3. Operations Research /A.M.Natarajan, P.Balasubramani,A. Tamilarasi/Pearson Education.
4. Operations Research: Methods & Problems / Maurice Saseini, Arhur Yaspan & Lawrence Friedman/ Literary Licensing
5. Operations Research / R.Pannerselvam, PHI Publications.

Course Code	Course title						Core/PE/OE
PE 551 MN	MINE ENVIRONMENTAL ENGINEERING LAB						PC
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	-	-	-	2	25	50	1

Course Objectives

1. To explain detection of various mine gases using gas detectors and measurement of relative humidity and cooling power of mine air, etc.
2. To acquaint knowledge of the constructional features and characteristic curves for centrifugal and axial flow fans and ventilation survey using anemometer, velometer, smoke tube, pitot static tube and other instruments, etc.
3. To study the constructional features of flame safety lamps, cap lamps, fire extinguishers, etc.
4. To familiarize with the stone dust barriers, rescue apparatus, etc.
5. To illustrate the conduct of illumination survey, ground vibrations, noise level meters, air borne dust survey, water quality analysis, etc.

Course Outcomes

After completing this course, the student will be able to:

1. Understand the detection of various mine gases using gas detectors and measurement of relative humidity and cooling power of mine air, etc.
2. Acquire knowledge of the constructional features and characteristic curves for mine fanes, ventilation survey instruments, etc.
3. Recognize the constructional features of flame safety lamps, cap lamps, fire extinguishers, etc
4. Discover the working of stone dust barriers, rescue apparatus, etc.
5. Comprehend the conduct of illumination survey, ground vibration monitoring, noise survey, air borne dust survey, water quality analysis, etc.

LIST OF EXPERIMENTS :

1. Detection of mine gases CH_4, O_2, CO, SO_2, NO_x

   Gas analysis by Orsat/Haldane apparatus
2. Measurement of relative humidity by Hygrometer and cooling power of air by Kata thermometer.
3. Study of Constructional features and Characteristic curves of centrifugal and axial flow fans. Fans in series and fans in parallel
4. Measurement of air quantity by anemometer, velometer, smoke tube, etc
5. Constructional features of a flame safety lamp and cap lamp.
6. Study of fire extinguishers used in mines.
7. Study of stone dust, water and triggered barriers.
8. Study of oxygen self-rescuer, self-contained breathing apparatus.

9. Proximate analysis of coal
10. Air sampling using High volume air sampler and determination of dust concentration and percentage of different gases.
11. Illumination survey by Lux meter
12. Study of ground vibrations and air overpressure
13. Water quality – Hardness, BOD, COD, pH detector, TDS meter, etc.
14. Pressure measurement: Pitot static tube, U – Tube manometer, Inclined U – Tube manometer and Magnahelix
15. Study of Noise level meter and carrying our noise survey
16. Study of U/G mine environmental monitoring by Tube bundle systems and MINOS (Different types of sensors)
17. Study of Airborne respirable dust survey by gravimetric dust sampler.
18. Solving simple ventilation networks using the Hardy cross method

Course Code	Course title						Core/PE/OE
PC 552 MN	MINERAL PROCESSING LAB						Core
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	-	-	-	2	25	50	1

Course Objectives

1. To impart knowledge on various types of laboratory sampling techniques and determination of particle size distribution by sieve analysis.
2. To explain the procedure of working of jaw and roll crusher and analysis of particle size distribution using sieve analysis and jaw crusher.
3. To make familiar with the method of size reduction using jaw and roll crusher and ball mills.
4. To teach the method of coal washing and separation of minerals by heavy media separation and concentration of minerals using froth floatation.
5. To carry out experiments on concentration of minerals using magnetic separator, mineral jig, Wilfley table and flow charts for concentration of common minerals.

Course Outcomes

After completing this course, the student will be able to:

1. Understand the knowledge on various types of laboratory sampling techniques and determination of particle size distribution by sieve analysis.
2. Gain knowledge on the procedure of working of jaw and roll crusher and analysis of particle size distribution using sieve analysis and jaw crusher.
3. Familiarize the method of size reduction using jaw and roll crusher and ball mills.
4. Appreciate the method of coal washing and separation of minerals by heavy media separation and concentration of minerals using froth floatation.
5. Analysis experiments on concentration of minerals using magnetic separator, mineral jig, Wilfley table and flow charts for concentration of common minerals.

LIST OF EXPERIMENTS:

1) Sampling by grab sampling, coning and quartering, riffle sampling techniques, etc.
2) Determination of particle size distribution by sieve analysis. Influence of time on sieving.
3) Studies on size reduction using Jaw crusher. Determination of average size, surface area and power consumption.
4) Size reduction using Roll crusher. Determination of average size and power consumption.
5) Studies on size reduction using Ball mill. Determination of average size and power consumption.
6) Coal washing and separation of other minerals by Heavy media separations (sink and float experiment)
7) Concentrating minerals using Froth Flotation
8) Concentration of minerals using magnetic separator
9) Separation of minerals by using mineral jig
10) Separation of minerals by using Wilfley table
11) Settling characteristics of minerals by using settling tank
12) Study of flow charts for concentration of Gold, Uranium, Copper, Lead, Zinc, Graphite etc.

Course Code	Course title						Core/PE/OE
PW 941 MN	SURVEY CAMP						PW
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	-	-	-	-	50	-	2

Course Objectives

1. To introduce the knowledge of the working principle of Theodolite, Total station and their practical applications.
2. To conduct field survey of buildings and other structures using theodolite, dumpy level and other surveying instruments.
3. To familiarize with the use of GPs, GIS and remote sensing in the field.

Course Outcomes

After completing this course, the student will be able to:

1. Understand the working principle of Theodolite, Total station and its use in the field.
2. Discover the conduct of field survey of buildings and other structures using theodolite, dumpy level and other surveying instruments.
3. Acquire knowledge on the use of GPS, GIS and remote sensing in the field.

The students will be given basic training of handling of various survey instruments including Total station. The students are given certain tasks on all the instruments and equipment to solve the real practical problems in the vicinity of campus which enables them to learn and apply to the real-life survey problems.

After the completion of the survey camp, students need to submit a technical report on the project executed and present the work through a seminar talk to be organized by the Department. Award of sessional are based on the performance of the student at the work place and will be judged by internal guide (s) (25 Marks) followed by presentation before the committee constituted by the Department (25 Marks). One faculty member will coordinate the overall activity of Survey camp.

***Students have to undergo Survey camp for one-week duration at the end of semester IV and the credits will be awarded after evaluation in V semester.**

Scheme of Instruction, Evaluation

and

Syllabi of

B.E. MINING ENGINEERING

(BATCH 2022-2026)

VIth Semester

With effect from Academic Year 2024-25

DEPARTMENT OF MINING ENGINEERING

UNIVERSITY COLLEGE OF ENGINEERING

(Autonomous)

Osmania University

Hyderabad – 500 007, TG, INDIA

Estd.1917

Estd.1929

Scheme of Instruction for BE (Mining Engineering) VI-Semester

S.No.	Course Code	Course Title	Scheme of Instruction			Cont Hrs/ Wk	Scheme of Evaluation			Credits
			L	T	P		Hrs	CIE	SEE	
THEORY										
1	PC601MN	Mine Ground Control	3		-	3	3	40	60	3
2	PC602MN	Underground Metal Mining	3	-	-	3	3	40	60	3
3	PC603MN	Surface Mine Environmental Management	3	-	-	3	3	40	60	3
4	PC604MN	Computer Applications in Mining	3	-	-	3	3	40	60	3
5		PE-III	3	-	-	3	3	40	60	3
6		OE I	3	-	-	3	3	40	60	3
PRACTICALS										
7	PC651MN	Computer Applications in Mining Lab	-	-	2	2	3	25	50	1
8	PC652MN	Rock Mechanics Lab	-	-	2	2	3	25	50	1
9	PW653MN	Mini Project	-	-	6	6	-	50	-	3
			18	**-**	**10**	**28**	**24**	**340**	**460**	**23**
* At the end of VI semester students should undergo Internship-II (OC Mines) (Coal/Metal). Marks will be awarded in VII semester.										

CODE	PROFESSIONAL ELECTIVE-III	CODE	OPEN ELECTIVE-I
PE631MN	Rock Slope Engineering	OE601MN	Impact of Mining on National Economy and Environment
PE632MN	Materials Management in Mines		
PE633MN	Coal Bed Methane and Coal Gasification		

CODE	OPEN ELECTIVE-I Offered by other departments
OE 601 BM	Engineering Applications in Medicine
OE 602 BM	Human Assistive Technologies
OE 601 CE	Disaster Management
OE 602 CE	Road Safety Engineering
OE 601 CS	Python Programming
OE 602 CS	Cyber Security
OE 601 EC	Principles of Electronic Communication
OE 602 EC	Verilog HDL
OE 601 EE	Applications of Electrical Energy
OE 602 EE	Electrical Safety Management
OE 601 ME	3D Printing Technology
OE 602 ME	Finite Element Method

Course Code	Course title						Core/PE/OE
PC 601 MN	MINE GROUND CONTROL						PC
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	40	60	3

Course Objectives

1. To introduce various aspects of ground control in mines, design of pillars in mines and surface subsidence, etc.
2. To teach various support systems used in underground mines in Bord and Pillar and longwall mining systems and strata control, etc.
3. To impart knowledge on various types of rock bolting systems, their design, cable bolting, shortcreting, support of freshly exposed roof areas and strata control management plans, etc.
4. To explain open pit slope stability, various types of slope failures, determination of FOS, different stabilization techniques, etc.
5. To make familiarize with various instruments used for underground and surface mines and to illuminate knowledge of stowing in underground mines, design of stowing plants and other aspects, etc.

