

**DEPARTMENT OF GEOLOGY
PERIYAR UNIVERSITY
SALEM-636 011**



DEGREE OF MASTER OF SCIENCE

M.Sc BRANCH VII – APPLIED GEOLOGY

**CHOICE BASED CREDIT SYSTEM (CBCS)
DEPARTMENT OF GEOLOGY**

(SEMESTER PATTERN)

REGULATION & SYLLABUS

**For the Candidates admitted from the academic year
2014-2015 and onwards**

**M.Sc APPLIED GEOLOGY (CBCS)
DEPARTMENT OF GEOLOGY
CHOICE BASED CREDIT SYSTEM (CBCS)
REGULATIONS**

The M.Sc Applied Geology Master programme is being offered under Choice Based Credit System (CBCS). The CBCS enables the students to select varieties of subjects as per her /his interest and requirement. Acquiring knowledge in the related discipline is advantageous to the students. The CBCS programme is framed in such a way that to impart more Knowledge in the field of Earth Science.

M.Sc Applied Geology is equivalent to M.Sc Geology, Geoscience, and Earth science, offered by other Universities.

Condition for Admission

A candidate who has passed B.Sc degree in Applied Geology/ Geology of this university or an examination of some other university accepted by the Syndicate as equivalent there to shall be permitted to appear and qualify for the M.Sc Applied Geology (CBCS) Degree examinations of this university after a course of two academic years in the Department of Geology, Periyar University.

The Two-year Master's Programme will have the following components viz:

1. Core Courses

Core Theory	(12 X 4)	= 48
Practical	(4 X 4)	= 16
Dissertation	(1 X 10)	= 10

2. Elective Courses

Disciplinary	(3x4)	= 12
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4. Supportive Course

(offered by other dept)	(1x4)	= 4
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5. Human rights

(offered by other dept)

Total credit	<hr/>	= 90 credit
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6. Self study courses

(Optional, only credit will be added in the mark sheet)

The first four components are mandatory to qualify for a degree

Core courses

Core courses are compulsory basic subjects to the programme offered by the department. Each core course carries 4 credits. Core courses offered by one department will not be treated as elective by other. Core courses include theory, practical, project work, field training and industrial visits. Students can be permitted to carry out project works at reputed institutions and industries.

Elective courses

Elective courses (disciplinary) are offered by the parent department. Each elective course carries 4 credits.

Supportive courses

Supportive courses are aimed at bridging the gap in the curricula and to learn advancements in other disciplines. The department, in consultation with other departments, will offer supportive courses during I, II & III semesters. Similarly, students from Geology Department will study the supportive course from other department

Compulsory Course

A course on Human rights is compulsory in the II semester.

Self-study Courses

The department may allow the students to take up two extra courses with 4 credits each to enable them to acquire extra credits through self-study. The self-study courses are optional/ not mandatory.

These courses will be studied under the supervision of a faculty member.

Semester

An academic year consists of two semesters. The Normal semester periods are

- Odd Semester : July to November
- Even Semester: December to April

Each semester has 18 (eighteen) teaching weeks with working hours spread over 5 days a week.

Credits

The term credit is used to describe the quantum of syllabus for various programmes in terms of hours of study. It indicates differential weightage given according to the contents and duration of the courses in the curriculum design. The minimum credit requirement for a two-year Master's programme shall be 90.

Course weightage

A course carrying one credit for lectures will have instruction of one period per week during the semester. If four hours of lecture are necessary in each week for that course, then 4 credits will be the weightage. Thus, normally in each of the courses, credits will be assigned on the basis of the lectures/ tutorials/ laboratory work and other forms of learning in a 18-week schedule.

Evaluation

Evaluation will be done on a continuous basis during the course work through class test and mid term exams. Evaluation may be done by objective type questions, short answers, essays or a combination of these, but the end semester examination is a written examination.

Examinations

There shall be four examinations in the 2 year programme, each at end of the semester. Candidates failing in any subject/ subjects will be permitted to appear for subsequent semesters as per University norms.

The practical examinations will be conducted at the end of the first, second, third and fourth semester. Candidates failing in any of the practical examination / examinations will be permitted to appear for such failed practical examination/ examinations at corresponding subsequent practical examinations.

Passing Minimum:

A candidate has to secure a minimum of 50% mark in each course and earn a minimum of 90 credits for the award of Master's degree.

Distribution of marks:

Theory	-100
Internal mark*	-25
End semester Exam	-75

*Internal mark will be given based on three internal assessment tests (10), seminar (5), assignment (5) and attendance (5). The average of the highest two marks scored from assessment tests will be taken for assessment.

Practical	-100
Final Practical exam	-60
Record	-20
Periodical assessment	-20

Dissertation -200

Dissertation -150

Viva-voce -50

Field visit / Mine training

1. Geological mapping: Two weeks field geological mapping in between Ist and IInd semester. Students should submit report along with neat sketches.
2. Mine training: 15 days mine training at selected mine-sites in between 2nd and 3rd semester. Students should submit mine training in the form of report.
3. Geological Tour: Ten to fifteen days, geological tour at selected locations in between 2nd and 3rd semester. Based on tour, students have to submit a report.

Question paper pattern:

Time: 3 Hours
Marks

Maximum : 75

Passing minimum : 38

Marks

Part - A (5x5=25Marks)
Answer the ALL questions
(Either or Type)

Part - B (5x10=50Marks)
Answer the ALL questions
(Either or Type)

Commencement of this regulation:

These regulations and syllabus shall take effect from the academic year 2014-2015.

Course Structure

Course	Sl. No	Paper Code	Title of the Paper	Credits
Core Courses	1	14AGC1	Geomorphology	4
	2	14AGC2	Structural Geology	4
	3	14AGC3	Mineralogy	4
	4	14AGC4	Paleontology	4
	5	14AGC5	Igneous and Metamorphic Petrology	4
	6	14AGC6	Sedimentology	4
	7	14AGC7	Stratigraphic Principles and Indian Stratigraphy	4
	8	14AGC8	Applied Micropaleontology	4
	9	14AGC9	Exploration Geology	4
	10	14AGC10	Economic Geology	4
	11	14AGC11	REMOTE Sensing and GIS	4
	12	14AGC12	Hydrogeology	4
Practical Courses	13	14AGP1	Practical -I Structural Geology, Mineralogy and Palaeontology Practical	4
	14	14AGP2	Practical - II Petrology & Sedimentology	4
	15	14AGP3	Practical - III Economic Geology and Micropaleontology	4
	16	14AGP4	practical - iv Hydrogeology, Remote Sensing and GIS	4
	17	14AGPJ	Dissertation	10
Elective Courses	18	14AGE1	Mining and Engineering Geology	
	19	14AGE2	Analytical Techniques and Instrumentation	4
	20	14AGE3	Applied Stratigraphy	4
	21	14AGE4	Meteorology and Climate Change	4
	22	14AGE5	Environmental Geology and Human Health	4
	23	14AGE6	Marine Geology	4
Compulsory Courses	24		Human Rights	-
Supportive course	25		Any other Departments	4
			Total	90
Supportive Courses for other Departments	25	14GS1	Earth System Science	4
	26	14GS2	Watershed Management	4
Self Study Courses	27	14AGSS1	Gemmology	4
	28	14AGSS2	Rainwater Harvesting	4
	29	14AGSS3	Geohazards	4

Semester Wise Scheme of Examination

Sem	Paper code	Title of the Paper	L	P	C	Total	Internal	External	Total Mark	
I	14AGC1	Geomorphology	4		4		25	75	100	
	14AGC2	Structural Geology	4		4		25	75	100	
	14AGC3	Mineralogy	4		4		25	75	100	
	14AGC4	Paleontology	4		4		25	75	100	
		Elective - I / II *		4		4		25	75	100
	14AGP1	Practical -I Structural Geology, Mineralogy and Palaeontology Practical			4	4	24	40	60	100
II	14AGC5	Igneous and Metamorphic Petrology	4		4		25	75	100	
	14AGC6	Sedimentology	4		4		25	75	100	
	14AGC7	Stratigraphic Principles and Indian Stratigraphy	4		4		25	75	100	
	14AGC8	Applied Micropaleontology	4		4		25	75	100	
	14AGP2	Practical - II Petrology & Sedimentology			4	4		40	60	100
		Elective - III / IV *		4		4		25	75	100
		Supportive Course other Dept.		4		4		25	75	100
	06PHR01	Human Rights	-		-		28	25	75	100
III	14AGC9	Exploration Geology	4		4		25	75	100	
	14AGC10	Economic Geology	4		4		25	75	100	
	14AGC11	Remote Sensing and GIS	4		4		25	75	100	
	14AGC12	Hydrogeology	4		4		25	75	100	
	14AGP3	Practical - III Economic Geology and Micropaleontology			4	4		40	60	100
		Elective V / VI *		4		4	24	25	75	100
IV	14AGP4	Practical - IV Hydrogeology, Remote Sensing and GIS			4	4		25	75	100
	14AGPJ	Dissertation	10		10	14	50	150	200	
				90	90	90			2300	

*Elective papers will be selected from the listed papers mentioned under elective.

L- LECTURE, P- PRACTICAL, C- CREDIT

Credit System

Core Course	Elective Course	Supportive	Total
74	12	4	90

14AGC1 - GEOMORPHOLOGY

Unit I

Definition of Geomorphology. Evolution of geomorphic concepts. Principles/laws of geomorphology. Endogenic and exogenic driving forces. Resisting forces. Dynamic equilibrium of driving and resisting forces and Threshold. Modern concepts, quantitative geomorphology, process geomorphology.

