Scheme of Instruction, Evaluation

and

Syllabi of

B.E. MINING ENGINEERING
BATCH 2021 - 2025
(VII & VIII Semesters)

With effect from the Academic Year 2024-25

DEPARTMENT OF MINING ENGINEERING

Estd.1917

UNIVERSITY COLLEGE OF ENGINEERING

(Autonomous)

Osmania University

Hyderabad – 500 007, TS, INDIA

Estd.1929

Scheme of Instruction for BE (Mining Engg) - VII Semester

S.No.	Course Code	Course Title	Scheme of Instruction			Contact Hrs/ Wk	Scheme of Examination			Credits
			L	T	P		Hrs	CIE	SEE	
THEORY										
1	PC701 MN	Mine Legislation & Safety	3	-	-	3	3	30	70	3
2	PE I	Professional Elective-I	3	-	-	3	3	30	70	3
3	PE II	Professional Elective-II	3	-	-	3	3	30	70	3
4	PE III	Professional Elective-III	3	-	-	3	3	30	70	3
5	PE IV	Professional Elective-IV	3	-	-	3	3	30	70	3
6	OE-II	OE II	3	-	-	3	3	30	70	3
7	Mandatory Course I	Constitution of India	3	-	-	3	3	30	70	0
PRACTICALS										
8	PC751MN	Comprehension	2	-	-	2	2	25	50	1
9	PC752MN	Seminar	-	-	2	2	3	50	-	1
10	PW761MN	Project Work-I	-	-	6	6	3	50	-	2
11	PW961MN	Internship-II	-	-	-	-	-	50	-	1
			23	**0**	**8**	**31**	**29**	**385**	**540**	**23**

Sl No	**Course Code**	**Course Title**
PROFESSIONAL ELECTIVE-I		
1	PE711MN	Surface Mine Environmental Management
2	PE712MN	Mine Disaster & Rescue
3	PE713MN	Rock Excavation Engineering
PROFESSIONAL ELECTIVE-II		
1	PE721MN	Numerical Modelling in Mining
2	PE722MN	Sustainable Mining Industry
3	PE723MN	Mineral Exploration
PROFESSIONAL ELECTIVE-III		
1	PE731MN	Rock Slope Engineering
2	PE732MN	Mine Systems Engineering
3	PE733MN	Surface Mining and Mechanization
PROFESSIONAL ELECTIVE-IV		
1	PE741MN	Advanced Surveying Techniques
2	PE742MN	Geo-Statistics
3	PE743MN	Marine Mining

CODE	**OPEN ELECTIVE-II**
OE721MN	Rock Reinforcement Engineering
OE702CE	Green Building Technology
OE706EC	Verilog HDL
OE709EE	Non-Conventional Energy Sources
OE710ME	Startup Entrepreneurship
OE711ME	Nano Technology

Course Code	Course title						Core/PE/OE
PC 701 MN	MINE LEGISLATION & SAFETY						Core
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	30	70	**3**

Course Objectives

1. To introduce the history of mining laws, legislation applicable to mining to the students with basic knowledge
2. To teach the Mines Rules, Vocational Training Rules, Mines Rescue Rules etc and make them aware the necessity of these rules and their importance
3. To make familiarise with Coal Mines Regulations, Metalliferous Mines Regulations and associated technical circulars for safe and systematic extraction of mineral deposits
4. To discuss the electricity rules applicable to open cast and underground mines, Mines and Minerals Act, Mineral Concession Rules, and MCDR, etc.
5. To explain the accident scenario in the mines, accident classification, enquiry reports, Safety Management Plan, etc.

Course Outcomes

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

1. Digest the concept of Mining Laws and Legislation and other acts and bye-laws related to Mining Industry
2. To gain knowledge in the field of Mines Rules, Vocational Training Rules, Mines Rescue Rules and other related acts
3. To acquire knowledge on CMR, MMR, and associated technical circulars together with their applicability and reasons behind the provisions
4. To familiarize the concepts of electricity rules applicable to open cast and underground mines, Mines and Minerals Act and other related aspects
5. To understand the general causes of accidents in mines, their prevention, classification, reporting, occupational diseases, safety management and other related features.

UNIT- I

Introduction to mining laws and legislation, General principles of mining laws, development of mining legislation in India. The Mines Act, 1952, Bye-laws, Circulars, and standing orders (in brief).

UNIT- II

The Mines Rules, 1955; The Mines Vocational Training Rules, 1966; The Mines Rescue Rules, 1985.The Mines Crèche rules,1966; The Mines Maternity Benefit Act, 1961; Payment of Wages Act, 2005; The Employee's (Workmen's) Compensation Act, 2010; NCWB agreement (in brief).

UNIT- III

Coal Mines Regulations, 2017; Metalliferous Mines Regulations, 1961, and the associated technical
circulars.

UNIT- IV

Central Electricity Authority of Regulations 2010 applicable to opencast and u/g mines; General provisions of Mines and Minerals (Regulation and Development) Act 1957; The Mineral Concession Rules, 1960; The Mineral Conservation and Development Rules, 1988.

UNIT - V

General causes of accidents in mines and their prevention. Classification of accidents, accident enquiry reports, cost of accidents, occupational diseases. Safety management in mines, safety committee role of management, labour, union and government, safety audit, concepts of 2AP, MAP, etc, risk identification and management, safety conferences.

TEXT BOOKS

1. The Mines Act, 1952
2. The Mines Rules, 1955
3. The Mines Vocational Training Rules, 1966
4. The Employee's (Workmen's) Compensation Act, 2010
5. Central Electricity Authority of Regulations 2023
6. Coal Mines Regulations, 2017
7. Metalliferous Mines Regulations, 1961
8. Mines and Minerals (Regulation and Development) Act 1957

REFERENCE BOOKS:

1. Legislation in Indian Mines: A Critical Appraisal vol. 1&2 – Rakesh and Prasad.
2. The Mineral Concession Rules, 1960
3. The Mineral Conservation and Development Rules, 1988.
4. DGMS Technical Circulars

Course Code	Course title						Core/PE/OE
PE 711 MN	**SURFACE MINE ENVIRONMENTAL MANAGEMENT**						**PE**
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	30	70	**3**

Course Objectives

1. To explain the concept of ecology, systems approach to environmental management and environmental pollutants, etc.
2. To introduce the subject of various pollutants of air pollution, standards, monitoring, sampling and analysis, etc.
3. To teach various features of water and noise pollution, standards, prevention and control, 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 concept of ecology, environmental management, environmental pollution due to surface and underground mining, etc.
2. Acquire knowledge on air pollution, sources and hazards, sampling, monitoring, analysis, and prevention and control, etc.
3. Assimilate the knowledge on water and noise pollution, standards, sampling and analysis, effects on human health, prevention and control and 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
PE 712 MN	**MINE DISASTER & RESCUE**						**PE -I**
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	30	70	**3**

Course Objectives

1. To provide students an exposure to mine disasters, classification, causes and their significance for learning its prevention.
2. To gain understanding of approaches to Disaster Risk Reduction in mines, risk assessment, early warning systems and rescue recovery systems.
3. To teach the preparatory arrangements and equipment to combat disasters in mines. Disaster Management Plan, Standard Procedures of Rescue, Rescue equipment apparatus, etc.
4. To familiarize the conduct of Rescue and Recovery in Mines, Logistics, Post Disaster Damage Assessment, Rescue by large diameter holes, Rules and statutory regulations.
5. To explain various case studies of major disasters occurred in Indian mines due to explosions, inundation, rock fall, etc.

Course Outcomes

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

1. Know the various facets of disasters in mines, classification, causes and impacts, do's and don'ts during disasters .
2. Understand approaches to disaster risk reduction, risk assessment, early warning systems, disaster management.
3. Appreciate preparations and equipment required to handle disasters in mines, rescue trained team, emergency plan and evacuation and standard procedures for rescue and recovery.
4. Recognize the conduct of rescue and recovery in mines, leadership, logistics, damage assessment, public participation, court of inquiries, etc.
5. Appraise different disasters occurred in India and abroad such as Jitpur Methane Explosion, Rock Burst in KGF, Mahavir Colliery Disaster, Barkot Tunnel Disaster, etc.

UNIT I

Introduction to Disasters

Definition: Vulnerability, Hazard, Resilience, and Risks – Disasters: Types of disasters – Classification, Causes, Impacts- - urban disasters, Climate change - Dos and Don'ts during various types of Disasters.

UNIT II

Approaches to Disaster Risk Reduction

Disaster cycle - Phases, Culture of safety, prevention, mitigation and preparedness. Risk Assessment, how legislation helps in reducing risks in mines, Concept of factor of Safety,

Concept of Early Warning Systems in all activities in mines. Flow of information in the disaster management framework, Stakeholders, Rescue recovery setup in mines.

UNIT III

Preparations and Equipment to combat Disasters in Mines

Rescue preparedness in mines. Rescue trained persons. Roles of different responsible persons. Response and Recovery Phases of Disaster. Disaster Management Plans (Emergency Plan) for mines, Standard procedures for rescue and recovery in various situations in mines.

Rescue Equipment: Self-contained breathing apparatus, short duration self-contained breathing apparatus, Self-Rescuers, Resuscitating Apparatus, first aid and immediate Medical treatments required.

UNIT IV

Conduct of Rescue and Recovery In Mines:

Leadership in the event of Disaster, Response time, Response logistics, Recovery, Post Disaster Damage Assessment, Public Participation, Court of Enquiries, Rescue by Drilling large dia hole. Sailent features of Rescue, Rules and statutory regulations.

UNIT V

Case Studies of Jitpur Methane explosion, Dhori Coal Dust Explosion Disasters, Bumps Disaster in Kolar Gold Fields at Great depth, Chasnulla inundation disaster, Mahabir Colliery Disaster and Silkyara Bendno –Barkot tunnel disaster and its rescue. How these Disasters effected the legislation in Indian mines.

TEXTBOOK:

1. Singhal J.P. “Disaster Management”, Laxmi Publications, 2010. ISBN-10: 9380386427 ISBN-13: 978-9380386423
2. Tushar Bhattacharya, “Disaster Science and Management”, McGraw Hill India Education Pvt. Ltd., 2012. ISBN-10: 1259007367, ISBN-13: 978-1259007361]
3. Mines Disasters in India Vol – I and Vol II by NCSM, Dhanbad
4. Mine Disasters and Mine Rescue by M. A. Ramulu, Third edition, published by Orient blackswanpvt ltd., 2018

REFERENCES:

1. Govt. of India: Disaster Management Act , Government of India, New Delhi, 2005
2. Government of India, National Disaster Management Policy,2009.

E RESOURCES:

1.https://www.researchgate.net/publication/318339409_Mining_Disasters_-_What_lessons_can_be_learnt

2.https://www.researchgate.net/...Disaster...Management/.../279804770_Disaster_Prevention

Course Code	Course title						Core/PE/OE
PE 713 MN	**ROCK EXCAVATION ENGINEERING**						**PE-I**
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	30	70	**3**

Course Objectives

1. To impart knowledge on rock excavation techniques in mining and civil engineering and its relevance to physico-mechanical and geo-technical properties of rock.
2. To explain the mechanics of drilling, design and operating parameters for drilling, drillability index, economics, pneumatic vs hydraulics drills
3. To convey knowledge in the field of mechanics of blasting, blast design, initiation systems, economics and safety aspects, blasting techniques in tunnelling, etc.
4. To outline theories of rock tool interaction of surface excavation machinery like ripper, BWE, surface miners etc.
5. To discuss theories of rock tool interaction for underground excavation machinery like shearers, ploughs, road headers, TBMs etc. and selection criteria for cutting tools

Course Outcomes

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

1. Understand the scope and importance of rock excavation engineering and the relevance of physico-mechanical properties of rocks.
2. Acquire knowledge on various types of drilling, mechanics, design, and operating parameters for drilling, drillability index, bit wear, economics, energy consumption, etc.
3. Absorb knowledge on mechanics of rock fragmentation by explosives, blast design, economics and safety aspects, controlled blasting techniques, environmental issues etc.
4. Acquire proficiency in theories of rock tool interaction for surface excavation machinery like rippers, continuous surface miners, drillability and cuttability indices of rock.
5. Gain competency in theories of rock tool interaction for underground excavation machinery such as, shearers, ploughs, road headers, continuous miners, TBMs, etc.

UNIT -I:
INTRODUCTION

Scope and importance, Rock excavation engineering in mining, and civil industries; Goelogical, Physico-mechanical and geotechnical properties of rocks vis-à-vis excavation methods; selection of excavation methods.