Course Outcomes

After completing this course, the student will be able to:

1. Understand the various concepts of ground control in mines, design of pillars and subsidence and its control measures.
2. Appreciate the knowledge of various types of supports, limitations, insitu stresses, rigid and yielding supports, pressure arch theory, etc
3. To recognize the knowledge of various types of rock and cable bolting systems, roof stitching, shortcreting, design of supports, longwall powered supports, and strata control management plans.
4. Appreciate the various aspects of pit slope stability slope failure, determination of FOS and spoil dump stabilization techniques.
5. Gain knowledge of various types of instruments used in strata monitoring, instrumentation in the laboratory testing, different types of stowing methods, field of application, preparation of stowing material, surface and underground face arrangement and design of stowing plants.

UNIT-I : PILLAR DESIGN AND SUBSIDENCE

Definition and concept of ground control in mines, Design of pillars, barriers and shaft pillar– load estimation, factor of safety, various formulae used to design pillars of different typs, rock burst and bumps — phenomena, causes, prediction, monitoring and control, gas outbursts

Theories of subsidence, factors affecting subsidence, subsidence surveys, subsidence prediction techniques, subsidence control – surface and underground measures, pseudo-mining damage.

UNIT -II : UNDERGROUND SUPPORTS - I

Various methods of roof examination, objectives and limitations of supports, ground forces and in situ stresses, its estimation by various methods, ratio of vertical to horizontal stresses. Pressure arch theory, evolution of supports, conventional supports, rigid and yielding supports. Principles of working of different types of supports like timber and steel, arches, etc.

UNIT -III: UNDERGROUND SUPPORTS - II

Rock and cable bolting, roof stitching, shotcreting/ guniting, rigid and yielding supports, mechanism of functioning yielding supports, yielding characteristics, support of shaft bottoms, galleries, junctions and places of roof falls, freshly exposed roof supports, design of supports, longwall powered supports, Shields.

Design of SCAMP (Strata Control and Management Plan) for B & P and longwall - development, depillaring, etc. numerical problems

UNIT -IV: INTRODUCTION TO PIT SLOPE STABILITY

Approach to slope stability, slope parameters, different types of slope and dump failures, factors affecting slope stability, introduction to various methods of slope failure analysis, determination of factor of safety, introduction to different rock slope and dump stabilization techniques. Numerical problems.

UNIT -V : INSTRUMENTATION AND STOWING / FILLING

Various instruments used in Opencast and underground mines for measurement of convergence, deformation, load, pressure, anchorage capacity etc., in laboratory and field (in-situ) - Convergence indicators, load cells, strain gauges, LVDT, dial gauges, pressure cells and recorder, anchorage testing equipment, boltometer, flat jacks, hydraulic fracturing.

Need for stowing, desirable properties of stowing materials, various stowing materials – their relative merits, demerits, limitations. Selection and preparation of stowing materials. Different methods of stowing, fields of application and limitations, collection and transportation of materials, surface, underground and face arrangements, design of stowing plants. Steps to ensure effective stowing – hydraulic gradient, sand:water ratio. Selection and maintenance of pipelines. Numerical problems.

TEXT BOOKS:

1. Strata Control in Mineral Engineering, Z. T. Bieniawski, John Wiley & Sons.
2. Ground Control in Mining – S.K.Sarkar, AA Balkema Publishers
3. Coal Mine Ground Control – Syd S. Peng, Wiley-Blackwell

REFERENCES:

1. Underground winning of Coal, T.N. Singh, Oxford and IBH New Delhi.
2. Engineering Rock Mass Classifications, Bieniawski Z.T. 1989, Wiley, New York
3. Longwall mining, Peng S S and Chiang HS, Wiley, New York, 708p.

E RESOURCES

1. http//www.undergroundcoal.com.au/fundamentals/15_general.aspx
2. http//www.icevirtuallibrary.com/doi/abs/10.1680/ijoti.1939.14545

Course Code	Course title						Core/PE/OE
PC 602 MN	UNDERGROUND METAL MINING						PC
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	40	60	3

Course Objectives

1. To introduce metal mining terminology, exploration, block wise and mine wise reserves estimation, pre-stoping aspects and classification of stoping methods, etc.
2. To teach various types of mine entries, layouts, production, design of level intervals, ore-passes and other underground structures, etc.
3. To explain choice of stoping methods, optimum size of mine and stope, stope layout, sequence of stoping and other related aspects, etc.
4. To make familiar with various stoping methods – unsupported and supported, caving methods, along with case studies, etc.
5. To illuminate concepts of special mining techniques such as hydraulic mining, slurry mining, solution mining, ring drilling, VCR mining, etc.

Course Outcomes

After completing this course, the student will be able to:

1. Understand various metal mining terms, block and mine wise ore reserve estimation, classification of stoping methods, etc.
2. Grasp the knowledge of development of ore bodies, various types of mine entries and other constructional features in the metal mines, etc.
3. Acquire knowledge on choice of stoping methods, cost parameters, stope layout, sequence of stoping and other related aspects, etc.
4. Familiarize with the knowledge of various types of stoping methods, like unsupported, supported, caving methods and their case studies, etc.
5. Appreciate the knowledge in the field of novel and innovative mining techniques and special application with reference to hydraulic mining, slurry mining, nuclear mining, thermal mining, deep mining, VCR mining, etc.

UNIT - I

Introduction: 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

Development of ore bodies: 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 – cross 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, etc.
Case studies of Indian and foreign underground metal mines. statutory aspects.

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 pillar extraction; VCR mining; Ring drilling; Large Blast hole stoping. statutory aspects

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.
3. Elements of Mining Technology – Vol 1 – D J Deshmukh, Deneet and Co.

Course Code	Course title						Core/PE/OE
PC 603 MN	SURFACE MINE ENVIRONMENTAL MANAGEMENT						PC
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	40	60	3

Course Objectives

1. To explain the concept of ecology, systems approach to environmental management and environmental pollutants due to surface and underground mines, etc.
2. To introduce the subject of various pollutants of air pollution – ozone layer depletion, greenhouse gases, global warming, air pollution standards monitoring, sampling and analysis, etc.
3. To teach the various features of water and noise pollution, classification of pollutants, standards, prevention and control, noise standards, impact assessment, pollution due to vibrations – machine and blasting, etc.
4. To make familiar with various facets of land and soil pollution, reclamation techniques, acid mine drainage, environmental impact assessments, subsidence and waste management, etc.
5. To illuminate, the knowledge on environmental laws, various environmental acts, power and responsibilities of regulatory agencies, preparation and appraisal of EMP reports, etc.

Course Outcomes

After completing this course, the student will be able to:

1. Analyze and evaluate to concept of ecology, ecology in human beings' systems approach to environmental management, environmental pollution due to surface and underground mining, etc.
2. Acquire knowledge on air pollution and associated pollutants, ozone layer depletion, sources and hazards of dust production, sampling, monitoring, analysis, and prevention and control of pollutions, etc.
3. Assimilate the knowledge on water and noise pollution, their standards, sampling and analysis, effects on human health, prevention and control measures and environmental pollution due to blasting, etc.
4. Comprehend the knowledge on land and soil pollution, mine reclamation techniques, frame work for environmental impact assessment, subsidence and waste management, etc.
5. Appreciate the knowledge on various environmental laws, Acts, power and responsibilities of regulatory agencies, preparation and appraisal of EMP reports, etc.

UNIT – I

Introduction:

Concept of Ecology, ecological principle, greenhouse gasses and their control, global warming and its mitigation nature of the environment ecology and man, systems approach to environmental management, global and local environmental issues, objectives of sustainable development.

Environmental Pollutants due to surface and underground mining – land, air, water, noise; impact of humans on the extent of environmental problem; nature and extent of environmental problems due to mining.

UNIT – II

Air Pollution:

Ozone layer depletion, green-house gases and global warming, ambient air quality and emission standards, sources and classification of pollutants including dust and their effect on human health, sources, hazards, standards, sampling, monitoring and analysis, instrumentation and measurement of pollutants including dust. Control and preventive measures for air pollution including dust. Statutory aspects of air pollution, norms.

UNIT – III

Water & Noise Pollution:

Environmental Pollution due to Water - Sources and Classification of pollutants and their effect on human health, hazards, sampling and analysis, Water pollution standards, control and preventive measure for water pollution. Water treatment plants of different types. Noise standards – Measurement – Noise Impact Index assessment, control and preventive measures for noise pollution, pollution due to equipment vibrations, their monitoring, prevention and control, Environmental pollution due to Blasting, carrying capacity of environment, numerical problems. Ground vibration due to blasting and machines and their control, Statutory aspects of water and noise pollution standards.

UNIT – IV

Land effects & EIA:

Land and soil pollution, control, reclamation planning, land use analysis, monitoring and maintenance, reclamation equipment and techniques, acid and alkaline drainage, control measures. Framework for EIA its methodologies and their applicability; Environmental accounting and audit, environmental economics, environmental administration, uncertainties in EIA, subsidence management, waste management: solid waste – generation, treatment, disposal, effluent treatment.

UNIT - V

Environmental legislation:

Environmental laws, the Environmental (Protection) Act, 1986, The Water Act (1974), The Air (prevention and control of pollution) Act (1981), The Indian Forest Act 1927, The Forest (conservation)Act 1980, Power and responsibilities of regulatory agencies and occupation consent to establish and operate wild life protection act and rules, Environmental clearance procedure for a mining Project. Frame work of EMP, Legislative requirements of EMP; Preparation and appraisal of EMP report.

TEXTBOOK:

1. Environmental Impact of Mining C.G Down and J Stock Applied Science Publishers Ltd. London, Second Edition, 1980.
2. Mining and Environment B.B.Dhar Ashish Publishing House, New Delhi, 1986.
3. M.A Ramulu – Noise pollution
4. Ecology books to be added

Course Code	Course title						Core/PE/OE
PC 604 MN	COMPUTER APPLICATION IN MINING						PC
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	40	60	3

Course Objectives

1. To introduce the configuration of computers and servers, networking, cloud computing and data analytics, etc.
2. To impart knowledge on programming and DBMS concepts, their applications to opencast and underground mines and development of software packages for mining companies, etc.
3. To expose the knowledge on computerized mine planning, geo statistics, ore reserve estimation, ore body modelling, optimization and mine scheduling, etc.
4. To familiarize with the knowledge on applications of computer in mining in various fields such as, ventilation network analysis, support design, GIS, online and offline monitoring and underground structures, etc.
5. To illustrate the recent trends in mining software like Data-mine, Surpac, neural networks, robotics, MATLAB, expert systems, etc.

