



Solapur University, Solapur

Choice Based Credit System (CBCS)

Syllabus

M.Sc. Part I & II Applied Geology

To be implemented from the year 2016 onwards

School of Earth Sciences

Solapur University, Solapur

M.Sc Applied Geology

**School of Earth Science
Solapur University
M.Sc Applied Geology (CBCS Syllabus)**

Semester	CODE	TITLE OF THE PAPER	Semester Exam			L	T	P	Credit
			Theory	IA	Total				
First		Hard Core							
AGT	HCT1.1	Mineralogy and Optics (3:1)	70	30	100	4		4	
	HCT1.2	Geochemistry	70	30	100	4		4	
	HCT1.3	Sedimentology and Palaeontology (2:2)	70	30	100	4		4	
		Soft Core (any One)							
	SCT1.1	Economic Geology	70	30	100	4		4	
	SCT1.2	Structural Geology and Morphotectonics (2:2)	70	30	100	4			
		Practical (Hard Core)							
	HCP1.1	Practical HCP1.1	35	15	50		2	6	
	HCP1.2	Practical HCP1.2	35	15	50		2		
	HCP1.3	Practical HCP1.3	35	15	50		2		
		Soft Core (Any One)							
	SCP1.1	Practical SCP1.1	35	15	50		2	2	
	SCP1.2	Practical SCP1.2	35	15	50		2		
		Soft skill ICT, Scientific English, Tutorial			25		01	1	
		Total for First Semester	420	180	625			25	
Second		Hard Core							
AGT	HCT2.1	Igneous and Metamorphic Petrology (2:2)	70	30	100	4		4	
	HCT2.2	Indian Stratigraphy	70	30	100	4		4	
		Soft Core (any One)							
	SCT2.1	Hydrogeology	70	30	100	4		4	
	SCT2.2	Geotechnical Engineering	70	30	100	4			
		Open Elective (Any One)							
	OET2.1	Natural Resource Management	70	30	100	4		4	
	OET2.2	Watershed Management	70	30	100	4			
		Practical (Hard Core)							
	HCP2.1	Practical HCP2.1	35	15	50		2	4	
	HCP2.2	Practical HCP2.2	35	15	50		2		
		Practical (Soft Core) (any one)							
	SCP2.1	Practical SCP2.1	35	15	50		2	2	
	SCP2.2	Practical SCP2.2	35	15	50		2		
		Practical Open Elective(any one)							
	OEP2.1	Practical OEP2.1	35	15	50		2	2	
	OEP2.2	Practical OEP2.2	35	15	50		2		
		Soft skill ICT, Scientific English Tour and Tour report , Tutorial			25		01	1	
		Total for Second Semester	420	180	625			25	

*Fieldwork of 15-21 days is compulsory. The field work may be stretch or divided into parts in the academic year

Third		Hard Core	Theory	IA	Total				
AGT	HCT3.1	Mineral Exploration	70	30	100	4			4
	HCT3.2	Geotectonic and Physical Oceanography	70	30	100	4			4
		Soft Core (any One)							
	SCT3.1	Engineering Geology and Mining Geology (2:2)	70	30	100	4			4
	SCT3.2	Climatology & Planetary Science	70	30	100	4			
		Open Elective (Any One)							
	OET3.1	Research Methodology	70	30	100	4			4
	OET3.2	Geoarchaeology	70	30	100	4			
		Practical (Hard Core)							
	HCP3.1	Practical HCP3.1	35	15	50			2	4
	HCP3.2	Practical HCP3.2	35	15	50			2	
		Practical (Soft Core) (any one)							
	SCP3.1	Practical SCP3.1	35	15	50			2	2
	SCP3.2	Practical SCP3.2	35	15	50			2	
		Practical Open Elective(any one)							
	OEP3.1	Practical OEP3.1	35	15	50			2	2
	OEP3.2	Practical OEP3.2	35	15	50			2	
		Soft skill ICT, Scientific English, Tutorial			25		01		1
		Total for Third Semester	420	180	625				25
Fourth									
Fourth		Hard Core	Theory	IA	Total				
AGT	HCT4.1	Environmental Geology and Disaster Management (2:2)	70	30	100	4			4
	HCT4.2	Remote Sensing and GIS	70	30	100	4			4
	HCT4.3	Fuel Geology	70	30	100	4			4
		Soft Core (any One)							
	SCT4.1	Dissertation	70	30	100	4			4
	SCT4.2	Gemmology	70	30	100	4			
		Practical (Hard Core)							
	HCP4.1	Practical HCP4.1	35	15	50			2	6
	HCP4.2	Practical HCP4.2	35	15	50			2	
	HCP4.3	Practical HCP4.3	35	15	50			2	
		Soft Core (Any One)							
	SCP4.1	Practical SCP4.1	35	15	50			2	2
	SCP4.2	Practical SCP4.2	35	15	50			2	
		Soft skill ICT, Scientific English Tour and Tour report , Tutorial			25		01		1
		Total for Fourth Semester	420	180	625				25
*Fieldwork of 15-21 days is compulsory. The fieldwork may be stretch or divided into parts in the academic year,									

Paper No: HCT 1.1 MINERALOGY AND OPTICS**Load/week:04****Total load : 56****Credits:04****Marks: External :70****Internal:30**

Unit 1	Concepts of light under microscope, Uniaxial and biaxial ellipsoids, Interference figures of uniaxial and biaxial minerals, Determination of optics sign and pleochroism, Determination of optic axial angle(2V), Flash figures, bravais lattice and point lattice,32 classes of symmetry , Twinning and their laws in feldspars.	14
Unit2	Crystal cell structure, chemistry diagnostic properties and stability fields of 1.olivine 2. characteristic difference in opx and cpx, 3.alkali amphiboles and Ca-amphiboles	14
Unit3	Cell structure, Chemistry, Diagnostic optical properties and paragenesis of 1. Mica-dioctahedral and Trioctahedral, 2.alkali and plagioclase feldspars 3.Feldspathoids, 4.zeolites	14
Unit4	Structure, Chemistry, optical properties and paragenesis of 1.Clayminerals, 2.Alumino Silicates, 3. Garnets, 4.Epidote, 5.Basemetals, 6.Spineloids, Sn–W–Mo, 7. Gemstone	14

REFERENCEBOOKS:

1. An introduction to the Rock Forming Minerals Deer, Howie and Zussman.
2. Rock Forming Minerals Deer, Howie and Zussman.(Vol.1-5)
3. A textbook of Mineralogy by Dana.
4. Elements of Mineralogy Berry Mason.
5. Principles of Geochemistry Brian Mason, C.B.Moore.
6. Optical mineralogy P.F. Keer.
7. Optical Crystallography E.E. Wahlstrom.
8. Optical Mineralogy Philips and Dana T. Griffen.
9. A practical introduction optical mineralogy, Gribble and Hall.
- 10.An introduction to crystallography Phillips.
- 11.Minerals and rocks: exercise in crystallography, mineralogy and hand specimen Corneis Klein.
12. Mineralogy, Dexter Perkins,3rdEdition, PHI Publication.