UNIT -II:
MECHANICS OF DRILLING

Various types of rock drilling and their mechanics, design of operating parameters of surface and underground drilling, evaluation of drill performance, drillability index, mechanism of

bit wear, bit wear index, cutter life index, cuttability index, bit selection, problems of drilling, economics of drilling. Pneumatic vs hydraulic drills, evaluation of drill performance (penetration rate, drilling rate index, drill energy utilization index), energy consumption and other numerical problems.

UNIT -III:
MECHANICS OF BLASTING

Mechanics of rock fragmentation by explosives; advances in explosives and accessories, their selection criteria (impedance matching), blast design for surface excavations and optimization. Advanced blast initiation systems (timing design), primary and secondary blasting designs including parameters, cast blasting, techno - economic and safety aspects of surface and underground blasting. Blasting instruments, blast hole pressure measurement, blast performance evaluations, controlled blasting techniques, adverse impacts of blasting, VOD, blast induced ground vibrations, Air over pressure, etc and their control.
Advances in blast design for underground excavations, contour blasting, computer aided blast designs, review of tunnel blasting techniques, recent advances.

UNIT -IV: ROCK EXCAVATION USING SURFACE MINE MACHINERY

Theories of rock tool interaction for surface excavation machinery – rippers, rippability of rocks, bucket wheel excavators, continuous surface miners, etc.; Cuttability indices of rocks.

UNIT-V: ROCK EXCAVATION USING UNDERGROUND MINE MACHINERY

Theories of rock tool interaction for underground excavation machinery- Ploughs, Shearers, road headers, continuous miners, auger miners, tunnel boring machines, shaft borers, suitability TBMs for different types of strata.
Selection criteria for cutting tools; advanced rock cutting techniques – high pressure water jet assisted cutting, abrasive jets, specific energy consumption.

TEXT BOOKS:

1. Principles of Rock fragmentation, Clark G.B—John Wiley & Sons
2. Diamond Drilling, Chugh C.P.- Oxford Publication
3.Stack, B. (1978), Handbook of Mining and Tunnelling Machinery. Pub: J. Wiley. 742 pages

REFERENCES:

1. Rock fragmentation by blasting- Pradeep KSingh et.al
2. Blasting in ground excavation & mines- B. Singh et.al
3. Barton N, (2000). TBM Tunnelling in Jointed and Faulted Rocks, CRC Press 184 pages
4. Martin J.W., Martin T. J., Bennett, T.P.G., Martin K. M. (1982). Surface Mining Equipment, Publisher: Martin Consultants, Inc. USA
5. SME – Mining Engineering Hand Book
6. Clark G. B., (1987), Principles of Rock Fragmentation, John Willy and Sons,
7. Jimeno E. L. and Carcedo A. (1995), Drilling and Blasting of Rocks. Publisher C.R.C Press – 400 pages.

8. Holmberg, Persson and Bell (1994). Rock Explosives Engineering, Pub: Routledge Taylor & Francis Group.
9. Evans, I and Pomeroy, C. D. (1966), The Strength, Fracture, Workability of Coal, Pergamon Press
10. Sushil Bhandari (1999), Engineering Rock Blasting operations, Pub: Taylor and Francis, Pages 450

E RESOURCES

1. https//link.springer.com/chapter/10.1007/978-981-10-1989-0_16

Course Code	Course title						Core/PE/OE
PE 721 MN	**NUMERICAL MODELLING IN MINING**						**PE-I**
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	30	70	**3**

Course Objectives

1. Understand the concepts and principles of elastic and plastic models, including their applications in mining excavations.
2. Gain proficiency in numerical simulation methods for excavations in mining, such as finite difference methods
3. Learn the principles and techniques of finite element methods for structural analysis in mining, including linear and non-linear analysis
4. Familiarize with the boundary element method and its applications in mining, including the design of underground structures and prediction of subsidence
5. Develop practical skills of software packages such as FLAC and ANSYS for solving problems in mine excavation design and performance analysis

Course Outcomes

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

1. Analyse and evaluate the behaviour of elastic and plastic models in the context of mining excavations.
2. Apply numerical simulation methods, specifically finite difference methods, to model and analyse excavations in mining.
3. Utilize finite element methods to solve structural analysis problems in mining, including linear and non-linear analysis.
4. Apply boundary element method to solve problems related to isotropic and infinite media in the mining industry.
5. Demonstrate proficiency in utilizing numerical modelling software packages, such as FLAC and ANSYS to design and analyse mining excavations and predict subsidence.

UNIT I

Introduction to elastic and plastic models: Fundamentals, elastic, plastic, homogeneous and isotropic, non-linear, elastic and elastoplastic models; Need for numerical modelling in design of excavations in mines; Domain and boundary conditions; Discretisation of domain and boundary; Methods of numerical simulation for excavations in mining

UNIT II

Finite difference methods: Concept, formation of mesh element, finite difference patterns, solutions, application to mining Explicit finite difference method; Finite difference equation; Mechanical damping, mechanical time-step determination, solution stability, advantages and

their limitations; Non-linear solution methods, Introduction to Numerical Modelling software: FLAC, etc.

UNIT III

Finite element methods: Concept, discretisation, element configuration, element stiffness, Assembling elements to form a structural stiffness matrix; Imposing boundary conditions and solving structural equations Elements on assumed displacements, constant strain triangle, isoparametric formulation, advantages and their limitations., two and three dimensional solutions, linear and non-linear analysis, application software: ANSYS, etc.

UNIT IV

Boundary element method:

Concept, discretisation, formulation, merits, demerits and limitations, different methods of solution for isotropic and infinite media. Boundary Element Method: Introduction, formulation, advantages and their limitations.

UNIT V

Numerical Modelling Applications in mines:

Design of underground structures such as accesses to the deposits, pillar formation during development and depillaring operations, barrier pillar and panel, design of pillars against water logged areas, shaft pillar. Performance of longwall powered support. Design of pit slope and dump in opencast mines. Prediction of subsidence, rock reinforcement, simulation of conventional vertical and horizontal supports, rock stabilization and rock reinforcement like rock bolting, shotcreting, etc,

Suggested Reading:

1 Desai, C.S. and Abel, J.F., Introduction to the finite Element Method, Van Nostr and Riehokl Co., New York, 1983.
2 Zienkiewicz, O.C., The Finite Element Method in Engineering Science, Tata McGraw Hill 1972.
3 Segerlind, L.J., Applied Finite Element Analysis, John Wiley and Sons, New York, 1987.
4 Mukhopadyay, M., Matrix Finite Element – Computer and Structural Analysis, Oxford and IBH Publishing co., 1984
5 Brown, E.T., (Ed) Analytical and Computational Methods in Engineering and Rock Mechanics, Allen and Unwin, London, 1987.

Course Code	Course title						Core/PE/OE
PE 722 MN	**SUSTAINABLE MINING INDUSTRY**						**PE-II**
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	30	70	**3**

Course Objectives

1. To explain the concept of sustainable development, sustainable reporting, tools for measurement, MMDR Act, CSR, etc.
2. To familiarize with current status of mining practices, its impacts, mining and environmental framework, NMP, issue of leases and auctions.
3. To impart knowledge on clean coal technologies, CBM, underground gasification, leaching, etc.
4. To teach water pollution, control, sewage and treatment plants, processing of overburden for underground stowing, air and noise pollution, land reclamation and mine closure etc.
5. To impart knowledge on best practices for sustainable mining and case studies.

Course Outcomes

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

1. Understand the concepts of sustainable development for mining, legislative measures, MMRD Act, etc.
2. Recognize mining practices and impact on sustainability, NMP and other related aspects.
3. Appreciate clean coal technologies, methane extraction, underground gasification and other techniques for sustainable development.
4. Evaluate water pollution & control, water conservation, effluent treatment plants & new techniques for sustainable development, air pollution & land reclamation.
5. Apply the knowledge of innovative mining practices for sustainable mining and their benefits and case studies.

UNIT I

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

UNIT II

Current status of mining practices and their impact on sustainability. Mining and environmental frame work, National mineral policies in mineral based countries. Indian

national mineral policy, its historical development with the changing goals and sustainable practices. Issues of leases, auctions for mineral development in India.

UNIT III

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

UNIT IV

Mine water- Water conservation Acts and rules in India. New Initiatives in mines. Underground mine water, Water pollution and control measures, Phyto-remediation, Sewage and effluent treatment plants, their use and benefits. Waste management- processing of overburden material for underground stowing and innovative methods for utilisation of waste from mines.

Air quality in open pit mines, dust control measures, noise levels- pollution, monitoring and control.

Bio-diversity- Land reclamation and plantation. Mine closure plan- Collection and disbursement of Mine closure fund for both open pit and underground mines in India.

UNIT V

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

REFERENCES

MMRD Act 2015 and amendments, Ministry of Mines
Mineral concession Rules
Guidelines of MOEF and Climate change.
Annual reports of MOEF&CC.
Guidelines of Ministry of Coal in India,
Sustainable mining practices –A global perspective by Vasudevan Rajaram, Subijoy Dutta, Krishna Paremeswaran, ISBN-90-5809-689-0

Course Code	Course title						Core/PE/OE
PE 723 MN	**MINERAL EXPLORATION**						**PE-II**
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	30	70	**3**

Course Objectives

1. To understand the principles and methods of mineral exploration, including various criteria and techniques used for identifying and evaluating mineral resources.
2. To develop proficiency in estimating reserves through drilling, sample logging, data compilation and interpretation of geological cross-sections
3. To acquire knowledge and skills in sampling theory and methods for evaluating orebodies, including exploration drilling, core logging, and sampling techniques
4. To analyze exploration data to estimate reserves and assess the potential of mineral resources, considering factors such as cut-off grades and resource classification
5. To gain familiarity with geophysical and geochemical exploration, analysis of element distribution in rocks, chemical weathering processes, and remote sensing tools.

Course Outcomes

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

1. Understand and apply various criteria and methods for mineral exploration.
2. Develop skills in reserve estimation through by drilling, core sample logging, litholog preparation and interpretation of geological cross-sections for mining purposes
3. Apply sampling theory and methods for orebody evaluation including exploration drilling, core logging, and sampling techniques
4. Analyze and interpret exploration data to estimate reserves and assess the potential of mineral resources, considering factors such as cut-off grades and resource classification
5. Gain knowledge geophysical and geochemical exploration methods weathering and remote sensing techniques for mineral exploration

UNIT - I

Introduction:

Definition, objectives and criteria for mineral exploration, guides for ore search: Physiographic, stratigraphic, lithographical, structural mineralogical, geochemical, geobotanical and hydro geological , exploration techniques.

UNIT - II

Reserve Estimation: Types of drilling, drill core sample logging, data compilation, preparation of litholog of the bore hole – isochore and isopatch maps, preparation of geological cross sections, interpretation of the coal mining, geostatistics and exploration deposit reserve estimation.

UNIT - III

Exploration: Introduction to important mineral resources in India and worldwide, surface and aerial prospecting, reconnaissance, application of exploration methods Preliminary and detailed exploration by boring, exploratory mining by shafts, drifts, cross-cuts, collection and compilation of data for computer processing

UNIT - IV

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

UNIT - V

Geochemical Exploration: Geochemistry, geochemical exploration; distribution of elements in igneous rocks and minerals, primary haloes and primary dispersion; chemical weathering, mobility in secondary environment, displaced anomalies, pathfinders and their application

Geo Physical Exploration: Basic concepts of geophysical exploration, Methods of geophysical exploration: Gravity, Seismic, electrical, etc. Remote Sensing, Application of remote sensing in mineral exploration, visual image & satellite data interpretation, exploration adopting ground penetration radar.

Text / Reference books

1. M S Krishnaswamy," Mineral Deposits"
2. Arogyaswamy , "A Text book of Mining Geology"
3. William l Smith, " Remote sensing application in mineral exploration"

Course Code	Course title						Core/PE/OE
PE 731 MN	ROCK SLOPE ENGINEERING						PE-III
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	30	70	**3**

Course Objectives

1. To understand the fundamental principles of rock slope stability and the factors that influence slope failure.
2. To develop skills in analyzing and designing slopes, considering factors such as slope height, slope angle, and water pressure.
3. To acquire knowledge and proficiency in analyzing plane failure and wedge failure including graphical analysis and influence of tension cracks.
4. To analyze circular failure and toppling failure including conditions for failure, derivation of failure analysis methods and the influence of groundwater.
5. To gain familiarity with rock slope failure monitoring techniques, stabilization, sub-surface monitoring and dump stabilization methods.

