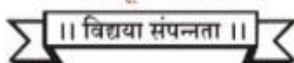


**PUNYASHLOK AHILYADEVJI HOLKAR**

**SOLAPUR UNIVERSITY, SOLAPUR**



पुण्यश्लोक अहिल्यादेवी होळकर  
सोलापूर विद्यापीठ



NAAC Accredited-2015  
'B' Grade (CGPA 2.62)

**Name of the Faculty: Science & Technology**

**Choice Based Credit System**

**Syllabus: Applied Geology**

**Name of the Course: M.Sc.-I (Sem. I & II)**

**(Syllabus to be Implemented from w.e.f. June 2020)**

**PREAMBLE:**

Department of Applied Geology of Punyashlok Ahilyadevi Holkar Solapur University is one of the oldest Departments in the Solapur district. The Department of Applied Geology at Punyashlok Ahilyadevi Holkar Solapur University offers the Master of Geology (M.Sc.) program. This program is designed to provide deep knowledge and develop necessary skills to acquire good jobs in various Industries such as Petroleum, Geotechnical, NRSA, Groundwater consultancy, Gemology, Exploration, Mining and in Government sector. Over the past 35 years, the faculty members of department have been committed to improving curriculum, increasing experiential learning, and identifying best practices in teaching through rigorous assessment and review of our programs.

**PROGRAM OBJECTIVES:**

The program objectives for student's post graduating with a degree from Applied Geology are;

1. Effective use of literature for evaluation of data, hypothesis and conclusions.
2. To communicate scientific ideas and interpretations of data in writing.
3. An interdisciplinary approach for solving the geologic problems associated with earth's geological material.
4. Conducting advanced study in many areas of geology and also eliminate deficiencies in their geological education.
5. Prepare for jobs in the Geology or student may be enrolled in doctoral program.

**PROGRAMME SPECIFIC OUTCOMES:**

1. Students can understand effective use of scientific methods in the geological sciences. They should have thorough knowledge about the;
  - a) Earth's interior, plate movement and the development of new features on the surface of the earth.
  - b) Formation process and classification of rocks and mineral.
  - c) Work of geological agents with the solid earth and the formation of new landforms.
  - d) Sequential arrangement of the strata and establishing history of deposition.
2. Apply knowledge and techniques from allied fields, including chemistry, physics, biology, mathematics, and computing, to solve geological problems.
3. Acquiring basic skills of geological science including use of modern technology in presenting public data, hypothesis and conclusion.
4. Applying existing field and laboratory procedures to acquire original data, and using appropriate means to analyze research data.
5. Students participate in workshops/seminar/conferences on current geological issues.
6. Contributing in public issues related with geological sciences and be ready for resolution.
7. Develop and present scientific proposal, conduct original research for Master's thesis.

**School of Earth Science  
Solapur University  
M.Sc Applied Geology (CBCS Syllabus) 2020-21**

Semester	CODE	TITLE OF THE PAPER	Semester Exam			L	T	P	Credit	
			Theory	IA	Total					
First		<b>Hard Core</b>								
	HCT1.1	Mineralogy	70	30	100	4			4	
	HCT1.2	Indian Stratigraphy	70	30	100	4			4	
	HCT1.3	Sedimentary and Metamorphic Petrology	70	30	100	4			4	
			<b>Soft Core (any One)</b>							
	SCT1.1	Geochemistry	70	30	100	4			4	
	SCT1.2	Paleontology	70	30	100	4				
			<b>Practical (Hard Core)</b>							
	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		
			<b>Soft Core (Any One)</b>							
	SCP1.1	Practical SCP1.1	35	15	50			2	2	
	SCP1.2	Practical SCP1.2	35	15	50			2		
			Tour			25		01	1	
			<b>Total for First Semester</b>	420	180	625				25
	Second		<b>Hard Core</b>							
AGT		HCT2.1	Igneous Petrology	70	30	100	4		4	
		HCT2.2	Structural Geology and Tectonics	70	30	100	4		4	
			<b>Soft Core (any One)</b>							
		SCT2.1	Hydrogeology	70	30	100	4		4	
		SCT2.2	Geotechnical Engineering	70	30	100	4			
			<b>Open Elective (Any One)</b>							
		OET2.1	SWAYAM	70	30	100	4		4	
		OET2.2	Watershed Management	70	30	100	4			
			<b>Practical (Hard Core)</b>							
		HCP2.1	Practical HCP2.1	35	15	50			2	4
		HCP2.2	Practical HCP2.2	35	15	50			2	
			<b>Practical (Soft Core) (any one)</b>							
		SCP2.1	Practical SCP2.1	35	15	50			2	2
		SCP2.2	Practical SCP2.2	35	15	50			2	
			<b>Practical Open Elective(any one)</b>							
		OEP2.1	Practical OEP2.1	35	15	50			2	2
	OEP2.2	Practical OEP2.2	35	15	50			2		
		Soft skill and Tour			25		01	1		
		<b>Total for Second Semester</b>	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