Unit II

Role of tectonics, climate, slope, lithology, vegetation, land cover/land use and human in landscape evolution. Spatio-temporal scale of geomorphic processes. Mineral stability series. Physical, chemical and biological weathering. Soil profiles, Types of soils. Erosional and Depositional landforms. Agents of geomorphic processes - Volcanism, Gravity, glaciers, wind, rivers, tides, waves, currents.

Unit III

Classification of mountains, Types of volcanoes. Volcanic landforms. Isostasy, Tectonic landforms, Gravity landforms. Climate zones of the World. Genesis, distribution and types of glaciers. Landforms in glaciated regions. Aeolian process as a geomorphic agent. Aeolian landforms. Characteristics of dry and wet deserts.

Unit IV

Overland and subsurface flow. Fluvial process. Types of drainage pattern. Fluvial landforms. Types of Deltas. Classification of coast lines, Depositional and erosional coast lines. Coastal and marine landforms.

Unit V

Geomorphic sub-divisions of Indian sub-continent - Himalayan landscape, Indo-Gangetic plains, Deccan Plateau, Coastal low lands. Application of Geomorphology in groundwater exploration, environmental and natural resource management. Geomorphic mapping methods and tools.

Text / References Books

Richard Huggett 2007 Fundamentals of Geomorphology. II Edition. Routledge N. Y.
Ritter, D.F., Kochel, R.C., Miller, J.R., Process Geomorphology, Waveland press, 2002.
H.S. Sharma (1990) Indian Geomorphology. Concept Pub. Co., New Delhi.
Robert, S.A. and Suzanne, P.A., 2010 Geomorphology - The mechanics and chemistry of landscapes. Cambridge University Press.
Thornbury, W.D., 2004 Principles of Geomorphology. II edition. Wiley Eastern Ltd. New Delhi.

14AGC2 - STRUCTURAL GEOLOGY

UNIT -I

Mechanical Principles and Properties

Mechanical principles and properties of rocks and their controlling factors (Confining pressure, Temperature, Time, Pore Fluid Pressure etc). **Concepts of stress:** Two dimensional stress analyses. **Concepts of strain:** Homogeneous and inhomogeneous strain. The fundamental strain equation. Two dimensional strain analysis. Types of strain ellipses and ellipsoids, their properties and geological significance. Strain markers in naturally deformed rocks.

UNIT -II

Geometry and Mechanics of Folding and Faulting

Geometry and Mechanics of Folding: Types of folds. Geometry of folding - Superposed folds. Fold development and distribution of strain in folds. Mechanics of folding and buckling: Shear folds and similar folds - Modification of buckle and shear folds.

Geometry and mechanics of Faulting: Mechanics of faulting - Causes and dynamics faulting, strike slip-fault and over thrust. Geometry and mechanics of shear zones - Brittle - ductile structures in shear zones -geometry of thrust sheets - Fault orientation in relation to stress and strain axes.

UNIT -III

Planar and Linear fabrics

Planar and linear fabrics in deformed rocks, their origin and significance. **Planar Fabrics:** Types of foliation: slaty cleavage or schisosity - Fracture cleavage - Crenulations cleavage - Shear cleavage - Bedding cleavage - Axial plane cleavage. **Linear Fabrics:** Types of Lineation: Intersection Lineation - Crenulation Lineation - Mineral Lineation - Stretched - pebble Lineation - Rodding Lineation - Mullion Lineation - Boundinage - Pencil Structures. **Concept of petrofabrics and symmetry:** Types of fabrics, fabric elements and interpretation of fabric data on microscopic and mesoscopic scale.

Unit- IV

Joints, Unconformities and Tectonites

Nomenclature and age relationship of Joints and Faults. Joints in relation to stresses and their geometrical relationship with folds and faults. **Unconformities:** Types of unconformities. - Recognition and significance of unconformities - Distinction between fault and unconformity - Use of unconformity in dating the structural events.

Tectonites: Types of tectonites - Strain significance of tectonites - Regional terranes of tectonites **Diapirs:** Definition - Origin of diapirs- and Related structural features - Economic importance of diapirs.

Unit - V

Geotectonics

Plate tectonics: Concept of plate and plate movements, nature of convergent, divergent and conservative plate margins. Plate tectonics in relation to igneous, sedimentary and metamorphic processes and mineralization. Triple junctions, aulocogens, plume theory, island arcs. Nature and origin of earth's magnetic field. Evolution of Himalaya and Himalayan tectonics.

Text / References Books

- Belousov, V.V. 1968. Structural Geology, Mir Publishers.
- Billing, M.P. 1972. Structural Geology, Prentice-Hall.
- Condie, K.C., 1976. Plate tectonics and Crustal evolution.
- Davis, G.H., 1984. Structural Geology of Rocks and Regions. John Wiley & Sons.
- Ghosh, S.K. Structural Geology-Fundamentals and modern development, Pergamon, 1993
- Hobbs, B.E., Means, W.D. and Williams, P.F. John Wiley, 1976. An outline of structural geology,
- Paor, D. 1996. Structural Geology and Personal Computer, Pergamon,
- Park, R.G., 1983. Foundations of Structural Geology, Blackie and Sons Ltd.
- D M Ragan, John Wiley, 1985. Structural geology - An Introduction to Geometrical Techniques,
- Ramsay, J.G. Folding and fracturing of rocks, McGraw Hill, 1967
- Ramsay and Huber, Folding and fracturing of Rocks McGraw -Hill Book Co, New York.
- Rowland, S.M. and Duebendorfer, E.M. 1994. Structural Analysis and Synthesis, Pergamon,
- Uemura, T., and Mizutani, S., 1979. Geological Structures, Ed. Volume. John Wiley & Sons.
- Windley, B.F., 1976. The Evolving Continents. John Wiley and, New York.

14AGC3 - MINERALOGY

Unit - I

Crystallography: Atomic structure of crystal, space lattice and unit cell. Bonding in minerals. Nature of crystal. Symmetry elements. System of crystallization. Weiss and Millerian system of crystal notation. Interfacial angle. Twin crystals and Irregularities of crystals.

Unit -II

X- rays study of crystal: Application of X- rays in the study of crystal structures. Classification and structure of silicates. Classification and structure of clay minerals. Mineral identification by X- rays and Differential Thermal Analysis (DTA).

Unit - III

Mineral optics: Nature of light, polarized light. Double refraction. Snell's law. Parts and function of petrological microscope. Optical properties of minerals, uniaxial and biaxial minerals. Relative relief (RI) of minerals by Becke-line test. Extension angle and its types.

Unit - IV

Crystal chemistry: Crystalline and amorphous, Isomorphism, Polymorphism and Pseudomorphism. Physical properties of minerals. Chemical classification of minerals. Precious and semiprecious minerals. Chemical identification of industrial and ore minerals.

Unit - V

Rock and ore forming minerals: Physical, chemical, optical properties and mode of occurrence of olivine group, pyroxene group, amphibole group, feldspar group, mica group, quartz group and spinel group. *Paragenesis and mode of alteration:* Silicates, oxides, carbonates, sulphates and halides.

Text / References Books

- Andrew Puttins.,(1992),Introduction to mineral sciences, Cambridge University Press., Battey,M.H.,(1972),Mineralogy for students,Oliver and Boyd.
Dana,E.S.(1962),Text book of Mineralogy Revised by Ford,W.E.Wiley.
De Jong,W.F.,(1955), General crystallography,Freeman.
Deer, W., Howie, R.A. & Zussman, J., (1996), The Rock forming minerals. Longman.
Hans-Rudolt Wenk and Andrei Bulakh.,(2004), Minerals - Their constitution and origin.Cambridge University Press.
Hutchison, C.S., (1974), laboratory handbook of Petrographic Techniques. John Wiley.
Joseph .V.Smith., (1982), Geometrical and structural crystallography. John Wiley& sons.
Keith Frye.,(1974), Modern Mineralogy.Prentice-Hall.Inc New Jersey.
Klein, C and Hurlbut, Jr., C.S. (1993), Manual of Mineralogy. John Wiley.
Martin.J.Burger.,(1970), Contemporary Crystallography.McGraw-Hill book company.
Phillips, Wm, R. & Griffen, D.T., (1986), Optical Mineralogy,CBS edition.
Phillips,F.C.,(1963),Introduction to crystallography,Thomas Nelson.
Phillips,W.J.&N.,(1980), An introduction to mineralogy for geologist. John Wiley& sons.
Putnis Andrew., (1992), Introduction to Mineral Science, Cambridge University Press.

14AGC4 - PALEONTOLOGY

Unit I

Principles

Definition of palaeontology. Theories on the origin and evolutionary history of Life. Fossilization process and the nature of fossil record. Definitions for Species, index fossil, cosmopolitan species, fossil assemblage, fossil diversity, phylogeny. Types of biozones. Geological timescale. Morphological classification and Nomenclature. Cladistics.

Unit II

Invertebrate Paleontology I

Morphology, taxonomy, age, distribution and ecological niches of Anthozoa, Trilobita, Graptoloidea, Porifera, Bryozoa.

Unit III

Invertebrate Paleontology II

Morphology, taxonomy, age, distribution and ecological niches of Brachiopoda, Bivalvia, Gastropoda, Cephalopoda, and Echinoidea.

Unit IV

Vertebrate Paleontology

Evolutionary history of Reptilian, Avian, Piscean, and Amphibian fauna. Evolution of mammals. Evolution of horse, elephant and human. Functional morphology.

