SunRise University

Approved by Govt. of Rajasthan vide Sunrise University Act, 2011
Recognized by UGC Act, 1956 u/s 2 (f)

COURSE STRUCTURE & SYLLABUS M. Tech for MINING ENGINEERING PROGRAMME

SUNRISE UNIVERSITY

TEACHING SCHEME AND COURSE CONTENTS

FOR

M.TECH

IN

MINING ENGINEERING

Semester -I

Code	Subject	Cr	Hrs. /Week			Exam Hrs.	Maximum Marks				
			L	T	P		MS1	MS2	END TERM	IA	Total
Theory											
1MT MI01	Advanced Rock Mechanics and Ground Control	3	3	1	0	3	10	10	60	20	100
1MT MI02	Mine Planning and Design	3	3	1	0	3	10	10	60	20	100
Program Elective –I MT MI03	MTMI01	3	3	1	0	3	10	10	60	20	100
	MTMI02	3	4	1	0	3	10	10	60	20	100
Practicals & Sessionals											
Code	Subject	Cr	Hrs. /Week			Exam Hrs.	IA (60%)		EA (40%)		Total
			L	T	P		MP1 30%	MP2 30%			
1MT MI 05	Mine Planning and Design Lab	1MTMI 06	Mine Planning and Design Lab	1MTMI06	Mine Planning and Design Lab	1MTMI06	Mine Planning and Design Lab	1MTMI06	Mine Planning and Design Lab		100
	Grand Total	**27**	**18**	**6**	**11**						**500**

Semester - II

Code	Subject	Cr	Hrs. /Week			Exam Hrs.	Maximum Marks				
			L	T	P		MS1	MS2	END TERM	IA	Total
Theory											
2MTMI01	Mine Safety Management	3	3	1	0	3	10	10	60	20	100
2MTMI02	Mine Ventilation and Planning	3	3	1	0	3	10	10	60	20	100
Program Elective – III 2MTMI03	MN01	3	3	1	0	3	10	10	60	20	100
	MN 02	3	4	1	0	3	10	10	60	20	100
	MN 03										
Program Elective – IV MTMI04	MN 01										
Practicals & Sessionals											
Code	Subject	Cr	Hrs. /Week			Exam Hrs.	IA (60%)		EA (40%)	Total	
			L	T	P		MP1 30%	MP2 30%			
2MTMI05	Mine Ventilation and Planning Lab	1MTMI 06	Mine Planning and Design Lab	1MTMI 06	Mine Planning and Design Lab	1MTMI 06	Mine Planning and Design Lab	1MTMI 06	Mine Planning and Design Lab	100	
	Grand Total	**27**	**18**	**6**	**11**					**500**	

Semester - III

Code	Subject	Cr	Hrs. /Week			Exam Hrs.	Maximum Marks				
			L	T	P		MS1	MS2	END TERM	IA	Total
Theory											
3MTMI01	Program Elective /MOOCS	3	3	1	0	3	10	10	60	20	100
	MN 01	3	3	1	0	3	10	10	60	20	100
	MN 02	3	3	1	0	3	10	10	60	20	100
	MN 03	3	4	1	0	3	10	10	60	20	100
3MTMI02	Open Elective / MOOCS	3	4	1	0	3	10	10	60	20	100
Practicals & Sessionals											
Code	Subject	Cr	Hrs. /Week			Exam Hrs.	IA (60%)		EA (40%)		Total
			L	T	P		MP1 30%	MP2 30%			
3MTMI03	Dissertation Phase-I / Industrial Project (To be continued and Evaluated next Semester)*										200
	Grand Total	**27**	**18**	**6**	**11**						**500**

Semester - IV

Code	Subject	Cr	Hrs. /Week			Exam Hrs.	Maximum Marks				
			L	T	P		MS1	MS2	END TERM	IA	Total
Theory											
4MTMI01	Dissertation Phase II (Continued from III Semester)	3	3	1	0	3	10	10	60	20	200

M.Tech - I Sem		L	T	P	C
		3	0	0	3
ADVANCED ROCK MECHANICS AND GROUND CONTROL					

UNIT I - Stress Analysis: Stress analysis in 2D and 3D, equations of equilibrium, Mohr's Circles, plane stress and plane strain condition, stress distribution in simple structures, Flexure of beams and rectangular plates

UNIT – II- Properties of Rocks: Physico-mechanical properties of rocks including tri-axial strengths and in-situ strengths and their application in the design of different types of excavations, rock indices viz. drillability index, caving index, etc. Time dependent properties of rocks and their application in structural design, static and dynamic elastic constants of rocks, rock mass classification methods. Selection excavator based on rock properties.

UNIT III- In-Situ Stresses and Theories of Failure: In-situ stresses and instrumentation, drilling and blasting, measurement of stresses, strains, deformations, in-situ stress determination, strata monitoring in underground and opencast mines, mechanics a of drilling and blasting, blast vibration and its monitoring. Different theories of rock failure and their applications in design of mining structures.

UNIT IV - Design of Underground Openings, Subsidence, Rock Burst and Slope Stability: Design of single and multiple underground openings, pillars including shaft pillar, scaling factors, mining subsidence, rock burst, design of slopes and spoil banks, slope stability in rock & soil and its analysis, slope monitoring and stabilisation techniques. Design of pillars including barrier and shaft pillars.