Course Outcomes

After completing this course, the student will be able to:

1. Gain knowledge in the field of computers and servers, networking, MIS, and data analytics.
2. Comprehend various programming and DBMS techniques, and their application to mining problems, such as blast design, subsidence, etc., and development of software packages for mining companies.
3. Recognize the various features of computerized mine planning, ore reserve estimation, kriging, ore body modelling, incorporation of mining geological features and mine design & scheduling.
4. Appreciate the concepts of computer application in mining such as ventilation network analysis, support design, GIS, monitoring and control.
5. To acquire knowledge in the field of recent trends in computer application in mining and popular mining software such as Datamine, Surpace, etc., artificial intelligence, expert systems, neural networks, robotics, case studies and applications.

UNIT - I

Introduction to Computers: Configuration of computers and servers, evolution of operating systems; Networking Concepts, MIS Concepts – Cloud computing / grid computing in mining, Big Data analytics.

UNIT - II

Programming & DBMS Concepts: Algorithm, flow charts and Programming of mining application like pillar design including shaft pillar and barrier pillars, underground and opencast mines blast design, subsidence, - Database and Relational database - development of software packages for mining companies– forms, queries and reports, Enterprise resource planning for materials management

UNIT - III

Computerized Mine Planning: Introduction of Geostatistics, Reserve Estimation, kriging, block modelling and orebody modelling for different shapes and grades based on borehole and other data incorporating geological features, depth form surface and dip of the deposit, Optimization and mine design, mine scheduling.

UNIT - IV

Applications in Mining: Ventilation network analysis; support design, Applications of CAD in mining, GIS in Mining, online and offline monitoring and control. Design of surface and underground structures including pillars, panels (B&P & LW), shafts, excavations, slopes, etc.,

UNIT - V

Recent Trends & Mining Software: Introduction to mine software like Datamine, Surpac, etc., Functionalities of mine planning software, application of Artificial intelligence, expert system, neural networks and robotics to mining, fragmentation analysis software, and numerical analysis software applicable to mining like MATLAB. Case studies of mining applications.

TEXT BOOKS:

1. Kadri Dagdelen, Editor, Computer Applications in the Minerals Industries, Colorado School of Mines, 1999.
2. Ramani R.V., et al. Computers in Mineral Industry, Oxford and IBH Publishers, 1994.
3. Introduction of IoT to Mining
4. Introduction to Automation, Introduction to AI

REFERENCE BOOKS:

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

Course Code	Course title						Core/PE/OE
PE 631 MN	ROCK SLOPE ENGINEERING						PE
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	40	60	3

Course Objectives

1. To explain the fundamental principles of rock slope stability and the factors that influence slope failure, including geological parameters, rock strength properties, and groundwater flow, etc.
2. To teach the skills in analyzing and designing slopes, considering factors such as slope height, slope angle, and water pressure, etc.
3. To impart knowledge and proficiency in analyzing plane failure and wedge failure, including graphical analysis, influence of tension cracks, and use of rock reinforcement techniques, etc.
4. To illustrate the fundamentals of circular failure and toppling failure, including conditions for failure, derivation of failure analysis methods, and the influence of groundwater and slope curvature, etc.
5. To familiarize rock slope monitoring techniques and slope stabilization methods, including surface and sub-surface monitoring, instrumentation and guidelines for monitoring programs, etc.

Course Outcomes

After completing this course, the student will be able to:

1. Apply the principles of rock mechanics to assess the stability of rock slopes, considering factors such as slope parameters, water pressure, and geological properties, etc.
2. Analyze and interpret data related to geological and rock strength properties to evaluate their impact on slope stability, etc.
3. Demonstrate proficiency in analyzing plane failure, wedge failure, circular failure, and toppling failure, including the use of graphical methods and failure analysis techniques, etc.
4. Implement monitoring methods for rock slope failure, including surface and sub-surface monitoring techniques, and interpret monitoring data to assess slope stability, etc.
5. Develop an understanding of slope stabilization techniques, including rock reinforcement, rock removal, and protection measures against rock falls, and apply them in slope stabilization programs, etc.

UNIT – I

Basic Mechanics of Rock Slope Failure: Pit and slope geometry, rock slope economics; slope parameters; effect of water pressure; factor of safety of slopes; slope height vs slope angle; design of slopes and their optimization. Design of bench, slope and dumps.

UNIT – II

Parameters influencing slope stability: Controllable and uncontrollable parameters, geological parameters affecting slope stability; graphical representation of geological data; physico-mechanical properties of rockmass affecting slope stability, field measurement of permeability; measurement of water pressure, ground water flow in rock masses; influence of ground water on stability, pit geometry, orientation of benches with reference to geological features.

UNIT – III

Plane Failure and Wedge Failure: Plane failure analysis; graphical analysis of stability; influence of tension crack; analysis of failure;

Analysis of wedge failure; wedge stability charts; case studies. Numerical problems by analytical methods.

UNIT – IV

Circular and Toppling Failure: Conditions for circular failure; effect of ground water; circular failure charts; Bishop's and Janbu's methods of failure analysis; case studies.

Types of toppling failure; analysis of toppling failure; limit equilibrium analysis of toppling failures; slope depressurization; Numerical problems by analytical methods.

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, measurement, monitoring and interpretation of slope displacements. Causes of rock falls; protection measures against rock falls.

Rock slope stabilization, reinforcement and rock removal, Dump stabilization.

TEXT BOOKS:

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

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; 4th edition, 488p, 2007.

Course Code	Course title						Core/PE/OE
PE 632 MN	MATERIALS MANAGEMENT IN MINES						PE
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	40	60	3

Course Objectives

1. To teach introduction to materials management, its importance and need, ABC analysis, and related aspects, etc.
2. To explain knowledge on purchase management consisting of material planning and purchase, procedure, purchasing of capital equipment and procurement policies etc.
3. To illustrate the knowledge on various features of warehousing and software management, store system procedures, store accounting and stock verifications and value analysis, etc.
4. To impart knowledge on inventory management, replenishment model, computerized material management and spare parts management, etc.
5. To provide knowledge on material procurement procedures, central and local sales tax (GST), exercise duties, customs tariff, import policies, etc.

Course Outcomes

After completing this course, the student will be able to:

1. Understand the concept of materials management its importance, advantages, standardization, etc.
2. Comprehend material planning and purchase, procedures, price forecasting, purchasing decisions, and procurement policies, etc.
3. To acquire knowledge on warehousing and store management, store keeping principles, cost aspect and productivity, store accounting and stock incoming material control, etc.
4. To gain knowledge on inventory management, replenishment model, work in progress, computerization and spare parts management, etc.
5. Appreciate material procurement procedure, various taxes, customs tariff, import policies, procurement from government, and international market, insurance, etc.

UNIT – I

Introduction: Introduction to materials management, importance of integrated materials management, need for integrated materials management concept, definition, scope and advantage – an overview, A-B-C analysis, codification, variety reduction, standardization.

UNIT – II

Purchasing Management: Material planning and purchase, purchase system, procedures, price forecasting, purchasing of capital equipment, vendor development, account procedure, purchasing decisions, procurement policies.

UNIT – III

Warehousing and Store Management: Store keeping principles – past and latest techniques, stores – general layout, cost aspect and productivity, problems and development, store system procedures, incoming material control, store accounting and

stock incoming material control, store accounting and stock verification, value analysis.

UNIT – IV

Inventory Management: Introduction, basic models, definitions of commonly used terms, replenishment model, choice of systems, etc., inventory work in progress, safety stock, computerization in materials management, control, information to materials management case study, spare parts management.

UNIT – V

Material Procurement Procedures: Arbitration Act – Octroi, central and local sales tax, excise duties – customs tariff, import control policies, procurement from govt, agencies and international market - insurance, DGS and D tariff.

TEXT BOOKS:

1. Goplakrishnan, P, and Sundaresan, M. Material Management: An Integrated Approach, Prentice Hall of India Pvt Ltd., New Delhi, 1982.
2. Datta, A.K., Materials Management procedure, Test and cases, Prentice Hall of India Pvt Ltd., New Delhi 1984.

REFERENCE BOOKS:

1. Peckam, H.H., Effective Materials Management, prentice Hall Of India Pvt Ltd., 1984.
2. Prichard, J.W., and Eagle, R.H. Modern Inventory Management, N,Y., Wiley and Breach Science Publishers, 1972.

Course Code	Course title						Core/PE/OE
PE 633 MN	COAL BED METHANE AND COAL GASIFICATION						PE
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	40	60	3

Course Objectives

1. To make students aware of the formation of methane, coalification process and coal grades, methane generation and storage in coal beds, etc.
2. To acquaint with the knowledge of exploration of CBM, methane adsorption and desorption, etc.
3. To illustrate the knowledge on exploitation of CBM, transport of methane in coal bed, drilling of CBM well, well logging, hydraulic fracturing, etc.
4. To impart knowledge on measurement and transportation of methane, compression and transport, liquefaction and utilization, etc.
5. To provide knowledge on underground coal gasification, suitable conditions, principles, technologies, opening up of coal seams, merits and demerits of underground coal gasification, etc.

Course Outcomes

After completing this course, the student will be able to:

1. Understand the formation of methane, coalification process, coal grades, methane generation and storage in coal beds, etc.
2. Acquire knowledge on geological control in CBM, methane adsorption, desorption in coal, etc.
3. Gain knowledge on exploitation of CBM, transport, drilling, logging, hydraulic fracturing, water drainage and gas-water separation, etc
4. Comprehend the knowledge on measurement and transportation of methane, compression and transport, liquefaction and utilization and other methods, etc.
5. Demonstrate the knowledge on underground coal gasification, conditions suitable for UCG, principles, opening up of coal seams for UGC, merits and demerits of UCG, etc

UNIT- I

Formation of Methane:

Coalification process and coal grades. Methane generation and storage in coal beds.