**Paper No: HCT 1.1 MINERALOGY**

**Load/week:04**

**Total load: 56**

**Credits:04**

**Marks:External:70**

**Internal:30**

<b>Unit 1</b>	Isotropic and anisotropic substances; Concepts of light under microscope, Reflection, refraction and refractive index; Relief, birefringence and Becke line effect; Optically uniaxial and biaxial minerals; Determination of optic sign of uniaxial and biaxial minerals, Determination of optic axial angle(2V); Interference figures; Pleochroism and determination of pleochroic scheme in minerals; X-ray crystallography and Bragg's equation; Application of X-ray diffraction spectrometry in mineral characterization;	<b>14</b>
<b>Unit2</b>	Principle of crystal structure; Bonding in minerals; Silicate structures and structural formula; Isomorphism and solid solution; Types of ionic substitution; Polymorphism and types of polymorphic transformations; Pseudomorphism. A detailed study with reference to their atomic structure, chemistry, optical and physical properties and Paragenesis of the following Non silicates groups of mineral: Carbonates- Calcite Group, Phosphates- Apatite, Sulphates- Barite, Halides- Halite, Fluorite; Oxides and Hydroxides- Spinel Group, Hematite Group, Rutile Group.	<b>14</b>
<b>Unit3</b>	A detailed study with reference to their atomic structure, chemistry, optical and physical properties and Paragenesis of the following Silicates groups of mineral: Nesosilicates- Olivine Group, Garnet Group and Aluminosilicate Group; Sorosilicates: Epidote Group, Cyclosilicates- Beryl, Inosilicates- Pyroxene Group, Amphibole Group; Phyllosilicate- Mica Group, Chlorite Group, Pyrophyllite: Talc; Tectosilicates- Quartz, Feldspars, Feldspathoides and Zeolite Group.	<b>14</b>
<b>Unit4</b>	Crystals, crystalline solids and their formation; Ordered patterns, nets and lattices; Symmetry in crystals; Axial ratio, indices, lettering and order of the crystallographic axes; Crystallographic notation (Weiss and Miller indices and convention in notation); Classification of crystals, Introduction to 32 classes of symmetry; The crystal systems and symmetry types; Stereographic representation of crystal symmetry and their uses; Imperfection of crystals and crystal defects; Twinning- causes, effects and genetic types.	<b>14</b>

**REFERENCEBOOKS:**

- Battey, M.H. (1981) Mineralogy for students 2nd Edn. Longmans.
- Berry, L.G. and Mason, B. and Dietrich, R.V. (1983) Mineralogy, 2nd Edn, Freeman.
- Bunn, C.W. (1961) Chemical Crystallography, Clarendon.
- Deer, W.A., Howie, R.A. and Zussman, J. (1992) An Introduction to the rock forming minerals, Longman. Donald Bloss (1971) Crystallography and Crystal chemistry, Holt, Rinehart and Winston.
- Hota, R.N. (2011) Practical Approach to Crystallography and Mineralogy, CBS Publisher and Distributors Pvt Ltd., New Delhi.
- Hutchinson, C.S. (1974) Laboratory Handbook of Petrographic Techniques, John Wiley.
- Kerr, P.F. (1977) Optical Mineralogy 4th Edn., McGraw-Hill
- Klein, C. and Hurlbut, Jr., C.S. (1993) Manual of Mineralogy, John Wiley.
- Phillips, Wm, R. and Griffen, D.T. (1986) Optical Mineralogy, CBS Edition.
- Putnis, Andrew (1992) Introduction to Mineral Sciences, Cambridge University Press.
- Santosh, M. (1988) Fluid Inclusions, Geological Society of India, Bangalore.
- Slemmons, D.B. (1962) Determination of Volcanic and Plutonic Plagioclases using a three- or Four Axis Universal Stage, Geological Society of America.
- Spear, F.S. (1993) Mineralogical Phase Equilibria and Pressure -Temperature-Time Paths, Mineralogical Society of America Publication.
- Szymanski, A. (1988). Technical Mineralogy and Petrography, Elsevier.
- Winchell, A.N. (1962) Elements of Optical Mineralogy, John Wiley.

## **INTERNAL EVALUATION**

**(30 Marks)**

**(Seminar + Term paper + Test)**

## Paper No. HCT 1.2 : INDIAN STRATIGRAPHY

Load/week:04

Total load:56

Credits:04

Marks: External:70

Internal:30

<b>Unit 1</b>	Approaches to measurement of geological time; Surface and subsurface stratigraphic procedures, Stratigraphic Principles and concept of Litho, Bio and Chrono Stratigraphy, brief idea about sequence, magneto- seismic- chemo- and event stratigraphy; Stratigraphic correlations (Litho-, Bio- and Chronostratigraphic Correlation)	
<b>Unit 2</b>	Precambrian Stratigraphy of Peninsular India. Classification, Structure and Tectonics of Archaean Provinces of Peninsular India. Archaean of the Extra-Peninsular region. Archaean- Proterozoic boundary problem Stratigraphy, classification and evolution of the following proterozoic basins of Peninsular India. Cuddapah Basin, Vindhyan Basin, Delhi-Arvalii Supergroup, Pranhita- Godavari Basin, Indravati Basin, Bhima-Kaladgi Basin, Chhattisgarh basin	<b>14</b>
<b>Unit 3</b>	Stratigraphy, tectonic and classification of Gondwana formations of India. Paleozoic stratigraphy of Himalayan sequences from Kashmir, Spiti, Kumaon region, Cambrian of Spiti, Triassic of Spiti, Triassic of Pin valley. Indus Ophiolite belts, Trans-himalayan and Karakoram granite batholiths. Stratigraphy, classification and evolution of the Siwlaik group. Stratigraphy, tectonic and classification of Deccan volcanic, Stratigraphy and classification of marine transgression in South India, Stratigraphy and classification of Jurassic formation in Kutch,	<b>14</b>
<b>Unit 4</b>	K.T. boundary problem, Quaternaries of Peninsular India, Rise of Himalaya Glacial periods in Indian stratigraphic, Neogene-Quaternary boundary	<b>14</b>

### 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 Vol.2. Ramkrishnanand Vidynathan, Geological Society of India, Bangalore.

