COURSE STRUCTURE and SYLLABUS

for

2 Year MSc in Applied Geology

Indian Institute of Petroleum and Energy

Visakhapatnam, Andhra Pradesh - 530003

SEMESTER – I						
Sl. No	**Code**	**Course Name**	**L**	**T**	**P**	**Credit**
1	ES4101	Igneous and Metamorphic Petrology	3	1	0	4
2	ES4102	Sedimentary Geology and Stratigraphy	3	0	0	3
3	ES4103	Geomorphology & Remote Sensing	3	1	0	4
4	ES4104	Advanced Structural Geology	3	0	0	3
5	ES4105	Geochemistry and Geochemical Prospecting	3	0	0	3
6	ES4106	Geonumerics	1	0	3	3
7	ES4107	Petrological Laboratory	0	0	3	2
8	ES4108	Geological Fieldwork I	0	0	0	2
Total			**16**	**2**	**6**	**24**

SEMESTER - II						
Sl. No	**Code**	**Course Name**	**L**	**T**	**P**	**Credit**
1	ES4201	Economic and Mining Geology	3	1	0	4
2	ES4202	Introduction to Petroleum Engineering	3	0	0	3
3	ES4203	Basin Formation, Development and Analysis	3	0	0	3
4	ES4204	Fundamentals of Geophysics	3	0	0	3
5	ES4205	Engineering Geology and Hydrogeology	3	1	0	4
6	ES4206	Geochemistry Lab	0	0	3	2
7	ES4207	Structural Geology Lab	0	0	3	2
8	ES4208	Industrial Training	0	0	0	2
Total			**15**	**2**	**6**	**23**

SEMESTER - III						
Sl. No	**Code**	**Course Name**	**L**	**T**	**P**	**Credit**
1	ES5101	Exploration Geophysics	3	1	0	4
2	ES5102	Geohazards and Environmental Geology	3	0	0	3
3	ES5103	Drilling Techniques	3	0	0	3
4	ES5104		3	0	0	3
5		Elective - I	3	0	0	3
6	ES5105	Engineering Geology and Hydrogeology Lab	0	0	3	2
7	ES5106	Prospecting Lab	0	0	3	2
8	ES5107	Project	0	0	3	2
9	ES5108	Geophysical Fieldwork II	0	0	0	2
Total			**15**	**1**	**9**	**24**

SEMESTER – IV						
Sl. No	**Faculty**	**Course Name**	**L**	**T**	**P**	**Credit**
1	ES5201	Geomechanics	3	1	0	4
2		Elective - II	3	0	0	3
3		Elective - III	3	0	0	3
4		Elective - IV	3	0	0	3
5	ES5202	Comprehensive Viva	0	0	0	2
6	ES5203	Project	0	0	12	6
Total			**12**	**1**	**12**	**21**
CUMULATIVE TOTAL			**58**	**6**	**33**	**92**

ELECTIVES						
Sl. No	**Code**	**Course Name**	**L**	**T**	**P**	**Credit**
1	ES6001	Geologic Carbon Sequestration	3	0	0	3
2	ES6002	Geothermal Energy	3	0	0	3
3	ES6003	Geology of Unconventional Hydrocarbons	3	0	0	3
4	ES6004	Well Logging	3	0	0	3
5	ES6005	Petrophysics for Mineral Exploration	3	0	0	3
6	ES6006	Geoinformatics for Resource Estimation	3	0	0	3
7	ES6007	Geodesy and GPS	3	0	0	3
8	ES6008	Ocean Energy and Resources	3	0	0	3
9	ES6009	Geotechnical Practice for Waste Disposal	3	0	0	3
10	ES6010	Seismic Signal Processing, Imaging and Interpretation	3	0	0	3
11	ES6011	Applied Micropaleontology	3	0	0	3
12	ES6012	Managerial Economics	3	0	0	3

Semester - I						
Course Type	**Code**	**Name of Course**	**L**	**T**	**P**	**Credit**
Core		*Igneous and Metamorphic Petrology*	*3*	*1*	*0*	*4*

Unit	**Topics to be covered**
1	Introduction: Overview of petrology, rocks. Structure and dynamics of the Earth. Where are igneous rocks generated; Classification and nomenclature
2	Textures, Structures and field relations; Phase rule, unary, binary and Ternary Systems; Mantle melting & generation of basalts; Diversification of magmas; Igneous Rock Associations (subduction zones and granitoids); Magmatism and plate tectonics
3	Introduction to metamorphism, types of metamorphism; Chemographics and metamorphic phase diagrams; Pelitic Rocks: Barrow's zones, AFM projections, discontinuous and continuous reactions
4	Types of metamorphic reactions; Metamorphism of mafic rocks, ultramafic rocks and calcareous rocks; P-T paths and orogeny; Thermobarometry; Metamorphic Fluids, mass transport and metasomatism

Text Books/ Reference:

1. An Evolution of Igneous Rocks by N. L. Bowen
2. Atlas Igneous Rocks and their Textures by McKenzie, Donaldson and Guilford
3. Essentials of Igneous and Metamorphic Petrology by B. Ronald Frost and Carol D. Frost
4. Igneous and Metamorphic Petrology by Best
5. Igneous and Metamorphic rocks under Microscope by Shelly
6. Igneous Petrogenesis and Global Tectonic Environments by Marjorie Wilson
7. Petrography by William, Turner and Gilbert
8. Petrology by Nockolds, Knox and Chinner
9. Principles of Igneous and Metamorphic Petrology by Anthony Philpotts and Jay Ague
10. Principles of Igneous and Metamorphic Petrology by John D. Winter

Course Type	Code	Name of Course	L	T	P	Credit
Core		*Sedimentary Geology and Stratigraphy*	*3*	*0*	*0*	*3*

Unit	Topics to be covered
1	Origin transport and deposition of sediments; Sedimentary textures and structures; Composition, Classification and Diagenesis of siliciclastic and carbonate rocks
2	Other Chemical/Biochemical and Carbonaceous Sedimentary Rocks; Depositional Environments; Sedimentary Basins of India
3	Principles of Stratigraphy; Lithostratigraphy; Seismic, Sequence and Magnetic Stratigraphy; Biostratigraphy; Chronostratigraphy and Geologic Time

Text Books/ Reference:

1. Applied Sedimentology by Richard C. Selly
2. Atlas of Sedimentary Rocks Under the Microscope by A. E. Adams, C. Guilford, and W. S. MacKenzie
3. Petrology of sedimentary rocks by Sam Boggs
4. Principles of Sedimentology and Stratigraphy by Sam Boggs
5. Sedimentary Rocks in the Field: A Colour Guide by D. A. V. Stow
6. Sedimentology and Stratigraphy by Gary Nichols
7. A Manual of the Geology of India and Burma (Vols. I-IV) by E.H. Pascoe
8. Depositional Sedimentary Environments by H.E. Reineck and I.B. Singh
9. Fundamentals of historical geology and stratigraphy of India by G. R. Ravindra Kumar
10. Geology of India and Burma by M.S. Krishnan
11. Geology of India: Volume 1 and Volume 2 by M. Ramakrishnan and R. Vaidyanathan
12. Principles of Sequence Stratigraphy by O. Catenuanu
13. Seismic Stratigraphy- Applications to Hydrocarbon Exploration, Memoir of the American Association of Petroleum Geologists 26 by C.E. Payton

Course Type	Code	Name of Course	L	T	P	Credit
Core		*Geomorphology & Remote Sensing*	*3*	*1*	*0*	*4*

Unit	Topics to be covered
1	Approaches to Geomorphology; Geomorphic Systems; techniques of geomorphic analysis of landforms, slopes, drainage and processes, morphometry, terrain classification; Landforms formed by fluvial, aeolian and glacial actions; Coastal Processes and Landforms.
2	Mineral prospecting, Drainage Basin Morphology and Hydrogeology; river-valley projects, land use planning, hazard and risk studies.
3	Electromagnetic radiation and remote sensing: interaction of EMR with atmosphere and terrain features, platforms and sensors, resolution and calibration aspects of remotely sensed data
4	Photogrammetry, aerial photo interpretation, satellite remote sensing, fundamentals of digital image processing and classification
5	Introduction to Geographic Information System, spatial data models and data structures, visualization and query of spatial data, overlay analyses. Geological applications of remote sensing data and GIS; Recent trends in RS & GIS.

Text Books/ Reference:

1. Remote Sensing and GIS by Basudeb Bhatta
2. Image Interpretation in Geology by Drury
3. Introduction to Remote Sensing by J. B. Campbell
4. Principles & Applications of Photogeology by S. N. Pande
5. Remote Sensing: Principles and Interpretation by F. F. Sabins
6. Introduction to Physical Geology by Thompson and Turk
7. Morphotectonics by Adrian E. Scheidegger.
8. Principles of Geomorphology by William D. Thornbury
9. Terrain Analysis by D.S. Way

Course Type	Code	Name of Course	L	T	P	Credit
Core		*Advanced Structural Geology*	*3*	*0*	*0*	*3*

Unit	Topics to be covered
1	Basic continuum mechanics (stress, strain, and rheology)
2	Description and analysis of fractures (i.e., landslides, faults, and intrusive bodies)
3	Rock deformation and rheology in the light of brittle, ductile and plastic deformation processes
4	Structural mapping techniques and tools

Text Books/ Reference:

1. Basic methods of Structural Geology by S. Marshak and G. Mitra
2. Folding and fracturing of rocks by J.G. Ramsay
3. Mapping of Geological Structures by K. McClay
4. Structural Geology by H. Fossen
5. Structural Geology of Rocks and Region by G.R. Davis
6. Structural Geology of Rocks and Regions by G.H. Davis and S.J. Reynolds
7. Structural Geology: Fundamental and Modern by S.K. Ghosh
8. Tectonics by Eldridge M. Moores and Robert J. Twiss

Course Type	Code	Name of Course	L	T	P	Credit
Core		*Geochemistry and Geochemical Prospecting*	*3*	*0*	*0*	*3*