UNIT V -Design of Mine Supports: Advances of mine supports, supports and bord and pillar and longwall workings, rock load assessment, design of different types of supports like conventional and non-conventional supports like shotcrete, fibre reinforced shotcrete, strata grouting, rock bolting, supports in tunnels and shafts,

Text Books:

1. Obert, L. and Duvall, W.I., Rock Mechanics and Design of Structure in Rock John Wiley and Sons Inc., New York, 1967.
2. Vutukuri, V.S., and Lama, R.D., Handbook on Mechanical Properties of Rocks, Vol. I, II, III and IV, Transtech Publication, Berlin, 1974/78

Reference Books

1. Peng, S.S., Ground Control, Wiley Interscience, New York, 1987.
2. Brady, B.H.G. and Brown, S.T., Rock Mechanics, Wiley Interscience, 1985.
3. Hoek, E., and Brown, S.T., Underground Excavations in Rocks, Institute of Mining Metallurgy, London, 1980.

M.Tech - I Sem		L	T	P	C
		3	0	0	3
MINE PLANNING AND DESIGN					

UNIT – I- Introduction: Technical factors in mine planning, methodology of mine planning, short range & long range, mine modelling, mine simulation systems approach to mine planning based on mine subsystem and their elements, mine plan generation.

UNIT – II- Open Pit Mining: Selection of initial mine cuts, location of surface structures, division of mining area into blocks, mine design, bench drainage, geometry, haul roads, slope stability; open pit limits and optimisation, calendar plan, production planning, production scheduling, economic productivity indices.

UNIT – III- Underground Mining: Location of mine entries, mine and auxiliary, optimisation of mine parameters, design of shaft pillars and protective pillars, planning of production capacity, layout of development drives / raises / winzes etc, length of faces, size of panels, etc, planning of support systems, ventilation, lay out of drainage system, planning production schedule and monitoring, selection of depillaring / stopping method, manpower management, economic/ productivity indices, techno economic analysis, mine reclamation design.

UNIT – IV- Equipment Planning: Latest technological developments in increase in both types and capacities of equipment used in mining operations. Planning and selection of equipment for different mining conditions. Equipment design for optimum drilling and blasting operations. Equipment information – performance, monitoring and expert systems. Innovative mining systems.

UNIT – V- Project Implementation and Monitoring : Pre-project activities – feasibility report, environment clearance, detailed project, report, sources of funds, import of technology, selection of contracts and contract administration, time management, cost control material management system, project quality assurance, social responsibility, government orders and guidelines. Environmental impact assessment and preparation of environmental management plan. Mine closure plan.

Text Books:

1. Jayanth Bhattacharya, Principles of Mine Planning-Allied Publishers, Delhi 2003.
2. Hustrulid, W. and Kuchta, M., (eds)., Fundamentals of Open pit Mine Planning and Design, Elsevier, 1995.

Reference Books:

1. Ehrenburger, V and Fajkos, A., Mining Modelling, Elsevier, 1995.
2. Bawden, W.F., and Archibald., J.F., Innovative Mine Design for the 21st Century Elsevier,1993.
3. Passamehtoglu, A.G., Karpuz, C., Eskikaya, S. and Hizal, T., (Eds), Mine Planning and Equipment Selection, Elsevier, 1994.
4. Pazdziora, J., Design of Underground Hard Coal Mines, Elsevier, 1988.
5. Swilski, and Richards, Underground Hard Coal Mines, Elsevier, 1986.
   Singh, B. and Pal Roy, P., Blasting in Underground excavations and mines, CMR Dhanbad, 1993.

M.Tech - I Sem		L	T	P	C
		3	0	0	3
GROUND IMPROVEMENT TECHNIQUES					

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

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

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

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

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

Text Books

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

Reference Books:

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

M.Tech - I Sem		L	T	P	C
		3	0	0	3

TUNNELING AND UNDERGROUND SPACE TECHNOLOGY

UNIT I - Introduction: Congestion in cities and its impact on development of social infrastructure for transport, water and power supply, separation of pedestrian and motorized vehicles and its movements, storage of materials, defence facilities including civil shelters. Parameters influencing location, shape and size; geological aspects; planning and site investigations. Natural caves, archaeological caves and their construction; Scope and application, historical developments, art of tunnelling, tunnel engineering, Tunnels for various purposes like road, rail, hydropower tunnels and caverns, Underground storage for LPG and crude oil, Nuclear waste disposal, Metro tunnels, future tunnelling considerations. Planning and design, Assessment of behaviour of tunnelling media, deformation modulus and rock pressure assessment; determination of appropriate size and shape; Design of openings in rocks with the help of field data; Instrumentation and monitoring; Numerical modelling to assess the stability.

UNIT II -Tunnelling Methods: Types and purpose of tunnels; factors affecting choice of excavation techniques; soil and rock sampling and testing, Methods - soft ground tunnelling, hard rock tunnelling, shallow tunnelling, deep tunnelling; Shallow tunnels – cut and cover, cover and cut, pipe jacking, jacked box excavation techniques, methods of muck disposal, supporting, problems encountered and remedial measures.

UNIT III - Tunnelling by Drilling and Blasting: Unit operations in conventional tunnelling; Drilling - drilling principles, drilling equipment, drilling tools, drill selection, specific drilling, rock drillability factors; Blasting - explosives, initiators, blasting mechanics, blast holes nomenclature; types of cuts - fan, wedge and others; blast design, tunnel blast performance - powder factor, parameters influencing, models for prediction; mucking and transportation equipment selection.

UNIT IV - Tunnelling by Roadheaders, Impact Hammers and Tunnel Boring Machines: Cutting principles, method of excavation, selection, performance, limitations and problems. Boring principles, method of excavation, selection, performance, limitations and problems; Road headers, Impact Hammers, Tunnel Boring Machines and applications.