**INTERNAL EVALUATION**

**(30 Marks)**

## Paper : HCT 1.3 : SEDIMENTARY AND METAMORPHIC PETROLOGY

Load/week:04

Total load:56

Credits:04

Marks: External:70

Internal:30

<b>Unit 1</b>	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, Fundamentals of fluid and types of fluid, Reynold number and Froude number, their application. Bed configuration due to sediment transportation. Sedimentary textures of clastic and nonclastic rocks, concept of size and shape, Shape aspects–sphericity and roundness, surface textures fractals, Fabric measurements.	<b>14</b>
<b>Unit 2</b>	Classification of sedimentary environments, sedimentary basin and their tectonic setting. Structures in alluvial, fluvial, deltaic, lacustrine, coastal, marine, glacial and Aeolian conditions, products of various basins, heavy minerals and their significance in province studies. Paleo-climate and paleoenvironment analysis; Implication of facies in environmental interpretation and basin analysis; Sedimentary environments. Classification of clastic and non clastic rocks. Classification and composition of conglomerate, sandstones, shale and carbonate rocks; Diagenesis - physical and chemical, processes and evidences of diagenesis in sandstones, mud rocks and carbonate rocks; Detailed study of siliceous, phosphatic and ferruginous rocks; Study of evaporites such as gypsum, anhydrite and halite; Dolomites, their petrographic characteristics and models of dolomitization.	<b>14</b>
<b>Unit 3</b>	Metamorphism: Nature and scope; Factors controlling metamorphism (T, P and fluids); Types of metamorphism: Regional, contact, dynamic, hydrothermal, impact, retrograde and ocean floor metamorphism; Transient and steady state geotherms; Protolith types and characteristic metamorphic minerals; metamorphic textures and structures. Metamorphic zones; Metamorphic differentiation; Metasomatism; Granitization and crustal anatexis; Paired metamorphic belts; Eskolas classification of Metamorphic facies, Petrography and origin of following rock types: hornfelses, amphibolites, charnockites, and Migmatites	<b>14</b>
<b>Unit 4</b>	Regional & thermal Metamorphism of mafic and ultramafic rocks, pelitic sediments and impure calcareous rocks; ACF, AKF and AFM diagrams. Experimental studies on metamorphic reactions; P-T conditions of isograds, Concepts of geothermometry and geobarometry; Relationship of metamorphic rocks and associated mineral deposits; Tectonic controls of metamorphism.	<b>14</b>

### REFERENCE BOOKS:

- Sedimentary rocks 3<sup>rd</sup> edition, Pettijohn F.J., CBS Publication Stratigraphy and sedimentation 2<sup>nd</sup> edition, W.H. Freeman and Co.
- Principles of sedimentology, Friedman and Sanders J.m., JohnWiley.
- Origin of sedimentary rocks., Blatt H., Middleton Gand Murry R, PentileHall.
- Petrology of sedimentary rocks., Folk R. L., Hemphill publicationCo.
- Sedimentary petrology: An introduction., Tucker M.E., ELBS., Blackwell Scientific Publication.
- Applied sedimentology – Sukhtankar R.K . CBSPublishers.

### INTERNALEVALUATION

(30 Marks)

(Seminar + Term paper + Test)

## Paper No: SCT 1.1GEOCHEMISTRY

Load/week:04

Total load:56

Credits:04

Marks: External:70

Internal:30

<b>Unit 1</b>	<p>Introduction to the principles of geochemistry. Formation of universe, Origin and cosmic abundance of elements, Geochemical composition of the Solar System, the Sun, Planets, Moon, Comets, Asteroids and meteorites; Geochemical composition of the earth and its constituent parts such as crust, mantle, core.</p> <p>Chemical Bonding: Ionic bonding, Ionic substitution in crystals, Crystal-field theory, Covalent bonding, Metallic bonds, Van der Waals bonds, Hydrogen bond; Goldschmidt's geochemical classification of elements</p>	<b>14</b>
<b>Unit 2</b>	<p>Basic Thermodynamic Concepts: Aspects of equilibrium thermodynamics-enthalpy and entropy, free energies, chemical potentials, fugacity and activity. Few problems related to thermodynamics.</p> <p>Major, minor and trace elements and their representation on variation diagrams for presentation of geochemical data (bivariate, multivariate, element ratio variation, enrichment-depletion and vector diagrams); Primary differentiation of earth, Use of major elements for classification and characterization of igneous, metamorphic and sedimentary rocks.</p>	<b>14</b>
<b>Unit 3</b>	<p>The composition of atmosphere, biosphere and hydrosphere, Global biogeochemical cycles (Carbon, Oxygen, Nitrogen and Sulphur cycles), Primary and secondary dispersion of elements and their use in geochemical exploration for mineral deposits; Anomalies and various methods of geochemical surveys; Eh-pH diagrams</p> <p>Mineral stability- Pauling rules, speciation of elements during magmatic crystallization. laws of Goldschmidt, Ahren rules and Ringwood rules, Secondary environmental geochemistry</p>	<b>14</b>
<b>Unit 4</b>	<p>Discovery of radioactivity, radioactive decay and growth, Radioactive &amp; stable Isotope, Dating techniques using Rb-SR, K-Ar, U-Th-Pb, C-14, Applications of above methods for determining ages of igneous, metamorphic and sedimentary rocks, Stable isotopes and their applications</p> <p>Oxygen and hydrogen in hydrosphere and atmosphere, in ore deposit, in igneous, sedimentary rocks.</p> <p>Quality controls of data generation, Wet and Dry chemical analysis, Partial and total analysis</p>	<b>14</b>