Course Outcomes

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

1. Understand the principles of rock mechanics, access the stability of rock slopes, considering various factors.
2. Analyze and interpret data related to geological and rock strength properties to evaluate their impact on slope stability
3. Demonstrate proficiency in analyzing plane, wedge, circular, and toppling failures including the use of graphical methods and failure analysis techniques
4. Implement monitoring methods for rock slope failure including surface and sub-surface monitoring techniques and interpret monitoring data for slope stability
5. Develop understanding of slope stabilization techniques, including rock reinforce-ment and protective measures against rock falls for slope stabilization programs

UNIT – I

Basic Mechanics of Rock Slope Failure:

Pit 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.

UNIT – II

Parameters influencing slope stability:

Controllable and uncontrollable parameters, geological parameters affecting slope stability; graphical representation of geological data; plotting and analysis of field measurements; 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, and orientation of benches with reference to geological features.

UNIT – III

Plane Failure and Wedge Failure:

Conditions for Plane failure; graphical analysis of stability; influence of tension crack.
Conditions for 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.
Types of toppling failure; secondary toppling modes; 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 732 MN	**MINE SYSTEMS ENGINEERING**						**PE-III**
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	30	70	**3**

Course Objectives

1. To teach optimization techniques, introduce linear programming and graphical solution with mining examples.
2. To impart knowledge on Simplex method, Big M method and other techniques with mining examples.
3. To explain transportation problem formulation, assignment problems with mining examples.
4. To familiarize with the importance of inventory, EOQ model, waiting line theory, etc.
5. To develop proficiency in PERT and CPM and other related ascepts.

Course Outcomes

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

1. Understand the principles of linear programming and optimization techniques.
2. Recognize the various linear programming techniques such as simplex method, Big M method, duality with mining examples.
3. Appreciate transportation and assignment problems and gain proficiency in applying for mining problems.
4. Learn the importance of inventory, waiting line theory and Queuing problems and their application to mining.
5. Develop understanding in CPM and PERT analysis and its practical uses in mining engineering.

UNIT - I - Introduction

Introduction to optimization techniques, Introduction to 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, Mining Examples

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

TEXT BOOKS:

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

Course Code	Course title						Core/PE/OE
PE 733 MN	**SURFACE MINING AND MECHANIZATION**						**PE-III**
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	30	70	**3**

Course Objectives

1. To explain open pit planning, block modelling, cut-off grade, ultimate pit design, design of haul roads, pit layouts, and other aspects.
2. To explain parameters influencing open pit design, economics, high wall stability, design of waste dumps, design of ultimate pit slopes, and numerical problems.
3. To highlight various aspects of production and equipment planning, cash flow calculations, comminution, production and scheduling, workshops for HEMM, etc.
4. To familiarize the various facets of health, safety and environmental management, occupational hazards, lighting and ventilation, noise and vibrations, etc.
5. To teach recent trends and developments in open cast mining technology, in pit crushing and conveying, continuous surface mining, mine closure plans, etc.

Course Outcomes

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

1. Understand Open Pit Planning, Ultimate Pit Configuration, Design of Haul roads, Pit Layouts and related concepts.
2. Recognize the influence of pit slope on mine economics, high wall slope stability, design of open pits, numerical problems, etc and related topics.
3. Assimilate the knowledge on the Production and Equipment Planning related to surface mines, computerized truck dispatch systems, workshops for HEMM, etc.
4. Appreciate Occupational Health, Safety and Environmental Management, Radio-active emissions, accidents and their prevention and other features.
5. Discover Recent Trends in Opencast Mines, In-Pit Crushing and Conveying, Continuous Surface Mining Technology and other special types of mining.

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. 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.

TEXTBOOKS:

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 741 MN	**ADVANCED SURVEYING TECHNIQUES**						**PE-IV**
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	30	70	**3**

Course Objectives

1. To teach fundamentals of total station and electromagnetic waves, its application.
2. To impart knowledge on basic concepts on GPS, satellite, data processing and other related aspects.
3. To explain mine and cadastral surveying, surveying for highways, railways and tunnels and various other aspects.
4. To familiarize air-borne laser scanner its components, GPS levelling, photogrammetry and interferometry.
5. To highlight the data acquisition and post processing of GPS, scanning systems, overview of LIDAR applications, drone surveying, etc.

Course Outcomes

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

1. Understand fundamental of total station, comparison with conventional surveying, applications of electromagnetic waves, etc.
2. Learn satellite, GPS system and data processing and related aspects.
3. Comprehend mine and cadastral surveying, surveys for highways, railways and tunnels, gyro-theodolite, etc.
4. Appreciate air borne laser scanners, typical parameters and other related topics.
5. Gain proficiency in data acquisition and processing using various scanning techniques, LIDAR applications and terrestrial laser scanners.

UNIT I

FUNDAMENTALS OF TOTAL STATION AND ELECTROMAGNETIC WAVES

Types and working principles of Machines, Methods of Measuring Distance, Basic Principles of Total Station, Historical Development, Classifications, applications and comparison with conventional surveying. Classification - applications of Electromagnetic waves, Propagation properties, wave propagation at lower and higher frequencies-Refractive index (RI) - factors affecting RI. Care and Maintenance of total stations.

Electro-optical system: working principle, Sources of Error, Infrared and Laser Total Station instruments. COGO functions, offsets and stake out-land survey applications.

UNIT II

SATELLITE, GPS SYSTEM AND DATA PROCESSING

Basic concepts of GPS, GNSS, IRNSS and GAGAN - Different segments - space, control and user segments - satellite configuration – GPS signal structure, Anti Spoofing and Selective Availability - GPS receivers. Concepts of rapid, static methods with GPS - semi Kinematic and pure Kinematic methods -satellite geometry & accuracy measures - applications.

UNIT III

MINE AND CADASTRAL SURVEYING

Reconnaissance – Route surveys for highways, railways and tunnels –Mine surveying Equipment – Weisbach triangle – Tunnel alignment and setting out – Transfer of azimuth – Gyro Theodolite – Shafts and audits - Cadastral survey- Legal – Real – Tax cadastre – Land record system – Settlement procedure – deformation studies. Mine plan preparation - mapping process - use of mapping softwares, VAVIks mapping.

Route surveys of water ways, Hydrographic survey Tides – MSL – Sounding methods – Three point problem – River surveys – Measurement of current and discharge.

UNIT IV

AIRBORNE LASER SCANNERS

Airborne Topographic Laser Scanner – Ranging Principle – Pulse Laser and Continuous Wave Laser – First Return and Last Return – Ellipsoidal and Geoidal Height - Typical parameters of a Airborne Laser Scanner (ALS) – Specifications of Commercial ALS –- Components of ALS - GPS, IMU, LASER Scanner, Imaging Device, Hardware and Software. Merits of ALS in comparison to Levelling, echo sounding, GPS levelling, Photogrammetry and Interferometry

UNIT V

DATA ACQUISITION AND PRE & POST PROCESSING

Various Scanning Mechanism – Synchronization of GPS, IMU and ALS Data - Reflectivity of terrain objects – Laser Classification – Class I to Class IV Laser – Eye Safety. Ground Point filtering – Digital Surface Model and Digital Elevation Model. Overview of LIDAR Applications in various domains - 3D models – Corridor Mapping Applications – Forestry Applications. Terrestrial Laser Scanners (TLS) – Working Principle – Commercial TLS Specifications – Applications of TLS, Drone based Mapping - derivatives from drone surveying.

TEXTBOOKS:

- Satheesh Gopi, Rasathishkumar, N.Madhu, – Advanced Surveying, Total Station GPS and Remote Sensing – Pearson education, 2007 ISBN: 978-81317 00679 52.
- Alfred Leick, GPS satellite surveying, John Wiley & Sons Inc., 3rd Edition, 2004.
- Jie Shan and Charles K. Toth, Topographic Laser Ranging and Scanning – Principles and Processing, CRC Press, Taylor & Francis Group, 2009.

REFERENCES:

- Rueger, J.M. Electronic Distance Measurement, Springer-Verlag, Berlin, 1996.
- Michael Renslow, Manual of Airborne Topographic LiDAR, The American Society for Photogrammetry and Remote Sensing, 2013.
- R.Subramanian, Surveying and Levelling, Oxford University Press, Second Edition, 2012.

Course Code	Course title						Core/PE/OE
PE 742 MN	**GEO-STATISTICS**						**PE-IV**
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	30	70	**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

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, Neighbourhood 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 Ore body Modelling and Resource Estimation using Surpac Mine Planning Software.

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 743 MN	**MARINE MINING**						**PE-IV**
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	30	70	**3**

Course Objectives

1. To explain the exploration and characterization of inland water, mineralogical studies of marine sediments, continental slope and various other aspects.
2. To introduce the topic of marine mining its development, mineral resources, ocean profile, economics exclusive zones, etc.
3. To impart knowledge on marine geology and resources, sea water properties, poly metallic nodules, etc.
4. To make familiar with exploitation of marine deposits at shallow and deep-sea bed, mining of poly metallic nodules, deep sea drilling methods, etc.
5. To illuminate the knowledge on miscellaneous methods of marine mining, like placer mining, off shore platforms, grudging and hydraulicking.

Course Outcomes

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

1. Understand various aspects of marine mining, minerals present in marine sediments, etc.
2. Appreciate marine environment, topography, economics exclusive zones, etc.
3. Recognize the physical and chemical properties of sea water, marine deposits, beach places, deep sea bed mineral resources and poly metallic nodules.
4. Comprehend exploitation of marine deposits in shallow and deep-sea bed, oceanography instruments, mining of poly metallic nodules, etc.
5. Gain proficiency in beach sand mineral resources, hydraulic and grudging techniques, laws of sea, and legal consideration and legal aspects of ocean mining.

UNIT - I

Exploration and characterization of inland water. Mineralogical studies of marine sediments and continental slope, continental shelf and deep sea bed mineral resources. Exploration of dissolved and undissolved mineral deposits.

UNIT II INTRODUCTION TO MARINE MINING

Introduction to marine environment, development & status of ocean mineral resources for mining in India and other parts of the world, Ocean profile, Ocean floor topography/shelf, slope and rise; characteristics, economic exclusive zones

UNIT III MARINE GEOLOGY AND RESOURCES

Physical and chemical properties of seawater, overview of marine mineral deposits, beach placers, deep-sea bed mineral resources, polymetallic nodules, polymetallic sulphides, Cobalt rich crust, chemicals form the ocean, dissolved and undissolved mineral deposits, sea water as resource

UNIT IV EXPLOTIATION OF MARINE DEPOSITS

Shallow and deep sea bed, Deep sea bed Mining. Wells and algae for extraction of minerals, economics & technologies, oceanographic instruments, mining of polymetallic nodules, polymetallic sulphides, technical and environmental issues, probable solutions, deep sea drilling methods, ocean bottom samplers, drag buckets, grab buckets, coring systems, ocean bathymetry, temperature measurement systems, water samplers, ocean dynamic analysis, beach placer mining, underwater photographs, ,

UNIT V MISCELLENOUS METHODS OF MARINE MINING

Beach sand mineral resources, hydraulicking, different dredging techniques, field of applications, limitations, beach sand mining, remotely operated mining systems, Environmental impact of ocean mining. Laws of the sea, legal considerations in ocean mining, vehicles and transportation, offshore oil platforms. Placer mining, underwater surveying techniques and deep sea mining along with remote mining equipment.

Suggested Text books:

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

Course Code	Course title						Core/PE/OE
OE 721 MN	**ROCK REINFORCEMENT ENGINEERING**						**OE-II**
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	30	70	**3**

Course Objectives

1. To impart knowledge on various rock classification techniques assessment of support requirement for underground excavations.
2. To outline grouting and shortcreting techniques used in mining and allied engineering fields, mechanism of grouting, selection of grouting material and shortcreting techniques.
3. To describe various types of rock bolts and their field of application, mechanism of rock bolting, pre-tensioning, anchorage testing of rock bolts , design of rock bolting.
4. To convey knowledge on cable bolts and rock anchors and their types grouting material used and filed of application in mining and allied engineering.
5. To explain special methods of rock reinforcement like ground freezing, berms, fore-polling, geo-textile, dump stabilization etc.