UNIT- II:

Exploration CBM:

Geological control in Coal Bed Methane (CBM) exploration; Methane adsorption, desorption in coal. Coal as CBM reservoir

UNIT- III:

Exploitation of CBM:

In-place methane estimation; Transport of methane in coal-bed. Drilling & Completion of a CBM hole/well. Identification and characterization of coal beds by hole/well logs. Hydraulic fracturing in coal beds. Production performance of a CBM hole/well; Water drainage & gas-water separation.

UNIT- IV:

Measurement & Transportation of Methane:

Gas volume measurement. Compression & transport; Liquefaction and utilization. Enhanced recovery by CO_2 and N_2 adsorption methods.

UNIT- V:

Underground Coal Gasification (UCG) Concept:

Conditions suitable for UCG, Principles of UCG. UCG Process Component factors: Technology of UCG, opening up of coal seam for UCG. Underground Coal Gasification at Great Depth, Merits and Demerits of Underground coal gasification.

TEXT BOOKS:

1. Coal Bed Methane - 1st Edition - Elsevier
2. A guide to Coal bed methane reservoir engineering". Society of Petroleum engineers , published by Gas research institute, Chicago, Illinois.
3. Fundamentals of Coal bed Methane Reservoir Engineering, John Seidle, PennWell Books (15
September 2011)
4. Principles and Practices of Modern Coal Mining – R.D. Singh, New Age International

REFERENCES:

1. Underground Coal Mining Methods – J.G. Singh, Braj-Kalpa Publishers.
2. Winning and Working Coal in India Vol.II- R.T. Deshmukh and D.J.Deshmukh., Dhanbad Publishers

E- RESOURCES

1. http//www.gasification-syngas.org/technology/underground-coal-gasification
2. http//www.sciencedirect.com/science/article/pii/S0360128512000573
3. https//www.sciencedirect.com/science/article/pii/S2213397613000165
4. http//www.dghindia.org/index.php/page?pageId=38

Course Code	Course title						Core/PE/OE
OE 601 MN	IMPACTS OF MINING ON NATIONAL ECONOMY AND ENVIRONMENT						OE
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	40	60	3

Course Objectives

1. To explain the economic implication in India, overview of mining sector in India, economic contribution of mining, challenges and opportunities for sustainable economic growth.
2. To teach the method of environmental impact and migration assessment, EIA process, air, water and land pollution and case studies.
3. To make familiarize with the social and human rights issues in mining, social conflict, human rights considerations, CSR, and community development programs.
4. To impart knowledge on government policies and regulations, mining lease and licensing procedures, environmental clearance, and sustainable mining development, etc.
5. To illuminate future outlook and sustainable mining in India, technological advancement and innovations, future challenges and opportunities in mining sector.

Course Outcomes

After completing this course, the student will be able to:

1. Understand the economic implications on mining in India, contribution of mining to India's GDP and employment and case studies, etc.
2. Gain knowledge on environmental impact assessment air, water and land pollution, mitigation measures and case studies.
3. Comprehend social and human rights issues in mining, displacement resettlement and social conflicts, role of CSR, etc.
4. Demonstrate government policies and regulations related to mining in India, obtaining mining lease and licensing procedures, environmental clearance, responsible mining practices and sustainable development.
5. Recognize technological advancement and innovation in Indian mining sector, sustainable mining practices initiatives, role of renewable energy, environmental impact, future challenges and opportunities

Unit 1:

Economic Implications of Mining in India

Overview of the mining sector in India: Key minerals, production, and reserves, Economic contributions of mining to India's GDP and employment, Case studies of successful mining projects in India, Challenges and opportunities for sustainable economic growth through mining

Unit 2:

Environmental Impact Assessment and Mitigation

Environmental impact assessment (EIA) process and its importance, Assessment of environmental impacts: Air, water, and land pollution, Mitigation measures and best practices in the mining industry, Case studies of successful environmental management in mining operations

Unit 3:

Social and Human Rights Issues in Mining

Social and community impacts of mining: Displacement, resettlement, and social conflict, Human rights considerations in mining activities, Corporate social responsibility (CSR) initiatives in the mining sector, Stakeholder engagement and community development programs

Unit 4:

Government Policies and Regulations

Overview of mining policies and regulatory framework in India, Mining lease and licensing procedures in India, Environmental clearance and consent mechanisms for mining projects, Initiatives to promote responsible mining practices and sustainable development in India

Unit 5:

Future Outlook and Sustainable Mining in India

Technological advancements and innovation in the Indian mining industry Sustainable mining practices and initiatives in India Role of renewable energy in reducing the environmental impact of mining Future challenges and opportunities for the Indian mining sector

Reference books

1. Mining Economics and Strategy" by Ian C. Runge
2. Sustainable Mining Practices: A Global Perspective" by Reddy, G.V.R., et al.
3. Environmental Impact Assessment: Theory and Practice" by Peter Wathern
4. Social and Environmental Impacts in the Mining Sectors: Lessons from Africa" by Shingirirai Savious Mutanga
5. Mining, Society, and a Sustainable World" edited by John Strongman and Heikki S. Tuunanen

Course Code	Course title						Core/PE/OE
OE 601 BM	ENGINEERING APPLICATIONS IN MEDICINE						OE
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	40	60	3

Course Objectives

1. To make the students gain basic knowledge of Human Physiology.
2. To make the students learn the applications of various branches of engineering in Medicine.

Course Outcomes

After completing this course, the student will be able to:

1. Describe the major organs system of the human body
2. Understand the concepts of bioelectricity and medical instruments
3. Apply solid and fluid mechanics principles to joints and blood flow respectively
4. Learn the need and applications of BCI
5. Analyze and choose proper biomaterial for various applications

UNIT- I

Evolution of Modern healthcare, Major organ systems- Cardiovascular, Respiratory, Nervous, Skeletal, Muscular. Homeostasis. Physiological signals and their diagnostic importance.

UNIT-II

Bioelectricity-Excitable cells, Resting potential, Action potential, Accommodation, Strength-Duration Curve, Propagation of impulses in myelinated and unmyelinated nerves.

Medical Instrumentation System-Functions, Characteristics, Design Challenges.
Signal Processing-QRS detection.

UNIT- III

Solid mechanics -Analysis of muscle force and joint reaction force for the limb joints.

Fluid mechanics-Factors governing and opposing blood flow, Wind-Kessel model, Application of Hagen-Poiseuille flow to blood flow.

UNIT-IV

Brain-Computer Interface: Brain signals for BCIs, Generic setup for a BCI, Feature extraction and Feature translation involved in BCIs. Typical applications-Word forming, Device control.

UNIT-V

Materials and Tissue Replacements-Types of Biomaterials- Metals, Polymers, Ceramics and Composites and their applications in Soft and Hard tissue replacements. Implants-Manufacturing process, Design, fixation.

Suggested Reading:

1. John Enderle, Susan M. Blanchard and Joseph Bronzino, *Introduction to Biomedical Engineering*, Second Edition, Elsevier, 2005.
2. Ozkaya, Nordin. M, *Fundamentals of Biomechanics*, Springer International Publishing, 4th Edition, 2017.
3. Khandpur R.S., *Handbook of Biomedical Instrumentation*, Tata McGraw Hill, 2016.
4. John G.Webster, *Medical Instrumentation: Application and Design*, John Wiley and Sons Inc., 3rd Ed., 2003.

Course Code	Course title						Core/PE/OE
OE 602 BM	HUMAN ASSISTIVE TECHNOLOGIES						OE
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	40	60	3

Course Objectives

1. To extend knowledge of the amputee, of lost and remaining functions affecting locomotion, and to collect information on the best possible medical treatment.
2. To improve fitting techniques and practices, including training, so that existing devices might be used with greater comfort and function.
3. To develop improved lower-extremity devices.

Course Outcomes

After completing this course, the student will be able to:

1. Apply fundamental knowledge of engineering in rehabilitation
2. Apply analytical skills to assess and evaluate the need of the end-user
3. Develop self-learning initiatives and integrate learned knowledge for problem solving
4. Understand the basics of robotics and apply their principles in developing prosthetics
5. Apply the knowledge of computers in solving rehabilitation problems.

UNIT- I

Introduction to Rehabilitation Engineering, Definition of Rehabilitation Engineering, Scope and importance of the field, Historical perspective. Interdisciplinary nature and collaboration with healthcare professionals. Physical disabilities: mobility impairments, spinal cord injuries. Cognitive disabilities: learning disabilities, traumatic brain injuries. Psychosocial aspects of disability

UNIT-II

Assistive Technology, Human Factors and Ergonomics in Assistive Technology Design. Mobility Aids, Types of Wheelchairs and design aspects: Manual wheelchairs, Powered wheelchairs, Customizable features and design considerations, Auxiliary devices and systems. Human-Centered Designing.

UNIT- III

Sensory disabilities: visual and hearing impairments. Sensory augmentation and substitution: Visual system: Visual augmentation. Tactual vision substitution, Auditory vision substitution; Auditory system: Auditory augmentation. Cochlear implantation, Visual auditory substitution, Tactual auditory substitution, Tactual system: Tactual augmentation. Tactual substitution. Assessment and Outcome Measurement

UNIT-IV

Rehabilitation Robotics, Exoskeletons, Major Limb Prosthetic Devices, Orthotic Devices, Types of orthotics and prosthetics, Intelligent prosthetic Knee, Prosthetic Hand, Controlled orthotics and prosthetics Materials and fabrication techniques, Functional and cosmetic considerations. FES system, Restoration of Hand function, Restoration of standing and walking, Myo-electric Hand.