Unit	Topics to be covered
1	Principles of crystal chemistry; Chemical bonds, Coordination principle, Radius ratio, Crystal structure
2	Cosmic abundance of elements, Geochemical classification and distribution of elements in the earth; Geochemical cycle (Sulphur cycle, Nitrogen cycle, Phosphorous cycle)
3	Primary geochemical differentiation of the earth; Composition of the Earth's core, mantle and crust; Composition of hydrosphere and atmosphere. Role of Eh-pH in ore formation; Phase rule and its application
4	Principles and methods of geochemical prospecting, pathfinders and trace elements in rocks and soils. Primary and secondary dispersion patterns, geochemical anomalies and their interpretation

Text Books/ Reference:

1. Essentials of Geochemistry (2nd Edition) by J. Walther
2. Geochemistry by M. White
3. Introduction to Geochemistry by Francis Albarede
4. Introduction to Geochemistry - Principles and Applications by K. C. Misra
5. Principles of Geochemistry by Brain Mason and Carleton B. Moore
6. Geochemistry in Mineral Exploration by Hawkes HE and Webb JS
7. Elements of Prospecting and Exploration by T.C. Bagchi, D.K. Sengupta and S.V.L.N. Rao
8. Geochemical exploration methods for mineral deposits by A. A. Beus and S. V. Grigorian

Course Type	Code	Name of Course	L	T	P	Credit
Core		*Geonumerics*	*1*	*0*	*3*	*3*

Unit	Topics to be covered
1	Development of algorithms and flowcharts. Basic elements of Matlab/Python: variables, data types, declarations.
2	Expressions: literals, characters and strings. Arithmetic operations, order of operations, intrinsic functions. Input/output. Conditional statements. Logical operations. File operations: open, read, write, close.
3	Programming exercises in simple numerical analysis and in geoscience application areas: Finding roots, Interpolation, non-linear system of equations, Measures of Central Tendency, Dispersion, Bivariate Statistics, Regression, semi-variograms, directional variograms, and covariance, neural network.

Course Type	Code	Name of Course	L	T	P	Credit
Core		*Petrological Laboratory*	*0*	*0*	*3*	*3*

Unit	Topics to be covered
1	Megascopic and microscopic identification of igneous, sedimentary and metamorphic rocks, CIPW normative calculation, Use of ACF, AKF and AFM diagrams for the study of metamorphic rocks.
2	Mechanical analysis of supplied sediment sample. Graphical plotting of given size data and determination of sample statistics.
3	Determination of paleocurrent direction with the help of rose diagram drawn from supplied data.

Semester - II

Course Type	Code	Name of Course	L	T	P	Credit
Core		*Economics and Mining Geology*	*3*	*1*	*0*	*4*

Unit	Topics to be covered
1	Introduction/Earth Resources/Minerals Industry; Types & Origin of Mineral Resources.
2	Modern Resource-forming Systems; Magmatic Hydrothermal Ore Deposits; Ores in Continental and Marine Volcanics; Weathering, supergene enrichment and residual deposits. Sedimentary, metamorphic and metamorphosed ore deposits. Important examples.
3	Geological mapping, guides for ore search, delineation of ores, drilling, core-sampling, reserve estimation.
4	Introduction to underground and surface mining methods. Underground exploration and sampling of ore deposits. Methods of computation of developed ore reserves. Introduction to geostatistical ore reserve estimation.

Text Books/ Reference:

1. Economic Geology Principles and Practice: Metals, Minerals, Coal and Hydrocarbons – Introduction to Formation and Sustainable Exploitation of Mineral Deposits by Walter L. Pohl
2. Economic Mineral Deposits by Mead L. Jensen and Alan M. Bateman
3. Ore Genesis – A Holistic Approach by A. Mookherjee
4. Ore Geology and Industrial Minerals – An Introduction by A.M. Evans
5. Ore microscopy and ore petrography by James R. Craig and David J. Vaughan
6. The Geology of Ore Deposits by J.M. Guilbert and C.F. Park Jr.
7. Courses in Mining Geology by R.P.N. Arogyaswami
8. Elements of Prospecting and Exploration by T.C. Bagchi, D.K. Sengupta and S.V.L.N. Rao
9. Elements of prospecting for non-fuel mineral deposits by P.K. Banerjee and S. Ghosh
10. Geological Prospecting & Exploration by V. M. Kneiter
11. Introduction to Mining Engineering by H.L. Hartman
12. Mineral Economics by R.K. Sinha and N.L. Sharma
13. Mineral Economics: An Indian Perspective by Kirtikumar Randive and Sanjeevani Jawadand
14. Mining Geology by H.E. Mckinstry

Course Type	Code	Name of Course	L	T	P	Credit
Core		*Introduction to Petroleum Engineering*	*3*	*0*	*0*	*3*

Unit	Topics to be covered
1	Composition of oil, gas, and water; Elementary concepts of Reservoir modelling techniques, Drilling & Well completion, Pumping; System & Artificial Lift, Water flooding, Enhanced Oil Recovery, Transportation of crude oil and natural gas.
2	Application of the products, derived from petroleum, Unconventional Reserve, Offshore and subsea completions; Challenges and broader economic and environmental impacts
3	Major international hydrocarbon reserves; Petroleum Economics and drivers in global scale; Sustainable development through objective review of options in the Energy Basket.