Course Outcomes

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

1. Various rock classification techniques, their applications, support requirements for underground excavations.
2. Acquire the knowledge of grouting, and shortcreting techniques for rock information, working principles and field of applications.
3. Observe knowledge about rock bolts their types and filed of applications, installation, anchorage strength, failure of bolts, design of rock bolts etc.
4. Acquire proficiency in cable bolts and rock anchors their installation, grouting material, modes of failure, usage of rock anchors for stabilization of rock slopes, dams etc.
5. Gain competence in ground freezing for rock reinforcement, special methods of slope stabilization, fore-poling, geo-textiles, dump stabilization etc.

UNIT I

ROCKMASS CLASSIFICATION

Basic concepts of rockmass classification; Rock Quality Designation (RQD); Norwegian Geomechanics Classification i.e. Q-system; Rock Mass Rating (RMR); CMRI system; Application of rockmass classification in assessing the support requirement for underground excavations including shafts, caverns, and underground storage

UNIT II

GROUTING, GUNITING AND SHOTCRETING

Mechanism of rock reinforcement by grouting; selection of grouting material,operating parameters like optimum pressure and water-cement ratio, layout for grouting, holes, their diameter and depth, working principle and field application of grouting; Evaluating effectiveness of grouting, shotcreting operations, their field of application and design of mix, thickness of shotcreting; fiber reinforced shotcreting including selection of fibers.

UNIT III

ROCK BOLTS

Elements of rock bolts; types of rock bolts and their fields of application; types of grouting materials and procedure of installation of rock bolts; different material used as rock bolts, pre-tensioning of rock bolts; principles of rock bolting; different methods of testing bolts, anchorage test and boltometer, factors affecting anchorage strength of bolts, and design of rock bolting system for underground and opencast excavations i.e. determination of bolt length, diameter of bolts and bolt pattern, numerical problems.

UNIT IV

CABLE BOLTS AND ROCK ANCHORS

Classification of cable bolts; installation including mechanised fibre cable bolting and testing; modes of failure; different type of grouting materials; use of anchors in underground and opencast excavations and dumps etc; testing of anchors.

UNIT V

SPECIAL METHODS OF ROCK REINFORCEMENT

Ground freezing for slope stabilisation; fore-poling; geo-textiles and its area of application; dump stabilisation by various techniques including vegetation, wire netting, retaining walls, etc.,

REFERENCES

1. Brady, B.H.G. and Brown, S.T., Rock Mechanics, Wiley Interscience,1985.
2. Hoek, E and Brown, E.T., Underground Excavations in Rocks, Institute of Mining Metallurgy, London, 1980.
3. Schach, R., Garshael, K. and Heltzen, A. M., Rock Bolting – A Practical Handbook, Pergamon Press,1979
4. Peng, S.S. Ground Control, Wiley Interscience, New York,1987

Course Code	Course title						Core/PE/OE
OE 702 CE	GREEN BUILDING TECHNOLOGY						OE-II
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	30	70	**3**

Course Objectives

1. Exposure to the green building technologies and their significance.
2. Understand the judicial use of energy and its management
3. Educate about the Sun-earth relationship and its effect on climate
4. Enhance awareness of end-use energy requirements in the society
5. Develop suitable technologies for energy management

Course Outcomes

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

1. Understand the fundamentals of energy use and energy processes in building.
2. Identify the energy requirement and its management
3. Know the Sun-earth relationship vis-a-vis its effect on climate
4. Be acquainted with the end-use energy requirements
5. Be familiar with the audit procedures of energy

UNIT- I

Overview of the significance of energy use and energy processes in building: Indoor activities and environmental control - Internal and external factors on energy use and the attributes of the factors - Characteristics of energy use and its management - Macro aspect of energy use in dwellings and its implications

UNIT- II

Indoor environmental requirement and management: Thermal comfort - Ventilation and air quality – Air-conditioning requirement - Visual perception - Illumination requirement – Auditory requirement.

UNIT- III

Climate, solar radiation and their influences: Sun-earth relationship and the energy balance on the earth's surface - Climate, wind, solar radiation, and temperature - Sun shading and solar radiation on surfaces - Energy impact on the shape and orientation of buildings.

UNIT- IV

End-use, energy utilization and requirements: Lighting and day lighting - End-use energy requirements - Status of energy use in buildings Estimation of energy use in a building - Heat gain and thermal performance of building envelope - Steady and non-steady heat transfer through the glazed window and the wall - Standards for thermal performance of building envelope -Evaluation of the overall thermal transfer

UNIT- V

Energy management options: Energy audit and energy targeting - Technological options forenergy management.

Suggested Readings:

1. Michael Bauer, Peter Mösle and Michael Schwarz, *"Green Building – Guidebook for Sustainable Architecture"*, Springer, Heidelberg, Germany, 2010.
2. Norbert Lechner, *"Heating, Cooling, Lighting - Sustainable Design Methods forArchitects",* Wiley, New York, 2015.
3. Mike Montoya, *"Green Building Fundamentals*‖, Pearson, USA, 2010.
4. Charles J. Kibert, *"Sustainable Construction - Green Building Design and Delivery*‖, JohnWiley & Sons, New York, 2008.
5. Regina Leffers, *"Sustainable Construction and Design*‖, Pearson / Prentice Hall, USA,2009.
6. James Kachadorian, *"The Passive Solar House: Using Solar Design to Heat and Cool YourHome",* Chelsea Green Publishing Co., USA, 1997.

Course Code	Course title						Core/PE/OE
OE 706 EC	**VERILOG HDL**						**OE-II**
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	30	70	**3**

Course Objectives

1. To familiarize with various modelling styles: structural, dataflow and behavioral of VerilogHDL.
2. To design and develop Verilog HDL models of data path and control units of central processing unit.
3. To learn Synthesis and FPGA design flow.
4. To design and develop real time applications: Booth's multiplier, Divider, hardwired control for basic CPU, FIR filter.

Course Outcomes

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

1. Implement and distinguish different Verilog HDL modelling styles.
2. Construct and analyze Verilog HDL models of combinational and sequential circutis
3. Design and develop Verilog HDL modelling and test bench for digital systems for the given specifications
4. Outline FPGA design flow and timing analysis.

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 modeling: gate-level modeling, delays, hazards, dataflow modeling: Continuous Assignments, Delays, Expressions, Operators and Operands, Operator Types and Design Examples

UNIT - III

Behavioral Modeling: 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, Tasksand 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 709 EE	**NON-CONVENTIONAL ENERGY SOURCES**						**OE-II**
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	30	70	**3**

Course Objectives

1. To understand the different types of energy sources.
2. To Understand the need of non-conventional energy sources and their principles
3. To understand the limitations of non-conventional energy sources
4. To outline division aspects and utilization of renewable energy sources for dirimentapplication
5. To analyze the environmental aspects of renewable energy resources

Course Outcomes

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

1. Know the different energy resources and need of renewable energy resources.
2. Understand the concepts of working of fuel cell systems along with their applications
3. Describe the use of solar energy and the various components and measuring devices used in the energy production and their applications.
4. Appreciate the need of Wind Energy and their classification and various components used in energy generation and working of different electrical wind energy system.
5. Understand the concept of OTEC technology, Biomass energy resources and different types of biogas plants used in India.

UNIT- I

Review of Conventional and Non-Conventional energy sources, Need for non-conventional energy sources Types of Non-conventional energy sources, Fuel Cells, Principle of operation with special reference to H2O2 Cell, Classification and Block diagram of fuel cell systems, Ion exchange membrane cell, Molten carbonate cells, Solid oxide electrolyte cells, Regenerative system, Regenerative Fuel Cell, Advantages and disadvantages of Fuel Cells, Polarization, Conversion efficiency and Applications of Fuel Cells.

UNIT-II

Solar energy, Solar radiation and its measurements, Solar Energy collectors, Solar Energy storagesystems, Solar Pond, Application of Solar Pond, Applications of solar energy.

UNIT-III

Wind energy, Principles of wind energy conversion systems, Nature of wind, Power in the Wind, Basic components of WECS, Classification of WECS, Site selection considerations, Advantages and disadvantages of WECS, Wind energy collectors, Wind electric generating and control systems, Applications of Wind energy, Environmental aspects.

UNIT-IV

Energy from the Oceans, Ocean Thermal Electric Conversion (OTEC) methods, Principles of tidal power generation, Advantages and limitations of tidal power generation, Ocean waves, Wave energy conversion devices, Advantages and disadvantages of wave energy, Geo-thermal Energy, Types of Geo-thermal Energy Systems, Applications of Geo-thermal Energy.

UNIT-V

Energy from Biomass, Biomass conversion technologies / processes, Photosynthesis, Photosynthetic efficiency, Biogas generation, Selection of site for Biogas plant, Classification of Biogas plants, Details of commonly used Biogas plants in India, Advantages and disadvantages of Biogas generation, Thermal gasification of biomass, Biomass gasifies.

Suggested Readings:

1. Rai G.D, *"Non-Conventional Sources of Energy",* Khandala Publishers, New Delhi, 1999.
2. M. M. El-Wakil, *"Power Plant Technology"*, McGraw Hill, 1984

Course Code	Course title						Core/PE/OE
OE 710 ME	**STARTUP ENTREPRENEURSHIP**						**OE-II**
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	30	70	**3**

Course Objectives

1. To motivate students to take up entrepreneurship in future.
2. To learn nuances of starting an enterprise by creative thinking and shape ideas in to reality.
3. To understand action driven business plan and learn to prepare project budget.

Course Outcomes

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

1. Think creatively and transform ideas into reality.
2. Differentiate market transforming strategy.
3. Create a complete business plan and workout the budget plan.

UNIT – I

*Creativity & Discovery***:** Definition of Creativity, self-test creativity, discovery and delivery skills, The imagination threshold, Building creativity ladder, Collection of wild ideas, Bench marking the ideas, Innovative to borrow or adopt, choosing the best of many ideas, management of tradeoff between discovery and delivery, Sharpening observation skills, reinventing self, Inspire and aspire through success stories

UNIT – II

*From Idea to Startup***:** Introduction to think ahead backward, Validation of ideas using cost and strategy, visualizing the business through value profile, activity mapping, Risks as opportunities, building your own road map

UNIT – III

Innovation career lessons: Growing & Sharing Knowledge, The Role of Failure In Achieving Success, Creating vision, Strategy, Action & Resistance: Differentiated Market Transforming Strategy; Dare to Take Action; Fighting Resistance; All About the startup Ecosystem; Building a Team; Keeping it Simple and Working Hard

UNIT – IV

Action driven business plan: Creating a completed non-business plan (a series of actions each of which moves your idea toward implementation), including a list of the activities to be undertaken, with degrees of importance (scale of 1 to 3, where 1 is _most important'). A revision of the original product or service idea, in light of information gathered in the process, beginning to design the business or organization that will successfully implement your creative idea. Preparing an activity map

UNIT – V

Startup financing cycle: Preparing an initial cash flow statement, showing money flowing out (operations; capital) and flowing in. Estimate your capital needs realistically. Prepare a bootstrapping option (self-financing). Prepare a risk map. Prepare a business plan comprising five sections: The Need; The Product; Unique Features; The Market; Future Developments. Include a Gantt chart(project plan – detailed activities and starting and ending dates); and a project budget

Suggested Readings:

1. Vasant Desai, *"Dynamics of Entrepreneurial Development and Management"*, Himalaya Publishing House, 1997.
2. Prasanna Chandra, *"Project – Planning, Analysis, Selection, Implementation and Review",*
3. Tata McGraw-Hill Publishing Company Ltd., 1995.
4. B. Badhai, –*Entrepreneurship for Engineers*‖, Dhanpath Rai & Co., Delhi, 2001.
5. Stephen R. Covey and A. Roger Merrill, –*First Things First",* Simon and Schuster, 2002.
6. Robert D. Hisrich and Michael P.Peters, *"Entrepreneurship*‖, Tata McGraw Hill Edition,2002

Course Code	Course title						Core/PE/OE
OE 711 ME	**NANO TECHNOLOGY**						**OE-II**
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	30	70	**3**

Course Objectives

1. To familiarize Nano material and technology.
2. To understand Nano structures, fabrication and special Nano materials.

Course Outcomes

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

1. To understand that properties of material are size and shape dependent
2. To learn key concepts in understanding fabrication techniques
3. To critically analyze properties of nanomaterial for future engineering applications
4. To understand various approaches to synthesis of nanostructures.