UNIT V - Tunnel Surveying, Supports and Services: Surveying in Tunnels: Topographic and geological survey, Methods of surveying and different instruments used for surveying in tunnels, Supports in Tunnels: Principal types of supports, their design and applicability. Steel supports, rock bolts, shotcrete, wire mesh, chain link fabric and fibre reinforced shotcrete and other ground consolidation/grouting techniques. Ground Treatment in Tunnelling: Adverse ground conditions and its effect on tunnelling; introduction to ground control. Supports in Metro tunnels, Tunnel Services and Hazards: Ventilation, drainage and pumping. Explosion, flooding, chimney formation, squeezing ground.

Text Books:

1. Hudson, J.A., Rock Engineering Systems Theory and Practice, Ellis Horwood, England.
2. Clark G.B., (1987), Principles of Rock Fragmentation, john Wiley and Sons, New York.

Reference Books:

1. Lohanson, John and Mathiesen, C.F., Modern trends in Tunnelling and Blast Design, AA Balkima, 154 P, 2000.
2. Bickel J.O., Kuesel T.R. and King E.H., Tunnel Engineering Hand Book, Chapmen & Hill Inc., New York and CBS Publishers, New Delhi 2nd addition.

M.Tech - I Sem		L	T	P	C
		3	0	0	3
MODERN SURVEYING TECHNIQUES					

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, Pre and 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.

Text Books

1. Satheesh Gopi, Rasathishkumar, N.Madhu, – Advanced Surveying, Total Station GPS and Remote Sensing – Pearson education , 2007 ISBN: 978-81317 00679 52.
2. Alfred Leick, GPS satellite surveying, John Wiley & Sons Inc., 3rd Edition, 2004.

Reference Books:

1. Jie Shan and Charles K. Toth, Topographic Laser Ranging and Scanning – Principles and Processing, CRC Press, Taylor & Francis Group, 2009.
2. Rueger, J.M. Electronic Distance Measurement, Springer-Verlag, Berlin, 1996.
3. Michael Renslow, Manual of Airborne Topographic LiDAR, The American Society for Photogrammetry and Remote Sensing , 2013.
6. R.Subramanian, Surveying and Levelling, Oxford University Press, Second Edition, 2012.

M.Tech - I Sem		L	T	P	C
		3	0	0	3

INSTRUMENTATION IN MINING

UINT I -Electrical Instruments: Basic Concepts: Sensitivity, range, reproducibility and accuracy, drift, absolute and relative measurements, error, environmental factors and planning for instrumentation. Accuracy, precision, resolution, sensitivity, linearity, span and range - Dynamic characteristics. Ammeters (MI & MC), Volt meters, Watt meters (Dynami), Energy Meters, Megger, Power Factor meters, Earth resistance measurement. and thermocouples, Inclinometers

UINT II -Pressure Measurements and Flow Measurements: Unit of Pressure – Manometers- Different types, - Elastic type pressure gauges and sensors– Bourdon tube – Bellows – Diaphragm – Elastic elements with LVDT and strain gauge, deformation gauge – Capacitive type pressure gauge – Measurement of vacuum – McLeod gauge – Thermal conductivity gauge – Ionisation gauge. Piezometer, Flow meters – Variable head type flow meter – Orifice plate – Venture tube – Positive displacement flow meter: Nutating disc, Reciprocating piston, oval gear and helix type flow meter – Rotameter – Mass flow meters.

UNIT III -Vibration, Humidity, Velocity and Level Measurements: Mechanical type vibration measuring instruments – Seismic instruments as an accelerometer – Vibrometers – Geo-phones. Humidity – Hot wire electro type hygrometer – Dew cell – Electrolysis type hygrometer. Anemometer, Velometer, Pitot static tube, Sound level meter, microphone, Lux meter; Level measurements: – Float gauges - Displacer type – D/P methods -Bubbler system- Load cell – Electrical types – Conductivity sensors – Capacitive sensors – Nucleonic gauge - Ultrasonic gauge – Boiler drum level measurement :– Differential pressure method and Hydrastep method -Solid level measurement.

UNIT IV -Analysers: Dissolved Analyzer: Conductivity meter – pH meter – Dissolved oxygen analyser – Sodium analyser – Silica analyser – Turbidity meter – Gas analyser – O_2, NO_x – H_2S analyser – CO and CO_2 monitor, Dust & Smoke measurement. IR analyzers, thermal conductivity analyzers, analysis based on ionization of gases. hydrocarbons, nitrogen oxides, sulphur dioxide estimation - Calibration methods.

UNIT V -Rock Mechanics Instrumentation: Different types of Load cells, stress capsules, Flat jack, tape extensor meters, convergence indicators and recorders, borehole deformation gauges of different types, depth indicators. Seismic measurements, Applications in Mining**:** Coal mining – bord and pillar development, depillaring and Long wall, Metal mining and opencast mining applications, rock slope instrumentation.

Text/ Books

1. De, N.K. and Sen, P.K. 'Electric Drives' Prentice Hall of India Private Ltd, 2002.
2. Subramaniam, V. 'Electric Drives' Tata McGraw Hill , New Delhi,2007

Reference Books:

1. Dubey, G.K. 'Fundamentals of Electrical Drives' Narosa, Second Edition.
2. Morrris, A.S. Principles of Measurement and Instrumentation, Print ice-Hall of India Pvt., Ltd. New Delhi, 1999.
3. Doeblin, E.O. Measurement Systems Application & Design, Tata McGraw Hill Publishing Co., New. Delhi, 1999.

