SECOND YEAR SYLLABUS

for

MSc in Applied Geology

Indian Institute of Petroleum and Energy

Visakhapatnam, Andhra Pradesh - 530003

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	Geology of Fuels	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
13	ES6013	Geological Reservoir Characterization	3	0	0	3
14	ES6014	Applied Mineralogy	3	0	0	3

SEMESTER - III						
Course Type	Code	Name of Course	L	T	P	Credit
CORE	**ES5101**	**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	**ES5102**	**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	**ES5103**	**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	**ES5104**	**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	**ES5105**	**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	**ES5106**	**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

SEMISTER - IV						
Course Type	Code	Name of Course	L	T	P	Credit
CORE	**ES5201**	**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
ELECTIVE	**ES6001**	**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
ELECTIVE	**ES6002**	**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
ELECTIVE	**ES6003**	**GEOLOGY OF UNCONVENTIONAL HYDROCARBONS**	**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
ELECTIVE	**ES6004**	**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
ELECTIVE	**ES6005**	**PETROPHYSICS FOR MINERAL EXPLORATION**	**3**	**0**	**0**	**3**
Unit	*Topics to be covered*					
1						
Text Books/ Reference:						

Course Type	Code	Name of Course	L	T	P	Credit
ELECTIVE	**ES6006**	**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
ELECTIVE	**ES6007**	**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
ELECTIVE	**ES6008**	**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
ELECTIVE	**ES6009**	**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
ELECTIVE	**ES6010**	**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
ELECTIVE	**ES6011**	**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
ELECTIVE	**ES6012**		**3**	**0**	**0**	**3**

Unit	*Topics to be covered*
1	
2	
3	
4	

Text Books/ Reference:

1.

Course Type	Code	Name of Course	L	T	P	Credit
ELECTIVE	**ES6013**	**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.

Course Type	Code	Name of Course	L	T	P	Credit
ELECTIVE	**ES6014**	**APPLIED MINERALOGY**	**3**	**0**	**0**	**3**

Unit	*Topics to be covered*
1	
2	
3	
4	

Text Books/ Reference:

1.