UNIT-I

Introduction: Nanoscale, Properties at Nanoscale, advantages and disadvantages, importance of Nano Technology, Bottom-up and Top-down approaches, challenges in Nanotechnology

UNIT-II

Materials of Nano Technology: Introduction-Si-based materials, Ge-based materials, Smart materials, metals, Ferroelectric materials, Polymer materials, GaAs & InP (III-V) group materials, Nano tribology and Materials, Principles and analytical techniques of XRD, SEM, TEM and STM/AFM

UNIT-III

Nano Structures: Zero dimensional Nano structure (Nano Particles)- Synthesis procedure, characterization techniques, properties and applications of Nano Particles. One dimensional Nano structures (Nano Wires, Nano Tubes)- Various Synthesis procedure, characterization procedure and principles involved, properties and applications of Nano Wires, Types of Nano Tubes, Synthesis procedure, characterization properties and applications of Nano Tubes

UNIT-IV

*Nano Fabrication***:** Introduction, Basic fabrication techniques (Lithography, thin film deposition, and doping) MEMS fabrication techniques, Nano fabrication techniques (E-beam Nano-imprint fabrication, Epitaxy and strain engineering, Scanned probe techniques

UNIT-V

Special Nano Materials: Nano Composites: Introduction, Synthesis procedures, various systems(metal-polymer, metal- ceramics and polymer-Ceramics), Characterization procedures, applications. *Nano Biomaterials***:** Introduction, Biocompatibility, anti-bacterial activity, principles involved,applications

Suggested Reading:

1. A.K.Bandyopadyay, –*Nano Materials",* New Age Publications, 2007.
2. T. Pradeep, *"Nano: The Essentials: Understanding Nanoscience and Nanotechnolgy"*, TataMcGraw-Hill, 2008.
3. Carl. C. Koch, *"Nano Materials Synthesis, Properties and Applications",* Jaico PublishingHouse, 2008.
4. Willia Illsey Atkinson, *"NanoTechnology*‖, Jaico Publishing House, 2009

Course Code	Course title						Core/PE/OE
MC 701 HS	CONSTITUTION OF INDIA						MC
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	30	70	0

Course Objectives

1. To teach the history of Indian constitution, Philosophy, Preamble, Salient Features.
2. To explain the constitutional rights and duties, fundamental rights and other aspects
3. To illuminate knowledge on organs of governs, parliament and its functions, union executives, Judiciary, etc.
4. To impart knowledge on local administration, district administration and municipalities, mayor and role of elected representatives and organizational hierarchy
5. To familiarize with electoral process, chief and state election commission

Course Outcomes

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

1. Understand the history of making of Indian constitution and salient Features.
2. Appreciate the constitutional rights and fundamental rights of citizens, right to freedom of religion cultural and educational and important aspects.
3. Gain proficiency in organs of governs, parliament and its constitution and union executives, qualification, powers and etc.
4. Recognize the importance of local administration, municipalities, mayors, Panchayati raj, Zilla Panchayat, etc.
5. Comprehend the election process, election commission, its role and function.

UNIT-I

History of making of the Indian constitutions: History, Drafting Committee (Composition & Working). Philosophy of the Indian Constitution: Preamble, Salient Features.

UNIT-II

Contours of Constitutional Rights and Duties Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT-III

Organs of Governance: Parliament: Composition, Qualifications, Powers and Functions, Union executives: President, Governor, Council of Ministers, Judiciary, appointment and transfer of judges, qualifications, powers and functions

UNIT-IV

Local Administration – District's Administration head: Role and importance. Municipalities: Introduction, mayor and role of Elected Representative, CEO of Municipal Corporation. Panchayati Raj: Introduction, PRI: Zilla Panchayat, Elected Officials and their roles, CEO Zilla Panchayat: positions and role. Block level: Organizational Hierarchy (Different departments) Village level: role of elected and appointed officials. Importance of grass root democracy.

UNIT-V

Election commission: Election Commission: Role and functioning, Chief Election Commissioner and Election Commissioners, State Election Commission: Role and functioning. Institute and Bodies for the welfare of SC/ST/OBC and women

Suggested Reading:

1. ―The Constitution of India‖, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar, ―Framing of Indian Constitution‖, 1st Edition, 2015.
3. M. P. Jain, ―Indian Constitution Law‖, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, ―Introduction to the Constitution of India‖, Lexis Nexis, 2015. Web Resource:
1. http://www.nptel.ac.in/courses/103107084/Script.pdf

Course Code	Course title						Core/PE/OE
PC 751 MN	SEMINAR						Core
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	-	-	-	2	50		1

Course Objectives

1. To explain the appropriate area of relevance to select a seminar topic.
2. To impart knowledge on gathering literature on the selected topic by referring to technical articles from books, journal and electronic media
3. To assist in preparing a technical report for the relevant topic
4. To assist in developing a power point presentation (PPT) form the literature survey relevant to the topic selected
5. To help in delivering the seminar topic by rehearsals, posture, speech modulation, gestures, tone audibility, etc

Course Outcomes

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

1. Learn topic selection in the appropriate area of relevance.
2. Gain knowledge on gathering literature by referring to technical articles from books, journal and electronic media.
3. Acquire knowledge on preparing a professional technical report.
4. Attain proficiency in developing a power point presentation (PPT) by using most recent advanced features.
5. Expertise delivering the seminar topic by rehearsals, posture, speech modulation, gestures, tone audibility, etc.

At least two faculty members will be associated with the seminar presentation to evaluate and award marks.

1. The students have to select a topic related to mining engineering for presentation of seminar in consultation with faculty in charge (seminar) during the 1st week of the commencement of the session.
2. The student is required to refer various books, journals and E-media, to conduct literature survey related to the topic selected.
3. The student is required to collected information on referring to technical articles of experts, figures, photos, videos, animations videos, etc.
4. The student is required to prepare a technical report on the topic selected using the information collected above.
5. The student is required to prepare a PPT encompassing various relevant articles, collected above.

6. The student is expected to make a number of rehearsals for the presentation of the seminar.
7. The student is required to adhere the following: posture, speech modulation, gestures, tone audibility, training on mic handling and speech delivery.
8. The student is expected to come well dressed, well mannered, fully prepared for delivering the seminar.
9. The student is required to answer the queries raised in the seminar.
10. The student is required to submit the seminar report, soft copy of the PPT to the faculty incharge.

Course Code	Course title						Core/PE/OE
PC 752 MN	COMPREHENSION						Core
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	2	-	-	-	50	–	1

Course Objectives

1. To revise the knowledge on Mining Geology, Engineering Economics and Graphics, Rock Mechanics and Ground Control.
2. To recollect the subject knowledge on Mine Development, Mine Surveying, Mine Planning and Systems Engineering.
3. To revisit the learning on different types of mining methods – surface, underground coal and metal mining, mine ventilation, surface environment and underground hazards, drilling and blasting, etc.
4. To impart knowledge from special lectures though experts, faculty members, research scholars, post graduate students, engineers from industries and R&D institutions.
5. To prepare students fare mining competitive examinations for high studies (GATE) and mining job opportunities in India and Abroad, State and Central Government jobs other than mining and to inculcate interest in career opportunities and entrepreneurship.

Course Outcomes

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

1. Recollect the knowledge on Geology, Mine Economics, Rock Mechanics, Strata Mechanics and Mine Ground Control.
2. Understand the concepts of Mine Development, Surveying, Mine Planning and Systems Engineering
3. Discover understanding on various types of mining methods and machinery, surface environment, mine ventilation, mine hazards and rescue, drilling & blasting, etc
4. Recognize the expertise on special lectures by faculty members, research scholars, guest speakers from industries and R&D institutions, nuances in facing interviews for jobs
5. Gain awareness on various higher studies opportunities in India and Abroad, competitive jobs other than mining and entrepreneurship

UNIT-I

Revision of Mining Geology, Engineering mechanics & Graphics, Rock Mechanics, Ground control

UNIT-II

Revision of Mine Development, Mine Surveying, Mine Economics, Mine Planning, Mine Systems Engineering

UNIT-III

Revision of Mining Methods and Machinery, Surface Environment, Mine Ventilation and Underground Hazards, Drilling and Blasting, Surface Mining, U/G coal and metal mining.

UNIT-IV

The student will be exposed to on special lectures by faculty members, research scholars, post graduate students of the department and invited lectures by engineers from industries and R & D institutions. The objective of these preliminary talks will be to expose the students to real life practical problems and methodology to solve the technical problems.

UNIT-V

Introduction of mining competitive exams for higher studies and mining job opportunities in India and abroad, competitive exams for State and Central government jobs other than mining jobs, different carrier opportunities and entrepreneurship.

The students will attend special lectures by faculty members, research scholars, post graduate students and invited lectures by practicing engineers, scientists from R & D institutions and faculty from other institutions with objectives of exposing the students and find solutions to the same to real life practical problems and latest areas of research.

Note: The faculty handling comprehension subject may seek the help of other faculty of the mining and other branches who have handled those courses in preparing objective type and short questions along with the key.

Course Code	Course title						Core/PE/OE
PW 761 MN	PROJECT WORK - I						Core
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	-	-	-	6	50	–	2

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 preparatory work for conducting experiments in the laboratory or field and collect data for the project
5. To explore the various software and statistical tools for the analysis of the results to be obtained

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 preliminary experiments in the laboratory or field or develop computer programs or learn use of computer program.
5. Learn usage of various software and statistical tools for the analysis of the results to be obtained.
6. Analysis the results and draw logical and meaningful conclusions.
7. Teamwork.
8. Make preparatory work for writing the report / document comprising of statement of the problem, literature survey, methodology, results and analysis, conclusions, etc.

Guidelines:

1. The 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 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. 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 work on design, development and testing of the proposed work as per the schedule.
8. The project completed so far is to be submitted in the form of preliminary project report at the end of the semester with the approval of the supervisor.

The progress of the 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 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.

Course Code	Course title						Core/PE/OE
PW 961 MN	**INTERNSHIP-II**						**Core**
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	-	-	-	-	50	–	1

Course Objectives

1. Will expose Technical students to the industrial environment, which cannot be simulated in the classroom and hence creating competent professionals for the industry.
2. Provide possible opportunities to learn, understand and sharpen the real time technical / managerial skills required at the job
3. Exposure to the current technological developments relevant to the subject area of training
4. Expose students to the engineer's responsibilities and ethics
5. Familiarize with various materials, processes, products and their applications along with relevant aspects of quality control
6. Expose the students to future employers
7. Understand the social, economic and administrative considerations that influence the working environment of industrial organizations
8. Understand the psychology of the workers and their habits, attitudes and approach to problem solving
9. Gain experience in writing Technical reports/projects
10. Promote academic, professional and/or personal development

Course Outcomes

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

1. Understand the actual industrial environment and tuned to readily accept the works for execution.
2. Generate detail project reports and understand industry administration and finance machines.
3. Troubleshoot problems with more confidence
4. Design systems/products following standard procedures and norms
5. Interact with fellow workers and manage the activities efficiently

INTERNSHIP ACTIVITIES

During vacation of 6th semester
Internship with Industry/ Operating mines / Research Organization / Mining Software development company / Mining Consultancy

INTERNSHIP REPORT

a) Student's diary / daily log

The main purpose of writing daily diary is to cultivate the habit of documenting and to encourage the students to search for details. It develops the students" thought process and reasoning abilities. The students should record in the daily training diary the day to day account of the observations, impressions, information gathered and suggestions given, if any. It should contain the sketches & drawings related to the observations made by the students and equipment seen. The daily training diary should be signed after every day by the supervisor/ in charge of the section where the student has been working. The diary should also be shown to the Faculty Mentor visiting the industry from time to time and got ratified on the day of his visit. Student's Diary and Internship Report should be submitted by the students along with attendance record and an evaluation sheet duly signed and stamped by the industry to the Institute immediately after the completion of the training. It will be evaluated on the basis of the following criteria:

- Regularity in maintenance of the diary.
- Adequacy & quality of information recorded.
- Drawings, sketches and data recorded.
- Thought process and recording techniques used.
- Organization of the information

b) Internship report

After completion of Internship, the student should prepare a comprehensive report to indicate what he has observed and learnt in the training period. The student may contact Industrial Supervisor/ Faculty Mentor/TPO for assigning special topics and problems and should prepare the final report on the assigned topics. Daily diary will also help to a great extent in writing the industrial report since much of the information has already been incorporated by the student into the daily diary. The training report should be signed by the Internship Supervisor and Faculty Mentor.

The Internship report will be evaluated on the basis of following criteria:

i. Originality.
ii. Adequacy and purposeful write-up.
iii. Organization, format, drawings, sketches, style, language etc.
iv. Variety and relevance of learning experience.
v. Practical applications, relationships with basic theory and concepts taught in the course.