M.Tech - I Sem		L	T	P	C
		3	0	0	3
INTRODUCTION TO ROBOTICS AND APPLICATION TO MINING					

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

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

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

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

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

Tex Books

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

References Books:

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

M.Tech - I Sem		L	T	P	C
		3	0	0	3
REMOTE SENSING & GEOGRAPHICAL INFORMATION SYSTEM					

UNIT-I - Basic principles of Remote Sensing: Definition and components, Electro Magnetic Radiation; Wavelength regions of electro-magnetic radiation; Types of remote sensing with respect to wavelength regions; Black body radiation; Reflectance; spectral reflectance of land covers.

UNIT-II - Sensors and platforms: Types of sensors: Multispectral, Hyper-spectral, Microwave, scanners-along track and across track; Platform and their types-Geostationary and Polar orbiting, platforms based on altitudes. Satellite missions–MODIS, IRS, LANDSAT, SPOT, marine/ocean observation satellites.

UNIT-III - Digital Image Processing (DIP): Interpretation of Images; Registration: Transfer of Information from Imagery to Base Map; Classification; Exposure to various Image Processing Techniques and Generation of digitally processed outputs.

UNIT-IV - Geographical Information System (GIS): Definitions, History and development of GIS, components of GIS, applications of GIS; Coordinate Systems - Geographical Coordinate Systems, Projected Coordinate System, map projections; Geospatial data - Data input-existing GIS data, creating new data; attribute data query, spatial data query, raster data query.

UNIT – V - Applications: Recent trends in RS&GIS and Environmental assessment & monitoring, Land Use and Land cover classification, Vehicle tracking system, Application of Geo-statistical methods and GIS in mineral prospecting and ore reserve estimation, Applications of GPS in Mineral Resource Surveys, Mapping and Navigation. Role of DGPS surveys in mining leases and identifying illegalities.

Text Books

1. Anji Redddy M. Remote sensing and geographical information systems. 3rd edition. 2008.
2. Kaplan ED. Understanding GPS: principles and application. British Library Catalogue. 2006

Reference books:

1. Lillesand TM and Kiefer RW. Remote sensing and image interpretation. John Wiley and Sons, New York, 2004.
2. ML and Chouhan TS. Remote sensing and photogrammetry: principles and applications. Vigyan Prakashan, Jodhpur. 1998.

M.Tech - I Sem		L	T	P	C
		0	0	4	2
ROCK MECHANICS LAB					

1. Sample collection and Specimen preparation.
2. Determination of moisture content, density, voids ratio and porosity of rocks.
3. Determination of compressive strength, modulus of elasticity and poisson's ratio of rocks.
4. Determination of tensile strength of rocks.
5. Determination of shear strength, angle of internal friction and cohesion of soil.
6. Determination of point load strength index of rocks.
7. Determination of protodyknov's strength index of rocks.
8. Determination of slake durability index of rocks.
9. Determination of cohesion and angle of internal friction of rocks using triaxial test.
10. Determination of hydraulic conductivity of sand.

M.Tech - I Sem		L	T	P	C
		0	0	4	2
MINE PLANNING AND DESIGN LAB					

1. Estimation of reserves of coal and metaliferous deposits.
2. Design of the haul roadway of open pit mines.
3. Design of the surface mine.
4. Design of underground coal mine.
5. Design of mine ventilation system for board and pillar method.
6. Design of mine ventilation system for long wall panel.
7. Design of blast for open pit workings.
8. Design of blast for cast blasting technique.

I Year - I Semester		L	T	P	C
		2	0	0	2
RESEARCH METHODOLOGY AND IPR					

UNIT 1:

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

UNIT 2:

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

UNIT 3:

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT 4:

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

UNIT 5:

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

REFERENCES:

(1) Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
(2) Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
(3) Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
(4) Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
(5) Mayall, "Industrial Design", McGraw Hill, 1992.
(6) Niebel, "Product Design", McGraw Hill, 1974.
(7) Asimov, "Introduction to Design", Prentice Hall, 1962.
(8) (8) Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.
(9) T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

M.Tech - I Sem		L	T	P	C
		2	0	0	0
Writing Skills For Scientific Communication					

Unit-1:
Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness**,** Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising.

Unit-2: Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

Unit-3:
Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature.

Unit-4:
Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions.

Unit-5:
Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

Suggested Studies:
1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman'sbook .
4. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

COURSE OUTCOMES: The Students will be able to
CO1. Understand that how to improve your writing skills and level of readability
CO2. Learn about what to write in each section
CO3. Understand the skills needed when writing a Title Ensure the good quality of paper at very first-time submission

M.Tech - II Sem		L	T	P	C
		3	0	0	3

MINE SAFETY MANAGEMENT

UNIT I

Mine accidents and their analysis: Accident in mines;- different types, accident investigations; In-depth study of accidents due to various causes; and Human Behavioural Approach in mine safety, accident prevention and corrective action, accident proneness, creating and maintaining safety awareness, ZAP and MAP, job safety analysis, safety meeting and committee**.**

UNIT II

Health and mine safety: Definition of health and safety, management's role – function; evolution of management involvement, management's training, responsibility, cost of health and safety, role of labour organizations – Union impact and involvement, role of government – statutory controls and directions, spot and regular inspections, enforcement of standards, penalties for violations, collection and distribution of statistical data. Safety audit methods; Safety records management, Training of Miners. Recent trends of development of safety engineering approaches.