Unit V

Paleontological applications

Introduction to palynology, micropaleontology, ichnology, Taphonomy and basin analysis. Applications of palaeontology in palaeoclimatic and palaeoenvironmental studies, age fixation and stratigraphic correlation, hydrocarbon exploration.

Text / References Books

- Benton, M.J. and Harper, D.A.T., 2009 Introduction to Paleobiology and the fossil record. Wiley-Blackwell. London.
- D.M. Raup & Stanley (1985). Principles of paleontology. CBS Publ. & Distributors, New Delhi.
- E.N.K. Clarkson (1986). Invertebrate paleontology and evolution. George Allen & Unwin.
- Murray, J.W., 1985 Atlas of invertebrate macrofossils. Longman. London.
- Nield, E.W. and Tucker, V.C.T., 1985 Palaeontology: An introduction. Pergamon Press Ltd., Oxford.
- R.C. Moore, Lalicker & Fisher (1952). Invertebrate fossil. McGraw Hill Book Co., San Francisco.

PRACTICAL - I

**14AGP1 - STRUCTURAL GEOLOGY, MINERALOGY and PALAEOONTOLOGY
PRACTICAL**

Structural Geology

1. Preparation and interpretation of geological maps and sections.
2. Structural problems concerning economic mineral deposits.
3. Plotting and interpretation of petro fabric data and resultant diagrams.

Mineralogy

1. Study of symmetry and forms in the crystal models.
2. X-rays and X-ray refraction, Powder method, Determination of unit cell parameters.
3. Crystal projections -Stereographic projection, Spherical Projection and Gnomonic projection.
4. Study of common rock forming minerals under petrological microscope.
5. Colour enhancement and gem testing.
6. Determination of relative relief (RI) of minerals by Becke-line test.
7. Determination of sign of elongation of minerals.
8. Determination of pleochroic scheme of minerals.
9. Determination of optic sign of uniaxial and biaxial minerals.
10. Determination of extension angle and its types.
11. Identification of rock forming minerals in hand specimens.
12. Mineralogical calculations.
13. Chemical examination of Industrial and ore minerals.

Palaeontology

Morphological descriptions, systematics and illustrations of representative fossils belonging to Trilobita, Gastropoda, Bivalvia, Cephalopoda, Brachiopoda, and Echinodermata.

Interpretation of palaeoclimate and palaeoenvironment based on fossil data.

Biostratigraphic zonal assignment.

Identification of source, reservoir and seal facies with fossil data.

Text / References Books

- Murray, J.W. Atlas of Invertebrate Macrofossils, Longman. 1985.
Woods, H. Invertebrate Palaeontology, International Book Bureau, 1966.

14AGC5 - IGNEOUS AND METAMORPHIC PETROLOGY

Unit - I

Magma: Nature, cooling behaviors and properties, mechanism of partial melting and magma generation in the earth. Chemical composition and physical properties of magma. Role of volatiles in magma. *Equilibrium in igneous systems*: Eutectic crystallization, incongruent melting, binary systems, ternary systems. *Bowen's reaction principle*: Reaction series and its application to petrogenesis.

Unit - II

Magmatic evolution and differentiation: Fractional crystallization, gravitational differentiation, gas streaming, liquid immiscibility and assimilation. *Structures and textures*: definition, description, rock examples and genetic implications of common structures and textures of igneous rocks. Nomenclature of igneous rocks.

Unit - III

Classification of igneous rocks: Tyrrell's tabular, CIPW norm and IUGS rock classification. *Magmatism and tectonics*: Inter-relationship between tectonic settings and igneous rock suites. *Paragenesis*: Dunite, peridotite, pyroxenite. Granites, syenite and granitic rocks. Dolerites, basalts ultramafic rocks. Alkaline rocks. Kimberlites. Lamprophyres. Anorthosites. Carbonatites and Ophiolite suite.

Unit - IV

Concept of metamorphism: Types of metamorphism. Factors of metamorphism. Role of fluids. Nomenclature. Metamorphic structures and textures. *Classification of metamorphic rocks*: Eskola, Fyfe Turner and Verhoogen. Grade classification of Winkler. Facies series. *Phase relation*: ACF, AFM and AKF diagrams for metamorphic mineral assemblages.

Unit - V

General characteristics of metamorphic domain: Contact metamorphism. Regional metamorphism. Retrograde metamorphism. Metamorphism of carbonate rocks, pelitic, mafic and ultramafic rocks. *Paired metamorphic belts*: Orogeny and metamorphism. Anatexis and origin of migmatites. Petrogenesis of Charnockites and Geothermobarometry.

Text / References Books

- Asworth, J.R. (Ed) (1985), *Migmatites*. Blackie.
Baskar Rao, B. (1986), *Metamorphic Petrology*. Oxford & IBH.
Best, M.G. (2002), *Igneous and Metamorphic Petrology*, 2nd edition, Blackwell Publishers.
Bowen N.L. (1995), *The evolution of Igneous Rocks* - Princeton University Press,
Carmichael, I.S.E., Turner, F.J. & Verhoogen, J. (1974), *Igneous Petrology*. McGraw Hill.
Cox, K.G., Bell, J.D. and Pankhurst, R.J. (1979), *Interpretation of igneous rocks*. George Allen Unwin
Freeman W.H. (1982), *Petrography, An introduction to the study of rocks in thin sections* - Howell, William and Turner.
Hall, A. (1987), *Igneous Petrology*. Longman Scientific & Technical.
Harker A. (1909), *Natural History of Igneous rocks* - McMillan.
Hyndman, D.W. (1985), *Petrology of igneous and metamorphic rocks*. McGraw Hill.
Loren A. Raymond, WCB Publ. (1995), *Petrology, The Study of Igneous, Sedimentary and Metamorphic Rocks*.
Mason, R. (1984), *Petrology of metamorphic rocks*. CBS Publishers and Distributors.
McBirney, A.R. (1993), *Igneous Petrology*. CBS Publishers and Distributors.
Philpotts A. R. (1990), *Principles of Igneous and Metamorphic Petrology*, Prentice Hall.
Robin Gill. (2010), *Igneous Rocks and Processes: A Practical Guide* Wiley-Blackwell Publ.,
Spray, A.H. (1969), *Metamorphic textures*. Pergamon Press.
Turner, F.J. (1980), *Metamorphic Petrology*. McGraw Hill.
Winkler, H.G.E. (1979), *Petrogenesis of metamorphic rocks*. Springer Verlag.
Yardly B. W. *An Introduction to Metamorphic Petrology*. Longman.

14AGC6 - SEDIMENTOLOGY

Unit I

Principles

Definition and principles of Sedimentology. Development of Sedimentology as an interdisciplinary subject of geoscience. Time and space in Sedimentology. Completeness of sedimentary record. Primary and indirect modes of data acquisition in Sedimentology.

Unit II

Rock cycle. Processes of sediment genesis, transport and deposition. Physical, chemical and biological sedimentary structures. Sediment texture – classification of unconsolidated sediments, siliciclastics, carbonates, evaporates, volcanoclastics, and miscellaneous types.

Unit III

Controlling factors of sedimentation – Tectonics, eustatic cycles, climate and sediment influx. Facies concepts. Facies association, facies succession, depositional models. Facies successions formed under gravity, glacial, lacustrine, aeolian, fluvial, coastal and deep sea environments.

Unit IV

Classification of sedimentary basins. Diagenesis of sediments – Stages, zones and environments of diagenesis. Compaction, Porosity types and evolution, cementation, neomorphism, dissolution-recrystallization, dolomitization, and silicification. Palaeocurrent, heavy mineral and clay mineral analyses for provenance and basin analysis.

Unit V

An overview on Sedimentary basins of India. Applications of Sedimentology for palaeoclimatic and palaeoenvironmental interpretation. Study of sedimentary geochemistry for understanding depositional and diagenetic processes.

Text / References Books

- F.J. Pettijohn (1975) Sedimentary rocks. Harper and Row Publ., New Delhi.
- Flügel, E.V., 2002 Microfacies analysis of limestones. Elsevier.
- J.D. Collins and D.B. Thompson (1982) Sedimentary Structures. George Allen & Unwin, London.
- Lindholm, R., 1988 A practical approach to Sedimentology. Blackwell publication.
- M.E. Tucker and V.P. Wright 1990 Carbonate Sedimentology. Blackwell publication.
- Nicholls, G. Sedimentology and Stratigraphy. Wiley-Blackwell, 1999.
- Selley, R.C., Applied sedimentology, 2nd Edn., Academic Press, 2000.
- Leeder, M., 1999. *Sedimentology and Sedimentary Basins. From Turbulence to Tectonics*. Blackwell, Oxford, 592 pp

14AGC7 - STRATIGRAPHIC PRINCIPLES AND INDIAN STRATIGRAPHY

Unit I

Principles of Stratigraphy: Recent developments in stratigraphic classification and Geological Time Scale. Code of stratigraphic nomenclature – Stratotypes, Global Boundary Stratotype Sections and Points (GSSP). Stratigraphic Principles and concept of Litho, Bio and Chrono Stratigraphy, brief idea about sequence, magneto- seismic- chemo- and event, cyclo- stratigraphy; Stratigraphic correlations; Approaches to paleogeography.

Unit II

Precambrian stratigraphy: Precambrian chronostratigraphy of Dharwar craton, Eastern Ghats belt, Southern Granulite belt and Singhbhum-Chhotanagpur-Orissa Belt; Proterozoic stratigraphy of Cuddapah, Vindhyan, Godavari Supergroup and their equivalents; Precambrian/Cambrian boundary.