EVALUATION THROUGH SEMINAR PRESENTATION/VIVA-VOCE

The student will give a seminar based on his training report, before an expert committee constituted by the Department as per norms of the institute. The evaluation will be based on the following criteria:

- Quality of content presented.
- Effectiveness of presentation.
- Proper planning for presentation.
- Depth of knowledge and skills.
- Attendance record, daily diary, departmental reports shall also be analyzed along with the internship report.

Seminar presentation will enable sharing knowledge & experience amongst students & teachers and build Communication skills and confidence in students.

Students have to undergo summer internship of two weeks duration at the end of semester VI and the credits will be awarded after evaluation in VII semester.

Note: Students are to be provided with guidelines including information to be collected and familiarized with the same by a faculty in a class before they proceed for training.

Scheme of Instruction for BE (Mining Engg) – VIII Semester

S.No.	Course Code	Course Title	Scheme of Instruction			Contact Hrs/ Wk	Scheme of Examination			Credits
			L	T	P		Hrs	CIE	SEE	
THEORY										
1	OE III	Open Elective - III	2	-	-	2	3	30	70	2
2	MC II	Design of Experiments	2	-	-	2	3	30	70	0
PRACTICALS										
3	PW891MN	Project Work-II	-	-	12	12	-	50	100	6
			4	**0**	**12**	**16**	**6**	**110**	**240**	**8**

CODE	OPEN ELECTIVE-III
OE831MN	Environmental Management for Sustainable Mining
OE801BM	Basic Medical Equipment
OE802CS	Data Science Using R
OE803EC	Mobile Communication
OE804EC	Internet of Things and Applications
OE805EC	Global and Regional Satellite Navigation System
OE806EE	Application of Electrical Energy
OE807ME	Composite Material Applications
OE808ME	Industrial Administration and Financial Management
OE809CS	Software Engineering
OE810CS	Python Programming
OE811CS	Cyber Security

Course Code	Course title						Core/PE/OE
OE 831 MN	**ENVIRONMENTAL MANAGEMENT FOR SUSTAINABLE MINING**						**OE-III**
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	30	70	2

Course Objectives

1. To teach the fundamental concepts and principles of ecology and their relevance to environmental management is the context of mining activities.
2. To explain identification of sources and types of environmental pollutants arising from surface and underground mining
3. To impart knowledge on analyzing the impacts of water, noise, and land pollution due to mining activities
4. To illuminate knowledge of environmental management system, standards, and impact assessments, emphasizing the cost-benefit analysis and environmental accounting
5. To familiarize environmental laws and regulations pertinent to mining, understanding the roles and responsibilities of regulatory agencies and the process for obtaining environmental clearances

Course Outcomes

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

1. Comprehend the interplay between ecological principles, human activities, and the environment, formulating strategies for sustainable development in mining.
2. Recognize source and classifications of mining-related pollutants, effectively measuring, analysing, and implementing control measures to mitigate air and dust pollution
3. Evaluate the standards and preventive measures for water, noise and land pollution, including the impact on human health and methods for environmental restoration
4. Understand environmental management plans, conduct environmental impact assessments
5. Gain proficiency in environmental laws, understanding the procedural aspects of obtaining environmental clearance for mining projects and ensuring compliance with regulatory standards

UNIT I

ENVIRONMENT & ECOLOGY

Concept of Ecology, ecological principle, nature of the environment ecology and man. Goals, strategies and tools for environmental management – systems approach to environmental management – environmental guidelines – National Policies on environment with respects to mining activities – Global and Local environmental issues – resource degradation – desertification – Industrialization, Objectives of Sustainable Development.

UNIT II

ENVIRONMENTAL POLLUTION-I

Environmental Pollutants due to surface and underground mining – Air, Water, Noise, Sources and Classification of pollutants including dust and their effect on human health, Sources, hazards, sampling and analysis, standards, instrumentation and measurement of pollutants including dust, Control and preventive measure for air pollution including for dust, Structure of the atmosphere – ozone layer depletion – Acid rain – Greenhouse gases and global warming Ambient Air quality and emission standards, Air quality Sampling and monitoring, Dispersion of air pollutants

UNIT III

ENVIRONMENTAL POLLUTION-II

Environmental Pollution due to Water – Sources, Classification and measurements of pollutants and their effect on human health, hazards, sampling and analysis, Water pollution, measurement standards, Noise standards – Measurement – Noise Impact Index assessment, Control and preventive measures for water, noise pollution. Pollution due to equipment vibrations & their monitoring, prevention and control, Land pollution, land for alternation dealing with mind outland, re-vegetation, land use plan, Textural classification and properties of soil. Impact of pollution on human health.

UNIT IV

ENVIRONMENTAL MANAGEMENT

Environmental quality objectives, Emission and ambient standards – Minimum National standards – International environmental standards – ISO 14000 – EIA Notification – Siting of Industries – Environmental management plans, Environmental impact assessment, Environmental management system audits, Environmental economics – Principles of cost benefit analysis – Valuingthe Environment – Environmental Accounting, Environmental administration- training awareness and competence

UNIT V

ENVIRONMENTAL LEGISLATIONS

Environmental laws, the Environmental (Protective) Act, 2004, The Water Act (1974), The Air act (1981), The Forest Act 1927, The forest conservation act 1980, Power and responsibilities of regularity agencies and occupation consent to establish and operate wild life protection act and rules, Environmental clearance procedure for a mining Project

TEXT BOOKS:

1. Mackenthun, K.M. Basic Concepts in Environmental Management, Lewis Publications, London, 1998
2. Shyam Divan and Armin Rosencranz, Environmental Law and Policy in India, Oxford University Press, New Delhi.(2001)

REFERENCES

1. Hartman, H.L. Mine Ventilation and Air Conditioning, Wiley Interscience publication, 1999.
2. Mishra, G.B. Mine Environment and Ventilation, Oxford University Press,1992.
3. McPherson, M.J. Subsurface Ventilation and Environmental Engineering, Chapman & Hall Publication, London, 1993
4. Manahan S.E. Environmental Science andTechnology
5. Gregor I. Mcgregor. Environmental Law and Enforcement, Lewis Publishers, London,1994
6. Noel de Nevers, Air Pollution Control Engg., McGraw Hill, New York,1995
7. Anjaneyulu,Y. Air Pollution & Control Technologies, Allied Publishers (P) Ltd, India,2002
8. Nick Hanley, Jaison F. Shogren and Ben White.Environmental Economics – In Theory and Practice, Macmillan India Ltd, New Delhi, 1999
9. Roger Perman, Yue Ma and James McGilvray. Natural Resources and Environmental Economics, Second edition, Addision Wesley Longman Ltd, Singapore,1997
10. Christopher Sheldon and Mark Yoxon, Installing Environmental Management System –a step by step guide, Earthsecan Publications Ltd, London,1999
11. Lee Kuhre, ISO 14001 Certification –Environmental Management Systems, Prentice

Course Code	Course title						Core/PE/OE
OE 801 BM	**BASIC MEDICAL EQUIPMENT**						**OE-III**
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	30	70	2

Course Objectives

1. To make the student understand the need for several Biomedical Equipments.
2. To make the students understand the operating principles of a wide range of Biomedical Equipment.

Course Outcomes

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

1. Learn about various physiological parameters, monitoring and recording.
2. Assess the need and operating principle of equipment used in physiotherapy
3. Interpret the working principle and operating procedure and applications of Medical Imaging equipments.
4. Perceive the governing principles and functions of critical care equipments.
5. Learn about the various Therapeutic Equipment used for different applications

UNIT-I

*Medical Monitoring and recording***:** Patient monitoring: System concepts, bedside monitoring systems, central monitors, heart rate and pulse rate measurement. Temperature measurement Blood pressure measurement: Direct and indirect methods. Respiration rate measurement: Impedance pneumograph, Apnoea detectors. Ambulatory monitoring: Arrhythmia monitor

UNIT-II

Physiotherapy and Electrotherapy Equipment: Diathermy machines: Short wave diathermy, Microwave diathermy and ultrasonic diathermy Electro diagnostic/Therapeutic apparatus: Nerve muscle stimulator, Functional electrical stimulator etc

UNIT-III

Medical Imaging Equipment:

Ray machines: Properties and production of X-Rays, X-ray machine, Image Intensifier. X-ray computed tomography: basic principle and construction of the components. Ultrasonic Imaging: Physics of ultrasonic waves, medical ultrasound, basic pulse echo apparatus.

Magnetic Resonance Imaging: Principle, Image reconstruction techniques, Basic NMR components, Biological effects, Merits

UNIT-IV

Critical care Equipment:

Ventilators: Mechanics of respiration, artificial ventilators, Positive pressure ventilator, Types and classification of ventilators. Drug delivery system: Infusion pumps, basic components, implantable infusion system, closed loop control in infusion pump. Cardiac Defibrillators: Need for defibrillators, DC defibrillator, Implantable defibrillators, Defibrillator analyzer

UNIT-V

Therapeutic Equipment:

Cardiac pacemakers: Need for cardiac pacemakers, External and implantable pacemakers, types. Dialysis Machine: Function of kidney, artificial kidney, Dialyzers, Membranes, Hemodialysismachine. Lithotripters: The stone diseases problem, Modern Lithotripter systems, extra corporealshockwave therapy

Suggested Readings:

1. R.S.Khandpur, Hand Book of Biomedical Instrumentation, Tata McGrawHill, Second Edition,2014.
2. John G.Webster, Medical Instrumentation Application and design, Wiley India Edition, 2009

Course Code	Course title						Core/PE/OE
OE 801 BM	**DATA SCIENCE USING R**						**OE-III**
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	30	70	2

Course Objectives

1. To learn basics of R Programming environment: R language, R-studio and R packages
2. To learn various statistical concepts like linear and logistic regression, clusteranalysis, time series forecasting
3. To learn Decision tree induction, association rule mining and text mining

Course Outcomes

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

1. Use various data structures and pack ages in R for data visualization and summarization
2. Use linear, non-linear regression models, and classification techniques for data analysis
3. Use clustering methods including K-means and CURE algorithm

UNIT-I

Introduction to R: Introduction, Downloading and Installing R, IDE and Text Editors, Handling Packages in R.

*Getting Started with R***:** Introduction, Working with Directory, Data Types in R , Few Commands for Data Exploration.

*Loading and Handling Data In R***:** Introduction, Challenges of Analytical Data Processing, Expression, Variables, Functions, Missing Values Treatment In R, Using _As' Operator To Change The Structure Of The Data, Victors, Matrices, Factors, List, Few Common Analytical Tasks, Aggregation And Group Processing Of A Variable, Simple Analysis Using R, Methods For Reading Data, Comparison Of R GUI's For Data Input, Using R With Databases And Business Intelligence System

UNIT-II

Exploring Data In R: Introduction, Data Frames, R Functions for Understanding Data in Data Frames, Load Data Frames, Exploring Data, Data Summary, Finding the Missing Values, Invalid Values and Outliers, Descriptive Statistics, Spotting Problems In Data with Visualization

UNIT-III

Linear Regression Using R: Introduction, Model Fitting, Linear Regression, Assumptions of Linear Regression, Validating Linear Assumption.

Logistic Regression: Introduction, What Is Regression? Introduction to Generalized Linear Model, Logistic Regression, Binary Logistic Regression, Diagnosing Logistic Regression, Multinomial Logistic Regression Model

UNIT-IV

Decision Tree: Introduction, What Is a Decision Tree? Decision Tree Representation In R, Appropriate Problems For Decision Tree Learning, Basic Decision Tree Learning Algorithm, Measuring Features, Hypothesis Space Search In Decision Tree Learning, Inductive Bias In Decision Tree Learning, Why Prefer Short Hypotheses, Issues In Decision Tree Learning.

*Time Series in R***:** Introduction, What Is Time Series Data, Reading Time Series Data, Decomposing Time Series Data, Forecasts Using Exponential Smoothing, ARIMA Models

UNIT-V

Clustering: Introduction, What Is Clustering, Basic Concepts in Clustering, Hierarchical Clustering, K-Means Algorithm, CURE Algorithm, Clustering in Non-Euclidean Space, Clustering for Streams and Parallelism.

Association Rules: Introduction, Frequent Item set, Data Structure Overview, Mining Algorithm Interfaces, Auxiliary Functions, Sampling from Transaction, Generating Synthetic Transaction Data, Additional Measures of Interestingness, Distance Based Clustering Transaction and Association.

*Text Mining***:** Introduction, Definition of Text Mining, A Few Challenges in Text Mining, Text Mining Verses Data Mining, Text Mining In R, General Architectures of Text Mining Systems, Pre-Processing of Documents In R, Core Text Mining Operations, Using Background Knowledge for Text Mining, Text Mining Query Languages.