INTERNAL EVALUATION**(30 Marks)****(Seminar + Term paper + Test)**

Paper No: HCT 1.2 GEOCHEMISTRY

Load/week:04

Total load : 56

Credits:04

**Marks: External :70
Internal:30**

Unit 1	Introduction to the principles of geochemistry. Historical geochemistry. Origin and cosmic abundance of elements, Goldschmidt's geochemical classification of elements .Primary differentiation of earth, Brief classification and composition of meteorites, Distribution of elements in igneous, metamorphic and sedimentary rocks.	14
Unit 2	Comparative planetology: composition of crust, mantle and core of earth, Aspects of equilibrium thermodynamics- enthalpy and entropy, free energies, chemical potentials, fugacity and activity. Few problems related to thermodynamics Mineral stability– Pauling rules, speciation of elements during magmatic crystallization. Major and minor elemental substitution, laws of Goldschmidt, Ahren rules and Ringwood rules, Secondary environmental geochemistry, causes and products of chemical weathering, physico-chemical factors in sedimentation, fench diagrams, their signification and limits.	14
Unit 3	Composition of hydrosphere, Differences between the seawaters and freshwater composition, gains and losses of the Oceans, Composition and stratification of atmosphere, evolution of atmosphere through geological time. Gains and losses to atmosphere, aspects of air pollution, Climate changes during geological history and evolution of atmosphere in last 10000years, aspects of Palaeo climatology.	14
Unit 4	Use of trace and rare earth elements in geological problems, Isotope geochemistry, types of isotopes, natural and artificial radioactivity. Basic concepts in dating techniques: decay clocks and accumulation clocks, Dating techniques using Rb-Sr, U-Th- Pb,K-Ar, S,CandO methods, Quality controls of data generation, Wet and Dry chemical analysis, Partial and total analysis.	14

Reference Books:

1. Geochemistry pathways and processes 2nd edition, Harry. mc sween Jr, Steven M. Richards on and Maria E Uhle. Overseas Press
2. Radioactive minerals, Dhanaraju, geological society of India, Bangalore.
3. Principles of Geochemistry, Mason and Moore; John Wiley & Sons
4. Introduction to geochemisty .K.B. Krauskopf; Mcgraw- Hill Publication
5. Geochemistry in Mineral Exploration. A.W. Rose, H.E. Hawkes &J.S. Webb;Applied Publication
6. Handbook of Geochemistry Wadephol.
7. Statistical Methods in Exploration Geochemistry. Govett. J. G.S. Elsevier Publication
8. Nuclear Methods in mineralogy & geology techniques & applications., Attila Vertes, Sandor Nagy & Karoly Suvegh.PlenumPress
9. Stable Isotope Geochemistry, J.Hoefs, Springer- Verlag

INTERNAL EVALUATION

(30 Marks)

(Seminar + Term paper + Test)

Unit 1	Introduction and principles of sedimentology, Sedimentary cycle and diastrophic cycle, Sedimentary processes : Weathering–Mechanical ,Chemical and Biological , Transport mechanism saltation, traction and suspension, Deposition by fluids, Reynold number and Froude number, their application. Sedimentary textures of clastic and nonclastic rocks,concept of size and shape, Shape aspects–sphericity and roundness, surface textures fractals, Fabric measurements.	14
Unit 2	Classification of sedimentary environments: continental, marine and transition. Structures in alluvial, fluvial, deltaic, lacustrine, coastal, marine, glacial and Aeolian conditions, classification of clastic and non clastic rocks, classification of sandstone, classification of sedimentary basin and their tectonic setting, products of various basins, heavy minerals and their significance in province studies . Dolomitisation and dedolomitisation, Lithification and types of diagenesis.	14
Unit 3	Concepts offossil records its significance in mineral exploration stratigraphy and paleo-environmental studies, Morphology and classification of forminifera and their applications, morphology and classification of trilobites and their significance.	14
Unit 4	Evolution of 1.Devonian fishes, 2. Mesozoic reptiles, Siwalik mammals and their paleogeology, Gondwana flora, evolution of man.	14

REFERENCE BOOKS:

1. An introduction to sedimentology, Selley R.C.,Academic press.
2. Sedimentary rocks 3rd edition, Pettijohn F.J., CBS Publication Stratigraphy and sedimentation 2nd edition, W.H. Freeman and Co.
3. Principles of sedimentology, Friedman and Sanders J.m., John Wiley.
4. Origin of sedimentary rocks., Blatt H., Middleton Gand Murry R, Pentile Hall.
5. Petrology of sedimentary rocks., Folk R. L., Hemphill publication Co.
6. Sedimentary petrology: An introduction., Tucker M.E., ELBS., Blackwell Scientific Publication.
7. Applied sedimentology – Sukhtankar R.K . CBS Publishers.
8. Invertebrate palaeontology and evolution(2nd ed.) By Clarkson E.N.K.
9. Elements of Palaeontology Babin C.
10. Principles of Invertebrate Paleontology Shock & Twenhofel.
11. Paleontology of Vertebrates Jean Chaline.
12. Macropaleontology Bignot.
13. Paleontology Invertebrate Wood. Henry.

INTERNAL EVALUATION**(30 Marks)****(Seminar + Term paper + Test)**

Paper No: SCT 1.1 ECONOMICGEOLOGY

Load/week:04

Total load : 56

Credits:04

Marks: External :70

Internal:30

Unit 1	Significance of minerals in national economy. Tenor, grade and specification for minerals. India's status in mineral production Strategic, critical and essential minerals. National minerals policy. Principles and concepts of mineral. Economics, Mineral processing technology, gravity concentration method, magnetic separation, heavy mineral separation, froth flotation method, United Nations Framework of Classification of ore deposits	14
Unit 2	Ore bearing fluids: magma & magmatic fluids, hydrothermal fluids, meteoric waters, sea & connate water, metamorphic fluids, thermal springs & mine waters Classification of ore deposits –Lindgren and Bateman classifications. Controls of ore localization magmatic epochs and metallogenic provinces of India. Microtexture of Ore, Paragenesis and Zoning. Fluid inclusion, Geothermometry, wall rock alterations and their applications. Ore microscope polishing and mounting of ores. Physical and Optical properties of important ore minerals.	14
Unit 3	Processes of formation of mineral deposits: magmatic concentration, metamorphism, contact metasomatism, Hydrothermal, submarine exhalatives, volcanogenic deposits, residual. Mechanical concentration, oxidation & supergene enrichment and skarn deposits. Ores in igneous rocks , Ores deposits of metamorphic affiliations. Strata bound and stratiform ore deposits. Mineralization associated with convergent and divergent plate boundaries.	14
Unit 4	Overview of mineral deposits viz: Iron, manganese, chromium, base metals, precious metals, Industrial and refractory minerals with special reference to distribution in India. Their geology, Stratigraphy & depositional environments. Use of micro hardness tester and reflectivity, XRD studies in determinative mineralogy.	14

References:-

1. Economic mineral deposits, M.L. Jensen & A.M. Batman, John Wiley & Sons
2. The Geology of Ore deposits, J.M. Gulbert & C.F. Park(JR), SWH Freeman & Co.
3. Mineral processing technology, B.A.Wills, Peragamon Press.
4. Metal depositin relation of plate tectonics, F.J. Sawkins, Springer-Verlag Press.
5. Ore deposits, Evans,--
6. Ore Genesis : A Holistic Approach, Asoke Moodherjee, Allied Publishers Ltd.
7. Ore Petrography & Microscopy ,J.R. Craig & D.T. Vaughan, John Wiley & Sons.
8. Mineral Economics, R.K. Sinha,--
9. Mineral Resources of India, R.K. Sinha & Krishnaswamy , Oxford & IBH Publishing Co. Pvt. Ltd.
10. An introduction to Ore Geology, Anthony, M. Evans, Blackwell Scientific publication, 1980.
11. Ore Genesis, Ashok Mukherji, A holistic approach, Prentice Hall, Culcutta. A.K.
12. India's mineral wealth, Brown J.C.and Dey, Oxford 1936.
13. Ore Microscopy, Cameron E.N.,Wiley 1966.
14. Economic Geology, Umeshwar Rao, -----

INTERNAL EVALUATION

(30 Marks)

(Seminar + Term paper + Test)

Paper No: SCT 1.2

Title: STRUCTURALGEOLOGY AND MORPHOTECTONICS

Load/week:04

Total load : 56

Credits:04

Marks: External :70

Internal:30

Unit 1	Concept of primary and secondary structures, Types of stress and strain analysis using deformed objects homogeneous and heterogeneous deformations, Mohr circle, strain indicators, strain ellipse and reciprocal strain ellipse, behavior of rocks with respect to stress and strain. Determination of finite strains from originally spherical and ellipsoid markers.	14
Unit 2	Geometric classification of folds, mechanics of folding, folding in shear zones, buckling- states of strain within and outside buckled layers and field evidences of buckling , Faults and joints classification and significance, Mechanics of faulting with reference to stress and types of shear zones Geometry of thrust sheets, brittle and ductile structures in shear zones. Lineation and foliations morphology and classification ,significance of minor structures to determine major structures, Classification of unconformities and significance.	14
Unit 3	Concept of uniformitarianism morphological concepts of Davis Peenck, King Geomorphic processes, Erosional and depositional forms of 1. Fluvial, Aeolian Karst, Glacial and marine , various controls and scale of landforms and drainage network.	14
Unit 4	Coastal geomorphology, Classification of coasts , erosional and depositional features , Lineament analysis , Neotectonic evidences, Climate and landforms.	14