Unit III

Palaeozoic stratigraphy: Igneous activities and palaeogeography during the Palaeozoic Era. Stratigraphy, facies and fossil contents of the Palaeozoic rock formations of India. Permian-Triassic boundary.

Gondwana stratigraphy: Concept, classification, fauna, flora and age limits of Gondwana Supergroup and related paleogeography, paleoclimate, depositional characteristics and igneous activities.

Unit IV

Mesozoic stratigraphy: Classification, geographic distribution, lithologic characteristics, fauna and flora of Triassic, Jurassic and Cretaceous systems in principal basins of India. Cretaceous-Tertiary boundary. Deccan Traps and associated sedimentary formations. Age of Deccan traps.

Unit V

Cenozoic stratigraphy: Classification, depositional characteristics, fauna and flora of the Palaeogene and Neogene systems in their type localities and its equivalents in India. Epoch boundaries of the Cenozoic in India. Himalayan orogeny.

Text / References Books

- Danbar, C.O. and Rodgers, J. 1957. Principles of Stratigraphy. John Wiley & Sons.
- Doyle, P. & Bennett. M.R. 1996. Unlocking the Stratigraphic Record (John Willey).
- GSI Misc. Publ. No. 30. 2006. Geology and Mineral Resources of the States of India
- Krishnan, M.S. 1982. Geology of India and Burma. CBS Publishers, Delhi
- Naqvi, S.M. and Rogers, J.J.W. 1987. Precambrian Geology of India. Oxford University Press.
- Pascoe, E.H.1968. A Manual of the Geology of India & Burma (Vols.I-IV) Govt. of India Press, Delhi
- Ramkrishnan, M. and Vaidhyanadhan, R. 2008. Geology of India, Volume I and II, Geological Society of India, Bangalore
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- Robert, M. S. 1989. Stratigraphy: Principles and Methods, Van Nostrand Reinhold, New York. , Wadia, D.N. (1998) Geology of India. Tata McGraw Hill, India.

14AGC8 - APPLIED MICROPALAEONTOLOGY

Unit I

Principles of Micropaleontology: Microfossils - Definition, Types of microfossils. Historical developments and recent trends in Micropaleontological studies. Modern field and laboratory techniques in the study of microfossils - Surface and Sub-surface sampling methods, Processing and separation of microfossils, Preparation of faunal slides and thin sections.

Unit II

Calcareous Microfossils I: Dimorphism, test morphology, wall structure, chamber shape and arrangements, aperture openings and ornamentation of foraminifera. Classification and evolution of foraminifera. Ecology, paleoecology and geological distribution of foraminifera. Application of foraminifera in stratigraphy with special reference to India.

Unit III

Calcareous Microfossils II: Morphology, ornamentation (muscle scars, hinge types, pore canals, sculpture), orientation of carapace, classification and geological distribution of Ostracoda. Significance of ostracodes in ecology and paleo-ecological studies. Sample preparation techniques, morphology, ecology, application and geological distribution of calcareous nannofossils.

Unit IV

Phosphatic, Siliceous and Organic-Walled Microfossils: Composition, biological affinities, terminology and stratigraphic applications of conodonts. Preparation techniques, major morphological groups, geological history and application of Radiolarian and Diatoms. Maceration techniques, morphology and terminology, dispersal and sedimentation, geological history, application of fossil spores and pollen.

Unit V

Application of Microfossils: Significance of microfossils in bio-chronostratigraphy, event stratigraphy and sequence stratigraphy. Role of micropaleontology in hydrocarbon exploration and development. Environmental significance of microfossils. Application of microfossils in paleobathymetric and paleo-temperature estimation. Interpretation of sea-floor tectonism from micropaleontological evidences. Use of microfossils in engineering geology and environmental studies.

Text / References Books

- Armstrong, H. and Brasier, M.D., 2005. Microfossils. Blackwell Publishing.
Bignot, G., 1985. Elements of Micropaleontology. Graham and Trotman.
Brasier, M.D., 1980. Principles of Microfossils. George Allen & Unwin.
Glaessner, M.F., 1945. Principles of Micropaleontology. Hafner Publishing Company. , Haq, B.U. and Boersma, A., 1998. Introduction to Marine Micropaleontology. Elsevier.
Jones, D.J., 1969. Introduction to Microfossils. Hafner Publishing Company, New York. Jones, R.W., 1996. Micropaleontology in Petroleum Exploration. Oxford. Kathal, P.K., 1997. Microfossils and their applications. CBS Publishers and Distributors., Martin, R.E. 2000. Environmental Micropaleontology. Springer.

PRACTICAL - 2
14AGP2 - PETROLOGY & SEDIMENTOLOGY

Igneous Petrology

1. Megascopy of ultramafic, basic, intermediate and acidic igneous rocks.
2. Microscopy of ultramafic, basic, intermediate and acidic igneous rocks.
3. Modal classification of ultramafic, and basic igneous rocks following the IUGS nomenclature.
4. Modal classification of intermediate and acidic igneous rocks following the IUGS nomenclature.
5. Chemical classification of igneous rocks in the (Na₂O+K₂O) vs SiO₂ diagram.
6. Calculation of the CIPW norm of gabbro
7. Calculation of the CIPW norm of diorite.
8. Calculation of the CIPW norm of granite
9. Calculation of the CIPW norm of syenite
10. Calculation of the CIPW norm nepheline syenite.

Metamorphic Petrology

1. Megascopy of metamorphic rocks: slates, phyllites, schists and gneisses.
2. Megascopy of metamorphic rocks: amphibolites, charnockites, khondalites, eclogites.
3. Megascopy of metamorphic rocks: marbles and quartzites.
4. Microscopy of metamorphic rocks: slates, phyllites, schists and gneisses.
5. Microscopy of metamorphic rocks: amphibolites, charnockites, khondalites and eclogites.
6. Microscopy of metamorphic rocks: marbles and quartzites.
7. Construction and interpretation of ACF diagrams.
8. Construction and interpretation of AFM diagrams.

SEDIMENTOLOGY

Megascopic study of sedimentary rocks and their identification through characteristic features.

Granulometric analysis of unconsolidated sediments and interpreting their modes of transport, and environments of deposition.

Petrographic study of clastic and non-clastic rocks and interpreting textural properties, depositional environments and diagenesis.

Separation and analysis of heavy minerals from unconsolidated sediments and understanding provenance.

Construction of facies succession and depositional models with facies characteristics

14AGC9 - EXPLORATION GEOLOGY

UNIT-I

Geological Exploration

Introduction: Ore genesis in relation to minerals exploration. Regional local parameters for exploration. **Exploration:** Geological techniques and procedures of exploration. Regional (concept-based) exploration-different stages, planning and operations. Resources and reserves-Classification of resources and reserves. Documentation of exploration data.

UNIT- II

Geological Mapping &Exploration Techniques

Geological mapping: reconnaissance and detailed mapping-Selection of sites for geological prospecting. Different stages of exploration: objectives and tasks involved; preliminary studies and reconnaissance surveys. **Geologic aspects of drilling**-Types of drills- drill bits, core / sludge recovery, core logging; Drilling methods, planning, selection of sites, angle and direction of bore-holes. **Methods of sampling:** Weighting of samples and calculation of average grades-mathematical and statistical methods.

UNIT- III

Geophysical Exploration: I

Gravity method: Nature of gravity and its variation. Accuracy and precision of measurements. Gravimeters. Field procedures. Corrections. Free-air & Bouger anomalies. Interpretation of anomalies. Explorations for minerals. **Magnetic method:** Geomagnetic field and its variations. Magnetometers. Field procedures for land and airborne surveys. Exploration for minerals and oil and engineering sites.

UNIT-IV

Geophysical Exploration: II

Seismic method: Seismic waves and their speeds in rocks. Snell's law. Critical refraction. Instruments and field procedures for seismic refraction method. Corrections, Interpretation of data. Seismic reflection methods for oil exploration. Equipment for seismic reflection. Time and depth sections. **Electrical methods:** Introduction to S.P method and its use. Resistivity, true and apparent D.C. resistivity, true and apparent D.C. resistivity equipment, electrode arrangement, field procedure, and use for mineral exploration and at engineering sites.

UNIT -V

Geochemical Exploration

Mobility: Geochemical cycle. Mobility and association of elements. Geochemical tracers-elements and isotopes. **Dispersion:** Primary and secondary geochemical dispersion patterns. Geochemical and metallogenic provinces. **Methods of geochemical exploration:** Lithochemical methods-Pedochemical methods-Atmochemical geobotanical and biogeochemical methods. Geochemical sampling techniques-statistical analysis and interpretation of geochemical prospecting data.