UNIT-V

Case Studies and Real-World Applications. Augmentative and Alternative communications, Software tools for simulation and testing. Virtual reality applications in rehabilitation. Machine learning applications in assistive technology. Predictive analytics for personalized rehabilitation

Suggested Reading:

1. Robinson C.J., *Rehabilitation Engineering*, CRC Press, 1995.
2. Ballabio E., et al., *Rehabilitation Technology*, IOS Press, 1993.
3. Rory A Cooper, Hisaichi Ohnabe, Douglas A. Hobson, *Series in medical physis and biomedical engineering: An introduction to rehabilitation engineering*, Taylor and Francis Group, London, 2007.
4. Joseph D. Bronzino *The biomedical engineering handbook -biomedical engineering fundamentals*, 3rd Ed., CRC Press, Taylor & Francis Group, London, 2006.

Course Code	Course title						Core/PE/OE
OE 601 CE	DISASTER MANAGEMENT						OE
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	40	60	3

Course Objectives

1. To introduce basic conceptual understanding of natural & man-made hazards and different contextual aspects.
2. To develop the knowledge and understanding of the International and national strategy for disaster reduction (UN-ISDR)
3. To ensure skills and abilities to analyze potential effects of disasters and of the strategies and methods to deliver public health response to avert these effects.
4. To promote the use of science and technology for implementing the disaster risk reduction (DRR) plans and policies.

Course Outcomes

After completing this course, the student will be able to:

1. Aptitude to link hazards, risk, vulnerability, differential impacts and capacity building to the life and property loss during disasters and its impacts on the society and sustainability .
2. Ability to understand various aspects of natural and man-made hazards and emerging trends.
3. Acquaintance with different steps involved in disaster risk reduction (DRR) and international initiatives for prevention, mitigation and preparedness.
4. Knack to appreciate the National Policy and Role of individuals, communities, and government organizations in disaster management.
5. Capacity to identifying current technological constraints and hazard specific solutions, particularly construction codes etc.

UNIT I: INTRODUCTION TO DISASTER

Understanding the Concepts, Definitions and Terminologies used in the field of Disaster Management (i.e. Hazard, Risk, Vulnerability, Resilience, and Capacity Building); Differential impacts of Disasters in terms of Gender, Age, Social Status, Location, Prosperity, Disabilities; Disaster- Development Nexus.

UNIT II: TYPES of HAZARDS AND EMRGING TRENDS

Classification, Causes, Consequences and Controls of Geophysical hazards-Earthquakes, Landslides, Tsunami; Weather related hazards- Meteorological (Cyclones, and Storm-surge), Hydrological (Floods, Droughts, Avalanches), Climatological (Wildfire, Cold & Heat Waves); Biological hazards-Epidemic & Pandemics; Technological hazards- Chemical, Industrial, Nuclear; Man-made hazards-Structural Failure, Fire, Transportation accidents, Terrorism and Wars; Emerging Disasters- Urban Areas, Climate Change; Regional and Global Trends-loss of life & Property in various hazards

UNIT-III: DISASTER MANAGEMENT CYCLE AND INTERNATIONAL FRAMEWORK

Disaster Management Cycle: Pre-Disaster – Risk Assessment and Analysis, Risk Mapping, zonation and Micro-zonation, Prevention and Mitigation of Disasters, Early Warning System; Preparedness, Capacity Building; Awareness; During Disaster – Evacuation – Disaster Communication – Search and Rescue– Emergency Operation Centre – Incident Command System – Relief and Rehabilitation; Post-disaster – Damage and Needs Assessment, Restoration of Critical Infrastructure – Early Recovery– Reconstruction and Redevelopment; Paradigm Shift in Disaster Management: International Decade for Natural Disaster Reduction; Yokohama Strategy; Hyogo Framework of Action

UNIT IV: DISASTER RISK MANAGEMENT IN INDIA

Disaster Profile of India – Mega Disasters of India and Lessons Learnt; Disaster Management Act 2005 – Institutional and Financial Mechanism; National Policy on Disaster Management; National Guidelines and Plans on Disaster Management; Role of Government (local, state and national), Non-Government and Inter-governmental Agencies

UNIT V: TECHNOLOGICAL APPROACHES TO DISASTER RISK REDUCTION

Geo-informatics in Disaster Management (RS, GIS, GPS and RS); Technological in Disaster Communication System (Early Warning and Its Dissemination), rescue and restoration of services; Disaster Safe Designs and Constructions; Application of technology and innovations for Structural and Non Structural Mitigation; Science & Technology Institutions for Disaster Management in India

Suggested Reading:

1. Coppola D P, 2007. Introduction to International Disaster Management, Elsevier Science (B/H), London.
2. Manual on natural disaster management in India, M C Gupta, NIDM, New Delhi
3. An overview on natural & man-made disasters and their reduction, R K Bhandani, CSIR, New Delhi
4. World Disasters Report, 2009. International Federation of Red Cross and Red Crescent, Switzerland
5. Disasters in India Studies of grim reality, Anu Kapur& others, 2005, 283 pages, Rawat Publishers, Jaipur
6 National Disaster Management Policy, 2009, GoI.
7 Publications of National Disaster Management Authority (NDMA) on Various Templates and Guidelines for Disaster Management

Course Code	Course title						Core/PE/OE
OE 602 CE	ROAD SAFETY ENGINEERNIG						OE
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	40	60	3

Course Objectives

1. To introduce the fundamentals of road safety and road safety audit.
2. To get familiarized with various road safety techniques, measures and their applications.
3. To be able to understand and evaluate various traffic control devices.
4. Familiarize with traffic management techniques.
5. To examine and analyze the incident management process.

Course Outcomes

After completing this course, the student will be able to:

1. Analyze Accident data.
2. Plan and design of road safety improvement programs.
3. Apply the principles of road safety in urban transport.
4. Apply traffic management techniques.
5. Able to plan effective incident management program.

UNIT-I

Road accidents: Causes, scientific investigations and data collection, analysis of individual accidents to arrive at real causes, statistical methods of analysis of accident data, Basic concepts of road accident statistics, safety performance function: The empirical Bayes method identification of hazards road location. Application of computer analysis of accident data.

UNIT-II

Safety in Road Design: Operating the road network for safety, highway operation and counter measures, road safety audit, principles-procedures and practice, code of good practice and checklists, vehicle design factors & driver characteristics influencing road safety

UNIT-III

Road Signs and Traffic Signals: Classification, Location of signs, measures of sign effectiveness, Types of visual perception, sign regulations, sign visibility, sign variables, Text versus symbols, Road marking: Role of road marking, classification, visibility. Traffic signals: Need, Signal face illumination and location of signals, factors affecting signal design, pedestrian's safety, fixed and vehicle actuated signals. Design of signals, area traffic control, Delineators, traffic impact attenuators, road side rest areas, safety barriers, traffic aid posts.

UNIT IV

Traffic Management Techniques: Integrated safety improvement and traffic calming schemes, speed and load limit, traffic lights, safety cameras, tests on driver and vehicles, pedestrian safety issues, parking, parking enforcement and its influence on accidents, travel demand management, methods of traffic management measures: restriction of turning movements, One way streets, tidal flow operation methods, exclusive bus lanes and closing side-streets; latest tools and techniques used for road safety; legislation, enforcement, education and propaganda.

UNIT-V

Incident Management: Introduction, characteristics of traffic incidents types of incidents, impacts, incident management process, incident traffic management; application of ITS: Motorist information, equipment used; planning effective incident management program, best practice in incident management programs. National importance of survival of transpiration systems during and after all natural disasters especially cyclones, earthquakes, floods etc and manmade disasters like sabotage, terrorism etc.

Suggested Reading:

1. Khanna, S.K., Justo, C.E.G and Veeraragavan, A, 'Highway Engineering', Revised 10th Edition, Nem Chand & Bros, 2017
2. KadiyaliL.R,.*Traffic Engineering and Transport planning*, 9th Edition, Khanna Tech Publishers, 2013.
3. Donald Drew, *Traffic Flow Theory Chapter 14 in Differential Equation Models*, Springer, 1983
4. C. Jotinkhisty and B. Kent Lall, *Transportation Engineering – An Introduction, 3rd Edition, Pearson publications, 2017*
5. Rune Elvik, Alena Hoye, TrulsVaa, Michael Sorenson, *Handbook of Road Safety measures, second Edition, Emerald Publishing, 2009.*

Course Code	Course title						Core/PE/OE
OE 601 CS	PYTHON PROGRAMMING						OE
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	40	60	3

Course Objectives

1. To know the basics of programming.
2. To convert and algorithm into a Python program
3. To construct Python programs with control structures
4. To structure a Python Program as a set of functions
5. To use Python data structures-lists, tuples, dictionaries.
6. To do input/output with files in Python
7. To construct Python programs as a set of objects.

Course Outcomes

After completing this course, the student will be able to:

1. Develop algorithmic solutions to simple computational problems.
2. Develop and execute simple Python programs.
3. Develop simple Python programs for solving problems.
4. Structure a Python program into functions.
5. Represent compound data using Python lists, tuples, dictionaries.
6. Read and write data from/to files in Python Programs

UNIT-I

Introduction to Computing and Problem Solving: Fundamentals of Computing – Computing Devices – Identification of Computational Problems – Pseudo Code and Flowcharts – Instructions – Algorithms – Building Blocks of Algorithms.

Introduction to Python Programming: Python Interpreter and Interactive Mode– Variables and Identifiers – Arithmetic Operators – Values and Types – Statements, Reading Input, Print Output, Type Conversions, The type() Function and Is Operator, Dynamic and Strongly Typed Language.

Control Flow Statements: The if, The if…else, The if…elif…else Decision Control Statements, Nested if Statement, The while Loop, The for Loop, The continue and break Statements.

UNIT-II

Functions: Built-In Functions, Commonly Used Modules, Function Definition and Calling the Function, The return Statement and void Function, Scope and Lifetime of Variables, Default Parameters, Keyword Arguments, Command Line Arguments.