Mining Frequent Patterns, Associations and Correlations: Basic Concepts and Methods. Frequent Item set, Closed Item set And Association Rules.

Frequent Item set: Mining Methods, Pattern Evaluation Methods, and Sentiment Analysis

Suggested Readings:

1. Seema Acharya, –*Data Analytics using R",* Mc Graw Hill education.
2. Nina Zumel and John Mount, –*Practical Data Science with R"*, Manning Shelter Island.
3. Crawley, MichaelJ., ― *The R book",* John Wiley & Sons, Ltd

Course Code	Course title						Core/PE/OE
OE 801 BM	**DATA SCIENCE USING R**						**OE-III**
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	30	70	2

Course Objectives

1. Understand basics of Cellular systems, their generations and Characteristics of Mobile Communications.
2. Understand the Frequency reuse mechanism for Mobile operations and Co-Channel interference concepts
3. Understand the Mobile signal Coverage in different terrains and Lee models
4. Understand the working of Antennas at Cell-site and at Mobile units.
5. Understand the various Handoff mechanisms and Concept of Dropped calls

Course Outcomes

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

1. Able to analyze the various operational features of Mobile Communication Systems
2. Able to deal with the Mobile communication system designs of Frequency re-use and Interference Factors
3. Able to carry out the Design aspects of Mobile signal coverage over different terrains
4. Able to analyze the different Cell-site and Mobile antennas for different applications
5. Able to characterize the Handoffs mechanisms

UNIT – I

Introduction to Cellular Mobile Communications: History of Mobile cellular: AMPS system (First-generation systems), Second-generation System, 3G Systems, 4G Systems, 5G Systems, Other Cellular-like Systems, Spectrum allocation, Spectrum Efficiency Considerations. Basic Cellular systems, Circuit-Switched and Packet-Switched Systems, Performance criteria, Voice quality, Data quality, Picture quality, Service quality and special features. Uniqueness of Mobile Radio Environment, Description of Mobile Radio Transmission Medium, Model of Transmission Medium, Mobile Fading characteristics, The Radius of Active Scatter region, Delay spread and Coherence Bandwidth, Noise level in Cellular Frequency band

UNIT – II

Frequency Reuse Concept and Cellular system Components: Concept of Frequency reuse channels, Frequency reuse schemes, Frequency reuse distance, Number of Customers in the System, Co-Channel Interference Reduction Factor, Desired C/I from a Normal case in an Omni-directional antenna System, Handoff mechanism, Cell splitting, Consideration of the Components of Cellular Systems, Antennas, Switching equipment and Data Links.

UNIT – III

Cell Coverage: General Introduction, Ground Incident angle and Ground Elevation angle, Ground Reflection angle and Reflection point, Obtaining the Mobile Point-to-Point Model (Lee Model), A standard condition, Obtain Area-to-Area Prediction model, The Phase difference between a direct path and groundreflected path, A general formula for Mobile Radio Propagation Propagation over water or Flat open area, Between Fixed stations, Land-to-Mobile transmission over water, Foliage Loss, Propagation in Near-In distance, Long distance propagation, Obtain Path loss from a Point-to-Point Prediction Model in Non-obstuctive condition and obstructive condition, Form of a Point-to-Point Model, General Formula and its Merit

UNIT – IV

Cell-Site and Mobile Antennas: Antennas at Cell-site, Omnidirectional antennas, Directional antennas, Location antennas, Set-up Channel antennas, Space Diversity Antennas at cell site, Umbrella-Pattern Antennas, Interference reduction antennas, Unique Situations of Cell-Site antennas, Smart antennas, types and applications Mobile Antennas, Roof-mounted antenna, Glass-Mounted antenna, High-gain antenna, horizontally and vertically oriented Space-Diversity Antennas

UNIT – V

Handoff and Dropped Calls: Value of Implementing Handoffs, Types of Handoff, Initiation of Hard Handoff, Delaying a Handoff, Forced Handoffs. Queuing of handoffs, Power difference Handoffs, MAHO and Soft Handoff, Cellsite Handoff only, Intersystem Handoff Introduction to Dropped Call Rate and Formula of Dropped Call Rate

Suggested Readings:

1. William C.Y.Lee, “Wireless and Cellular Telecommunications‖, 3rd International edition, McGraw Hill, 2006
2. Theodere S. Rappaport, “Wireless Communications, Principles and Practice‖, 2nd edition, Prentice Hall, 2003.
3. Gordon L. Stuber. ―Principles of Mobile Communications”, 3 rd edition, Springer Publications, 2011.

Course Code	Course title						Core/PE/OE
OE 804 BM	**INTERNET OF THINGS AND APPLICATIONS**						**OE-III**
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	30	70	2

Course Objectives

1. To introduce the concepts of automation in daily life.
2. To familiarize the concepts of all IoT based communication systems.
3. To understand the importance of cloud technologies in the field of IoT.
4. To get familiar with standard embedded boards like Raspberry Pi.
5. To study a real time system with a view of an application program interface (API)

Course Outcomes

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

1. Able to design IoT based solutions for given problem statements.
2. Able to develop programs for Raspberry Pi.
3. Able to demonstrate the functionality of cloud communication.
4. Able to analyze the technologies used in IoT.
5. Able to incorporate multiple sensors to develop an IoT based system

UNIT- I

Introduction to Internet of Things Definition and Characteristics of IoT, Physical Design of IoT: Things in IoT,IoT protocols, Logical Design of IoT: IoT functional Blocks, Communication Models, APIs, IoT enabling TEchnologies: Wireless Sensor Networks, Cloud Computing, Big Data Analytics IoT Applications: Smart Home, Smart Cities, Smart Environment, Smart Energy, Smart Retail and Logistics, Smart Agriculture and Industry, Smart Industry and smart Health (Ref1)

UNIT- II

Internet Principles and communication technology Internet Communications: An Overview – IP, TCP, IP protocol Suite, UDP. IP addresses – DNS, Static and Dynamic IP addresses, MAC Addresses, TCP and UDP Ports, Application Layer Protocols – HTTP, HTTPS, Cost Vs Ease of Production, Prototypes and Production, Open Source Vs Closed Source. Prototyping Embedded Devices – Sensors, Actuators, Microcontrollers, SoC, Choosing a platform, Prototyping Hardware platforms – Arduino, Raspberry Pi. Prototyping the physical design – Laser Cutting, 3D printing, CNC Milling.

UNIT- III

API Development and Embedded programming Getting started with API, Writing a new API, Real time Reactions, Other Protocols, Techniques for writing embedded code: Memory management, Performance and Battery Life, Libraries, Debugging. Developing Internet of Things: IoT design Methodology, Case study on IoT System for weather Monitoring.

UNIT -IV

IoT Systems - Logical Design using Python Introduction to Python, Data Types and Structures, Control Flow, Functions, Modules, Packages, File Hnadling, Date/Time Operations., Classes, and Python packages for IoT, IoT Physical Devices and Endpoints: Raspberry Pi, Interfaces of Pi, Programming pi with Python - Controlling LED and LDR using Pi with python programming.

UNIT- V

Cloud computing and Data analytics and IoT Product Manufacturing Introduction to Cloud storage models and Communication APIs, Amazon webservices for IoT, Skynet IoT Messaging Platform. Introduction to Data Analytics for IoT (Ref 1). Case studies illustrating IoT Design – Smart Lighting, Weather Monitoring, Smart Irrigation. (Ref 1) Business model for IoT product manufacturing, IoT Startups, Mass manufacturing, Ethical issues in IoT.

Suggested Readings:

1. Vijay Madisetti ,ArshdeepBahga, ―Internet of Things (A Hands-on-Approach)", VPT Publisher, 1st Edition, 2014
2. Adrian McEwen (Author), Hakim Cassimally‖, "Designing the Internet of Things", Wiley India Publishers
3. Kenneth A Lambert and B.L. Juneja, "Fundamentals of Python‖, Cenage Learning

Course Code	Course title						Core/PE/OE
OE 805 EC	**GLOBAL AND REGIONAL SATELLITE NAVIGATION SYSTEM**						**OE-III**
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	30	70	2

Course Objectives

1. To explain the basic principle of GPS and its operation.
2. To make the students to understand signal structure.
3. To make the students understand the GPS errors.
4. Highlight the importance of integrating GPS with other systems.
5. To make the students understand about various GRNSS.

Course Outcomes

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

1. Able to understand the principle and operation of GPS.
2. Able to understand the GPS Signal structure and services.
3. Able to understand about various errors.
4. Able to use of GPS in various fields such as navigation, GIS etc.
5. Able to understand principle of Operation of various GRNSS.

UNIT- I

Introduction to Satellites, their properties, Orbits and Launch vehicles, Kepler‘s Laws, GPS fundamentals: Principle of Trilaiteration, Transit, GPS Operating Principle, And Architecture: Space, Control and User Segments and its Frequencies.

UNIT- II

GPS Signal structure: C/A and P-Codes, SPS and PPS services, GPS Coordinate Systems: Significance, Types of GPS receivers, Selective Availability, Spoofing and Anti-spoofing.

UNIT- III

GPS Errors: Ionospheric error, Tropospheric error, Ephemeris error, Clock errors, Satellite and receiver instrumental biases, Multipath; Dilution of Precision (DOP).

UNIT- IV

GPS Modernization: Future GPS satellites, New signals and their benefits, New Control Segment, Principle of operation of DGPS, architecture and limitations, GPS Applications: Surveying Mapping Marine, air and land Navigation, Military and Space Application. GPS Integration with Geographic Information System (GIS), Inertial Navigation System (INS), Pseudolite and Cellular.

UNIT- V

Other GRNSS: GLONASS, GALILEO, QZNSS, CNSS and IRNSS System: Principle of Operation, Features and their Current Status.

Suggested Readings:

1. Ahmed El-Rabbany, ―Introduction to GPS", Artech House Publishers, 2/e, Boston 2006.
2. Elliot D Kaplan and Christopher J Hegarty,‖ Understanding GPS principles and applications‖, Artech House Publishers, 2/e Boston & London 2005.
3. B.Hofmann-Wellenhof, H.Lichtenegger, and J.Collins, ―GPS Theory and Practice," Springer Verlog, 5/e, 2008.

Course Code	Course title						Core/PE/OE
OE 806 EE	**APPLICATIONS OF ELECTRICAL ENERGY**						**OE-III**
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	30	70	2

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 know the applications of various lamps to factory lighting, street lighting etc.
4. To understand the concept of electric traction including speed – time curves of different traction services.
5. To understand systems of train lighting

Course Outcomes

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

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

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, 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- IV

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.

UNIT – V

Train Lighting: Systems of train lighting, Special requirements of train lighting, Methods of obtaining unidirectional polarity, Methods of obtaining constant output, Single battery system, Double battery parallel block system, Principal equipment of double battery system, Coach wiring, Dynamo

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. 4. B.L.Theraja, A Text Book of Electrical Technology, S.Chand& Company Ltd, Vol-I.

Course Code	Course title						Core/PE/OE
OE 807 ME	**COMPOSITE MATERIAL APPLICATIONS**						**OE-III**
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	30	70	2

Course Objectives

1. To know the properties of fiber and matrix materials used in composites, as well as some common manufacturing techniques.
2. To know the various moulding process and architecture of composite laminates
3. To know how to estimate the laminate properties from lamina properties.
4. To understand the strength of an orthotropic lamina and measurement of basic composite properties.

Course Outcomes

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

1. Understand the distinction of composites, its advantages, classification and applications
2. Predict the properties of composite lamina and laminate
3. Understand the testing of composites and design the structure using the appropriate design criteria

UNIT- I

Introduction to composite materials, general characteristics, Fibres, Matrix materials, interfaces, polymer matrix composites, metal matrix composites, ceramic matrix composites, carbon fibre composites.

UNIT- II

Molding Processes: hand layup, vacuum molding, compression molding, pultrusion molding, centrifugal molding, filament winding, prepegs and molding compounds and architecture of composite materials: laminates, sandwich composites and other architectures.

UNIT- III

Micromechanics of Composites: Mechanical properties: Production of Elastic constant, micromechanical approach, Halpin-Tsal equations, Transverse stresses. Thermal properties: Hygrothermal stresses, mechanics of load transfer from matrix to fibre.

UNIT- IV

Macromechanics of Composites: Elastic constants of a lamina, relations between engineering constants and reduced stiffness and compliances, variation of lamina properties with orientation, analysis of laminated composites, stresses and strains with orientation.