### **Reference Books:**

- Geochemistry pathways and processes 2<sup>nd</sup> edition, Harry McSwain Jr, Steven M. Richardson and Maria E Uhle. Overseas Press
- Radioactive minerals, Dhanaraju, geological society of India, Bangalore.
- Principles of Geochemistry, Mason and Moore; John Wiley & Sons
- Introduction to geochemistry .K.B. Krauskopf; McGraw- Hill Publication
- Geochemistry in Mineral Exploration. A.W. Rose, H.E. Hawkes & J.S. Webb; Applied Publication
- Handbook of Geochemistry Wedepohl.
- Statistical Methods in Exploration Geochemistry. Govett. J. G.S. Elsevier Publication
- Nuclear Methods in mineralogy & geology techniques & applications., Attila Vertes, Sandor Nagy & Karoly Suvegh. Plenum Press
- Stable Isotope Geochemistry, J. Hoefs, Springer-Verlag

### **INTERNAL EVALUATION**

**(30 Marks)**

**(Seminar + Term paper + Test)**

## Paper No. SCT 1.2 : PALAEONTOLOGY

Paper No:SCT1.2

Load/week:04

Total load:56

Credits:04

Marks: External:70

Internal:30

<b>Unit 1</b>	Origin and evolution of life through the ages, origin of metazoan, nomenclature, and Classification, species concept, Migration dispersion and extinction of animals and plants. Concept of evolution, Precambrian life , Major evidences in the history of Palaeozoic life. Palaeoecology, Techniques in Palaeontology - mega fossils - microfossils - nannofossils - ichnofossils - collection, reformation & illustration - binomial nomenclature	<b>14</b>
<b>Unit 2</b>	Triassic, Jurassic and Cretaceous systems in major basins of India. Concept, classification, fauna, flora and age limits of Gondwana Supergroup and related paleogeography, paleoclimate, depositional characteristics and igneous activities. Stratigraphy of Deccan Trap, Permian/Triassic boundary. Palaeogene, Neogene and Quaternary systems and their equivalents in India; Epoch boundaries of the Cenozoic in India. Cretaceous/Tertiary boundary. Paleogene/ Neogene boundary.	<b>14</b>
<b>Unit 3</b>	Types of fossils and taphonomy; Origin of life; Modern concept of systematic of fossils; Concept of species and type specimens; Types of growth; Concept of evolution and extinction; Micro and macro-evolution; Phylogenetic analysis. Brief morphology and evolutionary trends in Bivalves, Gastropods, Cephalopods, Brachiopods, Echinoids, Graptoloides and Trilobites; Ichnofossils their modes of preservation and significance.	<b>14</b>
<b>Unit 4</b>	Study of important microfossils: Diatom, Radiolaria, Conodont, Ostracod, Stable isotope studies of shells in paleoclimatology; Study of paleobotany micro and mega fossils. Application of paleobotany in assessing paleoclimate and paleoenvironment; Applications of important mega and micro fossils in the exploration of coal and petroleum. Study of important Indian Gondwana and Paleogene flora; Paleogeographic maps. Origin and evolution of the mammals; Siwalik mammals; Evolution of Homo; Major extinction and origination through ages.	<b>14</b>

### Reference Books :

- Historical Geology and Stratigraphy of India Ravindra kumar
- Geology of India & Burma D.N.Wadia
- A Manual of Geology of India and Burma Pascoe volume 1,2,3,4
- Geology of Maharashtra, G.G. Deshpande, Geological Society of India, Bangalore.
- Geology of India Vol.1. and Vol2. Ramakrishnan and Vidynathan, Geological Society of India, Bangalore.
- Boardman, R.S., Cheethan, A.M. and Rowell, A.J. (1988) Fossil Invertebrates, Blackwell.
- Clarksons, E.N.K. (1998) Invertebrate Paleontology and Evolution, Allen and

Unwin, London.