REFERENCEBOOKS

1. Fundamentals of Geomorphology R.J.Rice
2. Geomorphology Richard J. Chorley, Stanley A. Schumm, David E. Sugden.
3. Principles of Geomorphology William D. Thornbury.
4. Geomorphology Majeed Husain.
5. Indian Geomorphology H.S. Sharma.
6. Experimental fluvial Geomorphology Stanley A. Schumm, Paul Mosaley, William E. Weaver.
7. Geomorphology and Remote Sensing in Environmental management S.Singh
8. The Evolving Continents Windley.
9. The Geology of Continental Margins Burke and Drake.
10. The Breakup of Pangaea R.S.Dietz and J.C.Holden.

INTERNAL EVALUATION

(30 Marks)

(Seminar + Term paper + Test)

PRACTICAL HCP 1.1 + HCP 1.2: MINERALOGY&OPTICS+GEOCHEMISTRY

Marks : 100

Credit : 4

MINERALOGY AND OPTICS:-

Mineralogy Practical:

1. Sample preparation and obtaining XRD pattern.
2. Indexing an XRD pattern. Calculation of 2θ and d spacing values. Calculation of mineral formula of the following; a) Olivine, b)Pyroxene, c)Amphibole, d)Garnet.
3. Determination of anorthite content of plagioclase by optical properties.
4. Megascopic and Microscopic identification of major rock forming minerals with emphasis on distinguishing features.

OPTICS:-

1. Study of optic figures, optic axis, optic sign and flash figures of uniaxial and biaxial minerals.
2. Determination of refractive index of uniaxial and biaxial minerals using various minerals.
3. Determination of birefringence with the help of Michael Levy chart, quartz wedge and by using berek compensator.
4. Determination of $2V$ by 4 axes universal stage. Scheme of Pleochroism.

Geochemistry

1. Brief outlines of analytical methods and instrumentation.
2. Analysis of water quality for various purposes- agricultural, industrial and domestic; PH, Conductivity, carbonate, Bicarbonate, Total Hardness, Chlorides, Sulfate and nitrates by titration. Estimation of Ca, Na, K by flame photometer and F, Br, I by Ion analyzer.
3. Silicate analysis; Preparation of Solution 'A', Estimation of SiO_2 and Al_2O_3 preparation of solution B; Estimation of Total Fe, Na_2O and K_2O .
4. Calorimetric Methods- Estimation of Cu, Zn, Mo.
5. Determination of total heavy metals (bloom test) in water and soils.

PRACTICAL HCP 1.3 + SCP 1.1/SCP1.2: SEDIMENTOLOGY & PALAEONTOLOGY + ECONOMIC GEOLOGY OR STRUCTURAL GEOLOGY AND MORPHOTECTONICS

Marks : 100

Credit : 4

SEDIMENTOLOGY & PALAEONTOLOGY

1. Megascopic and Microscopic characters of Clastic rocks, Limestone and heavy minerals.
2. Study of Sedimentary structures and their attributes, study of sedimentary textures -size analysis by sieving and other techniques.
3. Determination of sphericity and roundness of grains, graphical presentation of data and determination of statistical parameters; insoluble residue analysis and preparation of acetate peels of limestone.
4. Identification and study of Invertebrate fossils, illustration functional morphology and classification. Identification of Micro-fossils-foraminifera and ostracoda.
5. Identification of plant fossils- Gondwana and intertrappean. Sample preparation in micropalaeontological studies

ECONOMIC GEOLOGY

1. Study of Ore Microscope.
2. Study of Typical Megascopic Ores. Study of Ores under Microscope. Optical Parameters.
3. Determinative Mineralogy. Study of Ore Textures.
4. Preparation of Paragenetic Sequence. Ore reserve calculation. Microchemical techniques.

STRUCTURAL GEOLOGY AND MORPHOTECTONICS

1. Solution to structural geology problems by orthographic and stereographic methods.
2. Completion of outcrops, construction of structural sections and interpretation of geological maps.
3. Plotting and interpretation of mesoscopic structural data.
4. Identification of landforms on toposheets (aerial photographs and satellite imageries) Soils: textural characteristics, study of representative soil profiles.
5. Morphometric analysis: bifurcation ratio, Drainage density, stream frequency, constant of channel maintenance

SEMESTER II

Paper No: HCT 2.1 IGNEOUS AND METAMORPHIC PETROLOGY

Load/week:04

Total load : 56

Credits:04

Marks: External :70

Internal:30

Unit 1	Magma–physical and chemical properties and cooling behavior, magmatic crystallisation ,differentiation and assimilation Phase equilibria studies of binary and ternary silicate systems 1. Silica –Lucite, 2.Forsterite-Silica, 3.Orthoclase – Albite, 4.Diopside–Anorthits–Albite with petrogenetic significance, IUGS classification of igneous rocks, Magmatism related to plate tectonics-tholeiitic basalts, calc–alkaline magmatism.	14
Unit 2	Petrogenetic, Chemical, Mineralogical and field aspects of important rocks of India–Deccan flood basalts ,Layered intrusions, Carbonatites, Granitoids and formation of perthites, Kimberlites, Lamprophyres.	14
Unit 3	Metamorphism and metamorphic processes, characteristics of metamorphic reactions solid-solid, dehydration, decarbonation, Oxidation and their significance, Diagrammatic representation of mineral paragenesis–ACF,AKF,AFM ,Isograde and borrowian metamorphic zones, metamorphic facies differentiation, Retrograde metamorphism, metamorphism related to plate tectonics and paired metamorphic belts	14
Unit 4	Eskolas regional metamorphic facies Zeolite Greenschist , Glaucophaneschist, Amphibolite schist, Granulite, Eclogite, products of pelite, basic, ultrabasic and impure calcareous rocks. Thermal metamorphic facies sanidinite), Hornfels	14

Reference Book:

- 1) Metamorphism and metamorphic belts Miyashiro A.
- 2) Metamorphic petrology Turner F.J.
- 3) Metamorphic petrology Turner and Verhoogen.
- 4) Igneous and metamorphic petrology by Turner and Verhoogen.
- 5) Metamorphic Petrology by Winkler.
- 6) The Dynamic Earth System, A.M. Patwardhan, PHI Publication
- 7) Deccan Volcanism, K.V. Subbarao and R.N. Sukheswala, Geological Society of India, Memoir.No:3
- 8) Principles of Igneous and Metamorphic Petrology, John D Winter, PHI Publication
- 9) Petrology: Igneous and metamorphic best.
- 10) Metamorphic petrology, Harker.
- 11) Petrology: Igneous, metamorphic, sedimentary, Elher/ Blatt.
- 12) Evolution of Igneous rocks, Bowen N.L.