Text Books/ Reference:

1. Introduction to Petroleum Engineering by John R. Fanchi and Richard L. Christiansen

Course Type	Code	Name of Course	L	T	P	Credit
Core		*Basin formation, Development and Analysis*	*3*	*0*	*0*	*3*

Unit	Topics to be covered
1	Classification and mechanics of formation of major basin types, subsidence analysis, fill character and modelling techniques.
2	Application to petroleum play assessment; Facies analysis: Principles, siliciclastic and carbonate facies models.
3	Basin mapping methods- structure and isopach contouring, lithofacies and biofacies maps, preparation of stratigraphic crosssections and palaeogeographic synthesis; regional and global stratigraphic cycles.
4	Heat flow analysis for understanding maturity of the basin. Resource potential of sedimentary basins. Basin modeling and its uses, Basin modeling techniques.

Text Books/ Reference:

1. Hydrocarbon exploration and production by F. John, M. Cook and M. Graham
2. Introduction of Petroleum Geology by G.D. Holson and E.N. Tiratso
3. Applied Sedimentology by Richard C. Selly
4. Depositional Sedimentary Environments by H.E. Reineck and I.B. Singh
5. Physical Principles of Sedimentology by Kenneth J. Hsü
6. Sedimentology and Stratigraphy by Gary Nichols

Course Type	Code	Name of Course	L	T	P	Credit
Core		*Fundamentals of Geophysics*	*3*	*0*	*0*	*3*

Unit	Topics to be covered
1	Introduction to geophysics, Earth as a planet and member of the solar system, origin and evolution of the Earth, Internal structure of the Earth; Concept of plate tectonics, plate motions and triple junctions.
2	Gravitation, gravity anomalies and its variations, geoid, isostasy, rheology; Geomagnetic field, its origin and variations, paleomagnetism, and geomagnetic reversals
3	Introduction to seismology, seismic waves - P, S and surface waves, seismograph, travel time curves and radial Earth structures, general properties of surface waves and normal modes,.
4	Earthquake source theory, intensity and magnitude scales of earthquakes, PREM model, elastic rebound theory, global seismicity and tectonics, focal mechanisms, seismic anisotropy
5	Heat within the Earth, thermal structure of continental and oceanic lithospheres at subduction zones and spreading centers, mantle convection.

Text Books/ Reference:

1. Fundamentals of Geophysics by Lowrie
2. An Introduction to Geophysical Exploration by Philip Kearey, Michael Brooks and Ian Hill
3. Applied geophysics by W.W. Telford
4. Introduction of Geophysical Prospecting by M B Dobrin and C H Savit
5. Exploration Geophysics by Kaul and Bhattacharya
6. Geophysical methods in geology by G.R. Foulger and C. Peirce

Course Type	Code	Name of Course	L	T	P	Credit
Core		*Engineering Geology and Hydrogeology*	*3*	*1*	*0*	*4*

Unit	Topics to be covered
1	Engineering properties of rocks, and soils and their classifications. Weathering. Discontinuities in rock masses. Engineering behavior of rock materials and rock masses.
2	Rock mass classification system; Rock slope stability, landslides and stability of structures, construction materials.
3	Geological investigation of dams and reservoirs, tunnels and excavations, foundations and structures in earthquake prone regions. Site investigations and important case studies. Surveying.
4	Hydrologic cycle, runoff estimation, vertical distribution of soil moisture, groundwater, aquifer systems, springs, groundwater flow, coastal aquifers and seawater intrusion, well hydraulics. Artificial Recharge; Ground water Modeling.
5	Field techniques in groundwater exploration and exploitation, chemistry and quality, case studies on groundwater development and management.

Text Books/ Reference:

1. Engineering Geology- Principle and Practice by Price and David George
2. Fundamentals of Engineering Geology by F.G. Bell
3. Introduction to the Rock Physics by G. Yves and P. Victor
4. Practical Engineering Geology by Steve Hencher
5. Engineering Rock Mass Classification: Tunneling Foundations and Landslides by R K Goel and Bhawani Singh
6. Hydrogeology by K R Karanth
7. Ground Water by H.M. Raghunath
8. Ground Water Hydrology by D.K. Todd
9. Groundwater Geochemistry by J. Merkel Broder
10. Groundwater Geophysics in Hard Rock by Prabhat C. Chandra
11. Groundwater Prospecting and Management by H. P. Patra, Shyamal Kumar Adhikari, and Subrata Kunar
12. Hydrogeology by S.N. Davies and R.J.N. Dc-West

Course Type	Code	Name of Course	L	T	P	Credit
Core		*Geochemistry Lab*	*0*	*0*	*3*	*2*

Unit	Topics to be covered
1	Chemical analysis of rocks and minerals, digestion techniques, preparation of standards, estimation of major oxide percentages using spectrophotometric / flame photometric and titrimetric methods. Preparation of calibration curves. Gravimetric estimation of silica and R_2O_3.

Course Type	Code	Name of Course	L	T	P	Credit
Core		*Structural Geology Lab*	*0*	*0*	*3*	*2*

Unit	Topics to be covered
1	Topographic map study, Measurement of attitude of planar and linear structures, Profile and cross section from given geological map.
2	Interpretation of geological maps. Outcrop completion, 3-point problem, Geometric and trigonometric methods of calculation of orientation and thickness of beds, Equal area projection of planar and linear structural data.
3	Two-dimensional strain analysis from the supplied specimen and data. Computer aids to analysis of structural data.