- Dobzhansky, Ayala, Stebbins and Valentine (1977) Evolution, Freeman.
- Horowitz, A.S. and Potter, E.D. (1971) Introductory Petrography of Fossils, Springer Verlag.
- Mayr, E. (1971) Population, Species and Evolution, Harvard.
- Prothero, D.R. (2004) Bringing Fossil to Life – An Introduction to Paleontology (2nd Ed.), McGraw Hill.
- Raup, D.M. and Stanley, S.M. (1985) Principles of Paleontology ,CBS Publishers, New Delhi.
- Smith, A.B. (1994) Systematics and Fossil Record – Documenting Evolutionary Patterns, Blackwell.
- Streen, C.W. and Carroll, R.L. (1989) Paleontology – the record of life, John Wiley.

## **INTERNALEVALUATION**

**(30 Marks)**

**(Seminar + Term paper + Test)**

# **Practical Hcp 1.1 + Hcp 1.2: Mineralogy+ Indian Stratigraphy**

**Marks:100**

**Credit :4**

## **MINERALOGY**

1. Physical properties of common rock forming minerals in hand specimen.
2. Optical properties of common rock forming minerals in thin sections.
3. Study of Interference figures of uniaxial and biaxial minerals and determination of optic sign.
4. Conversions of oxide and element weight percentages.
5. Calculation of mineral formulae.
6. Study of Crystallographic systems.

## **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 Delhigrup.
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 HCP 1.3 + SCP 1.1/SCP1.2: SEDIMENTOLOGY & METAMORPHIC PETROLOGY + GEOCHEMISTRY OR STRUCTURAL GEOLOGY AND GEOTECTONICS**

**Marks:100**

**Credit :4**

## **SEDIMENTOLOGY & METAMORPHIC PETROLOGY**

1. Detailed study of clastic and non-clastic rocks in hand specimens
2. Study of assemblages of sedimentary structures in context of their paleoenvironmental significance.
3. Study of Sedimentary structures and their attributes, study of sedimentary textures -size analysis by sieving and other techniques.
4. 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.
5. Megascopic and Microscopic study of metamorphic rocks of different metamorphic facies.
6. Detailed study of textures in thin sections with reference to time relations between the phases of deformation and recrystallization of minerals.
7. Calculation of ACF, AKF and AFM values from chemical and structural formulation of minerals and their graphical representation
8. Use of rock composition diagrams
9. Calculation of P-T conditions from the composition of co-existing mineral assemblages serving as geothermometers and geobarometers

## **GEOCHEMISTRY**

1. Demonstration of sampling methods for geochemical analysis.
2. Preparation of anomaly maps using chemical data.
3. Calculation of important indices related to petrogenesis and weathering.
4. Discriminant diagrams and interpretation of geochemical data.
5. REE and trace elements plotting and interpretation.
6. End member calculations from given EPMA data.

## **STRUCTURAL GEOLOGY AND TECTONICS**

1. Preparation and interpretation of geological maps and cross sections.
2. Structure contour maps, isopach maps and other facies maps, balanced cross-section, their importance in unraveling the geological history.
3. Structural problems concerning economic deposit based on orthographic and stereographic projections.
4. Solution to structural geology problems by orthographic and stereographic methods.
5. Completion of outcrops, construction of structural sections and interpretation of geological maps.
6. Plotting and interpretation of mesoscopic structural data.
7. Recording and plotting of the field data.

## **INTERNAL EVALUATION**

**(30 Marks)**

**(Seminar + Term paper + Test)**

## SEMESTER II

### Paper No: HCT 2.1 IGNEOUS PETROLOGY

Load/week:04

Total load:56

Credits:04

Marks: External:70

Internal:30

<b>Unit 1</b>	Introduction to rocks and magmas; Internal structure and thermal properties of the earth; The nature of magmas (temperature, viscosity and volatile component); Melting (partial melting, batch melting, dynamic melting); and generation of magmas; Movement and storage of magma (magma chambers and modes of emplacement); A window to the mantle: crustal xenoliths, xenocrysts and glimmerites). Mantle metasomatism; Petrography of gabbros, charnockites, carbonatites. Magma and Plate tectonics.	<b>14</b>
<b>Unit 2</b>	Introduction to phase petrology; Phase relations of silicates and silicate melts: Elementary Thermodynamics, Chemical Potential and Gibbs Energy, Free Energy, Enthalpy, and Entropy, The Clausius–Clapeyron Equation; Unary Systems: (kyanite, sillimanite, and andalusite, SiO <sub>2</sub> polymorph); Binary systems: (Di-An, Ne-Si, Fo-Si, Ab –Or, and Fo- H <sub>2</sub> O); Ternary systems (Ab-An-Di, Fo-Di-Si).	<b>14</b>
<b>Unit 3</b>	Diversity and evolution of magma; Magma Formation, Segregation, and Ascent vis-a-vis plate tectonics; IUGS classification of Plutonic rocks and volcanic rocks; TAS classification of volcanic rock; Forms, textures and structures of igneous rocks; Petrography and interpretation of igneous textures in terms of rate of nucleation and crystal growth.	<b>14</b>
<b>Unit 4</b>	Petrography and petrogenesis of major igneous rock clans with Indian examples and world famous localities: The basalt clan (MORB, OIB, CFB, spillites, komatiites); The andesites, boninites and related rocks. The trachyte-syenite clan; Granites and granitic rocks; The anorthosites and ultramafic rocks; Nephelinites and carbonatites; Lamprophyres, lamproites and kimberlites; The alkaline rocks. LIP's; Lunar basalts.	<b>14</b>