INTERNAL EVALUATION

(30 Marks)

(Seminar + Term paper + Test)

Paper No: HCT 2.2 INDIAN STRATIGRAPHY

Load/week:04

Total load : 56

Credits:04

**Marks: External :70
Internal:30**

Unit 1	Precambrian Stratigraphy of Peninsular India. Classification, Structure and Tectonics of Archaean Provinces of Peninsular India. Correlation of Archean Stratigraphy in India. Archaeans of the Extra-Peninsular region.	14
Unit 2	Archaean- Proterozoic boundary problem Stratigraphy, classification and evolution of the following proterozoic basins of Peninsular India. Cuddapah Basin Vindhyan Basin, Delhi SuperGroup, Pranhita- Godavari Basin, Indravati Basin, Bhima-Kaladgi Basin	14
Unit 3	Stratigraphy, tectonic and classification of Gondwana formations, Stratigraphy, tectonic and classification of Deccan volcanic, Stratigraphy and classification of marine transgression in South India, Stratigraphy and classification of Jurassic formation in Kutch Correlation of Paleozoic–Mesozoic and Cenozoic stratigraphic succession in ExtraPeninsular India	14
Unit 4	K.T. boundary problem, Fossils of Siwaliks, Rise of Himalaya Glacial periods in Indian stratigraphic	14

Reference Books :

1. Historical Geology and Stratigraphy of India Ravindra kumar
2. Geology of India & Burma D.N.Wadia
3. A Manual of Geology of India and Burma Pascoe volume 1,2,3,4
4. Geology of Maharashtra, G.G, Deshpande, Geological Society of India, Bangalore.
5. Geology of India Vol.1 and Vol2. Ramakrishnan and Vidynathan, Geological Society of India, Bangalore.

INTERNAL EVALUATION

(30 Marks)

(Seminar + Term paper + Test)

Paper No: SCT 2.1 : HYDROGEOLOGY**Load/week:04****Total load : 56****Credits:04****Marks: External :70****Internal:30**

Unit 1	Introduction , Scope of Hydrogeology, Hydrologic cycle : Types of Precipitation, Evapotranspiration, Initialization, Runoff, Age of groundwater and classification of groundwater, Darcy law and its range of validity, Hydraulic conductivity methods of determination of hydraulic conductivity, Hydrographic units, Hydraulic conductivity for an anisotropic aquifer , Groundwater movement and tracer technique, Groundwater equations for steady and unsteady flow.	14
Unit 2	Occurrence of groundwater: Types of openings in the rocks, Groundwater in Granitic, Basaltic, Metamorphic, Lime stones, Alluvium (unconsolidated sedimentary), Sandstones and Shale, Porosity, permeability, specific yield, specific retention, transmissivity storage coefficient (definitions and methods of determination) Hydrographs, Watertable and piezometric level contour maps construction and interpretation Well hydraulics: Determination of aquifer characteristics from pump tests (Thies, Thesis, Chow's Cooper Jacobs, Ruston and Singh, Recovery method etc.)	14
Unit 3	Fresh and salt water relationship in coastal area and islands, Ghyben–Hergberg principle and its modification, prevention and control of seawater intrusion, Groundwater provinces of India, Introduction to various methods of prospecting and exploration of groundwater Geological, Geophysical, Remote sensing, Consumptive and Conjunctive use of surface and groundwater, Types of confining layers, Types of Aquifers, Basic ideas of groundwater development and management	14
Unit 4	Artificial recharge methods and structures , Waterlogging problems, Problems of overexploitation, Groundwater legislation , Assessment of groundwater quality, Geochemistry of groundwater, Computer application in Hydrogeological studies .	14

References:

1. Groundwater, Todd, D.K., John Wiley.
2. Hydrogeology, Davies, S.N. & Dewiest, R.J.M. John Wiley.
3. Groundwater, Freeze, R.A. & Cherry, J.A., Prentice Hall.
4. Applied Hydrogeology, Fetter, C.W., Merrill publishing.
5. Groundwater, Raghunath, N.M. Wiley Eastern.
6. Groundwater assessment-development and management. Karanth, K.R. Tata Mc Graw Hill.
7. Regional Groundwater quality, Alley, W.M., VNR, New York.
8. Water. Subramaniam. V, Kingston Publ. London.
9. Groundwater and Tubewells, S.P. Garg, CBS Publication.
10. F.M. Introduction to Groundwater Hydrology,
11. Theory of Aquifer tests USGS, Wisler, C.P and Brater E.F.
12. Chow V.T. (ed) Handbook of Applied Geology.
13. Groundwater Resource and Evaluation, Walton, W.C.
14. David K. Todd and Larry W. Mays, Groundwater hydrology, 3rd edition, Wiley India.

INTERNAL EVALUATION**(30 Marks)****(Seminar + Term paper + Test)**

Load/week:04**Total load : 56****Credits:04****Marks: External :70****Internal:30**

Unit 1	Importance of geological studies in engineering investigations, dependence of design on geological features of project site. Complexity of soil structure, major soil deposits of India, Field identification of soils. Introduction to soil exploration-objective and purpose. Three phase soil system, weight -volume relationships, Index properties of soil-methods of determination and their significance. IS and Unified Soil classification systems.	14
Unit 2	Subsurface Explorations for Water Retaining Structures: Various Physical and Mechanical properties of rocks affecting strength & water tightness of them from foundation point of view. Effect of weathering, deterioration of rock masses on exposure to atmosphere & hydrothermal alteration of rocks on water retaining structures & suitable treatment for such rocks. Geological Foundation Treatments for weak and fragmented rock, fractured rocks, jointed rock, leakages etc. in various Civil Engineering Projects .	14
Unit 3	Rock Mechanics: General principles of rock mechanics. Dependence of physical and mechanical properties of rocks on geological characters. Various laboratory testing methods. Calculation of R.Q.D. Joint Frequency Index, Various Methods of Geomechanical classifications of rocks such as Terzahagi, U.S.B.M, R.M.R., R.S.R., Q. system, Deer and Miller, Bieniawski's Geomechanical classification etc. and computation of representative rock formation such as DTB.	14
Unit 4	Stability of Slopes- Classification of slopes and their modes of failure, Taylor's stability number, Infinite Slopes in cohesive and cohesion less soil, Landslides- Causes and remedial measures. Introduction to Geoenvironmental engineering, subsurface contamination, contaminant transport, effects of subsurface contamination, Control and remediation, Soil- A geochemical trap, detection of polluted zones, Monitoring effectiveness of designed facilities.	14

Books &References :

1. Jaeger – Rock Mechanics in Engineering, Cambridge Univ Press London, 1990.
2. Megaw T. M.& Tunnels: Planning, Design, Construction
3. Goodmann – Engg. Geology.
4. J. V. Bartlett - Int. ED, Ellis Horwood ltd. John Willey & Sons
5. Bieniawski Z. T. - Engineering Classification of jointed Rock Masses.
6. Introduction to Rock Mechanics by B. P. Verma-Khanna Pub New Delhi

INTERNAL EVALUATION**(30 Marks)****(Seminar + Term paper + Test)**

Paper No: OET 2.1 : NATURAL RESOURCE MANAGEMENT
Marks: External 70 **Internal 30**

Unit	Topic	Credit	Lectures
UNIT-1	Introduction: Definition, broad classification of natural resources. Renewable: Solar, Wind, Geothermal, Tidal, Biomass (Bio Gas), Ocean and Magneto- hydrodynamic Power. Non Renewable: Thermal Power, Hydro Energy, Nuclear Energy and Fossil fuels. Impact on Environment and their applications. Energy Production Consumption and Energy use pertain in different part of the world.	1	14
UNIT-2	Conservation of Energy: Importance, Methods of Conservation, Measures for Promoting Energy Conservation. Mineral Resources: metals and non-metals, formation of mineral deposits, Conservation of mineral resources and their distribution in India.	1	14
UNIT- 3	Water Resources: Surface, Ground and Frozen Water, Desalination, Uses for Agriculture, Energy Generation, Domestic Consumption. Causes for Water Stress, Water Availability and its Demand. Types of dam and impacts Water Conservation Strategies in India, Rain Water Harvesting.	1	14
UNIT-4	Land & Forest Resources: Agricultural Practices in India, Exploitation of Agricultural Land. Range Land Management. Mining, Quarrying and their Impacts. Land degradation, its causes and consequences. Importance of Forestry, Forest Products, Forest-Based Industries. Forest Fire and its Control. Afforestation and Joint Forest Management, Social Forestry, Agro-Forestry.	1	14

INTERNAL EVALUATION 30 MARKS
(Seminar + term paper + test)

Reference Books:

1. Biomass Energy and Environment: H.R. Ravindranath, Oxford University Press, New York. 1995.
2. Ecology and Environment: P.D. Shrama, Rastogi Publications, New Delhi, 2004.
3. Energy Resources and Environment: V.K. Prabhakar, Anmol Publisher Environmental

Unit 1	Watershed definition, size, characteristics, factors affecting, watershed operations: causes and consequences of watershed deterioration. Definition, different approaches and objectives of watershed management. Peoples participation and organisation. Watershed management plan.	14
Unit 2	Erosion process : Factors affection soil erosion, soil erosion and its types, modelling of erosion using Universal soil loss equation. Groundwater table – depth, perched, capillary rise, recharge. Land capability classification : purpose and basic eight classes.	14
Unit 3	Rainfall and its measurement: Formation precipitation/rainfall, rainfall pattern in India, rainfall parameters, rainfall measurement types. Estimating runoff processes, factors affecting runoff, design of peak runoff through rational and cook's method.	14
Unit 4	Agronomic measures of soil and water conservation. Basic engineering measures for soil and water conservation, contour cultivation, bunding, terracing, continuous contour and staggered trenches, treatment of catchments, gully plugging, check dams, small storage structures, designing of simple bund structure.	14

Books:

1. Common guidelines for watershed development projects (2008). Government of India
2. Dhruva N.V.V., Sastry G.O., (1990): Watershed management, ICAR, New Delhi.
3. Frevert R.K., Schwab G.O., Edminster T.W., and Barnes K.K. (2009) Soil and water conservation engineering, 4th edition, John Willey and Sons, New York.
4. Jain S.K. and Sing V.P. (2006) Water resources system planning and management, Elsevier India, New Delhi
5. Mukherjee A. (2004) Participatory learning and action: Monitoring and evaluation and participatory monitoring and evaluation, Concept publishing company, New Delhi.
6. Rao K.V.S. (2003) Watersheds: comprehensive development, B.S. Publication.
7. Sharda V.N., Sikka A.K. and Juyal G.P. (2006) Participatory integrated watershed management: A field manual, central soil and water conservation research training institute, Dehradun.
8. Singh R.V. (2003) watershed planning and management, Yash publication, Bikaner

INTERNAL EVALUATION**(30 Marks)****(Seminar + Term paper + Test)**

PRACTICAL HCP 2.1 + HCP 2.2: Igneous and Metamorphic Petrology + Indian Stratigraphy

Marks : 100

Credit : 4

Igneous and Metamorphic Petrology

IGNEOUS PETROLOGY:-

1. Study of the mineralogy and textures of igneous rocks in thin sections.
2. Calculation of CIPW norms and Niggli calculations for all types of saturated and unsaturated rocks. Megascopic and microscopic study of representative rocks.
3. Quantitative mineralogical studies on thin section and rock classification. Classification of igneous rocks under IUGS scheme
4. Classification of volcanic rocks under TAS scheme.

METAMORPHIC PETROLOGY:-

1. Study of representative metamorphic rocks megascopically and microscopically.
2. Study of mineralogy and structures of metamorphic rocks in thin sections, paragenetic (Chronological) interpretations.
3. Model analysis and calculations of ACF, AFM, AKF diagrams. Geothermobarometric calculations.

Indian Stratigraphy

1. Preparation of Indian stratigraphy column
2. Identification of Precambrian Stratigraphy of South India. Preparation of Dharwar distribution map.
3. Identification of purana basins of India.
4. Preparation of tectonic evolution map of cuddapah basin. Map showing evolution of vindhyan stratigraphy. Distribution of Aravali supergroup and Delhi group.
5. Preparation of map showing Gondwana supergroup and succession from type area. Map showing marine transgression of South India.
6. Tectonic evolution of Himalayas.

PRACTICAL SCP 2.1/2.2 + OEP 2.1/2.2:

Marks : 100

Credit : 4

PRACTICAL SCP 2.1: HYDROGEOLOGY

1. Preparation and interpretation of Hydrogeological maps. Computation of Hydraulic Gradient.
2. Groundwater flow maps and flow net analysis, problem related to Darcy's law.
3. Analysis of well inventory data, pump test analysis, field techniques and computation of aquifer parameters by different methods.
4. Use of well logging techniques.
5. Application of computer programs in solving groundwater problems.

PRACTICAL SCP 2.2: GEOTECHNICAL ENGINEERING

1. Study of Engineering Geological map
2. Study and Interpretation of seismic zonation map of India
3. Preparing geological cross sections from drill hole data & using them for designing of civil engineering structures in folded & faulted region, spillways on igneous rocks etc.
4. Study of soil profile of different terrains of India
5. Study of Morphometric parameters of terrain
6. Computation of RQD & Joint Frequency Index

PRACTICAL OEP 2.1: NATURAL RESOURCE MANAGEMENT

1. Study on water budget.
2. Estimation of roof top water harvesting.
3. Study on land capability classification.
4. Determination of ecological foot print.
5. Proximate analysis of coal for moisture volatile matter and carbon contain.
6. Study of calorific value of biomass.
7. Estimation of biogas generation.
8. Preparing mineral distribution map of India.

PRACTICAL OEP 2.2 : WATERSHED MANAGEMENT

1. Study of drainage pattern
2. Determination of contour interval and profile.
3. Determination of drainage density.
4. Study of water holding capacity.
5. Study of wilting coefficient
6. Estimation of peak runoff
7. Estimation soil erosion
8. Studies based on bund geometry
9. Demarcating contour interval on the field.

Paper No: HCT 3.1 : MINERAL EXPLORATION

Total load : 56

Credits:04

Marks: External :70

Internal:30

Unit 1:	<p>Introduction to prospecting and exploration: scale of prospecting; classification of prospecting methods, objectives of exploration, principles of exploration, methods and stages.</p> <p>Optimization of exploration: planning, choice of exploration methods, integrated exploration sequence, organization and operation during exploration. Evaluation of mineral deposit at various stages of exploration, workable standards.</p> <p>Prospecting criteria and guides, geological criteria, climate, stratigraphy, facies and lithological aspects, structure and geological aspects, geochemical and geophysical anomalies, geological conditions favorable for prospecting.</p>	14
Unit 2:	<p>Exploration equipments and system, exploration openings, reconnaissance bore holes drilling system, exploration by underground and bore hole workings. Factors affecting choice of system. Methods and types of sampling, choice of sampling, sample spacing, grading mineral deposits, sample error and check.</p> <p>Introduction to geophysical prospecting, classification and types of prospecting methods, concept and principles of gravity and magnetic surveys, anomalies, their correction, instrumentation and field data acquisition, interpretation and application to geological problems. Concept of seismic reflection and refraction methods, instrumentation and field data acquisition, preparation of travel times curves, identification of subsurface structure</p>	14
Unit 3:	<p>Types of electrical surveys, electrode configuration, field data, resistivity methods interpretations of subsurface lithology and structures by qualitative and quantitative analysis.</p> <p>Radiometric prospecting, principles and concept, GM and scintillation counters, field data acquisition and interpretation.</p> <p>Subsurface Geophysical exploration: Types of Well Logging, Instruments, subsurface structural and stratigraphic correlation.</p>	14
Unit 4:	<p>Geochemistry in mineral exploration, classification of geochemical surveys, association of elements, mobility and path finder elements. Geochemical dispersion and landscape: patterns of deep seated origin, formation of productive plutons, geochemical provinces, host rock petrochemistry, ores related to productive plutons.</p> <p>Biogeochemical and geobotanical surveys: choice of sampling medium and their anomalies, mapping technique, merits and demerits, biogeochemical and geobotanical indicators.</p> <p>Data handling and statistical interpretation of data, organization and data bank, univariate and multivariate analysis, calculation of background, threshold and cut off values.</p>	14

Reference Books:

1. Geological prospecting -- Kreiter
2. Mineral Exploration by A.W. Rose, H.E. Hawkes & J.S. Webb
3. Rock geochemistry in mineral exploration by G.J.S. Govette Elsevier
4. Analytical methods in geochemistry prospecting by Fleteher W.K. Elsevier
5. Geochemical exploration methods for mineral deposits. by Beus A.A. & Grigorian S.V.
6. Introduction to geophysical prospecting by Dobrin M.B.
7. Outlines of geophysical prospecting for geologists. by Ramchander Rao. M.B. --
8. Fundamentals of Geophysics by William Lowric
9. Applied Geophysics by Telford W.M., Geldart L.P. & Sheriff R.E.