Semester - III						
Course Type	**Code**	**Name of Course**	**L**	**T**	**P**	**Credit**
Core		*Exploration Geophysics*	*3*	*1*	*0*	*4*

Unit	**Topics to be covered**
1	Gravity method: Gravitational force; Gravitational acceleration; Gravitational potential, Earth's gravitational field, Collections; corrections and presentation of Gravity data, Regional and residual anomalies, Gravity anomaly over buried objects of known shape: sphere, cylinder, Gravity corrections: Free-air correction, Bouguer correction, Latitude correction, Terrain correction. Interpretation of gravity anomalies with case studies.
2	Magnetic method: Geomagnetic field, Induced magnetism, Remanent magnetism, Susceptibility, Field survey method, Equipment, Data processing, Qualitative and quantitative interpretation of magnetic data.
3	Electrical Methods: Electrical properties of rocks, Flow of current through ground surface, Apparent resistivity, Electrode arrangements, VES and CST and their qualitative interpretation, Quantitative interpretation of VES curves with case studies.
4	Electromagnetic methods: Electromagnetic spectrum and induction, EM frequency and depth of penetration, EM response of conductors, Classification of EM methods and their description. Telluric current method, Magnetotelluric method, CSMT/CSAMT, Tilt angle method, Turam method, VLF method, Transient EM methods, Ground Penetrating Radar.
5	Induced Polarization Methods: Earth's polarization, IP measures, Time and frequency domain techniques, Field surveys, Equipments, Data acquisition and interpretation.
6	Seismic Methods: Basic principles, Types of seismic waves and their propagation characteristic, Seismic velocities in Earth's materials, Refraction and reflection, field procedure, data acquisition and interpretation, Siesmic startigraphy, Detection of hydrocarbons.
7	Radiometric Methods: Basic principles, Radioactive elements in rocks, Gamma ray spectrum and spectrometer, Radon sniffer, Data collection and interpretation.
8	Thermal methods: Thermal conductivity of rocks and minerals, Temperature measurements, Field surveys, Interpretation.
9	Airborne, marine and satellite geophysics: Airborne survey, Data acquisition, Equipment, Measurement, Data processing and interpretation, Marine geophysics, Satellite-gravity-magnetic and thermal imagery.

Text Books/ Reference:

1. Introduction to geophysical exploration, Keary Brooks
2. Introduction to geophysical prospecting, M.B.Dobrin.
3. Applied Geophysics, W.M. Telford et. al. Geoelectric Methods: Theory and Application Hardcover – 1 July 2017 by Bhattacharya and Shalivahan Srivastava (Author)
4. Exploration seismology, Sheriff. R.E.
5. Seismic stratigraphy-application to hydrocarbon exploration Ed. By Charles Payton.
6. Seismic exploration fundamentals, J.A. Coffeen
7. Electrical methods of Geophysical Prospecting, Keller and Frischknecht
8. Mining Geophysics, Parasnis
9. Philip Kearey and Michael Brooks, An introduction to geophysical exploration, 2000, Blackwell Science.
10. Field Geophysics by John Milsom

Course Type	Code	Name of Course	L	T	P	Credit
Core		*Geohazards and Environmental Geology*	*3*	*0*	*0*	*3*

Unit	Topics to be covered
1	Interaction between modern society and Earth processes and resources; Natural Earth processes - Landslides and Related Phenomena; Subsidence; River Flooding meteorite impacts, mass wasting, coastal processes, and climate trends.
2	Development of natural resources, pollution and waste disposal, climate change, land use and engineering, and energy resources. Geological causes of soil, air and water pollution. Waste disposal: Solid Waste Management, Hazardous Chemical Waste Management, Radioactive Waste Management, Geology and Environmental Health
3	Role of Geologists and Geophysicist on the road to net zero

Text Books/ Reference:

1. Introduction Environmental Geology by Keller
2. Disaster Management by Dr. S. R. Singh
3. Disaster Management by H. Sarvothaman and Anandha Kumar
4. Natural Disaster by R. K. Sharma and G. Sharma (2005) (ed)
5. Natural Disaster Reduction by Girish K.M. and G.C. Mathur
6. Natural Hazard by Bryant Edwards
7. Space technology for disaster management: A remote sensing and GIS perspective, Indian institute of Remote sensing (NRSA), Dehradhun
8. Environmental Geology by K. S. Valdiya
9. Environmental Geology, Handbook of Field Methods and Case Studies by Klaus Knödel, Gerhard Lange and Hans-Jürgen Voigt

Course Type	Code	Name of Course	L	T	P	Credit
Core		*Drilling Techniques*	*3*	*0*	*0*	*3*

Unit	Topics to be covered
1	Rotary Drilling Mechanics; Water and Oil Base Mud; Drill String Design Basics; Drill Bits; Hydraulics; Casing Design Basics; Cement; Well Bore Architecture; Example Well; Pressure Control; Directional Drilling; Down Hole Motors.
2	Special Methods of Drilling (Aerated drilling, Under-balanced drilling, Overbalanced drilling; HPHT Drilling; Variable pressure regime; Plasma drilling, Electrical Drilling, Re-entry drilling; Jet Drilling, Drilling automation.
3	Smart wells Design, Managed Pressure Drilling; Drilling Economics; Computer Application in Drilling.