UNIT III

Fault tree analysis: Introduction – methodology, symbols and Boolean techniques, qualitative analysis, computerized methods, statistical analysis, safety information, systems design. Appraisal of advance Techniques - fault tree analysis, Failure–Statistical methods of Risk analysis: Appraisal of advanced techniques Mode and Effect Analysis (FMEA); Failure Mode Effect and Critical Analysis (FMECA)

UNIT IV

Risk assessment and disaster management: Principles, risk and hazard control, risk and hazard evaluation and data collection for identified health risks, exposure assessment and risk characterization, probabilistic risk analysis, risk management, safety culture, human factors, reliability evaluation, safety audit. Identification of causes of mine disasters, preventive action.
Concepts of Disaster, Types of Disaster and Dimensions of Natural and Anthropogenic Disasters (landslide, subsidence, fire and earthquake); Principles and Components of Disaster Management. Disaster Management and Mitigation, typical cases of mine disasters in India.

UNIT V

Miner's occupational diseases and enquiry committee: Miner's occupational health and diseases, preventive medical examinations, various types of injuries, compensable diseases, medical attention and removable of causative factors in the mines. Recommendations of inquiry committee carried out for safety and health issues in India.

Text / Reference books:

1. Brown DB. System analysis and design for safety. Prentice Hall. 1976.
2. Stranks J. Management systems for safety. Pitman publishing. 1994.
3. DeReamer R. Modern safety practices. John Wiley and Sons. 1959.
4. Wahab KA. New technology in health and safety. SMME. 1992.
5. Ericson CA. Fault tree analysis primer. Create Space Independent Publishing Platform. 2011.

M.Tech - II Sem		L	T	P	C
		3	0	0	3

MINE VENTILATION AND PLANNING

UNIT-I

Mine Gases: Origin, occurrence, physical, chemical and physiological properties of mine gases, instruments used for spot detection of mine gases. Various damps, methane drainage techniques. Gas chromatography.

UNIT-II

Mine Climate and Control: Sources of heat and humidity in mines and their effects, instruments used for measurement of temperature, humidity, pressure and velocity. Heat stress indices, Cooling power and method of improving cooling power.

UNIT-III

Natural Ventilation and Laws of Air flow: Natural ventilation, Factors effecting NVP, Direction of air flow, Derivation of NVP, Motive column, Atkinson law governing airflow in mine openings.

UNIT-IV

Mechanical Ventilation: Definition of Mechanical ventilation, Different types of fans and their characteristics, Operating point, Fan laws, installation. Ventilation appliances, economic size of roadways, determination of quantity and head requirements. Fan selection and evasee.

Ventilation networks: simple and complex, solutions to simple ventilation network. Introduction to Hardy cross method for solving complex network. Introduction to ventilation softwares.

UNIT-V

Ventilation Planning: Standards of ventilation, ascensional ventilation, descensional ventilation, ventilation planning for different mining methods: Bord and pillar, Longwall mining method and cut and fill, sub level caving and shrinkage stoping method.

Text / Reference books:

1. Mishra GB. Mine environment and ventilation. Oxford University Press. 1992.
2. Hartman HL. Mine ventilation and air conditioning. Wiley Interscience publication.1993.
3. Hall CJ. Mine ventilation engineering. Society of mining engineers, New engineers, New York, 2nd Edition. 1992.
4. Vutukuri VS. Mine environment engineering, Trans tech publishers. 1986.
5. McPherson MJ. Subsurface ventilation and environmental engineering. Chapman and hall publication, London. 1993.

M.Tech - II Sem		L	T	P	C
		3	0	0	3

SURFACE MINE ENVIRONMENTAL ENGINEERING (MN 2031)

UNIT I

Introduction: Goals, strategies and tools for environmental management – systems approach to environmental management – environmental guideline – National Policies on environment with respects to mining activities – Global and Local environmental issues – resource degradation – desertification – Industrialization, Objectives of Sustainable Development. Structure of the atmosphere – ozone layer depletion – Acid rain – Green house gases and global warming Ambient Air quality and emission standards, Air quality Sampling and monitoring, Dispersion of air pollutants.

UNIT II

Environmental Pollution – I: Environmental Pollutants due to surface – Air, Water, Noise, Sources and Classification of pollutants including dust and their effect on human health, Sources, hazards, sampling and analysis, standards, instrumentation and measurement of pollutants including dust, Air born dust modeling, Control and preventive measures for air pollution including for dust, , Water pollution standards, Noise standards – Measurement – Noise Impact Index assessment, Control and preventive measures for water, noise pollution. Pollution due to blast and equipment vibrations their monitoring, prevention and control.

UNIT III

Environmental Pollution – Ii: Land pollution, land for alternation dealing with mind out land , re-vegetation, tailing management, tailing dams, method and construction, land use plan, Mine closure planning. Textural classification and properties of soil. Impact of pollution on human health, miner's diseases and their social impact.

UNIT IV

Environmental Management: Environmental quality objectives, Emission and ambient standards – Minimum National standards – International environmental standards – ISO 14000 – EIA Notification – Sitting of Industries – Environmental management plans, Environmental impact assessment, Environmental management system audits, Environmental economics – Principles of cost benefit analysis – Valuing the Environment – Environmental Accounting, Environmental administration- training awareness and competence, Mine subsidence, its prediction and control.

UNIT V

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

Text/Reference Books:

1. Manahan S.E. Environmental Science and Technology.
2. Mackenthun, K.M. Basic Concepts in Environmental Management, Lewis Publications, London, 1998.
3. Noel de Nevers, Air Pollution Control Engg., McGraw Hill, New York, 1995
4. Anjaneyulu,Y. Air Pollution & Control Technologies, Allied Publishers (P) Ltd, India, 2002.
5. Nick Hanley, Jaison F. Shogren and Ben White. Environmental Economics – In Theory and Practice, Macmillan India Ltd, New Delhi, 1999.
6. Roger Perman, Yue Ma and James McGilvray. Natural Resources and Environmental Economics, Second edition, Addision Wesley Longman Ltd, Singapore, 1997.