Text / References Books

- Telford et al: Applied Geophysics., Parasnis: Mining Geophysics
Bhattacharya and Patra: Geoelectrical soundings., Nettleton-Introduction to Geophysics., Dobrin, M.B. (1976) :-Introduction to Geophysical Prospecting
Brooks, A.R. 1972, Geobotany and Biogeochemistry in mineral exploration, Harper and Row., Dobrin, M.B.1960, Introduction to Geophysical prospecting, , Govett,G.J.S.(Ed) 1983. Handbook of Exploration Geochemistry, Elsevier
Hawks, H.E. and Webb, 1965, Geochemistry in Mineral Exploration, Harper and Row., Publishers, D.A. Cox, , 1995, The elements of Earth, , Oxford University Press, New York., Mason and Moore, 1985, Principles of Geochemistry, , Wiley Eastern Ltd. New Delhi,. Mc Graw Hill Book Co., New Delhi., Pacal, 2nd Ed. 1977, Geochemical prospecting methods, Ustrendi.
Parasnis, D.S. 1975. Principles of Applied Geophysics, Chapman and Hall
Ramachandran Rao, M.B. 1975, Outlines of Geophysical prospecting (A Manual for Geologists) Presa Ranga, University of Mysore,
Rose,A.W.Hawks,H.E. and Webb,J.A. 1979, Geochemistry in Mineral Exploration, Academic press.
Sharma,P.V. 1986, Geophysical methods in Geology, Elsevier
Stanislane, M. 1984, Introduction to Applied Geophysics, Reidel Publishers
McKinstry H.E. (1960) - Mining Geology: Asia Publishing House
Mathur S.M. (2001) - Guide to Field Geology: Prentice Hall of India
Ramachandra Rao M.B.(1975) - Outlines of Geophysical Prospecting - A manual for Geologist: University of Mysore.
Lowire. W. (1997) - Fundamentals of Geophysics. Cambridge Low price Editions., Dobrin M.B.(1981) Introduction to Geophysical prospecting. McGraw - Hill International Book Company.
Kearey.P and Brooks.M (1984) An Introduction to Geophysical Exploration-ELBS., Mason.B (1966); Principles of Geochemistry - Willey Toppan.
Burger. H.R. (1992)- Exploration Geophysics of the Shallow Subsurface: Prentice Hall., Robinson. E.S. and Coruh.C. (2002)- Basic Exploration Geophysics- John Wiley., Gunter Faure. (1998) - Principles and applications of Geochemistry-prentice Hall., Krauskope.B.K.- (1988) ;Introduction to Geochemistry.,

14AGC10 - ECONOMIC GEOLOGY

Unit-I

Basic ideas about ore bodies-Texture & structures of ores- Geochemical parameters of ore formation (use of trace element, stable isotopes, fluid inclusion studies, etc. in ore genesis).

UNIT-II

Physical and chemical controls of ore deposition and post depositional changes. Geological thermometry and barometry applied to ore minerals. Crustal evolution and metallogeny of the Indian shield. Distribution of ore deposits with reference to plate tectonics. Process of ore formation and their rock association. Magmatic deposit- sublimation -contact metasomatic deposits.

UNIT-III

Properties- mineralogy- modes of occurrence & Indian occurrences and minerals required for the following industries - Abrasive, Cement, Refractory, Paints and Chemical Industries.

Unit-IV

Classification of ore deposits -Ore deposits of different important geological settings - (i)Ore deposits of kimberlite & carbonatite affiliations(ii) Ore deposits of pegmatitic environment(iii)Orthomagmatic deposits of chromite, platinum, titanium and iron associated with basic and ultrabasic rocks (iv)Orthomagmatic Cu-Ni-Fe-(platinoid) deposits associated with basic ultrabasic rocks(v)Greisen deposits(vi)Skarn deposits (vii)Porphyry Mo-Cu deposits (viii)Stratiform sulphide, oxide and sulphate deposits of sedimentary & volcanic environments.(ix.)Vein association & some other hydrothermal deposits (x.)Stratabound deposits(xi)Sedimentary deposits(xii)Residual deposits and supergene enrichment(xiii.)Metamorphic & metamorphosed deposits.

UNIT - V

ORE MICROSCOPY

Polishing and mounting of ores - study of textures and structures of Ore Minerals- Applications of ore microscopy.

Metallic ore deposits: Mineralogy, modes of occurrence & genesis, distribution of the following metallic ore deposits in India : Iron, Copper, Manganese, Lead and Zinc, Aluminium, Gold and Silver deposits, Tin &Platinum Group of Element (PGE) Nickel and Chromium Titanium & Vanadium- Rare Earth Elements(REE).

Text / References Books

Alkinson,1985,ore desposit Geology,Chapman & Hall., Barnes H.L (1979);.Geochemistry of Hydrothermal deposits., Bateman,A.M & Jonsen M.l:1981 Economic mineral Deposits, john Wiley ., Craig (1985), Ore petrology and Petrography, John Wiley, New York., Craig J.R. and Vaughan D.J. (1981); Ore Microscopy and Ore Petrography., Edwards R and K. Atkinsin (1986) Ore deposit geology Chapman and hall London., Edwards R. and Atkinson K. (1986); Ore Deposit Geology., Evans A.M. (1993); Ore Geology and Industrial Minerals An Introduction., Gokhale & Rao (1972), Ore deposits of India, Thompson Press. Gokhale K.V.G.K. & D.M. Rao (1977) Ore deposits of India Oxford & IBH Delhi. Iyengar, N.K.N: Mineral Wealth of Tamil Nadu, Madras Govt. Krishnan M.S. (1964) Mineral Resources of Madras, GSI , Kolkatta. Krishnaswamy S 1980, Indian Mineral Resources, Oxford IBH. Ramdohr Paul F (1980); Ore Minerals and their Intergrowths. Venkatramiah, 1989, Engineering Geology, John Wiley, New York.

14AGC11 - REMOTE SENSING AND GIS

Unit –I

Aerial remote sensing

Developments in aerial photography. Geometry and types of aerial photographs. Scale of photographs. Types of aerial cameras and filters. Panchromatic, colour and infra-red films. Photographic system (negative to positive sequences). Flight planning.

Unit II

Aerial photo interpretation

Stereoscopy, Relief displacement, Vertical exaggeration and Photo Mosaic. Elements of photo interpretation: tone, texture, pattern, drainage and lineaments. Applications: Structural and lithological mapping, groundwater exploration.

Unit-III

Satellite Remote sensing

Electromagnetic Radiation, EMR spectrum, EMR interaction with atmosphere, EMR interaction with earth features. Atmospheric windows, Resolutions (Spectral, spatial, Temporal and Radiometric) Platforms and Sensors, Outline of Digital image processing, Multi-spectral remote sensing data. Remote sensing satellites: Landsat, SPOT and IRS series of satellite data. Remote sensing Application in mineral exploration.

Unit –IV

GIS data model

Geographic Information System (GIS): Introduction, Definition, GIS Components. Data models: Vector Data model, Topology and Non-Topology models. Raster Data: Quad tree model, Run-length encoding. Raster and vector data conversion. Database management.

Unit –V

GIS data analysis

Spatial Data analysis: Data editing, Data query, Logical operation, arithmetic operations. Map overlaying, DEM and uses. GIS application in Natural resource mapping. GPS principles and applications

Text / References Books

- Burrough P.A 1968; Principles of Geographic Information System for Land Resources., Curran,B;1985 : Principles of Remote Sensing,Longman,London.Inc.
Lillisand,T.Mand P.W.Kiefer,2000:Remote sensing and image Interpretation,John Wiley., Pandey, S.N. 1987. Principles and applications of photogeology. Wiley Eastern, New Delhi., Sabins,F.F.Jr 1978:Remote sensing Principles and Interpretation, Freeman,sanfrancisco sons, New York.
Tor Bernhardsen;Geographic InfoOrmation Systems –AnIntrodutipon –John Wiley & Sons., Campbell, J. B. (1996) Introduction to Remote Sensing.622pp.
Drury, S.A. 1987. Image interpretation in Geology. Chapman and Hall.
Gupta, R.P. (2000) Remote Sensing Geology. Springer-Verlag. 356pp.
Miller, V.C. & Miller, C.F. 1961. Photogeology. McGraw Hill, New York.

14AGC12 - HYDROGEOLOGY

Unit-I

Hydrogeology: Hydrologic cycle and its components, Origin and age of groundwater, Occurrence of groundwater, Global distribution of fresh water. Vertical distribution of groundwater. *Aquifers:* Types of aquifers. *Springs:* Types of springs. *Hydrologic properties of rocks:* Porosity, Permeability, Specific yield, Specific retention, Hydraulic conductivity, Transmissivity and Storage coefficient.

Unit-II

Groundwater movements: Sub surface movement, Base flow, Effluent flow and influent flow. Darcy's law, Reynold's number, Laminar flow and turbulence flow. *Water level fluctuation:* Water table and Piezometric surface and its fluctuations. *Pumping test:* objectives, layout of the test and measurements.

Unit-III

Water well technology: Well types, drilling methods, construction of well, design of well, development and maintenance of wells. *Artificial recharge of groundwater:* Concept and methods. *Saline water intrusion in aquifers:* Saline water intrusion, Ghyben-Herzberg relation between fresh and saline water, Prevention and control of salt water intrusion in the coastal aquifers.

Unit-IV

Groundwater quality: Chemical composition of groundwater, major cations and anions, trace elements and their sources. *Water quality measurements:* physical, chemical and biological parameters. *Graphical representation of hydrochemical data:* Piper's facies analysis. *Groundwater Contaminations and Pollutions:* Problems related to arsenic and fluoride contamination, radio isotopes in hydrogeological studies. Trace element and health hazards, Impact of urbanization. Hydrogeochemical provinces of India.

Unit-V

Groundwater exploration techniques: Surface investigation of groundwater-Geologic method, electrical resistivity method, seismic method, gravity and magnetic method. *Subsurface investigation of groundwater:* test drilling, water level measurements. Application of Geophysical logging in Groundwater exploration. Groundwater provinces of India.