#### Reference Books :

1. Best, M. G. (2003) Igneous and Metamorphic Petrology, 2nd Edn., Blackwell.
2. Bhaskar Rao, B. (1986) Metamorphic Petrology, IBH & Oxford.
3. Bose, M.K. (1997) Igneous Petrology, World Press, Kolkata.
4. Cox, K. G., Bell, J. D. and Pankhurst, R. J. (1979) The Interpretation of Igneous Rocks. Unwin Hyman.
5. Fitton, J.G. and Upton, B.J.G. (Eds) (1987) Alkaline Igneous Rocks, Geological Society, London
6. Hall, A. (1996) Igneous Petrology, 2nd Edn., Longman.
7. Hota, R.N. (2011) Practical Approach to Petrology, CBS Publisher and Distributors Pvt Ltd., New Delhi
8. Turner, F.J. (1980) Metamorphic Petrology, McGraw Hill, New York.
9. Winter, J.D. (2001) Introduction to Igneous and Metamorphic Petrology, Prentice-Hall.

#### INTERNALEVALUATION

(30 Marks)

(Seminar + Term paper + Test)

**Paper No. HCT 2.2 : STRUCTURALGEOLOGY AND GEOTECTONICS**

**Load/week:04**

**Total load:56**

**Credits:04**

**Marks: External:70**

**Internal:30**

<b>Unit 1</b>	Introduction to structural geology: planes and line, Attitude, Bearing, Inclination, Strike, Dip, Apparent dip, Plunge, Trend and Pitch; 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, behaviour of rocks with respect to stress and strain. Determination of infinite strains from originally spherical and ellipsoid markers.	<b>14</b>
<b>Unit 2</b>	Introduction to folds: 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; Ramsay's classification of folds.  Introduction to faults: Geometric classification of faults and joints, Anderson's theory of faulting; types of shear zones (ductile and brittle), Determination of fault displacement; Recognition of faults; difference between fault and joint; Types of joints. Mylonites and cataclases, their origin and significance; thrust (sheets, ramp anticline, thrust system, duplex brittle). Lineation and foliations morphology and classification significance of minor structures to determine major structures, Classification of unconformities and significance.	<b>14</b>
<b>Unit 3</b>	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.  Tectonic framework of Indian subcontinent.  Orogenesis: Precambrian and Phanerozoic orogenesis, source and nature of tectonic forces, comparisons of hypothesis of orogenesis – contraction, expansion, convection, Plume hypothesis and micro plate tectonic, sea floor spreading. Tectonic model of evolution of the Himalayas.	<b>14</b>
<b>Unit 4</b>	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.  Coastal geomorphology, Classification of coasts, erosional and depositional features, Lineament analysis, Neotectonic Features and evidences-characteristic landforms, Methods of analysis of neotectonism, Climate and landforms.	<b>14</b>

## REFERENCEBOOKS

### Structural Geology

- Ghosh, S.K. (1993) Structural Geology: Fundamental and Modern Developments. Pergamon Press.
- Hobbs, B.E., Means, W.D. and Williams, P.F. (1976) An outline of Structural Geology, John Wiley and Sons, New York.
- Marshak, S. and Mitra, G. (1988) Basic methods of Structural Geology, Prentice-Hall, New Jersey.
- Ramsay, J.G. (1967) Folding and fracturing of rocks, McGraw Hill.
- Ramsay, J.G. and Huber, M.I. (1983) Techniques of Modern Structural Geology, Vol. I, Strain Analysis, Academic Press.
- Ramsay, J.G. and Huber, M.I. (1987) Techniques of Modern Structural Geology, Vol. II, Folds and Fractures, Academic Press.
- Ramsay, J.G. and Huber, M.I. (2000) Techniques of Modern Structural Geology, Vol. III (Application of continuum mechanics), Academic Press.
- Turner, F.J. and Weiss, L.E. (1963) Structural analysis of Metamorphic Tectonites, McGraw Hill.

### Geotectonics

- Condie, K.C. (1989) Plate Tectonics and Crustal Evolution, 3rd Ed., Pergamon, Oxford Press.
- Gass, I.G. (1982) Understanding the Earth, Artemis Press (Pvt) Ltd. U.K.
- Kearey Phillips and Vine, F.J. (1996) Global Tectonics, Blackwell Science, Oxford.
- Keary, P., Klepeis, K.A. and Vine, F.J. (2012) Global Tectonics, Third Edition (Reprint), Wiley-Blackwell, Wiley India Pvt. Ltd.
- Moores, E and Twiss, R.J. (1995) Tectonics, Freeman.
- Moores, Eldridge M. and Twiss, Robert J. (1995) Tectonics, Freeman and Company.
- Patwardhan, A.M. (1999) The Dynamic Earth System, Prentice-Hall, New Delhi
- Storetvedt, K.N. (1997) Our Evolving Planet: Earths History in New Perspective, Bergen (Norway), Alma Mater Fortag.
- Summerfield, M.A. (2000) Geomorphology and Global Tectonics, Wiley.
- Valdiya, K.S. (1984) Aspects of Tectonics -Focus on south central Asia, Tata McGraw- Hill.
- Valdiya, K.S. (2010) The Making of India: Geodynamic Evolution, Macmillan Publishers India Limited.
- Windley, B.F. (1977) The Evolving Continents, John Wiley and Sons, New York.