INTERNAL EVALUATION**(30 Marks)****(Seminar + Term paper + Test)****Paper No: HCT3.2: GEOTECTONICS AND PHYSICAL OCEANOGRAPHY Load/week:04****Total load : 56****Credits:04****Marks: External :70****Internal:30**

Unit 1:	Plate tectonics; Basic concepts and definition, types of plate margins their characters and associated processes like magnetism, seismicity, volcanism mountain belts, Benioff zones. Tectonic evolution of continents, cratons and ocean basins. Tectonics of Indian sub continent. Orogenesis: Precambrian and Phanerozoic orogenesis, source and nature of tectonic forces, comparison of hypothesis of orogenesis – contraction, expansion, convection, Plume hypothesis and micro plate tectonic, sea floor spreading. Tectonic model of evolution of the Himalayas.	14
Unit 2:	Morphologic and tectonic domains of the ocean floor. Structure, composition and mechanism of the formation of oceanic crust. Ocean margins and their significance. Opening and closing of ocean gateways and their effects on circulation and climate during the Cenozoic. Sea level processes and Sea level changes.	14
Unit 3:	Estuaries: classification and nomenclature; tides in estuaries; estuarine circulation and mixing; depth – averaged and breadth – averaged models; sedimentation in estuaries; salinity intrusion in estuaries; effect of stratification; Oceanic sediments: Factors controlling the deposition and distribution of oceanic sediments; geochronology of oceanic sediments, diagenetic changes in oxic and anoxic environments. Indian perspective: Ridges deltas, hot spots.	14
Unit 4:	The global wind system; action of wind on ocean surface; Ekman's theory; Sverdrup, Stommel and Munk's theories; upwelling and sinking with special reference to the Indian ocean. Inertial currents; divergences and convergences; geostrophic motion; barotropic and baroclinic conditions; oceanic eddies, relationship between density, pressure and dynamic topography; relative and slope currents. Wind driven coastal currents; typical scales of motion in the ocean. Indogangetic delta.	14

Reference Books :-

The evolving continent by Windley.

Plate Tectonic and crustal Evolution by Condie.

Marine Geology by J.Kennet

Aspects of Tectonics by Waldiya.

INTERNAL EVALUATION**(30 Marks)****(Seminar + Term paper + Test)**

Paper No: HCT3.1 : ENGINEERING GEOLOGY and MINING GEOLOGY

Total load : 56

Credits:04

Marks: External :70

Internal:30

Unit 1:	Engineering properties of rocks., rock discontinuity, physical characters of building stones. Modulus of elasticity for rocks, modulus of deformation. Geological investigation for civil engineering. Geological criterias for site selection of dams, tunnels and reservoir. Dams foundation rock problem. Geotechnical evaluation of tunnel alignment lining, bridges and transportation routes. Rock mass classification methods for restoration of slope	14
Unit 2:	Mass movement – land slides and causes of hill slope instability, methods of surface subsurface investigation, slope stability analysis. Earthquakes and seismicity, seismic zones of India. Types of engineering structures involved in watershed management. Problems of groundwater in engineering projects. Geotechnical case studies of major projects in India. RQD properties of soil, low bearing capacity, rock aggregates their classification and properties, manufacturing of sands, aggregates.	14
Unit 3:	Application of rock mechanics in mining, planning, exploration and exploratory mining of surface and underground mineral deposit involving diamond drilling, shaft sinking, drifting cross cutting, winzing, stopping, room and pillaring, top-slicing, sub level caving and block caving, cycles of surface and under ground mining operations.	14
Unit 4:	Exploration for placer deposit. Open pit mining. Ocean bottom mining , types of drilling methods viz. diamond drilling and chern drilling. mining hazards-mine diseases, mine inundation, fire and rock burst, mine gasses, open cast and underground mining methods. Mine restoration and safety.	14

Reference Books :-

Engineering Geology by Davis.

Engineering Geology by Parbeensingh.

Principle of Engineering Geology by Krynneen and Judd

Geology and Engineers by Laggets

Mining geology by Mckinstry

Elements of mining by Clark G.B

Courses in mining geology by Arogyaswami R.P.N.

Introduction to geophysical prospecting by Dobrin

INTERNAL EVALUATION

(30 Marks)

(Seminar + Term paper + Test)

Paper No: SCT 3.2 : CLIMATOLOGY & PLANETARY SCIENCE**Total load : 56****Credits:04****Marks: External :70****Internal:30**

Unit 1:	Nature and scope of climatology, development of modern climatology and tropical climatology, Earth's atmosphere: evolution, structure and chemical composition, Solar radiation and terrestrial radiation: electromagnetic spectrum, latitude and seasonal variations, effect of atmosphere, greenhouse effect and heat budget, Temperature measurements and controls, lapse rate and inversion of temperature.	14
Unit 2:	Atmospheric pressure and winds: pressure measurement and distribution, wind observation and measurement, factor affecting wind, geostrophic wind and gradient wind, local winds, models of general circulation of the atmosphere, Jet stream, Atmospheric moisture: forms of condensation and precipitation, hydrological cycle, Stable and unstable atmosphere: environmental lapse rate, dry and wet adiabatic lapse rate and atmospheric stability, Air masses: classification and modification, Fronts: characteristics and types, Classification of climates : Thornthwaite's and Koppen's classification.	14
Unit 3:	Solar system : major concepts, planets, satellites, asteroids, meteorites and comets; formation and internal differentiation of the planets; general features of terrestrial and Jovian planets. Planetary atmosphere; exogenic and endogenic processes association with origin and internal evolution of planets – Planetary volcanism, craters, impact cratering processes, elemental composition, mineralogy and petrology; thermal, seismic and magnetic properties and chronological techniques	14
Unit 4:	Planetary surfaces, atmospheres, interiors, magnetic fields, and ring systems and their associated origins and processes will be explored. Also, the Sun and its effects on the planets will be addressed. The moon and its terrestrial analog IO, Phobos and Deimos, minor bodies such as asteroids, comets, meteorites. Past, present and future planetary exploration mission.	14

Reference books:

Foures G., and Mensing T.M., Introduction to Planetary Science

Taylor and Francis, Introduction to Planetary Geology

INTERNAL EVALUATION**(30 Marks)****Paper No. OET 3.1 RESEARCH METHODOLOGY****Total load : 56****Credits:04****Marks: External :70****Internal:30**

Unit 1:	Formulation of Research Problem: Criteria of quality research, types of research, significance, literature review, purpose, process of literature review, analysis of an article, search engine, formulation of research problems. Research ethics and plagiarism.	14
Unit 2:	Definitions of problem, objectives of research, planning of experiments, data collection and record keeping, results and discussions, presentation of research outcome as a research paper or filing patent.	14

Unit 3 :	Indices, publications, types, Impact factor, calculation of Impact Factor, uses, Calculation of immediacy Index, SCOPUS index, h – index, advantages, criticism ISSN, ISBN numbers.	14
Unit 4:	Various search engines available on internet, normal vs advanced search, key – words, formulation of search statement, Listing various journals in relevant topic, Science abstracts, e – database. Application of Computers in research, internet browsing, tool bar options, provisions of MS – word, MS – Excel, MS – PowerPoint, Coral draw, SPSS	14

Reference Books:

1. Research Methods - Ram Ahuja, Rawat Publications
2. Philosophy of Science – Mario Bunge, Transaction Publishers
3. Research Methodology - Methods and Techniques, C. R. Kothari New Age
4. Fundamentals of Statistics - Goon, Gupta and Das Gupta (Vol. I & Vol. II)

INTERNAL EVALUATION

(30 Marks)

(Seminar + Term paper + Test)