UNIT- V

Strength of an orthotropic lamina: Maximum stress theory, maximum strain criteria, maximum work (Tsai-Hill) criterion, quadratic interaction criteria. Designing with composite materials. Measurement of constituent material properties: Fibre tests, Matrix tests. Measurement of basic composite properties: Tensile test, compressive test, a plane shear test, interlaminar shear test, flexure test.

Suggested Readings:

1. Jones, R.M., "Mechanics of Composite Materials", McGraw Hill Co., 1967.
2. Ronald F. Gibson, "Principles of Composite Materials Mechanics", McGrawHill, Inc.,1994.
3. Krishan, K. Chewla, "Composite Material", Springer - verlag, 1987. 4. Carl. T. Herakovich, "Mechanics of Fibrous Composites", John Wiley Sons Inc., 1998

Course Code	Course title						Core/PE/OE
OE 808 ME	**INDUSTRIAL ADMINISTRATION AND FINANCIAL MANAGEMENT**						**OE-III**
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	30	70	2

Course Objectives

1. To understand various types of organizational structures, manufacturing processes and importance of plant layout and the role of scheduling function in optimizing the utilization of resources
2. To understand the importance of quality, inventory control and concepts like MRP I and MRP II
3. To understand the nature of financial management and concepts like breakeven analysis, depreciation and replacement analysis

Course Outcomes

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

1. Understand the different phases of product life cycle, types of manufacturing systems, plant layout
2. optimization problems
3. Role of scheduling function in better utilization of resources
4. Fundamental concepts of quality control, process control, material control and appreciate the importance of MRP-I and MRP –II.
5. Know the different terminology used in financial management and apply different techniques of capital budgeting
6. Analyse and various types of costs involved in running an industrial organization

UNIT-I

Types of organizations, organizational structures. Designing Products, Services and Processes: New product design and development. Product life cycle: phasing multiple products. Manufacturing process Technology: Product, job shop, batch, assembly line and continuous process technology; flexible manufacturing systems. Design of Services, service process technology operations capacity; capacity planning decisions, measuring capacity; estimating future capacity needs.

UNIT-II

Locating production and services facilities, effects of location and costs and revenues, factor rating, simple median model (linear programming) Layout planning; process layout; product layout — Assembly lines; line balancing manufacturing cellular layout. Scheduling systems andaggregate planning for production and services; loading assignment algorithm; priority sequencing and other criteria.

UNIT-III

Quality planning and Control: basic concepts, definitions and history of quality control. Quality function and concept of quality cycle. Quality policy and objectives. Economics of quality and measurement of the cost of quality. Quality considerations in design. Process control: machine and process capability analysis. Use of control charts and process engineering techniques for implementing the quality plan. Acceptance sampling: single, double and multiple sampling, operating characteristic Curve - calculation of producers risk and consumers risk.

UNIT-IV

Inventory control: deterministic and stochastic inventory models; variable demand; lead time, specific service level, perishable products and service. Inventory control in application; concepts for the practioners; saving money in inventory systems; ABC classifications. Inventory control procedures; Quantity - reorders versus periodic inventory systems; material requirement planning (MRP); MRP as a scheduling and ordering system; MRP system components; MRP computational procedure; Detailed capacity planning; MRP - limitation and advantages; Manufacturing Resources Planning (MRP-II).

UNIT-V

Elements of cost, overheads, breakeven analysis, depreciation, replacement analysis. Nature of financial management-time value of money, techniques of capital budgeting and method, cost of capital, financial leverage.

Suggested Reading

1. Buifa and Sarin, "Production and operations management" - Wiley Publications.
2. I.M. Pandey, "Elements of Financial Management" Vikas Publications, New Delhi, 1994.
3. James C. Van Home & John, M. Wachowicz, Jr., "Fundamentals of Financial Management", Pearson Education Asia, 11 Th ed. 2001.

Course Code	Course title						Core/PE/OE
OE 809 CS	**SOFTWARE ENGINEERING**						**OE-III**
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	30	70	2

Course Objectives

1. To introduce the basic concepts of software development- processes from defining a product to shipping and maintaining that product
2. To impart knowledge on various phases, methodologies and practices of software development
3. To understand the importance of testing in software development and study various testing strategies and software quality metrics

Course Outcomes

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

1. Acquire working knowledge of alternative approaches and techniques for each phase of software development
2. Acquire skills necessary for independently developing a complete software project
3. Understand the practical challenges associated with the development of a significant software system

UNIT-I

Introduction to Software Engineering: A generic view of Process: Software Engineering, Process Framework, CMM Process Patterns, Process Assessment. Process Models: Prescriptive Models, Waterfall Model, Incremental Process Models, Evolutionary Process Models, Specialized Process Models, The Unified Models, Personal and Team Process Models, Process Technology, Product and Process. An Agile view of Process: Introduction to Agility and Agile Process, Agile Process Models.

UNIT-II

Software Engineering Principles: SE Principles, Communication Principles, Planning Principles, Modeling Principles, Construction Principles, Deployment. System Engineering: Computer-based Systems, The System Engineering Hierarchy, Business Process Engineering, Product Engineering, System Modeling. Requirements Engineering: A Bridge to Design and Construction, Requirements Engineering Tasks, Initiating Requirements Engineering Process, Eliciting Requirements, Developing Use-Cases, Building the Analysis Model, Negotiating Requirements, Validating Requirements.

UNIT-III

Building the Analysis Model: Requirements Analysis Modeling Approaches, Data Modeling Concepts, Object-Oriented Analysis, Scenario-based Modeling, Flow-oriented Modeling, Class-based Modeling, Creating a Behavioral Model. Design Engineering: Design within the context of SE, Design Process and Design Quality, Design Concepts, The Design Model, Pattern-based Software Design

UNIT-IV

Creating an Architectural Design: Software Architecture, Data Design, Architectural Styles and Patterns, Architectural Design, Assessing Alternative Architectural Designs, Mapping Data Flow into a Software Architecture. Modeling Component-Level Design: Definition of Component, Designing Class-based Components, Conducting Component-level Design, Object Constraint Language, Designing Conventional Components. Performing User Interface Design: The Golden Rules, User Interface Analysis and Design, Interface Analysis, Interface Design Steps, Design Evaluation.

UNIT-V

Software Quality Assurance: Basic Elements, Tasks, Goals and Metrics, Formal Approaches, Statistical Software Quality Assurance, Software Reliability, ISO 9000 Quality Standards, SQA Plan.
Testing Strategies: A Strategic Approach to Software Testing, Strategic Issues, Test Strategies for O-O Software, Validation Testing, System Testing, The Art of Debugging.
Testing Tactics: Software Testing Fundamentals, Black-box and White-box Testing, Basis Path Testing, Control Structure Testing, O-O Testing Methods, Testing Methods applicable on the Class Level, Inter Class Test Case Design, Testing for Specialized Environments, Architectures and Applications, Testing Patterns.
Product Metrics: Software Quality, A Framework for Product Metrics, Metrics for the Analysis Model, Metrics for the Design Model, Metrics for Source Code, Metrics for Testing, Metrics for Maintenance

Suggested Readings:

1. Roger S.Pressman,‖ Software Enigneering: A Practitioner's Approach‖, 7th Edition, McGraw Hill, 2009.
2. Ali Behforooz and Frederick J.Hudson, ―Software Engineering Fundamentals‖, Oxford University Press, 1996.
3. Pankaj Jalote , ―An Integrated Approach to Software Engineering‖, 3rd Edition, Narosa Publishing House, 2008

Course Code	Course title						Core/PE/OE
OE 810 CS	**PYTHON PROGRAMMING**						**OE-III**
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	30	70	2

Course Objectives

1. To know the basics of Programming
2. To convert an 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, mergesort, 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, Updated for Python 3, Shroff/O‘Reilly Publishers, 2016 (http://greenteapress.com/wp/think- python/)

Course Code	Course title						Core/PE/OE
OE 811 CS	**CYBER SECURITY**						**OE-III**
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	30	70	2

Course Objectives

1. Understand the 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 applications.

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, searc 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 retrival, 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
MC-II	DESIGN OF EXPERIMENTS						MC
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	2	-	-	-	30	70	0

Course Objectives

1. To Understand design and conduct experiments, as well as to analyze and interpret data
2. To understand the process of designing an experiment including factorial designs with practical cases
3. An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, manufacturability, and sustainability.
4. To investigate and apply new statistical analyses using Minitab and other software
5. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

Course Outcomes

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

1. Gains the knowledge of DOE methodology and its tools.
2. Plan, Design , and Conduct Experiments with effectively
3. Analyze the resulting data to obtain the optimized conclusions
4. Understand the process of designing and experimentation with various
5. Approaches and Increase the efficiency of experimentations
6. Will be trained in statistical modeling and in the choice of experimental designs to use in scientific investigations

UNIT I

Introduction to Design of Experiments: History, Basic Principles of DOE, Steps for Planning, Conducting and Analysing of Experiment, Typical applications of Experimental design, Guidelines for Designing Experiments. Basic Statistical Concepts, Mean median and mode, Measures of Variability, Statistical Distributions: Normal, Log Normal & Weibull distributions, Hypothesis testing

UNIT II

Experimental Design, Factorial Experiments: factors, levels, interactions, Two-level, Three level experimental designs for two factors and three factors Factor effects, Factor interactions, Fractional factorial design, Response Surface Methodology: Central composite designs, Box–Behnken design

UNIT III

Experimental Design Quality: Using Taguchi's Orthogonal Arrays, Types, selection of standard orthogonal arrays, Signal to Noise Ratio, Evaluation of sensitivity to noise. Signal to Noise ratios for static problems: Smaller-the-better type, Nominal-the –better-type, Larger-the-better type. Signal to Noise ratios for Dynamic problems. Parameter & Tolerance Design and concepts.

UNIT IV

Analysis & Interpretation Methods: Analysis of variance (ANOVA), Regression analysis, Grey relational analysis from experimental data, case study problems.

UNIT V

Advanced Optimization Techniques: Multi stage optimization – dynamic programming; stochastic programming; Multi objective optimization, Genetic algorithms and Simulated Annealing techniques; Neural network & Fuzzy logic principles in optimization.

Suggested Readings:

1. Montgomery, D.C., Design and Analysis of experiments, John Wiley and Sons, 2003
2. Phillip J.Rose, Taguchi techniques for quality engineering, McGraw Hill, 1996
3. Fundamentals of Quality control and improvement 2nd edition, Amitava Mitra, Pearson Education Asia, 2002
4. Rao, Singaresu, S., "Engineering Optimization – Theory & Practice", New Age International (P) Limited, New Delhi, 2000
5. Johnson Ray, C., "Optimum design of mechanical elements", Wiley, John & Sons, 1990
6. Kalyanamoy Deb, "Optimization for Engineering design algorithms and Examples", Prentice Hall of India Pvt. 1995
7. Goldberg, D.E., "Genetic algorithms in search, optimization and machine", Barnen, Addison- Wesley, New York, 1989

Course Code	Course title						Core/PE/OE
PW 891 MN	PROJECT WORK - II						Core
	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	-	-	-	12	50	–	2

Course Objectives

1. To conduct further work on literature survey by referring journals and electronic media.
2. To finalize the fabrication of apparatus or device or instrument / fine tune the experimentation procedure / conduct field study / fine tune the use of computer program for the topic selected.
3. To conduct experiments in the laboratory or field and collect data for the project and obtain the results.
4. To analyze the results, form item no. 3 above and draw conclusions.
5. To prepare a report/ document comprising of statement of the problem, literature survey, methodology, results and analysis, and conclusions.

Course Outcomes

At the end of the course, students will learn new aspects, develop skills and demonstrate the ability to:

1. Conduct the project work by comprehending the problem by applying the principles .
2. Improve the design, fabricate apparatus or device or instrument / design experiments / conduct field study / fine tune the use of a computer program for the topic selected.
3. Gain expertise in conducting experiments in the laboratory or field or develop computer programs or learn use of computer program.
4. Comprehend the results and draw logical and meaningful conclusions.
5. To cultivate the team spirit by working in a team and gain knowledge in mutual interactions.
6. Develop 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 project is a team activity having 3-4 students in each team under the guidance of a supervisor selected by the students or expert in the relevant area.
2. The 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. 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 work on design, development and testing of the proposed work as per the schedule.
8. Completed project and documentation in the form of Project Report is to be submitted at the end of semester in consultation and approval of the Supervisor.

The progress of the 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 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.