Strings: Creating and Storing Strings, Basic String Operations, Accessing Characters in String by Index Number, String Slicing and Joining, String Methods, Formatting Strings.

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: selection sort, insertion sort, merge sort, histogram.

UNIT-III

Files and Exception: Text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file.

Strings: Basic String Operations, String Slicing, Testing, Searching, and Manipulating Strings

Dictionaries and Sets: Dictionaries, Sets, Serializing Objects.

UNIT-IV

Object-Oriented Programming: Classes and Objects, Creating Classes in Python, Creating Objects in Python, The Constructor Method, Classes with Multiple Objects, Class Attributes versus Data Attributes, Encapsulation, Inheritance The Polymorphism.

Functional Programming: Lambda. Iterators, Generators, List Comprehensions.

UNIT-V

GUI Programming: Graphical User Interfaces, Using the tkinter Module, Display text with Label Widgets, Organizing Widgets with Frames, Button Widgets and Info Dialog Boxes, Getting Input with Entry Widget, Using Labels as Output Fields, Radio Buttons, Check Buttons

Suggested Readings:

1. Richard L. Halterman, "*Learning To Program With Python*", Copyright © 2011.
2. Dr. Charles R, "*Python for Everybody, Exploring Data Using Python 3*", Severance. 2016.
3. Gowrishankar S., Veena A, "*Introduction to Python Programming*", CRC Press, Taylor & Francis Group, 2019.
4. Allen B. Downey, "*Think Python: How to Think Like a Computer Scientist*", 2nd Edition, Shroff O"Reilly Publishers, 2016

Course Code	Course title						Core/PE/OE
OE 602 CS	CYBER SECURITY						OE
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	40	60	3

Course Objectives

1. Learn the various threats in networks and security concepts.
2. Apply authentication applications in different networks.
3. Understand security services for email.
4. Awareness of firewall and IT laws and policies.

Course Outcomes

After completing this course, the student will be able to:

1. Understand the various network threats.
2. Analyze the forensic tools for evidence collection
3. Apply the firewalls for threat analysis

UNIT-I

Ethical hacking, Attack Vectors, Cyberspace and Criminal Behaviour, Clarification of Terms, Traditional Problems associated with Computer Crimes, Realms of Cyber world, brief history of the internet, contaminants and destruction of data, unauthorized access, computer intrusions, white-collar crimes, viruses and malicious code, virus attacks, pornography, software piracy, mail bombs, exploitation, stalking and obscenity in internet, Cyber psychology, Social Engineering.

UNIT-II

Introduction to Digital forensics, Forensic software and handling, forensic hardware and handling, analysis and advanced tools, forensic technology and practices, Biometrics: face, iris and fingerprint recognition, Audio-video evidence collection, Preservation and Forensic Analysis.

UNIT-III

Investigation Tools, e-discovery, EDRM Models, digital evidence collection and preservation, email investigation, email tracking, IP tracking, email recovery, search and seizure of computer systems, password cracking.

UNIT-IV

Forensic Analysis of OS artifact, Internet Artifacts, File System Artifacts, Registry Artifacts, Application Artifacts, Report Writing, Mobile Forensic- identification, collection and preservation of mobile evidences, social media analysis, data retrieval, Email analysis from mobile phones.

UNIT-V

Ethics, Policies and IT Act

Basics of Law and Technology, Introduction to Indian Laws, Scope and Jurisprudence, Digital Signatures, E Commerce-an Introduction, possible crime scenarios, law coverage, data interchange, mobile communication development, smart card and expert systems Indian Laws, Information Technology Act 2000, Indian Evidence Act, India Technology Amendment Act 2008, Indian Penal Code , Computer Security Act 1987, National Information Infrastructure Protection Act 1996, Fraud Act 1997, Children Online Protection Act 1998, Computer Fraud and Abuse Act 2001, Intellectual Property, IP Theft, Copyright, Trademark, Privacy and Censorship, Introduction to Cyber Ethics, rights over intellectual property, Corporate IT Policy Formulations, Compliance Auditing.

Suggested Readings:

1. Charles P. Fleeger, "*Security in Computing*", Prentice Hall, New Delhi, 2009.
2. BehrouzA.Forouzan, "*Cryptography & Network Security*", Tata McGraw Hill, India, New Delhi, 2009.
3. William Stallings, "*Cryptography and Network Security*", Prentice Hall, New Delhi, 2006.
4. Chalie Kaufman, Radia Perlman, Mike Speciner, "*Network Security: Private Communication in a Public Network*", Pearson Education, New Delhi, 2004.
5. Neal Krawetz, "*Introduction to Network Security*", Thomson Learning, Boston, 2007.
6. Bruce Schneier, "*Applied Cryptography*", John Wiley & Sons, New York, 2004.

Course Code	Course title						Core/PE/OE
OE 601 EC	PRINCIPLES OF ELECTRONIC COMMUNICATION						OE
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
Students need to have a fundamental understanding of signals and electronic circuits	L	T	D	P			
	3	-	-	-	40	60	3

Course Objectives

1. Introduce fundamental concepts in the understanding of Electronic communications systems.
2. Introduce network model and some of the network layers including physical layer, data link layer, network layer and transport layer
3. Introduce the evolution of wireless systems and current wireless technologies
4. Introduce fundamental concepts in the understanding of Telecommunication and optical communications systems
5. Introduce fundamental concepts in Analog and Digital Communications

Course Outcomes

After completing this course, the student will be able to:

1. Understand the working of analog and digital communication systems.
2. Understand the Data Communication and Networking
3. Understand the concepts of modulation and demodulations
4. Understand the evolution of communication technologies from traditional telephony systems to modern wireless communication systems
5. Understand the principles of optical communications systems

Unit-I

Introduction to communication systems: Electromagnetic Frequency Spectrum, Signal and its representation, Elements of Electronic Communications System, Types of Communication Channels, Signal Transmission Concepts-Baseband transmission and Broadband transmission, Communication parameters-Transmitted power, Channel bandwidth and Noise, Need for modulation Signal Radiation and Propagation-Principle of electromagnetic radiation, Types of Antennas, Antenna Parameters and Mechanisms of Propagation

Unit-II

Analog and Digital Communications: Amplitude modulation and demodulation, FM modulation and demodulation, Digital converters, Digital modulation schemes – ASK, FSK, PSK, QPSK, Digital demodulation

UNIT-III

Data Communication and Networking: Network Models, OSI Model, Data Link Layer – Media Access control, Ethernet, Network Layer – Internet Protocol (IPv4/IPv6), Transport Layer – TCP, UDP

UNIT-IV

Telecommunication Systems: Telephones, Telephone system, Paging systems, Internet Telephony. Optical Communications: Optical Principles, Optical Communication Systems, Fiber –Optic Cables, Optical Transmitters & Receivers, Wavelength Division Multiplexing

UNIT-V

Wireless Communications: Evolution of Wireless Systems: AMPS, GSM, CDMA, WCDMA, And OFDM. Current Wireless Technologies: Wireless LAN, Bluetooth, PAN and ZigBee, Infrared wireless, RFID communication, UWB, Wireless mesh networks, Vehicular adhoc networks

SUGGESTED READING:

1 Louis E. Frenzel, "*Principles of Electronic Communication Systems*", 3e, McGraw Hill publications, 2008.
2 Behrouz A. Forouzan,*"Data Communications and Networking",* 5e TMH, 2012.
3 Kennady, Davis, "*Electronic Communications systems*", 4e, TMH, 1999.
4 Keiser Gerd "Optical Fiber Communication (SIE)",5th Edition, McGraw Hill Education India,2017.
5 Simon Haykin, "Communication Systems", 5th Edition, Wiley publications, 2006.

OE 602 EC	Verilog HDL						OE-I
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
Students need to have a fundamental understanding of signals and electronic circuits	L	T	D	P			
	3	-	-	-	40	60	3

Course Objectives

1. To familiarize with various modeling styles: structural, dataflow and behavioral of Verilog HDL
2. To develop combinational and sequential circuits using various modeling styles of Verilog HDL
3. To design and develop Verilog HDL models of combinational and sequential circuits
4. To learn Synthesis and FPGA design flow
5. To design and develop real time applications: Booth‘s multiplier, Divider, hardwired control for basic CPU, FIR filter

Course Outcomes:

On completion of the course, student will be able to

1. Implement and distinguish different Verilog HDL modeling styles
2. Construct and analyze Verilog HDL models of combinational and sequential circuits
3. Design and develop Verilog HDL modeling and test bench for digital systems for the given specifications
4. Outline FPGA design flow and timing analysis
5. Understand implementation of real time applications

UNIT–I

Introduction to HDL: Overview and Importance of HDLs, Differences between HLL, HDL and ALP. Design methodologies, Modules, Lexical Conventions, Number Specifications, Strings, Identifiers and Keywords Data types, System task and compiler Directives, Port declaration and port connection rules

UNIT–II

Structural and Dataflow modelling: gate-level modelling, delays, hazards, dataflow modelling: Continuous Assignments, Delays, Expressions, Operators and Operands, Operator Types and Design Examples.

UNIT–III

Behavioural Modelling: Structured Procedures, Procedural Assignments, Timing Controls, Conditional Statements, multi-way branching, Loops, Sequential and Parallel blocks, Generate blocks. Combinational, sequential logic modules Simulation: Types of Simulation, Event driven Simulation and Cycle Based Simulation; design examples.

UNIT-IV

Synthesis and Verification: Tasks and Functions: Differences between Tasks and Functions, Tasks and Functions. Verilog HDL synthesis, synthesis, Application Specific IC (ASIC) and Field Programmable Gate Array (FPGA) design flow. Verification: Timing analysis and Test bench design. Design examples.

UNIT – V

Real time implementations: Fixed-Point Arithmetic modules: Addition, Multiplication, Division, Arithmetic and Logic Unit (ALU), Timer, Universal Asynchronous Receiver and Transmitter (UART), DSP modules: FIR and IIR filters, CPU design: Data path and control units.