## INTERNALEVALUATION

(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

<b>Unit 1</b>	Origin of water: meteoric, juvenile, magmatic and sea waters, Hydrologic cycle: precipitation, runoff, infiltration and evapotranspiration, Hydrographs. Subsurface movement and vertical distribution of groundwater, Springs, Classification of aquifers, Concepts of drainage basin and groundwater basin. hydrological properties of rocks – specific yield, specific retention, porosity, hydraulic conductivity, transmissivity, storage coefficient, water table fluctuations – causative factors, concept of barometric and tidal efficiencies, water table contour maps, Classification of rocks with respect to their water bearing characteristics, Hydro-stratigraphic units, Groundwater provinces of India, Hydrogeology of and Zones of India, wet lands.	<b>14</b>
<b>Unit 2</b>	Theory of groundwater flow, Darcy's Law and its applications, determination of permeability in laboratory and in field, Types of wells, drilling methods, construction, design, development and maintenance of wells, specific capacity and its determination. Unconfined, confined, steady, unsteady and radial flow conditions, Pump tests – methods, data analysis and interpretation for hydrogeologic boundaries, Evaluation of aquifer parameters using Thiem, Theis, Jacob and Walton methods, Groundwater modeling – numerical and electrical models.  Groundwater quality – physical and chemical properties of water, quality criteria for different uses, graphical presentation of water quality data, groundwater quality in different provinces of India – problems of arsenic and fluoride, Saline water intrusion in coastal and other aquifers and its prevention, Radioisotopes in hydrogeological studies, Groundwater contamination.	<b>14</b>
<b>Unit 3</b>	Geological – lithological and structural mapping, fracture trace analysis, Hydrogeological – lithological classification with respect of hydrologic properties, Hydraulic continuity in relation to geologic structures, Location of springs Remote sensing – hydrogeomorphic mapping of the terrain using different images of different satellite missions, lineament mapping, shallow groundwater potential zone mapping using satellite images, Surface geophysical methods – seismic, gravity, geoelectrical and magnetic, Subsurface geophysical methods – well logging for delineation of aquifers and estimation of water quality.	<b>14</b>
<b>Unit 4</b>	Groundwater problems related to foundation work, mining, canals and tunnels, Problems of over exploitation and groundwater mining. Groundwater development in urban areas and rain water harvesting, Artificial recharge methods, Groundwater problems in arid regions and remediation. Groundwater balance and methods of estimation. Groundwater legislation. Sustainability criteria and managing renewable and nonrenewable groundwater resources.	<b>14</b>

**Reference Books :**

1. Davies, S.N. and De Wiest, R.J.N. (1966) Hydrogeology, John Wiley and Sons, New York.
2. Driscoll, F.G. (1988) Groundwater and Wells, UOP, Johnson Div. St. Paul. Min. USA.
3. Karanth, K. R. (1989) Hydrogeology, Tata McGraw Hill Publishers.
4. Nagabhushaniah, H.S. (2001) Groundwater in Hydrosphere (Groundwater hydrology), CBS Publ.
5. Raghunath, H.M. (1990) Groundwater, Wiley Eastern Ltd.,
6. Todd, D.K. (1995) Groundwater Hydrology, John Wiley and Sons.
7. Tolman, C.F. (1937) Groundwater, McGraw Hill, New York and London.

**INTERNALEVALUATION  
(Seminar + Term paper + Test)****(30 Marks)**

## Paper No: SCT 2.2 Geotechnical Engineering

Load/week:04

Total load:56

Credits:04

Marks: External:70  
Internal:30

<b>Unit 1</b>	Scope of geology in civil engineering and mining industry; Various stages of engineering geological investigations for civil engineering projects; Engineering properties of rocks and soils: soil classification, rock discontinuities; Physical characters of building stones, metal and concrete aggregates; Use of remote sensing in engineering geology.	<b>14</b>
Unit 2	Preliminary geological investigations for the various engineering projects: dams, reservoirs, tunnels, highways, bridges, hydroelectric power projects, shoreline and airfield engineering; Case history of engineering projects and geological causes for mishaps and failure of engineering structures.	<b>14</b>
<b>Unit 3</b>	Mass movements with special emphasis on landslides and cause of hill slope instability; Earthquake and seismicity, seismic zones of India, aseismic design of building; Influence of geological conditions on foundation and design of buildings.	<b>14</b>
<b>Unit 4</b>	Geophysical methods for the selection of engineering sites; exploratory drilling, study and construction of subsurface sections based upon drilling data; Core logging: core recovery, preservation of cores, R.Q.D. analyses; Preparation and presentation of geotechnical reports.	<b>14</b>