M.Tech - II Sem		L	T	P	C
		3	0	0	3
MINE SYSTEM ENGINEERING (MN 2032)					

UNIT I

Introduction: Introduction to systems engineering, systems concept and analysis, models in systems analysis, tools and methodology of system analysis.

UNIT II

Operations Research: Introduction to operations research, introduction to linear programming, application to mineral industry.

UNIT III

Simulation Techniques: Introduction to Monto-carlo sampling and deterministic simulation of different mining subsystems and total system, simulation application for equipment selection and production scheduling.

UNIT IV

Network Analysis: Network analysis, monitoring and control of developmental activities in mining project by CPM and PERT.

UNIT V

Miscellaneous: Inventory of mineral resources, basic models and optimisation, introduction to statistical decision theory and its application in mineral industry.

Text/ Reference Books:

1. Syal, I.C., and Gupta, B.P., Computer Programming and Engineering Analysis, A.B., Wheeler and Company, Madras 1986.
2. Anon., Management by Network Analysis, The Institution of Engineers (India), 1976.
3. Rao, S.S., Finite Element Methods in Engineering, Pergamon Press, 1982.
4. Cummings, A.B., and Given I.V. SME Mining Engg., Handbook Vol I and II, SME-41 ME, Inc, New York, 1973.

M.Tech - II Sem		L	T	P	C
		3	0	0	3

SUSTAINABLE MINING INDUSTRY (MN 2033)

UNIT-I

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

UNIT-II

Current status of mining practices and their impact on sustainability. Mining and environmental frame work , National mineral policies in mineral based countries. Indian national mineral policy, its historical development with the changing goals and sustainable practices. Issues of leases , auctions for mineral development in India.

UNIT-III

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

UNIT-IV

Mine water- Water conservation Acts and rules in India.New Initiatives in mines. Underground mine water, Water pollution and control measures, Phyto-remediation, Sewage and effluent treatment plants, their use and benfits.Waste management- processing of overburden material for underground stowing and innovative methods for utilisation of waste from mines.
Air quality in open pit mines, dust control measures, noise levels- pollution, monitoring and control.
Bio-divrsity- Land reclamation and plantation. Mine closure plan- Collection and disbursement of Mine closure fund for both open pit and underground mines in India.

UNIT-V

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

Text books:

1.MMRD Act 2015 and amendments, Ministry of Mines
2.Mineral concession Rules
3.Guidelines of MOEF and Climate change,- Annual reports of MOEF&CC, Ministry of Mines, Ministry of Coal in India,
4Sustaianble mining practices –A global perspective by Vasudevan Rajaram, Subijoy Dutta, Krishna Paremeswaran,ISBN-90-5809-689-0

M.Tech - II Sem		L	T	P	C
		3	0	0	3

GEO STATISTICS (MN 2041)

UNIT - I

Introduction to mineral exploration: Significance and necessity; Prospecting and exploration criteria; Exploration strategy and design - stages of mineral exploration; theory and methods of sampling; resources and reserves - terminology and classification schemes; conventional methods of ore estimation.

UNIT - II

Classical statistical distributions: normal and lognormal, and their applications in resource evaluation.

Geostatistics: definition; schools of thought; stationarity assumptions and regionalized variables; what, when and why of Geostatistics.

UNIT - III

Semi-variogram and co-variogram: definitions, characteristics, and computations in one, two and three dimensions; mathematical models; associated difficulties viz. anisotropy, non-stationarities, regularisation, presence of nugget effect and presence of trend. Extension, estimation and dispersion variance; calculation by discretisation and auxiliary functions.

Kriging: definition and derivation of Kriging system of equations. Practice of semi-variogram modeling; practice of Kriging - steps and procedure. An introduction to advanced Geostatistics.

UNIT - IV

Advanced Geostatistics: Practical difficulties associated with semi-variography, viz. anisotropy, non-stationarity, regularisation, misclassified tonnage; grade control plan. presence of nugget effect and presence of trend. Extension, Estimation and Dispersion variances: definitions, methods of calculations and applications; Screen Effect.

UNIT - V

Geostatistical applications: optimization of exploration drilling; calculation of mineral inventory; establishment of grade-tonnage relations; misclassified tonnage; grade control plan. Geostatistical conditional simulation - theory and approach. Geostatistical case studies of selected mineral deposits.

Text / Reference books:

1. Sarma DD. Geo statistics with applications in earth sciences. Springer publications. 2009.
2. Journel AG and Huijbregts C J. Mining geo statictics. Academic press. 1981.
3. Andereson F. Geo statictics by example approach using R. 2006

M.Tech - II Sem		L	T	P	C
		3	0	0	3

ADVANCED UNDERGROUND MINE PLANNING AND DESIGN (MN 2042)

UNIT - I

Introduction: Exploration, resource, reserve, grade, thickness and size of the deposit, the various reserve estimation techniques. Characteristics of planning process, scope of mining activities, stages of mine planning, feasibility report, detailed project report, mining plan, mine closure plan, mine environmental plan and other plans.

UNIT – II

Underground coal mining methods: Classification of methods of mining coal; factors governing choice of coal mining methods. The various underground coal mining techniques: bord and pillar, blasting gallery, continuous miner, longwall and other special techniques. Criteria for selection of different mining equipment.

UNIT – III

Design of underground coal mining methods: Pillar mining systems: design of panels, rooms and pillars; design and methods of pillar extraction with bord and pillar, blasting gallery and longwall mining: methods and design considerations for exploitation of thick seams by inclined slicing, horizontal slicing and cross-inclined slicing methods; sub-level caving and integrated caving methods. Design and methods of exploitation of contiguous seams, exploitation of seams under water bodies and seams liable to bumps. Design and method of underground hydraulic mining. Underground gassification of coal.