Text Books/ Reference:

1. A Beginner's Guide to Drilling Technology by Dr. V K Rao and P K Sahoo
2. Theory and Technology of Drilling Engineering (Pb 2021) by Guan Z, Springer

Course Type	Code	Name of Course	L	T	P	Credit
Core		*Geology of Fuels*	*3*	*0*	*0*	*3*

Unit	Topics to be covered
1	Origin of petroleum, source rock characteristics; Maturation of kerogen, paleo-thermometers; composition of petroleum; Primary and secondary migration. traps and seals – classification of traps
2	Subsurface environments: water, temperature and pressure; Petroliferous basins of India. Reservoirs: porosity, permeability and capillary pressure, reservoir heterogeneity
3	Origin of coal; classification of coal; morphology, composition of peat, lignite, anthracite; Structure and petrography of coals; Physical and chemical properties of coal; Coal reserve in India; Exploration of coal; utilization of coal-combustion and gasification of coal; coal and environment.
4	Nuclear fuel cycle, mineralogy and geochemistry of radioactive minerals. classification of uranium deposits, metallogenic epochs and provinces of uranium mineralization. uranium exploration.

Text Books/ Reference:

1. Coal and organic Petrology by Singh, M.P. (Ed.)
2. Elements of Petroleum Geology by R.C. Selley
3. Introduction of Petroleum Geology by G.D. Holson and E.N. Tiratso
4. Petroleum Formation and Occurrence by B.P. Tissot and D.H. Welte
5. Textbook of Coal (Indian context) by D. Chandra, R.M. Singh and M.P. Singh
6. Textbook of Coal petrology by E. Stach, M-Th. Mackowsky, G.H. Taylor, D. Chandra, M. Teichumullelr and R. Teichmuller
7. Principle of Nuclear Geology by U Aswathanarayana

Course Type	Code	Name of Course	L	T	P	Credit
Core		*Engineering Geology and Hydrogeology Lab*	*0*	*0*	*3*	*2*

Unit	Topics to be covered
1	Maps and numerical exercises. Instrumentation in engineering geology (Determination UCS, UTS, Shear strength, permeability, porosity).
2	Determination of pH, Temperature, TDS and other parameters for ground water quality assessment.
3	Graphical representation of supplied ground water quality data. Resistivity survey for ground water. Titration methods to determine the composition of minerals.

Course Type	Code	Name of Course	L	T	P	Credit
Core		Prospecting Lab	0	0	3	2

Unit	Topics to be covered
1	Apply drift correction to the acquired gravity data.
2	Apply diurnal correction to the given magnetic data
3	Interpretation of SP anomaly
5	Interpretation of VES data over two layered earth.
5	Travel time distance curve for horizontal refractor.
6	Calculation of Gravity effect due to sphere.
7	Convolution, Correlation, Cross-correlation
8	Problem of equivalence and suppression
9	Calculation of b and c values

Semester - IV

Course Type	Code	Name of Course	L	T	P	Credit
Core		*Geomechanics*	*3*	*1*	*0*	*4*

Unit	Topics to be covered
1	Physico-mechanical properties of rocks; Elastic and time dependent behaviour; Constitutive Equations; Elastic moduli; Poroelasticity: Biot's poroelastic theory for static properties; The effective stress concepts.
2	Theories of rock failure: Elasticity failure mechanics, Compressive strength criteria, shear failure – Mohr-Coulomb criterion, Failure criteria based on intermediate stress; Slope Stability.
3	Stresses around opening: In situ stresses and stress distribution around openings with constant and varying pore-pressure, Borehole along a principal stress direction, Stresses around deviated borehole.
4	Hydromechanical behavior of fractures: Normal and shear stiffness of rock Fractures; Compaction and Subsidence.

Text Books/ Reference:

1. Reservoir Geomechanics by Mark Zobac, Cambridge University Press, 2007
2. Petroleum Related Rock Mechanics 3rd Ed by Erling Fjær, Rune Martin Holt, Per Horsrud, Arne Marius Raaen

Electives						
Course Type	**Code**	**Name of Course**	**L**	**T**	**P**	**Credit**
DE		*Geologic Carbon Sequestration*	*3*	*0*	*0*	*3*

Unit	**Topics to be covered**
1	Introduction: Global warming; The Carbon Budget of our Atmosphere; CCS in a nutshell; Carbon Neutrality
2	Carbon history: Global carbon flux, sources and sinks of atmospheric carbon, natural CO2 source; Carbon cycle, global carbon budget, calculating carbon budget in terms of equivalent atmospheric CO2, history of atmospheric CO2 through geological time, methods to monitor atmospheric CO2, proxy for past CO2 reconstruction, ice-core and marine sedimentary records
3	Carbon capture: Combustion: Post-combustion capture; Capture by Oxyfuel Combustion; Pre-combustion capture; Carbon Dioxide Utilisation; Carbon negative technologies
4	Geological Carbon Storage: The transport of carbon dioxide; Why Geological Storage; Rocks for Geological Carbon Storage; Reservoirs, seals and traps; Storage in aquifers and depleted oil fields; Trapping the carbon dioxide; Leakage and monitoring; risks and challenges in CO2 storage; possible hazards associated with carbon sequestration, economic considerations; Future prospects