Text / References Books

- Alley, W.M., (1993), Regional Groundwater Quality-VNR, New York
Davies, S.N. and De Wiest, D.R., (1966), Hydrogeology-John Wiley & sons, Inc, New York, 463p.
Fetter, C.W., (1990), Applied Hydrogeology-Mc Graw Hill, Publisher, New Delhi.
Freeze, R.A. and John, A., (1979), Groundwater, Cherry, Prentice Hall, Inc, 604p.
Hem J.D., (1970), Study and interpretation of the chemical characteristics of Natural water, USGS Edition.
Hiscock, K., (2005), Hydrogeology, Principles and Practice, Blackwell Publishing, 389p.
Karanth, K.R., (1987), Groundwater Assessment, Development and Management-Tata McGraw Hill New Delhi 720p.
Manning, J.C., (2007), Applied Principles of Hydrology, CBS Publishers and Distributors, New Delhi.

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- Raghunath, H.M., (2007), Groundwater 3rd edition, New Age International Publishers, 520p.
- Reddy and Rami, J.P., (2008), A Textbook of Hydrology, University Science Press, Bangalore.
- Schwartz, F.W and Zhang, H., (2003), Fundamentals of groundwater, John Wiley & sons, Inc, New York, 583p.
- Shaw, E.M., (1994), Hydrology in Practice, 3rd edition, Chapman and Hall, London, 569p.
- Subramaniam, V., (2000), Water-Kingston Publ. London.
- Todd, D.K., (1980), Groundwater Hydrology- John Wiley & sons publishers, New York, 535p.

Practical - III

14AGP3 - ECONOMIC GEOLOGY AND MICROPALAEONTOLOGY

Economic geology

Study of ore minerals under reflected light microscope for identification of ore minerals, ore structures and textures, ore paragenesis

Micropaleontology

Techniques of separation of microfossils from matrix. Types of microfossils: Calcareous, Siliceous, Phosphatic and organic walled microfossils. Study of morphological characters of important benthic, planktic and larger foraminifera, ostracoda useful in ecology, paleoecology and biostratigraphy. Preparation of oriented sections of larger benthic foraminifera, nannofossils, radiolaria and diatoms. Exercises on Biostratigraphy and interpretations. Study of microfossil assemblages from various geological formations and interpretation of environment, geological age. SEM applications in Micropaleontology.

Practical - 4
14AGP4 - HYDROGEOLOGY, REMOTE SENSING AND GIS

Hydrogeology

Estimation of chemical dissolved constituents: major, minor and traces in groundwater using standard laboratory techniques. *Diagrammatic representation of hydrochemical data:* bar, circular radial, multivariate schoeller diagram, four coordinate diagram, stiffs diagram, horizontal and vertical scale diagram. Plotting on maps-Piper, U.S. Salinity Laboratory diagram, Wilcox, Doneen, Gibbs and Durov plots. *Groundwater exploration techniques:* geophysical and geological methods of ground water exploration; *Pumping test:* time draw down and time recovery tests and evaluation of aquifer parameters.

Remote sensing and GIS

Aerial Photography: Stereovision Test, Pocket & Mirror Steoscope-3D Observation, Demarcation of marginal informations, Identification photo Recognition elements. Interpretation of drainage pattern, landforms, rock types and structures.

Satellite Remote sensing: Decoding of Satellite data, Interpretation of satellite data for geomorphology, structure and lithology. Exposure to Digital Image Processing techniques

GIS: Scanning, Digitization, Preparation of Vector and Raster Image, Geo-Referencing. Overlay analysis.

14AGE5 - ENVIRONMENTAL GEOLOGY AND HUMAN HEALTH

Unit - I

Environmental Geology

Earth's place in space. ***Fundamentals concepts of Environmental Geology:*** Human Population Growth - Sustainability - Earth as a System - Hazardous Earth Processes - Scientific Knowledge and Values. Internal Structure of Earth and Plate Tectonics - Plate Tectonics & Environmental Geology. Minerals and Rocks. Ecology and Geology.

Unit - II

Natural Hazards

Hazards, Disasters, and Nature Processes - ***Evaluating Hazards:*** History, Linkages, Disaster Prediction, and Risk Assessment - Fundamentals principles concerning Nature Hazards - Human response to Hazards - Global Climate and Hazards - Population Increase, Land - use Change and Nature Hazards.

Unit - III

Volcanoes and Earthquakes

Earthquakes: Magnitude and intensity. Plate boundary related Earthquakes - Earthquake processes (Faulting, Tectonic group). Earthquake shaking (seismic waves, seismograph) -Earthquake cycle - Earthquake caused by Human Activity- Effects of Earthquakes - Tsunami - Earthquake risk and Earthquake prediction - Earthquake warning system. ***Volcanic activity*** - Volcanic Hazards, Forecasting volcanic activity. ***Landslides:*** Human use Landslide - Minimising the Landslide Hazards- Perception of Landslides,

Unit - IV

River, Flooding, and Coastal Hazards

Rivers and Flooding: Sediments in River - River velocity, Discharge, Erosion, and Sediments deposition- Effects of Land - use Change - Channel Pattern & Floodplain Formation - River Flooding - Urbanisation & Flooding- The Nature and Extent of Flood Hazards - Adjustments to Flood Hazards - Perception of Flooding. ***Coastal processes:*** Erosion - Coastal Hazards & Engineering structure - Human activity and Coastal erosion - Perception of and Adjustment to Coastal Hazards.

Unit - V

Resources and Pollution

Water Resources: A brief global prospective surface water - Groundwater - Interactions between surface water and Ground water - Desalination - Water Managements - Water and Ecosystem. ***Water Pollution:*** Selected Water Pollutions - Oxygen - Demanding Waste - Pathogenic Organisms - Nutrients - Toxic Substances - Synthetic Organic Chemicals - Heavy Metals - Surface Water Pollution and Treatment- Point Source and Non-point Source - Ground water Pollution and Treatment. ***Mineral resources:*** Mineral of Human use - Geology of Mineral Resources - Environmental Impact of Mineral Development - Recycling Mineral Resource Energy. Geothermal Energy.

Text / References Books

Chiras, D.D, 1989 Environmental Science - A framework for decision making, Addison - Wesley Publishing Company. New York., Davis, N. et.AL., 1976 Environmental Geosciences, John Wiley and sons, New York., Keller, E.A. 1979 Environmental Geology., Montgomery, C.W., 1989 Environmental Geology, Brown publications., Strahler, A.N., 1973 Environmental Geology, John Wiley and sons, New York., Valdiya, K. S. 1987Environmental Geology - Indian Context . McGraw Hill Publ., Keller, E. C. Bell and Howell, Columbus. Environmental Geology
Khoshoo, T. L. 1988Environmental Concerns and Strategies By. Ashish Publ.New Delhi., Bennett, M. R. B., Doyle, P. 1997Environmental Geology By. John Wiley & Sons, New York., Rekha Ghosh and D. S. Chatterjee. Environmental Geology - Geocosystems Protection in Mining Areas. Capital Publ. Co., New Delhi., Environmental Assessment Source Book 1991 Vol. I, II & III. Environment Department, The World Bank, Washington DC.
Ray, P. K. and Prasad, A. K. 1995 Pollution and Health. Wiley Eastern Publ., New Delhi., Keith, L. H. 1996Principles of Environmental Sampling. ACS Professional Reference book, Amer. Chem. Soc., Washington DC.

14AGE3 - APPLIED STRATIGRAPHY

Unit I

Concept of time in stratigraphy - measuring time, radiometric age dating techniques and problems. Spatial and temporal scales of cycles in sedimentary records. Controls on the development of stratigraphic records. Recent developments in stratigraphy on Stratotypes, Global Boundary Stratotype Sections and Points (GSSP). Lateral variation and facies. Graphic representation of stratigraphic data, methods of stratigraphic correlation.

Unit II

International Code of Stratigraphic Nomenclature. Lithostratigraphy, Codes units, correlation and contacts. Biostratigraphy- units, biogeographic zone, provinces, controlling factors, zonation and their time significance. Geochronology. Chronostratigraphy - the ICS International Chronostratigraphic Chart, code and units.

Unit III

Sequence Stratigraphy - Definition, origin of sequence concepts. Facies, facies association, facies succession, Conformity, unconformity, offlap, parasequences, systems Tracts, Roles of tectonics, eustasy, sediment influx and climate in sequence development. Sequences in clastic and carbonate deposits.

Unit IV

Chemostratigraphy-definition, evolution of chemostratigraphic concepts, secular and cyclic variation of geochemical composition over time. Mobile and immobile elements. Geochemical indices, geochemical proxy, geochemical signature, marker, fingerprint, geochemical signals, positive and negative excursions, anomalies, enrichment and depletion, chemozone. Absolute and relative dating of chemozones, scales of correlation. Statistical distinction of depositional units. Applications in hydrocarbon exploration, reservoir characterization and stratigraphic correlation.

Unit V

Relative sea level fluctuations, recognition of sequence surfaces and sequence cycles through seismic and outcrop data. Dating sequences through fossils and Defining sequence surfaces through palaeontological, petrographic, mineralogical, geochemical and other methods. Seismic and outcrop based sequence modeling. Limitations of sequences. Global bio-events and boundary problems in stratigraphy.