SUGGESTED READING:

1 Samir Palnitkar, ―*Verilog HDL A Guide to Digital Design and Synthesis,*‖ 2nd Edition, Pearson Education, 2006.

2 Ming-Bo Lin, ―*Digital System Designs and Practices: Using Verilog HDL and FPGA,*‖ Wiley India Edition, 2008

3 J. Bhasker, ―*A Verilog HDL Primer*,‖ 2nd Edition, BS Publications, 2001

Course Code	Course title						Core/PE/OE
OE 601 EE	APPLICATIONS OF ELECTRICAL ENERGY						OE
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	40	60	3

Course Objectives

1. To introduce the students and understand Utilization of electrical energy for various applications like industrial heating.
2. To understand various techniques of electric welding and types of batteries.
3. To understand the concept of illumination and study about the laws of illumination.
4. To know the applications of various lamps to factory lighting, street lighting etc.
5. To understand the concept of electric traction including speed – time curves of different traction services.

Course Outcomes

After the completion of this course, the students shall be able to:

1. Identify a suitable heating scheme for a given application.
2. Identify proper welding technique and various characteristics of batteries.
3. Study the nature and production of light and laws related to illumination.
4. Classify types of electric light sources based on nature and operation and their objectives, performance and reliability.
5. Determine the speed-time characteristics of various traction services and also estimate the energy consumption levels at various modes of operation.

UNIT I

Industrial Heating: Advantages and methods of electric heating. Description, operation and performance of resistance ovens, Design of heating element. High frequency heating, Induction Heating, Induction furnaces, Core type, Coreless furnaces, Dielectric heating. Electric Arc furnaces, Direct Arc furnace, Indirect Arc furnaces.

UNIT II

Electric welding: Classification of electric welding, welding transformer and its rating, various types of Electric arc welding and electric resistance welding.

Batteries: Lead acid batteries, SMF batteries, Construction and maintenance, Charging and rating of batteries.

UNIT III

Illumination: Introduction, nature and production of light, Sensitivity of the eye, Units of light. The inverse square law and cosine law, Solid angle, Lighting calculations, Determination of M.S.C.P, Rousseau‟s construction.

UNIT IV

Types of lamps - Discharge lamps, Sodium vapour lamps, Mercury vapour lamps, Fluorescent lamp. Starting and power factor corrections, stroboscopic effects, Neon signs, Application to factory lighting, Street lighting and Flood lighting.

UNIT V

Electric Traction: System of Electric Traction, Transmission of drive, Systems of track electrification, Traction mechanics, Speed time curves, Tractive effort, Power of Traction motor, Specific energy consumption, Mechanics of train movement, Coefficient of adhesion.

Suggested Reading:

1. Partab H, Art and Science of Utilization of Electric Power, Dhanpat Rai & Sons, 1997.
2. K.B. Raina & S.K. Bhattacharya, Electrical Design, Estimating 1. and Costing, Wiley Eastern Ltd., 1991.
3. Partab H, Modern Electric Traction, Dhanpat Rai & Sons, 2000.
   B.L.Theraja, A Text Book of Electrical Technology, S.Chand & Company Ltd, Vol-I.

Course Code	Course title						Core/PE/OE
OE 602 EE	ELECTRICAL SAFETY MANAGEMENT						OE
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	40	60	3

Course Objectives

1. Understand electrical safety measures, the hazards associated with electric current, and voltage identify different types of electrical shocks
2. Understand installation work of electrical plant and equipment. Safety during installation of outdoor switchyard equipment, safety during installation of electrical rotating machines.
3. Understand procedure of domestic wirings ,to handle different domestic electrical appliances, Procedure of Agricultural pump installation
4. Identifies different hazardous zones, classification of equipment enclosure for various hazardous gases, importance of earthing system. Understand Management Safety Policy
5. Understand standards on electrical safety, different IE Rules and Acts

Course Outcomes

After the completion of this course, the students shall be able to:

1. Explain the objectives and precautions of Electrical safety, effects of shocks and their prevention.
2. Summarize the safety aspects during installation of plant and equipment.
3. Describe the electrical safety in residential, commercial and agricultural installations.
4. Describe the various Electrical safety in hazardous areas, Equipment earthing and system neutral earthing.
5. State the electrical systems safety management and IE rules.

UNIT I

INTRODUCTION TO ELECTRICAL SAFETY, SHOCKS AND THEIR PREVENTION*:*

Terms and definitions, objectives of safety and security measures, Hazards associated with electric current, and voltage, who is exposed, principles of electrical safety, Approaches to prevent, Accidents, scope of subject electrical safety. Primary and secondary electrical shocks, possibilities of getting electrical shock and its severity, medical analysis of electric shocks and its effects, shocks due to flash/ Spark over's, prevention of shocks, safety precautions against contact shocks, flash shocks, burns, residential buildings and shops.

UNIT II

SAFETY DURING INSTALLATION OF PLANT AND EQUIPMENT:

Introduction, preliminary preparations, preconditions for start of installation work, during, risks during installation of electrical plant and equipment, safety aspects during installation, field quality and safety during erection, personal protective equipment for erection personnel, installation of a large oil immersed power transformer, installation of outdoor switchyard equipment, safety during installation of electrical rotating machines, drying out and insulation resistance measurement of rotating machines.

UNIT III

ELECTRICAL SAFETY IN RESIDENTIAL, COMMERCIAL AND AGRICULTURAL INSTALLATIONS: Wiring and fitting – Domestic appliances – water tap giving shock – shock from wet wall – fan firing shock – multi-storied building – Temporary installations – Agricultural pump installation – Do's and Don'ts for safety in the use of domestic electrical appliances.

UNIT IV

ELECTRICAL SAFETY IN HAZARDOUS AREAS: Hazardous zones – class 0,1 and 2 – spark, flashovers and corona discharge and functional requirements – Specifications of electrical plants, equipment for hazardous locations – Classification of equipment enclosure for various hazardous gases and vapours – classification of equipment/enclosure for hazardous locations.

UNIT V

SAFETY MANAGEMENT OF ELECTRICAL SYSTEMS: Principles of Safety Management, Management Safety Policy, Safety organization, safety auditing, Motivation to managers, supervisors, employees.

REVIEW OF IE RULES AND ACTS AND THEIR SIGNIFICANCE:
Objective and scope – ground clearances and section clearances – standards on electrical safety - safe limits of current, voltage –Rules regarding first aid and firefighting facility.
The Electricity Act, 2003, (Part1, 2, 3, 4 & 5).

Suggested Reading:

1. S.Rao, Prof. H.L.Saluja, "Electrical safety, fire safety Engineering and safety management", 1st edition
   Khanna Publishers. New Delhi, 2016 Reprint.
2. Pradeep Chaturvedi, "Energy management policy, planning and utilization", Concept Publishing company, New Delhi, 1997.

Course Code	Course title						Core/PE/OE
OE 601 ME	3D PRINTING TECHNOLOGY						OE
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	40	60	3

Course Objectives

1. To understand the fundamental concepts of 3D Printing, its advantages and limitations.
2. To know the working principle, advantages, disadvantages and applications of liquid, solid and Powder based 3D Printing Technologies.
3. To know the various types of STL file errors and other data formats used in 3D Printing Technology.
4. To know the features of various 3D Printing software's.
5. To know diversified applications of 3D Printing Technologies.

Course Outcomes

After the completion of this course, the students shall be able to:

1. Interpret the features of 3D Printing and compare it with conventional methods.
2. Illustrate the working principle of liquid, solid and powder based 3D Printing Technologies.
3. Identify various types of errors in STL file and other data formats used in 3D Printing Technology.
4. Select suitable software used in 3D Printing Technology.
5. Apply the knowledge of various 3D Printing technologies for developing innovative applications.

UNIT- I

Introduction: Prototyping fundamentals: Need for time compression in product development, Historical development, Fundamentals of 3D Printing, 3D Printing Process Chain, Advantages and Limitations of 3D Printing, 3D Printing wheel, Commonly used Terms, Classification of 3D printing processes, Fundamental Automated Processes: Distinction between 3D Printing and Conventional Machining Processes.

UNIT-II

Liquid-based 3D Printing Systems: Stereo Lithography Apparatus (SLA): Models and specifications, Process, working principle, photopolymers, photo polymerization, Layering technology, laser and laser scanning, Applications, Advantages and Disadvantages, Case studies. Polyjet: Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies Solid-based 3D Printing System: Laminated Object Manufacturing (LOM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Fused Deposition Modeling

(FDM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies.

UNIT- III

Powder Based 3D Printing Systems: Working principle, Specifications, Materials used, Process, Applications, Advantages and Disadvantages, Case studies of the following 3D Printing Technologies like Selective laser sintering (SLS), Selective Laser Melting (SLM) and Direct Metal Laser Sintering (DMLS), Laser Engineered Net Shaping (LENS), Electron Beam Melting (EBM),

UNIT-IV

3D Printing Data Formats & Software: STL Format, STL File Problems, Consequence of Building Valid and Invalid Tessellated Models, STL file Repairs: Generic Solution, Other Translators, Newly Proposed Formats. 3D Printing Software's Features: Magics, Mimics, Solid View, View Expert, 3 D Rhino, 3 D doctor, Flash Print, Object Studio, Cura, ITK Snap, 3-matic, Simplant, 3-matic, Simplant, MeshLab, Ansys for Additive Manufacturing.

UNIT-V

Applications of 3D Printing : Application in Design, Application in Engineering, Analysis and Planning, Aerospace Industry, Automotive Industry, Electronic Industry, Jewellery Industry, Coin Industry, GIS application, Arts and Architecture. RP Medical and Bioengineering Applications: Planning and simulation of complex surgery, Customized Implants & Prosthesis, Design and Production of Medical Devices, Forensic Science and Anthropology, Visualization of Biomolecules. Biopolymers, Packaging, Disaster Management, Entertainment and Sports industry.