Text Books/ Reference:

Course Type	**Code**	**Name of Course**	**L**	**T**	**P**	**Credit**
DE		*Geothermal Energy*	*3*	*0*	*0*	*3*

Unit	**Topics to be covered**
1	Introduction to Geothermal Energy, Geological background: Origin of geothermal energy; Terrestrial heat flow, geothermal gradient; Relationship of plate tectonics and terrestrial heat flow; Geothermal resources and its assessment, Recent Advancements.
2	Thermodynamics and Geothermal Systems; Chemistry of Geothermal Fluids; Subsurface Fluid Flow: The Hydrology of Geothermal Systems
3	Exploring for Geothermal Systems: Field Geology and Surface Manifestations, Geochemistry as an Exploration Tool; Geophysics as an Exploration Tool, Remote Sensing as an Exploration Tool.
4	Geothermal Energy Utilization: examples and case studies of Geothermal power plants (Dry steam power plants, Flash steam power plants, Binary power plants); Geothermal direct uses. Case Studies.

Text Books/ Reference:

1. Glassley, William E. Geothermal energy: renewable energy and the environment. CRC press, 2014.
2. DiPippo, Ronald. Geothermal power plants: principles, applications, case studies and environmental impact. Butterworth-Heinemann, 2012.

Course Type	Code	Name of Course	L	T	P	Credit
DE		*Unconventional Hydrocarbon Resources*	*3*	*0*	*0*	*3*

Unit	Topics to be covered
1	Differences between conventional and unconventional petroleum accumulations; Unconventional petroleum accumulations; Tight-Sandstone Oil and Gas; Coalbed Methane; Shale Gas; Natural gas hydrate; Carbonate fracture cavity Reservoir; Volcanic Reservoirs; Oil and Gas in Metamorphic Reservoir; Heavy oil and Bitumen;
2	Future development of unconventional petroleum resources
3	Techniques for unconventional petroleum exploration and exploitation. Case studies.

Text Books/ Reference:

1. Carrol J., Natural Gas Hydrates: A guide for engineers, Gulf Professional Publishing 2011.
2. Warner H.R, Jr. (ed), Petroleum Engineering Handbook Vol. VI, Emerging and Peripheral Technologies, SPE 2007.
3. Thakur P., Aminian K., Schatzel S. (ed) Coal Bed Methane: From Prospects to Pipeline, Elsevier 2014.
4. Islam M.R., Unconventional Gas Reservoirs: Evaluation, Appraisal, and Development, Gulf Professional Publishing 2014

Course Type	Code	Name of Course	L	T	P	Credit
DE		*Well Logging*	*3*	*0*	*0*	*3*

Unit	Topics to be covered
1	Introduction: Basic log types, Logging Operations, The logging environments
2	Theory and physics of well-log measurements: Quantitative interpretation of well logs to estimate rock and fluid properties, including porosity, net pay thickness, fluid saturations, fluid type/ density.
3	Log interpretation techniques: Quicklook interpretation, Full Interpretation, Advanced Interpretation
4	Well-log interpretation in clay-free, shaly-sand, and organic-shale formations; Facies, Sequences and depositional environments from log, Sequence stratigraphy and stratigraphy from logs.

Text Books/ Reference:

1. Rider, Malcolm H. The geological interpretation of well logs. Rider-French Consulting ltd 1986.
2. Darling, Toby. Well logging and formation evaluation. Elsevier, 2005.
3. Formation Evaluation, E J Lynch
4. Induction Logging, Plusynin.
5. Log Interpretation Principles and Charts, Schlumberger
6. Development and Exploitation of Oils and Gas Fields, Murovyer and Andiasevrentnal
7. Handbook of Well Log Analysis, S J Peterson

Course Type	Code	Name of Course	L	T	P	Credit
DE		*Petrophysics for Mineral Exploration*	*3*	*0*	*0*	*3*
Unit	**Topics to be covered**					
1	Will be given later					
Text Books/ Reference:						

Course Type	Code	Name of Course	L	T	P	Credit
DE		*Geoinformatics for Resource Estimation*	*3*	*0*	*0*	*3*
Unit	**Topics to be covered**					
1	Will be given later					
Text Books/ Reference:						

Course Type	Code	Name of Course	L	T	P	Credit
DE		*Geodesy and GPS*	*3*	*0*	*0*	*3*
Unit	**Topics to be covered**					
1	Will be given later					
Text Books/ Reference:						

Course Type	Code	Name of Course	L	T	P	Credit
DE		*Ocean Energy and Resources*	*3*	*0*	*0*	*3*
Unit	**Topics to be covered**					
1	Will be given later					
Text Books/ Reference:						

Course Type	Code	Name of Course	L	T	P	Credit
DE		*Geotechnical Practice for Waste Disposal*	*3*	*0*	*0*	*3*