Text / References Books

- Banner, J.L., 2004 Radiogenic isotopes: systematics and applications to earth surface processes and chemical stratigraphy. *Earth-Science Reviews*. 65. 141-194.,
Brenner, R.E. and McHargue, T.R., 1988. *Integrative Stratigraphy: Concepts and Applications*-Prentice Hall
Catuneanu, O., 2006. *Principles of Sequence Stratigraphy*. Elsevier B.V.
Catuneanu, O., Abreu, V., Bhattacharya, J.P., Blum, M.D., Dalrymple, R.W., Eriksson, P.G., Fielding, C.R., Fisher, W.L., Galloway, W.E., Gibling, M.R., Giles, K.A., Holbrook, J.M., Jordan, R., Kendall, C.G.St.C., Macurda, B., Martinsen, O.J., Miall, A.D., Neal, J.E., Nummedal, D., Pomar, L., Posamentier, H.W., Pratt, B.R., Sarg, J.F., Shanley, K.W., Steel, R.J., Strasser, A., Tucker, M.E. and Winker, C., 2009. Towards the standardization of sequence stratigraphy. *Earth Sci. Rev* 92, 1-33.
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Catuneanu, O., Galloway, W.E., Kendall, C.G.St.C., Miall, A.D., Posamentier, H.W., and Strasser, A., 2011. *Sequence Stratigraphy: Methodology and Nomenclature*. *Newslett. Stratigr* 44, 173-245.

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- Cotillon, P. 1992. Stratigraphy. Springer
- Das, N., 1997. Chemostratigraphy of sedimentary sequences: A review of the state of the art. Jour. Geol. Soc. Ind 49, 621-628.
- Doyle, P. & Bennett. M.R. 1996. Unlocking the Stratigraphic Record. John Wiley.
- Emery, D. and Myers, K. 1996. Sequence Stratigraphy,
- Grammer, G. M., Eberli, G. P. and Van Buchem, F. S. P., 1996. Application of high resolution sequence stratigraphy to evaluate lateral variability in outcrop and subsurface - Desert Creek and Ismay intervals, Paradox basin. In: Longman, M. W. and Sonnelfeld, M. D., (Eds). Paleozoic systems of the Rocky mountain region, Rocky mountain section; SEPM. 235-266.
- GSI Misc. Publn. No. 30. 2006. Geology and Mineral Resources of the States of India
GSI Misc. Publ. Vol.16 (1988). Stratigraphic Boundary Problems in India.
- Haq, B.U., Hardenbol, J., Vail, P.R., 1987. Chronology of fluctuating sea levels since the Triassic. Science 235, 1156-1167.
<http://www.stratigraphy.org/index.php/ics-stratigraphicguide>.
- Koutsoukos**, Eduardo A.M. (Ed.). 2005. Applied Stratigraphy. Springer.
- Miall, A. 2010. The Geology of Stratigraphic Sequences. Springer.
- Miall, A. D. and Miall, C. E., 2001. Sequence stratigraphy as a scientific enterprise: the evolution and persistence of conflicting paradigms. Earth Sci. Rev 54, 321-348.
- Miall, A.D., 1991. Stratigraphic sequences and their chronostratigraphic correlation. Jour.Sediment. Petrol 61, 497-505.
- Miall, A.D., 2009. Correlation of Sequences and the Global Eustasy Paradigm: A Review of Current Data. CSPG CSEG CWLS convention, Frontiers + Innovation. Alberta, Canada 123-126.
- Ramkrishnan, M. and Vaidhyanadhan, R. 2008. Geology of India, Volume I and II, Geological Society of India, Bangalore
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- Sarg, J. F., 1988. Carbonate sequence stratigraphy. In: Sea level changes - An integrated approach. SEPM Spl. Pub 42, 155-181.
- Taylor, S.R., McLennan, S.M., 1985. The continental crust; its composition and evolution. Blackwell, Oxford, 312p.
- Vail, P.R., Mitchum, R.M. and Thompson, S., 1977. Seismic stratigraphy and global changes of sea level. Part 4 Global cycles of relative changes of sea level. In: Payton, C.E., (Ed). Seismic stratigraphy - Applications to hydrocarbon exploration. Mem.Amer.Asson. Petrol.Geol 26, 83-97.
- Veizer, J., Ala, D. and Azmy, K., 1999. $^{87}\text{Sr}/^{86}\text{Sr}$, $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ evolution of Phanerozoic seawater. Chem. Geol 161, 59-88.

14AGE4 - METEOROLOGY AND CLIMATE CHANGE

Unit I

Meteorology and radiation

Meteorology: introduction, definition, scales in meteorology, branches and applications. Earth Radiation balance: Sun's Energy output, Incoming radiation, Energy spectra of sun and earth, Insulation, Insulation over the globe, insulation losses in atmosphere, long wave radiation, Global radiation balance, Solar energy.

Unit II

Atmosphere, temperature and precipitation

Atmosphere: Composition and structure of atmosphere, Layered structure of atmosphere. Temperature: Introduction, factors influences air temperature, Surface temperature, air temperature, daily cycle of temperature, annual cycle of temperature, urban heat island. Precipitation: Precipitation processes, orographic precipitation, convection precipitation, frontal type of precipitation.

Unit III

El Nino and weather forecasting

El Nino: Introduction, upwelling. El Nino La Nino events and consequences: unusual weather and rainfall, sea surface temperatures, atmospheric consequences, economic consequence. Detection and prediction of El Nino. Weather forecasting: Persistence, trends, climatology, analog and numerical weather prediction methods. Forecasting surface features: Anti cyclone, cyclone, cold front and warm fronts. Forecasting precipitation: effect of frontal lifting, effect of moisture, rain and snow.

Unit IV

Climate change

Introduction, definition. Classification of climate; Koppen's, Bergeron, Thornthwaite's and Strahler classification. Climate change, Palaeoclimatology, Climatic changes through geological time, Geological records of climate, Assessing climate change, Green house effect, green house gases, Climatic change and global warming, Kyoto protocol.

Unit V

Causes and impact of climate change

Causes of climate change: Astronomical theories, Plate tectonism, Ocean circulation pattern, Changes in compositions of atmosphere, Changes in solar radiation. Impact of climate change: Rising of CO₂, impact on atmospheric circulation & weather pattern, biosphere, hydrosphere, sea level changes

Text / References Books

- Dorothy J.Meeritts and Andrew De Wet & Kirsten Menking, Environmental Geology - W.H.Freeman and Company, New York ,1997., Daniel B.Botkin, Edward A.Keller, Environmental Science - John Wiley& Sons,INC, 2010., Rev.Fr.S.Ignacimuthu, Environmental Studies, MJP Publishers, 2012., Travis Hudson, Living with Earth- An Introduction to Environmental Geology, PHI Learning Private Ltd, 2012
S.A. Ackerman and J.A Knox, Meteorology understanding the Atmosphere, 2nd edition Thomson Books House USA.p467., Alan Strahler and Arthur Strahler 2002. Physical Geography, 2nd edition John Wiley & Sons Inc.P748.
Alan .H. Strahler and Arthur N.Strahlur 1992.Modern Physical Geography Fourth Editions John Wiley &Sons.In.p638., David Brunt 2007.Meteorology.
John.M. Das 1995 The Monsoons, National Book house Trust, New Delhi (Third Edition), Meteorology, The Encyclopedia Britannia 15th Ed. (2005) Byers, Horace General, Meteorology New York Mc Graw Hill 1994.

14AGE1 - MINING AND ENGINEERING GEOLOGY

MINING GEOLOGY

Unit I

Mining terminology, classification, geological factors considered for the selection of mining method viz.- Alluvial/Surface mining, Quarrying, Open-cast mining, and Underground mining methods; Geological conditions for- Types of openings, their position, shape and size -adits, inclines, shafts, levels, cross-cuts, winzes and raises. Types of drilling methods. Explosive types, composition and its applications. Surface mining machineries.

Unit II

Alluvial mining: Types of placer mining, Panning, hydraulicking, Mechanical methods. Opencast mining Methods - bench cut, glory hole, strip mining. Factors considered for mechanization and transportation. Underground mining methods - board and pillar, room and pillar, long wall mining. Mine supports, Mine ventilation and Drainage. Mining hazards. Mines and Minerals Act.

ENGINEERING GEOLOGY

Unit III

Scope of geology in civil engineering and mining industry. Various stages of engineering geological investigations for civil engineering projects. Engineering properties of rocks, rock discontinuities, physical characters of building stones, concrete and other aggregates. Use of remote sensing in engineering geology.

Unit IV

Geological considerations for the construction of dams and reservoir sites. Types of dams, dam foundation, rock problems. Geotechnical evaluations of tunnel alignments and transportation routes. Methods of tunneling; Classification of ground for tunneling purposes; various types of support.

Unit V

Geological considerations for the construction of roads/ highways and bridges. Mass Movements with special emphasis on landslide and causes of hill slope instability. Engineering consideration of seismicity, influence of geological condition on foundation and design of buildings, seismic resistant structure, earthquake problems in India.

Text / References Books

- Arogyaswamy, R.N.P. 1994. Course in mining Geology. Oxford IBH - New Delhi.,
Chandra, B. Krishna, J and Chandrasekaran, A. 1994. Elements of Earthquake Engineering. South Asian Publishers
Chugh, C.P. 1992.