UNIT - IV

Underground metal mining methods: Classification of exploitation methods; choice of mining systems - geomechanical, techno-economical, environmental and safety considerations. Factors governing the choice of methods. The different underground stoping methods: breast stoping, under hand and overhand, room and pillar, sublevel, square set, shrinkage , cut and fill methods and other stoping methods.

UNIT – V

Design of underground metal mining methods: General engineering design; design methods in mining; input parameter for design - geological and other rock mass parameters; empirical, observational and analytical methods of design; design of excavations in massive elastic, stratified and jointed rocks.

Design of stoping layouts for mining of different types of ore deposits. Unit operations of stoping. Mining in rockburst prone areas. Novel and innovative mining methods: hydraulic, thermal, hydrochemical and biochemical methods; marine mining and nuclear device mining systems.

Text / Reference books:

1. Mathur SP. Mine planning for coal. M G Consultants, Bilaspur. 1993.
2. Bhattacharya J. Principles of mine planning. Allied Publishers Pvt Limited, New Delhi. 2003.
3. Hustrulid W and Kuchta M. Open Pit Mine Planning and Design. A A Balkema Rotterdam. 1995.
4. Vorobjev BM and Desmukh RT. Advanced coal mining vol-II. Asia Publishing house, Bombay, revised edition. 1966

M.Tech - II Sem		L	T	P	C
		3	0	0	3

NUMERICAL METHODS IN GEOTECHNICAL ENGINEERING (MN 2043)

UNIT: 1

Introduction: Categories of Problems in Geo- technical Engineering, Finite Difference Method, Boundary Corrections for Grids. Accuracy, Convergence and Stability. Idealization of soil behaviour; Linear, Bilinear and multi- linear, Hyperbolic, Spline function, Ramberg – Osgood‟s Model, Polynomials, Higher order elastic models, perfect plasticity, frictional. Elastic models of soil behaviour – The winkler – Filenenko- boroditch – Pasternak – Ressiener models.

UNIT: II

Seepage: Finite Difference Solution to Laplace equation for Homogeneous and Layered Soils.

UNIT:III

Consolidation: Finite Difference Solution for One Dimensional, Two and three dimensional consolidations. Multi layered systems. Consolidation of Ground for Construction Load and Static Load.

Unit: IV

Shallow Foundations: Beams on Elastic foundations, solution by Finite Difference and – Finite Element Method (Direct Approach) Limit analysis, Lower Bound and Upperbound theories Method of Finite difference solution of Raft foundations.

UNIT: V

Pile Foundation: Pile Stresses – Static loading – Finite Element Method Solution (Direct approach) of the pile static pile capacity- wave equation - - Lateral piles by Finite Element Method (Direct Approach) and Finite Difference method.

REFERENCE:

1. Numerical methods in Geotechnical Engineering by C.S. Desai and J.T. Christian McGraw Hill publications.
2. Analytical and computer methods in foundation engineering, JE Bowles, McGraw Hill publications.
3. Foundation analysis and design, JE Bowles, McGraw Hill publications
4. Foundation analysis by RF Scott, Printice Hall
5. Hytenyi, Beams on Elastic Foundations – university of Michigan Press.
6. Elastic Analysis of Soil – Foundation Interaction, APS Selvadurai – Elsevier
7. Pile Foundation Analalysis & Design by Poulos and Davis.

M.Tech - II Sem		L	T	P	C
		0	0	4	2
GEOTECHNICAL ENGINEERING LAB (MN 205)					

List of Experiments:

1. Determination of moisture content and specific gravity of soil
2. Grain size distribution analysis and hydrometer analysis
3. Atterberg limits (liquid limit, plastic limit, shrinkage limit)
4. Field identification tests
5. Vibration test for relative density of sand
6. Standard and modified proctor compaction tests
7. Falling head permeability test and constant head permeability test
8. CBR

M.Tech - II Sem		L	T	P	C
		0	0	4	2
MINE VENTILATION AND PLANNING LAB (MN 206)					

1.Determination of air quantity.

2.Determination of air cooling power.

3.Detection of mine gases and construction of mine fans.

4.Performance of evasee.

5.Performance of fans in series and parallel.

6.Determination of weisbach coefficient.

7.Study and analysis of ventilation network.

8.Study of Fire extinguishers, rescue and reviving apparatus.

9.Study of various types of stopings and re-opening a sealed off area.

10Konimeter, gravimetric dust sampler and personal dust sampler.

M.Tech - I Sem		L	T	P	C
		0	0	4	2
MINI PROJECT					

M.Tech - III Sem		L	T	P	C
		3	0	0	3

INTRODUCTION TO PETROLEUM ENGINEERING (MN 3011)

UNIT-I

Introduction:

What is Petroleum Engineering & Significance? Introduction Petroleum Industry- Upstream Sector – Midstream Processing-Downstream Processing- Indian and World Scenario of Petroleum and Natural Gas- Petroleum Trade- Geopolitics.

UNIT II

Upstream Sector-1

Exploration & Production – Indian and World Scenario of Petroleum and Natural Gas Resources-

The Reservoir –Reservoir fluids- Hydrocarbon Phase diagrams- Onshore and Offshore Reservoirs – Reservoir Drives.

UNIT III

Upstream Sector-2

Exploration and Drilling Rigs- Rig Components-Drill and drill bits- Drilling fluids-Well Completions

Production System: Sketches of Well - Well head- Christmas tree and Casing and various other parts-

Cementing-Safety Systems- Subsea Wells: Drilling & Completion and Production

Artificial Lift: Principles and operation of Rod Pumps – Downhole Pumps – Gas Lift – Plunger Lift-Electrical submersible pumps.