Unit	Topics to be covered
1	Introduction, Contaminant transport, Soil contamination, Groundwater contamination, Removal of contaminants from soil and Ground water; Contaminant site remediation;
2	Solid waste disposal and stabilization: Engineered landfill: Site selection, dumping; Design of landfill: CNS layer, lechate and air collection units;
3	Hazardous waste control and storage system, mechanism of Stabilization, incineration; Case studies

Text Books/ Reference:

1. Daniel, D. E. (Ed.). (2012). Geotechnical practice for waste disposal. Springer Science & Business Media.

Course Type	Code	Name of Course	L	T	P	Credit
DE		*Seismic Signal Processing, Imaging and Interpretation*	*3*	*0*	*0*	*3*

Unit	Topics to be covered
1	Overview of Seismic Data Processing: Introduction and review of fundamentals of seismic data acquisition and other factors affecting processing; Fundamentals of Time-Series Analysis: Fourier theory, Fourier transforms, sampling and aliasing, the convolutional model of the seismic trace, spectral analysis and filtering
2	Basic Data Processing Sequence: First-order data processing steps from treatment of field data to intermediate stacks, marine and land seismic data; Processing Refinements; Essential refinements to improve the seismic image including filter design, relative amplitude recovery, deconvolution, velocity analysis and residual statics
3	More Advanced Processing: Velocity filtering, noise-reduction filtering, migration techniques and other sophisticated (and sometimes dangerous) techniques for data enhancement.
4	Seismic migration/imaging; Seismic data processing using software; Interpretation of seismic images

Text Books/ Reference:

1. Engineering Seismology by Agarwal
2. Modem Global Seismology, Thorne Lay and Wallace
3. Internal Constitution of the Earth by Gutenberg
4. Introduction to Seismology by Bath
5. Elementary Seismology, Charles. F. Richter
6. An introduction to the theory of seismology, Bullen. K.E. and Bolt
7. Quantitative seismology: theory & methods, Aki. K. and Richards
8. R.N. Bracewell, 1986, Fourier transform and its applications, Mc Graw Hill Publishers.
9. A.V. Oppenheium and R. W. Schafer. Digital signal processing, Prentice hall of India.

Course Type	Code	Name of Course	L	T	P	Credit
DE		*Applied Micropaleontology*	*3*	*0*	*0*	*3*

Unit	Topics to be covered
1	Systematic Micropaleontology: foraminifera, calcareous nannoplankton, ostracodes, pteropods, calpionellids, calcareous algae, bryozoa, radiolaria, diatoms, and silicoflagellates, ebridians, conodonts, dinoflagellates, acritarchs, tasmanitids, chitinozoa, spores and pollen.
2	Microfossils' guide. Assemblages. Biostratigraphic units. Biostratigraphic scales and correlations. Paleoecological, paleogeographic, paleoclimatic and paleoceanographic interpretations.
3	Surface and subsurface sampling methods for micro palaeontological studies; brief description of major microfossil groups used in hydrocarbon exploration;
4	Paleo-environmental interpretation using microfossils; bio stratigraphic classification, dating and correlation of stratigraphic sequences, standard planktonic foraminiferal zones; application of micropalaeontology in sequence stratigraphy; case studies from Indian sedimentary basins.

Text Books/ Reference:

1. Elements of Micropaleontology by G. Bignot
2. Introduction to Marine Micropaleontology by Haq and Boersma
3. Micropaleontology in Petroleum Exploration by R.W. Jones
4. Micropaleontology: Principles and Applications by Pratul Kumar Sarswati and M.S. Srinivisan

Course Type	Code	Name of Course	L	T	P	Credit
DE		*Managerial Economics*	*3*	*0*	*0*	*3*

Unit	Topics to be covered
1	The Central Concepts of Economics and Nature and Scope of Managerial Economics: The Concepts of Scarcity, Choice, Opportunity Costs and Efficiency; The Modern Mixed Economy-Market and Government; The basic process of decision making: Demand, Supply and Markets; Equilibrium and Surplus; Quotas, and Price Ceilings
2	Behavior of the Consumer-Demand and Demand Analysis: Demand analysis of consumer and Elasticities of Demand; Demand estimation and Forecasting
3	Behavior of the Firm-Production and Cost Analysis: Production Theory: Short-run and Long-run Production Functions; Cost Theory: Short-run and Long-run Cost Functions
4	Market Structure and Pricing: Market structure and degree of competition; Price determination under different Market Structure- Short-run and Long-run Analysis
5	Regulations and Risks: Regulations and Role of Government in the Economy; Risk and Uncertainty in Managerial Decision Making-Mergers and Acquisitions
6	Project Evaluation and Long-run Investment Decisions: Capital Budgeting and its Process-NPV, IRR; Project Evaluation: Capital Rationing and Profitability Index

Text Books/ Reference:

1. Managerial Economics: Principles and Worldwide Applications, Dominick Salvatore, Oxford University Press; Eighth edition, 2016.
2. Managerial Economics: Foundations of Business Analysis and Strategy, Christopher R. Thomas and S. Charles Maurice, McGraw Hill; Twelfth edition, 2020.
3. Managerial Economics, G.S. Gupta, McGraw Hill Education; Second edition, 2017.
4. Economics: Principles and Policy, William J. Baumol, Alan S. Blinder, Cengage Learning, 14th Edition, 2019.