Paper No. OET 3.2 : GEOARCHAEOLOGY

Total load : 56

Credits:04

Marks: External :70

Internal:30

Unit 1:	Minerals – definition and types, physical properties for distinguishing common minerals: colour, luster, transparency, hardness (Moh’s scale of hardness), fracture and cleavage, crystalline forms of minerals and conditions of crystal formations General study of various rock forming minerals: quartz, feldspar, mica Rocks – types of rocks: igneous, sedimentary and metamorphic, their characteristic features, origin and field structures, general information on rocks found in India	14
Unit 2:	Geological time-scale – the position of the Quaternary Period within the standard geological column; plio-pleistocene boundary Minerals used in the manufacture of ancient objects – quartz, chalcedony, agate, jasper, flint, opal, amethyst, carnelian, mica, garnet, calcite, gypsum, talc, beryl, topaz, jade etc.	14
Unit 3 :	Weathering, soils and palaeosols in archaeology: various land forms, nature and causes of weathering, rate of weathering, weathering and site formation, weathering and relative dating, soil micromorphology and archaeology, loess, paleosols Fluvial environments in archaeology: river terraces and other formations, alluvial archaeology – understanding site formation and palaeoenvironment; lacustrine deposits and sea level changes	14
Unit 4:	Formation of caves and glacial deposits – moraines Quaternary formations with special reference to India , Geochronology, Biota, Sedimentology Pedology, volcanic ash deposits	14

Reference Books:

1. Principles of Engineering Geology by S.K.Garg.1999, Khanna Publ, New Delhi
2. Principles of Geomorphology by Thorbury W. D. CBS Publishers & Distributors Pvt. Ltd., New Delhi(2004)
3. Geology of India and Burma By. M. S. Krishnan,1982, CBS Publishers, New Delhi
4. Physical Geology by Arthur Holmes-ELBS Publication.
5. Structural Geology by M. P. Billings

PRACTICAL HCP 3.1 + HCP 3.2:**MINERAL EXPLORATION + GEOTECTONIC AND PHYSICAL OCEANOGRAPHY****Marks : 100****Credit : 4****MINERAL EXPLORATION**

1. Reserve calculation problems
2. Problems on structures and site selection
3. Management of resources
4. Types of reconnaissance and determinative mineralogical aspects.
5. Sample analysis using AAS *
6. Mineral characterization using XRD *

*With the help of common facility centre of Instrumentation.

GEOTECTONIC AND PHYSICAL OCEANOGRAPHY

1. Study of Tectonic elements of the given tectonic maps.
2. Identification of palaeotectonic regimes and delineating their characteristics.
3. Identification of different tectonic features in the given map/ sketches.
4. Study of tectonic maps of different parts of India.
5. Interpretation of Neotectonic features using aerial photographs.
6. Maps related to Ocean features

PRACTICAL SCP 3.1/3.2 + OEP 3.1/3.2**PRACTICAL SCP3.1 : ENGINEERING GEOLOGY & MINING GEOLOGY**

1. Salient points for the construction of contours of bunds, stream bunds, percolation tank, subsurface dam etc.
2. Use of morphometric analysis in planning watershed development.
3. Structural maps for engineering construction
4. Engineering properties of rocks.
5. Determination of Rock strength and soil strength.
6. Ground subsidence and their improvement techniques.

Practicals of Mining Geology:

1. Mine valuation and calculation
2. Mine survey problems.
3. Terminology of mines
4. Calculation of reserve

PRACTICAL SCP3.2 : CLIMATOLOGY & PLANETARY SCIENCE

1. Interpretation of daily weather report

2. Wind rose diagram; Line graph; Dispersion diagram
3. Study of Planetary images and construction of geological maps from orbital images of Terrestrial planets.
4. Study of meteorites.

PRACTICAL OEP 3.1: RESEARCH METHODOLOGY

1. Demonstration of common lab instruments for carrying out analysis as per API.
2. Demonstration or video clip of analytical instruments used in Earth Sciences.
3. Presentation of any published research paper.
4. Practical use of MS-Excel, MS-PPT, coral draw and any other softwares

PRACTICAL OEP 3.2 : GEOARCHAEOLOGY

1. Megascopic identification of following mineral specimens
2. Megascopic identification of following different rock specimens
3. Interpretation and construction of geological sections from contoured geological maps
4. Study of various geomorphic features.

Paper No: HCT 4.1: : ENVIRONMENTAL GEOLOGY AND DISASTER MANAGEMENT

Load/week:04

Total load : 56

Credits:04

Marks: External :70

Internal:30

Unit 1	Fundamental concepts of Environmental Geology, Concept of ecosystem – biotic communities, food chain and Ecologic Pyramids. Biogeochemical cycles. Impact of anthropogenic activities on air, water and soil resources. Their types, sources and causes of pollutants, coastal pollution; mixing and dispersal of pollutants in estuaries and near-shore areas; coastal zone management. Controlling measures.	14
Unit 2	Waste: Source and classification of waste products. Waste disposal and recycling methods. Control and management of waste materials. Impact assessment of anthropogenic activities such as urbanization, open cast mining and quarrying, disposal of mine and radioactive wastes, fly ash, use of fertilizers. Environmental protection – legislative measures in India. Remediation measures.	14
Unit 3	Study of Natural Hazards like meteorite impact hazard, landslides, floods and drought, earthquakes, mining, volcanic eruptions: their classification, causes, assessment, prediction and controlling measures. Use of GIS and remote sensing in natural disasters management. Preparedness for relief and recovery operations	14
Unit 4	Case histories of natural disasters of India viz. Koyana earthquake, Killari earthquake, Uttar Kasi, Nepal earthquake, Jammu and Kashmir, Uttarakhand floods, East coast cyclones, Tsunami, drought prone regions of India with special reference to Maharashtra,	14

Reference:

Environmental chemistry; A.K. De
 Environmental Geology; Keller
 Environmental Geology; Valdiya
 Mineral economics : Sinha and Roy.
 Mineral economics : Chatterjee.

INTERNAL EVALUATION

(30 Marks)

(Seminar + Term paper + Test)

Paper No: HCT 4.2: REMOTE SENSING and GIS:

Load/week:04

Total load : 56

Credits:04

**Marks: External :70
Internal:30**

Unit 1	Concept of Remote Sensing : Electromagnetic energy, Interaction of EMR with atmosphere and earth material, atmospheric windows, EMR spectrum. Platforms, sensor types, MSS. Aerial Remote Sensing : Flight planning, types of aerial photographs. Photogrammetry – stereoscopic vision, scale, relief displacement, parallax, vertical exaggeration. Satellite Remote Sensing : LANDSAT & IRS characteristics, products and FCC.	14
Unit 2	Interpretation techniques, visual and digital in brief. Recognition of photo elements and terrain elements like size, shape tone, texture, pattern, shadow, sight and association. Terrain analysis: Relief, landforms, drainage pattern. Use of remote sensing in lithology, structure and geomorphology. Application of remote sensing in groundwater and mineral exploration.	14
Unit 3	Basic concept of GIS, components, history and applications. Hardware and software requirement for GIS. Map features, scale, resolution, accuracy and database extent. Map projection and parameters: Geographical co-ordinate system, types of projection and parameters, projection transformation and managing in GIS.	14
Unit 4	Geospatial data models: Spatial and non-spatial data, VECTOR AND RASTER models. GIS ANALYSIS : Digitization, editing and structuring of map data, overlay analysis. Digital elevation and terrain models (DEM/DTM),buffer analysis and query analysis. Use of GIS in lithological, structural, groundwater and mineral exploration. Introduction to Global Positioning System,and its applications and limitations.	14

Reference Books -

- Principles and applications of photogeology by S.N. Pande
- Photogeology and regional mapping by J.A.E. Allum.
- Remote sensing and image interpretation by Lilley sand
- Photogeology by Miller and Miller.
- Thermal and microwave remote sensing by Sabins.
- PhotogeologybyPanda
- Textbook of Remote sensing and GIS by M. Anjireddy

INTERNAL EVALUATION

(30 Marks)

(Seminar + Term paper + Test)