Well Workover and Intervention- Well Stimulation: Matrix Acidizing and Hydro-fracturing.

UNIT IV

Gathering of Oil & Gas and Storage:

Well Tubing- Separaion of Reservoir Fluids- Manifolds and Gathering – Production Separators – Gas Treatment and Compression - Oil & Gas Storage, Metering and Export.

Midstream processing: Transportation of Crude Oil & its Products and Natural Gas- - World

and Indian pipeline scenario- Design of Oil and Gas pipelines - Safety aspects of pipelines- Environmental issues.

UNIT V

Downstream Processing

Crude Oil Refining: Classification and Composition – Constituents - Products and their specifications– Pre-treatment of crude oil- Refinery distillation- Safety in refinery operations.

Text Books:

1. Havard Devold, Oil and Gas Production Handbook: An Introduction to Oil & Gas Production,ABB ATPA Oil and Gas, 2006.
2. John R. Fanchi and Christiansen, R.L., Introduction to Petroleum Engineering, John Wiley & Sons, 2017.

Outcomes:

- The students will be able to understand the role of petroleum engineers in various facets of petroleum exploration, production, transportation, refining and processing.
- Students get motivated to work for the energy security after knowing the present scenario of petroleum and natural gas.

M.Tech - III Sem		L	T	P	C
		3	0	0	3
COMPUTATIONAL FLUID DYNAMICS (MN 3012)					

UNIT – I

Introduction: Finite difference method, finite volume method, finite element method, governing equations and boundary conditions. Derivation of finite difference equations. Solution methods: Solution methods of elliptical equations – finite difference formulations, interactive solution methods, direct method with Gaussian elimination. Parabolic equations-explicit schemes and Von Neumann stability analysis, implicit schemes, alternating direction implicit schemes, approximate factorization, fractional step methods, direct method with tridiagonal matrix algorithm.

UNIT – II

Hyperbolic equations: Explicit schemes and Von Neumann stability analysis, implicit schemes, multi step methods, nonlinear problems, second order one-dimensional wave equations. Burgers equations: Explicit and implicit schemes, Runge-Kutta method.

UNIT – III

Formulations of incompressible viscous flows: Formulations of incompressible viscous flows by finite difference methods, pressure correction methods, vortex methods. Treatment of compressible flows: potential equation, Eluer equations, Navier-stokes system of equations, flowfield-dependent variation methods, boundary conditions, example problems.

UNIT – IV

Finite volume method: Finite volume method via finite difference method, formulations for two and three-dimensional problems.

UNIT – V

Standard variational methods: Linear fluid flow problems, steady state problems, Transient problems.

TEXT BOOK:

1. Computational fluid dynamics, T. J.Chung, Cambridge University press,2002.
2. Computational Fluid Dynamics by John D. Anderson /TMH

REFERENCE:

1. Text book of fluid dynamics, Frank Chorlton, CBS Publishers &distributors, 1985.
2. Computational Techniques for Fluid Dynamics, Volume 1& 2 By C. A. J. Fletcher/ Springer

M.Tech - III Sem		L	T	P	C
		3	0	0	3
FINITE ELEMENT ANALYSIS (MN 3013)					

UNIT – I

Introduction: Background - General description of the method - Analysis Procedure. Node numbering – Mesh generation - Linear constitutive equations - Plane stress, Plane strain and axisymmetric cases of elasticity - Energy principles - Variational methods – Raleigh-Ritz method – Galerkin Method.

UNIT – II

One Dimensional Problems: Finite element modelling – Coordinates and shape functions – Linear and quadratic elements - Applications to axial loadings of rods – Extension to plane trusses – Bending of beams Element, Finite element formulation of stiffness matrix and load vectors – Assembly for global equations – Boundary conditions.

UNIT – III

Two Dimensional Problems: Convergence requirements - Constant Strain Triangular (CST) Element – Rectangular Element -Finite element modelling - Element equations, Load vectors and boundary conditions – Assembly - shape functions from Lagrange and serendipity family—Application to heat transfer.

UNIT – IV

Isoparametric Formulation: Introduction – Coordinate Transformation –Basic theorem of Isoparametric concept – Uniqueness of mapping – Isoparametric, Subparametric and Superparametric elements – Assembling Stiffness matrix – Numerical Examples.

UNIT – V

Applications: Application of displacement finite elements to the analysis of simple problems (one and two dimensional cases) in the area of structural mechanics. Computer Programs: Development of computer programs for an axial and beam bending elements – Programming and use of computer packages for design of underground excavations, mining structures, slope and dump stability, design of supports, etc.

Text/Reference Books:

1. Krishnamoorthy, C.S, Finite Element Analysis Theory & Programming, McGraw-Hill, 1995.
2. Desai C.S and Abel,, J.F., Introduction to Finite Element Method, Affiliated East West Press Pvt. Ltd., New Delhi, 2000
3. Chandrupatla T.R., and Belegundu A.D., “Introduction to Finite Elements in Engineering”, Pearson Education, 2011, 4th Edition.
4. Bhavikkatti, S.S. Introduction to Finite Element Analysis –Newage International (P) Limited Publishers, New Delhi, 2011.
5. Bathe. K.J., "Finite Element Procedure", Prentice Hall of India, New Delhi, 2006.

SEMESTER IV

S No.	Code	Course Name	L	T	P	C
1	MN 401	Dissertation Phase II (Continued from III Semester)	0	0	32	16
		Total				16