### Reference Books :

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 SWAYAM**

**Load/week:04**

**Total load:56**

**Credits:04**

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

**The students should choose any course given on SWAYAM.**

**Paper No: OET 2.2 Watershed Management**

**Load/week:04**

**Total load:56**

**Credits:04**

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

<p><b>Unit 1</b></p>	<p><b>Watershed management</b> – Concept, need, principles &amp; components of watershed management, integrated watershed management; Factors affecting watershed management;soil erosion and its types, modelling of erosion using Universal soil loss equation, socio-economic concept of watershed. Peoplesparticipation in watershed management.</p> <p><b>Groundwater Management:</b> Hydrologic cycle: precipitation, runoff, infiltration and evapotranspiration, Hydrographs. Subsurface movement and vertical distribution of groundwater, Springs, Classification of aquifers, Concepts of drainage basin and groundwater basin.</p> <p>hydrological properties of rocks – specific yield, specific retention, porosity, hydraulic conductivity, transmissivity, storage coefficient,</p> <p>Water table contour maps, Groundwater provinces of India, Hydrogeology and Zones of India. BIS and WHO parameters.</p>	<p><b>14</b></p>
<p><b>Unit 2</b></p>	<p><b>Rainfall:</b>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.</p> <p><b>Rain Water Harvesting:</b> Introduction to rainwater harvesting; Rainwater harvesting systems; scope of Rainwater harvesting; benefits &amp; disadvantages of rainwater harvesting system</p> <p><b>Coastal Waters Management:</b> Discussion of coastal water quality issues; impacts from watershed development, and coastal management techniques.</p>	<p><b>14</b></p>
<p><b>Unit 3</b></p>	<p><b>Grassland waters management</b> -Definition of grassland, range land and pasture land and their classification. Major grass covers of India. Management of grass land, range and pasture to improve and maintain them and watershed management, carrying capacity of grassland range and pastures. Controlled grazing, rotational and deferred grazing management of grasses and legumes for special problem sites. Drainage of pasture land.</p> <p><b>Dryland farming practices</b> - Principles of conservation farming in dry and irrigated lands; dry land farming choice of crops and cropping, tillage and manuring practices, seeding, mulching for moisture conservation, moisture judging for irrigation, consumptive use of water. Water requirement of crops, water use efficiency and evapotranspiration ratios.</p>	<p><b>14</b></p>
<p><b>Unit 4</b></p>	<p><b>Agronomical practices</b> - Role of agronomy in soil conservation. Principles of scientific land management for soils conservation viz. (i) soil and water loss (ii) soil</p>	<p><b>14</b></p>

	<p>drainage (iii) soil structure and organic matter (iv) tillage and (v) soil fertility and fertilizer programmes. conservation cropping systems, soil depleting and soil building system, basis for selecting crop rotations for different soil &amp; climatic zones. Mixed &amp; cover cropping.</p> <p><b>Strip cropping</b> - functions and types, methods of laying out strips, selecting crops for strips and inter-culture, procedure to fix strip width and strips ratios of erosion permitting to erosion resisting crops for different soil climatic belts.</p> <p><b>Engineering measures</b> -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.</p>	
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**Reference Books :**

1. Common guidelines for watershed development projects (2008). Government of India
2. Dhruva N.V.V., Sastry G.O., (1990): Watershed management, ICAR, NewDelhi.
3. Frevert R.K., Schwab G.O., Edminster T.W., and Barnes K.K. (2009) Soil and water conservation engineering, 4<sup>th</sup> edition, John Willey and sons, NewYork.
4. Jain S.K. and Sing V.P. (2006) Water resources system planning and management, Elsevier India, NewDelhi
5. Mukherjee A. (2004) Participatory learning and action: Monitoring and evaluation and participatory monitoring and evaluation, Concept publishing company, NewDelhi.
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 Petrology + Structural Geology And Geotectonics**

**Marks:100**

**Credit :4**

### **IGNEOUS PETROLOGY:-**

1. Megascopic and microscopic study of different igneous rocks
2. Calculation of CIPW norms calculations for all types of saturated and unsaturated rocks.
3. Modal analysis
4. Classification of plutonic rocks under IUGSscheme
5. Classification of volcanic rocks under TASscheme.
6. Preparation and description of variation diagrams.

### **STRUCTURAL GEOLOGY AND TECTONICS**

1. Preparation and interpretation of geological maps and cross sections.
2. Structure contour maps, isopach maps and other facies maps, balanced cross-section, their importance in unraveling the geological history.
3. Structural problems concerning economic deposit based on orthographic and stereographic projections.
4. Solution to structural geology problems by orthographic and stereographic methods.
5. Preparation & interpretation of pi and beta diagram.
6. Completion of outcrops, construction of structural sections and interpretation of geological maps.
7. Recording and plotting of the field data.

## **PRACTICAL SCP 2.1/2.2 + OEP 2.1/2.2 :**

### **Hydrogeology or Geotechnical Engineering + SWAYAM or Watershed Management**

**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. Calculation eh, ph, water hardness
4. Analysis of well inventory data, pump test analysis, field techniques and computation of aquifer parameters by different methods.
5. Use of well logging techniques.
6. Exercises on groundwater exploration using remote sensing techniques.
7. Water budgeting 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 2.2 : SWAYAM**

### **PRACTICAL OEP 2.2 : WATERSHED MANAGEMENT**

1. Toposheets reading and analysis.
2. Study of drainage pattern.
3. Determination of contour interval and profile.
4. Determination of drainage density.
5. Study of water holding capacity.
6. Rainfall profiling on regional scale.
7. Water budgeting (domestic, agriculture, industrial)
8. Study of wilting coefficient
9. Estimation of peak runoff
10. Estimation soil erosion