Paper No: HCT4.3 : FUEL GEOLOGY**Load/week:04****Total load : 56****Credits:04****Marks: External :70
Internal:30**

Unit :1	Role of fuels in national development, Types of fuels, Conventional and Non-Conventional energy resources. eg. Fossil fuels, Coal, Petroleum, Natural gas, Ocean Thermal energy, Wind energy, Biomass energy and Geothermal energy, Tidal energy, Solar energy and Energy from the waste. Status of Conventional and Non- Conventional energy resource in India.	14
Unit :2	Physical properties of petroleum, composition of petroleum and natural gas; genesis of hydrocarbons, conversion of organic matter to petroleum, migration and accumulation of oil; study of reservoir rocks, trap rocks and cap rocks; different types of traps including structural traps, stratigraphic traps and combination traps, salt dome; methods of petroleum exploration; Enhanced recovery operations for petroleum and natural gas. Oil producing basins of India and their stratigraphy and structure. Shale and oil gas hydrates	14
Unit :3	Origin and composition of coal, Coal petrographic, classification of coal deposits, chemical constituents of coal, distribution and stratigraphy of Tertiary and Gondwana coal in India.	14
Unit :4	Introduction to various radioactive minerals, their half lives and breeding characteristics. Use of atomic energy as alternative energy resource. Nature and types of Uranium deposits and their occurrence and genesis. Nuclear fusion and Nuclear breeder. Nuclear waste and its management. Atomic mineral . Distribution in India. Brief introduction to radioactive surveys.	14

Reference Books -

Petroleum Geology by F..K. North

Petroleum formation and occurrence by Tissot and Welte

Petroleum asia journal, A.A.P.G. Journal

Handbook of Energy Technology by V.D. Hunt

Introduction to Petroleum geology by Hobsson and Tirtsoo.

Nuclear Geology by Ashwathnarayan

Development in Petroleum Geology by Hobson.

Coal Deposits by Tatsch

Petroleum Development in Geology by Dicky

Geothermal Systems by Reach and Mufflur.

Petroleum Geology by Levorson

Paper No: SCT4.1 : DISSERTATION**Load/week:04****Total load : 56****Credits:04****Marks: External :70
Internal:30**

Students has to do project work on allotted topics

Paper No: SCT4.2 : GEMMOLOGY

Load/week:04

Total load : 56

Credits:04

Marks: External :70

Internal:30

Unit :1	CRYSTALLOGRAPHY : Nature of crystals; Systems of crystallography; Crystalline and non-crystalline materials; Forms; Habit; Twinning. OPTICAL PROPERTIES : Colour; Transparency; Visible Spectrum; Light Reflection; Total Internal Reflection; Single and Double Refraction; Dispersion; Polarization; Refractive index and its determination by Refractometer; Reflectivity; Reflectometers. COLOUR AND CAUSES OF COLOUR : Pleochroism; Interference; Lustre; Sheen; Opalescence; Adularescence; Irridescence; Asterism; Chatoyancy.	14
Unit :2	INSTRUMENTS USED FOR GEM IDENTIFICATION : Jeweler's Lens; Microscope; Spectroscope; Dichroscope; Chelsea colour filter; Ultraviolet light and X-rays; Polariscope; Refractometer. SYNTHETICS, COMPOSITES AND IMITATION GEMSTONES AND PLASTICS : Different methods of manufacture; Characteristics; Identification.	14
Unit :3	FASHIONING OF GEMSTONES : Procedures, processes and equipment used in cutting of diamonds and other stones. Different styles of cutting. Grading gemstones for quality of cutting. TREATMENT OF GEMSTONES : Dyeing, Coating, Heat Treatment, Irradiation, Waxing, fracture filling, oiling, laser drilling, HPHT, diffusion, mass diffusion, graphitisation, composite stones, glass filling. OCCURRENCES OF GEMSTONES : Geographical origin of gemstones is an important aspect in the assessment of quality of gemstones especially Rubies, Sapphires and Emeralds.	14
Unit :4	Electrical and Magnetic properties of gemstones, conductometer. Thermal conductivity and Thermal probes. Marketing aspects : Gem & Jewellery industry an overview, analysis of prospects and problems of various sectors such as precious/semi precious, diamonds, pearls, synthetic, imitation, jewellery studded and plain gold. Export procedures and formalities.	14

Reference Books:

1. An introduction to the Rock Forming Minerals Deer, Howie and Zussman.
2. Rock Forming Minerals Deer, Howie and Zussman.(Vol.1-5)
3. A textbook of Mineralogy by Dana.
4. Optical mineralogy P.F. Keer.
5. Optical Crystallography E.E. Wahlstrom.
- 6.An introduction to crystallography Phillips.
- 7.Minerals and rocks: exercise in crystallography, mineralogy and hand specimen Corneis Klein.

AGP 305 PRACTICAL RELATED TO AGT 301 AND AGT 302

(70 marks)

Practical AGT 301 (Geotectonics and Physical oceanography)

Study of Tectonic elements of the given tectonic maps.

Identification of palaeotectonic regimes and delineating their characteristics.
Identification of different tectonic features in the given map/ sketches.
Study of tectonic maps of different parts of India.
Interpretation of Neotectonic features using aerial photographs.
Maps related to Ocean features

Practical AGT 302 (Mineral exploration)

Reserve calculation problems
Problems on structures and site selection
Management of resources
Types of reconnaissance and determinative mineralogical aspects.
Sample analysis using AAS *
Mineral characterization using XRD *
*With the help of common facility centre of Instrumentation.

INTERNAL EVALUATION

(30 Marks)

(Viva-voce + Journal + Data evaluation)

PRACTICAL HCP 4.1 +HCP 4.2

PRACTICAL HCP 4.1 : Environmental Geology & Disaster Management

1. Identification and mapping of natural hazards and zones and terminology of the associated features: viz, floods, landslides, glaciers, with the help of topographic sheets, aerial photographs and LANDSAT imageries.
2. Determination of pollutants from surface and subsurface water samples.
3. Assessment of the mining hazards with respect to case histories.
4. Classification of coastal zones and mapping.
5. Utilization of coastal environmental maps with the help of toposheets, aerial photographs and LANDSAT imageries.
6. World wide distribution of disasters.
7. Mapping of disaster prone zone with the help of remote sensing.
8. Study of case histories of natural disasters in India.

PRACTICAL HCP 4.2 : Remote Sensing & GIS

1. Determination of photo scale and height determination
2. Study of different erosional, depositional landforms and tectonics landforms.
3. Interpretation of lithology and structures from aerial photographs and satellite imageries.
4. Study and analysis of lineaments and drainage from aerial photographs.
5. Nature of sources of geographical data.
6. Georeferencing and digitization
7. Preparation of DEM/DTM
8. Slope, buffer, mosaiking and overlay analysis

PRACTICAL HCP 4.3 +SCP 4.1/4/2

PRACTICAL HCP 4.3 : Fuel Geology

1. Flash point and smoke point of crude, refractive index for crude.
2. Calculation of reservoir, petroliferous basins of India.
3. Identification of radioactive minerals.
4. Isopach maps of petroleum reserve
5. Reserve calculation problems
6. Microscopic studies of ores, coal, placer minerals.

7. Identification, testing and evaluation of gem minerals and their quality improvement suggestion

PRACTICAL SCP 4.1 : Dissertation

A detailed report has to be submitted on the topic allotted by guide.

PRACTICAL SCP 4.2 : Gemology

1. Observation of external features (cut, colour, fractures, etc.) of a gemstones using a 10x lens;
2. Determination of specific gravity by hydrostatic weighing method and by using heavy liquids;
3. Measurement of refractive indices and birefringence tests using a gem-testing refractometer;
4. Detection of double refraction, interference figures and internal strain with the polariscope;
5. Observation of the internal features of various natural and synthetics gemstones with a microscope;
6. Use of colour filters in detecting synthetic gemstones;
7. Visual Identification of various gemstones by its crystal system and other external properties;
8. Various types of cuts and introduction to how to cut gemstones;