Suggested Reading:

1. Chee Kai Chua and Kah Fai Leong, "3D Printing and Additive Manufacturing Principles and Applications" Fifth Edition, World scientific
2. Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing- Ian Gibson, David W Rosen, Brent Stucker, Springer, Second Edition, 2010.
3. Rapid Prototyping & Engineering Applications – Frank W.Liou, CRC Press, Taylor & Francis Group, 2011.
4. Rafiq Noorani, Rapid Prototyping: Principles and Applications in Manufacturing, John Wiley & Sons, 2006.
5. NPTEL Course on Rapid Manufacturing. https://nptel.ac.in/courses/112/104/112104265

Course Code	Course title						Core/PE/OE
OE 602 ME	FINITE ELEMENT METHOD						OE
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	40	60	3

Course Objectives

1. To understand the theory and application of the finite element method for analyzing structural systems.
2. To learn Approximation theory for structural problems as the basis for finite element methods
3. To learn formulations for a variety of elements in one, two, and three dimensions.
4. Implementations of element formulations will be examined using MATLAB.
5. To understand modeling and analysis of structures using planar, solid and plate elements.

Course Outcomes

After the completion of this course, the students shall be able to:

1. Demonstrate a basic understanding of the concepts, mathematical formulation and numerical implementation.
2. Demonstrate the ability to invoke appropriate assumptions, select proper elements and develop FEA models that adequately and efficiently represent physical systems.
3. Underlying the FEA as applied to solid mechanics.
4. Solve 2D vector variable problems and analyze higher order elements and its applications.
5. Create his/her own FEA computer programs using Matlab to solve simple engineering problems.

UNIT- I

Introduction: Historical Background – Mathematical Modeling of field problems in Engineering – Governing Equations – Discrete and continuous models – Boundary, Initial and Eigen Value problems– Weighted Residual Methods – Variational Formulation of Boundary Value Problems – Ritz Technique – Basic concepts of the Finite Element Method.

UNIT-II

One-Dimensional Problems: One Dimensional Second Order Equations – Discretization – Element types- Linear and Higher order Elements – Derivation of Shape functions and Stiffness matrices and force vectors- Assembly of Matrices – Solution of problems from solid mechanics and heat transfer. Longitudinal vibration frequencies and mode shapes.

UNIT- III

Two Dimensional Scalar Variable Problems: Second Order 2D Equations involving Scalar Variable Functions – Variational formulation –Finite Element formulation – Triangular elements – Shape functions and element matrices and vectors. Application to Field Problems – Thermal problems – Torsion of Non circular shafts –Quadrilateral elements – Higher Order Elements.

UNIT-IV

Two Dimensional Vector Variable Problems: Equations of elasticity – Plane stress, plane strain and axisymmetric problems – Body forces and temperature effects – Stress calculations – Plate and shell elements.

UNIT-V

Isoparametric Formulation: Natural co-ordinate systems – Isoparametric elements – Shape functions for iso parametric elements – One and two dimensions – Serendipity elements – Numerical integration and application to plane stress problems – Matrix solution techniques – Solutions Techniques to Dynamic problems – Introduction to Analysis Software.

Suggested Reading:

1. Tirupathi R. Chandraputla and Ashok, D. Belgundu" Introduction to Finite Elements in Engineering", Pearson Education, 2002, 3rd Edition.
2. Rao S.S., "The Finite Element Methods in Engineering", pergamon Press, 1989.
3. Segerlind, L.J. "Applied Finite Element Analysis", Wiley Publication, 1984.
4. Reddy J.N., "An Introduction to Finite Element Method", McGraw-Hill Company, 1984.

Course Code	Course title						Core/PE/OE
PC 651 MN	COMPUTER APPLICATIONS IN MINING LAB						Core
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	-	-	-	2	25	50	1

Course Objectives

1. To conduct experiments on development of software for the prediction of surface subsidence and stress analysis of the coal pillar and its stability.
2. To explain the procedure of strata and support behavior and supports in longwall mining through computer programming.
3. To develop and conduct experiment on the slope stability for circular and wedge failure and regression analysis using computer software.
4. To undertake experiments on ventilation network analysis and reorganization of ventilation system of a mine using suitable software.
5. To carry out experiments on identification of most influencing blasts design parameters using IBM, SPSS, and XLSTAT/STRAYOS/OPITBLAST.

Course Outcomes

After completing this course, the student will be able to:

1. Recognize the prediction of surface subsidence and stress analysis and stability of coal pillar using suitable software.
2. Understand the strata and support behavior and chock shield powered longwall supports behavior using suitable software.
3. Comprehend stope stability analysis for various types of failures and regression analysis using suitable software.
4. Analysis the ventilation parameters and reorganization of ventilation systems using ventilation network analysis software.
5. Gain knowledge on the most influencing blast design parameters using IBM, SPSS, and XLSTAT/STRAYOS/OPITBLAST

LIST OF EXPERIMENTS:

1) Regression analysis in excel.
2) Application of mining software like Slide, Rocscience, Ansysis, Carlson, Surpac.
3) Slope stability analysis for circular failure
4) Prediction of surface subsidence over underground mine workings.
5) Stress analysis in stability of coal pillar including shaft pillar and barrier pillar
6) Study of strata and support behavior in underground mine
7) Behavior of chock shield supports in longwall mining.
8) Ventilation network analysis
9) Study of blast parameters using OPITBLAST/STRAYOS
10) Truck dispatch system application.

Course Code	Course title						Core/PE/OE
PE 652 MN	ROCK MECHANICS LAB						PC
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	-	-	-	2	25	50	1

Course Objectives

1. To conduct experiments on determination of physical properties of rock like density, hardness, moisture content, porosity and permeability, etc.
2. To explain experiments on the preparation of rock samples using, core drilling, cutting and polishing machines.
3. To familiarize with the conduct of experimentation for the determination of various mechanical properties of the rock.
4. To illustrate the experimentation on the determination of elastic constants of the rock.
5. To study different types of underground mine supports, design of pillars and compressibility of stowing materials.

Course Outcomes

After completing this course, the student will be able to:

1. Understand experiments on determination of physical properties of rock like density, hardness, moisture content, porosity and permeability.
2. Comprehend the conduct of experiments on the preparation of rock samples using, core drilling, cutting and polishing machines.
3. Recognize with the conduct of experimentation for the determination of various mechanical properties of the rock.
4. Discover the experimentation procedure of the determination of elastic constants of the rock.
5. Acquire the knowledge of different types of underground mine supports, design of pillars and compressibility of stowing materials.

LIST OF EXPERIMENTS :

1. Determination of physical properties of rock - density and hardness
2. Determination of physical properties of rock - moisture content, porosity and permeability
3. Sample preparation by core drilling, cutting and polishing.
4. Determination of Protodyaknov index
5. Determination of Point load strength index
6. Determination of Impact strength index
7. Determination of Slake durability index
8. Determination of Drillability (rotary) index

9. Determination of RQD of rocks.
10. Determination of Uniaxial compressive strength of rock.
11. Determination of Tensile strength of rock using Brazilian method
12. Determination of Shear strength of rocks
13. Determination of Modulus of elasticity using strain /dial gauge/LVDTs.
14. Determination of Shear strength of rock joints using a shear block.
15. Determination of Triaxial strength of rock and drawing of Mohr‘s envelope
16. Study of different types of supports and their withdrawal
17. Study of design of mine pillars including shaft pillar and barrier pillar.
18. Determination of compressibility of stowing material

Course Code	Course title						Core/PE/OE
PC 653 MN	MINI PROJECT						Core
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	-	-	-	2	25	50	1

Course Objectives

1. To select a topic and formulate a problem related to mining engineering relevant to the requirement in the mining field.
2. To conduct a literature survey in the topic selected from text books, journals, and electronic media.
3. To fabricate apparatus or device or instrument/ design experiments/ conduct field study/ develop or use a computer program for the topic selected.
4. To conduct experiments in the laboratory or field and collect data for the mini project.
5. To analysis the results from item no. 4 above and draw conclusions.
6. To prepare a report/ document comprising of statement of the problem, literature survey, methodology, results and analysis, and conclusions.

Course Outcomes

After completing this course, the student will be able to:

1. Formulate the problem by comprehending the principles and by applying them to a new problem either from literature survey or from the requirements raised from need analysis and fix boundaries for the same.
2. Conduct literature survey from various sources relevant to the study area. Visit the popular institution libraries outside the university.
3. Design, fabricate apparatus or device or instrument / design experiments / conduct field study / develop or use a computer program for the topic selected.
4. Conduct experiments in the laboratory or field or develop computer programs or learn use of computer program.
5. Carry out a research investigation.
6. Analysis the results and draw logical and meaningful conclusions.
7. Teamwork.
8. Prepare a report/ document comprising of statement of the problem, literature survey, methodology, results and analysis, conclusions, recommendations, suggestions for future studies and references used.

Guidelines:

1. The mini-project is a team activity having 3-4 students in a team. Under the guidance of a Supervisor selected by the students or expert in the relevant area.
2. The mini project may be a complete hardware or a software or combination of hardware and software with a focus on mining engineering or industry. The software part in mini project should be preferably less than 50% of the total work.

3. Mini Project should cater to a small system required in laboratory or real life.
4. It should encompass components, devices, with which functional familiarity is incorporated.
5. After interactions with course coordinator and based on comprehensive literature survey/ need analysis, the student shall identify the title and define the aim and objectives of mini-project.
6. Student is expected to detail out specifications, methodology, resources required, critical issues involved in design and implementation and submit the proposal during first week of the semester.
7. The student is expected to exert on design, development and testing of the proposed work as per the schedule.
8. Completed mini project and documentation in the form of mini project report is to be submitted at the end of semester

The progress of the Mini-project will be evaluated through review by a team of faculty in addition to the supervisor twice during the semester in the presence of all the students of the batch. The review committee will be constituted by the head of the department.

The final Mini-project work will be evaluated by an external examiner and a team of internal examiners including supervisor at the end of the semester along with other practical examinations on the basis of the presentation and report submitted.