



FIRST YEAR SYLLABUS

for

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 - I						
Course Type	Code	Name of Course	L	T	P	Credit
CORE	ES4101	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	ES4102	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	ES4103	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	ES4104	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	ES4105	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	ES4106	GEONUMERICS	1	0	3	3
<i>Unit</i>	<i>Topics to be covered</i>					
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	ES4107	PETROLOGICAL LABORATORY	0	0	3	3
<i>Unit</i>	<i>Topics to be covered</i>					
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	ES4201	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 <u>Walter L. Pohl</u>						
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	ES4202	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	ES4203	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	ES4204	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	ES4205	ENGINEERING GEOLOGY AND HYDROGEOLOGY	3	1	0	4
<i>Unit</i>	<i>Topics to be covered</i>					
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. De-West

Course Type	Code	Name of Course	L	T	P	Credit
CORE	ES4206	GEOCHEMISTRY LAB	0	0	3	2
<i>Unit</i>	<i>Topics to be covered</i>					
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 ₂ O ₃ .					

Course Type	Code	Name of Course	L	T	P	Credit
CORE	ES4207	STRUCTURAL GEOLOGY LAB	0	0	3	2
<i>Unit</i>	<i>Topics to be covered</i>					
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.					