High Technology in Drilling and Exploration, Oxford-IBH, New Delhi.,
Deshmukh, R.T. 1993.
Elements of mining Technology Dhanbad publishers., Dhanbad.
Gupta, H.K. and Rastogi, B.K. 1976.
Dams and Earthquakes. Elsevier Scientific Publishing Company.,
Indian Bureau of Mines (1979)
Mineral exploration. IBM, Nagpur., Krynine, D.H. & Judd, W.R. (1998)
Principles of Engineering Geology, CBS Edition., Mckinstry, H.E. 1980.
Mining Geology, Prentice Hall, N.Y., Parbinsingh 1991.
A Text Book of Engineering & General Geology. Kataria & Sons.,
Peters, W.C. 1987. Exploration and Mining Geology, John Wiley &
Sons, New York., Marjoribanks, R.W. 1997. Geological methods in
Mineral Exploration and Mining, Chapman & Hall, London., Schultz,
J.R. & Cleaves, A.B. 1951. Geology in Engineering, John Willey & Sons.,
Staheler A.N. and Strahler A.M. 1973. Environmental Geoscience-John
Wiley & Sons., Venkatramiah, 1989 Engineering Geology.Wiley

14AGE2 - ANALYTICAL TECHNIQUES AND INSTRUMENTATION

Unit-I

Introduction to analytical chemistry: Qualitative and quantitative analysis. Classification of methods. Types of instrumental analysis. various instrumental techniques and laboratory safety.

Unit-II

Laboratory techniques: Laboratory operation and practices. Units of measurements. Laboratory notes. Errors and evaluation. Determination of accuracy. Statistical evaluation of data.

Unit-III

Petrological microscopes: Principles, Parts, Operation and application of Petrological microscope, Ore microscope and Scanning electron microscope. Preparation of thin section. Preparation of rock powder for chemical analysis. Rock digestion through acid treatment, Rock digestion through fusion with alkali salts.

Unit-IV

Geochemical sampling techniques: Sampling methods and principles, Types of sampling, Sampling interval. Heavy mineral separation methods. *Flame photometer and UV spectrometer:* Basic principles, Parts and operation and mechanism.

Unit-V

Instruments used for geochemical analysis: Basic concept and techniques of Atomic Absorption Spectrometer (AAS). Inductively Coupled Plasma - Atomic Emission Spectrometer (ICP-AES). X-Ray Diffraction (XRD). X-Ray Fluorescence (XRF) and Differential Thermal Analysis (DTA).

Text / References Books

Dana, E.S., (1955), Text book of Mineralogy, John Wiley., Deer, W.A., Howie, R.A. and Zussman, J., (1996), The Rock forming Minerals-Longman., Flint, Y., (1970), Basic crystallography, Mid Publishers., Francis Rouessac and Annick Rouessac., (2007), Chemical Analysis (Modern Instrumentation Methods and Techniques) John Wiley & sons, 574p., Hutchinson, C.S., (1974), Laboratory Handbook of Petrographic Techniques-John Wiley., Kerr, P.F., (1959), Optical Mineralogy, McGraw Hill., Klein, C. and Hurlbut, Jr. C.S., (1993), Manual of Mineralogy-John Wiley., Madhu Arora., (2008), Analytical chemistry-Himalaya Publishing House, Mumbai., Phillips, Wm, R. and Griffen, D.T., (1996), Optical Mineralogy-CBS Edition., Putnis, Andrew, (1992), Introduction to Mineral Sciences-Cambridge University Press., Spear, F.S. (1993), Mineralogical Phase Equilibria and Pressure-Temperature-Time paths-Mineralogical Society of America Publ.

14AGE6 - MARINE GEOLOGY

UNIT - I Introduction

History of Marine Geology - HMS Challenger - Glomar Challenger - JOIDES Expedition - Marine Geology research Institutes and vessels of India - Sagar Kanya Bathymetry - Hypsometric curve - Profile of Ocean Basin - objectives and scope of study of marine geology - Instruments in Marine Geology: tide and wave gauges - CTD - Underwater gears (Snorkel and SCUBA) - Seafloor imaging - shipborne seafloor imaging - multibeam bathymetry - Side Scan Sonar - Echo Sounder - Underwater Cameras and Bottom Samplers - Data buoys - GPS - airborne seafloor imaging - multi- and hyperspectral sensors - LIDAR - radar methods - spaceborne seafloor imaging - TOPEX Poseidon - SeaWiFS - LANDSAT and Ikonos - seismics and subbottom profiling - core drilling - ODP - Tsunami Warning Systems - Remotely Operable Vehicles (ROV)-

UNIT - II Marine Processes and Geomorphic features

Waves, tides, currents, turbidity currents, long shore currents, rip currents, circulation, Wave Action: wave reflection, refraction and diffraction - Seiche and tsunamis - Coastal Zone Morphology (Estuaries, deltas, bays, raised beaches, features of wave erosion and deposition, tombolos, mud banks) - Deep sea Morphology (Continental shelf, Continental slope, abyssal plains, sea mounts, guyots, fracture pattern - Trenches and Submarine Canyons - Bengal Fan). Biogenic structures: Reefs of corals and algae - Littoral processes - Evolution of headlands and bays - Beaches - Raised and sunken features - Evolution and classification of sea coasts and shore lines. terrestrial-lacustrine-shallow marine-deep sea - siliciclastic versus carbonate sedimentation - deep ocean silica burps - shelf-to-basin transport phenomena turbidites and gravity flows - Submarine groundwater discharge

UNIT - III Seafloor Tectonics

Causes of marine regression and transgression - Description of important regressions and transgressions in the geological past - Eustasy -Origin and distribution of ocean basins - Palaeoceanography -- Ocean floor tectonics: Characteristics of Oceanic Plate - Geologic processes along Oceanic Plate boundaries - Seafloor Spreading - Evidence - lithospheric plates - seafloor geomagnetism - Accretionary tectonics - Oceanic ridges as divergent plate boundaries - Trenches as convergent plate boundaries - Subduction zones - Transform fault boundaries - Seafloor geologic process - Volcanism and seismicity - Benioff plane. Dynamics of convection in the mantle that drives the motion of tectonic plates

Tectonic, volcanic, and hydrothermal activity at mid-ocean ridges, and the structure of the oceanic crust -Coastal processes and the structure of continental margins - Past ocean circulation patterns and climates - Interactions of continental and oceanic geologic processes

UNIT - IV Marine Sediments and Marine Geochemistry

Marine sedimentation - Sources, types and distribution of marine sediments - Transport of sea bottom sediment - Rate of deposition - Mineral resources of the oceans and the factors controlling their distribution. Marine Sediments and Deposits: Stratigraphy and geochronometry of deep-sea deposits- phosphorite, glauconites, barium sulphate concretions, Polymetallic nodules - gas hydrates - Beach placers. Terrigenous, Biogenic and Chemical Types - Placer Deposits - Dredging and Disposal of Sediments

Physico-chemical characteristic of seawater - distribution of temperature, salinity and density -for sea water - diagenetic changes in oxic and anoxic environments - mobility of redox metals - Sedimentary markers of palaeo environmental conditions - chemistry of oceanic rocks. Sediment biogeochemistry - submarine hydrothermal systems - melt generation and flow in the earth's mantle - crustal magmatic systems - seafloor volcanic processes

UNIT – V Applied Marine Geology

Marine geophysical studies by application of gravity, magnetics, heat flow, and seismic methods in the study of the structure of the earth beneath the oceans - in paleoclimatology, modeling the general circulation of the ocean and atmosphere, micropaleontology, ocean paleochemistry and sedimentation dynamics of marine particulates - planetary forcing of sea-level cycles - Milankovich cyclicity - climatic forcing of sealevels - snowball earth - the modern climate system - sealevel and climatic forcing of sedimentation - the global historical sealevel record - ice-core record - tree-ring record - coral records - Sequence Stratigraphy: basic concepts and applications in carbonate platforms - Paleoceanography as integration of plate tectonics, climatology, physical oceanography, and palaeontology - marine microfossils in sediments - indicator fossils - palinspastic and paleolatitude maps different sedimentary processes in different types of ocean - Measures to control coastal erosion - Laws of the sea - Coastal zone regulation in India - India as Pioneer Investor in Seabed mining.

Text / References Books

- Shephard, F.P., 1973. Submarine Geology, Harper and Row.
Kurekian, K.K., 1990. Ocean, Prentice Hall.
Seabold, E. and Berger, W.H. , 1982. The Sea Floor, Springer Verlag.
Kuenen, Ph.H., 1950. Marine Geology. John Wiley and Sons.
King, C.A.M., 1959. Beaches and coasts, Edward Arnold, London.
King, C.A.M., 1975. Introduction to marine Geology and Geomorphology. Edward Arnold, London.
Radhakrishnan, V., 1996. General Geology V.V.P. Publishers, Tuticorin.
Shepard, F.P., 1978. Geological Oceanography, Heinmann, London.
The Ocean, 1969. A Scientific American book, W.H. Freeman and company, San Francisco.
Svedrup, J.F., The Ocean, John Wiley.

Supportive Courses
14GS1 - EARTH SYSTEM SCIENCE

Unit-I

Space Science

Introduction to various branches of Earth Sciences.

Solar System, Age of the Earth, Origin of Solar system. Meteors and Meteorites.

Earth Dynamics : Interior of the Earth, Composition of the Earth, Seismic waves, Seismograph,

Plate Tectonics, Basics of Earthquake Engineering, Landslides, Volcanoes.

Unit-II

Geological Oceanography:

Sea waves, Tides, Ocean currents, Geological work of seas and oceans, Tsunami and its causes, Warning system and mitigation.

Unit-III

Hydrogeology

Hydrogeology: Water table- Aquifer- Groundwater fluctuations and groundwater composition, Hydrological cycle. Glaciology: Glacier types, Different type of glaciers, Landforms formed by glacier. Petrology - Geological bodies and their structures: Rock, mineral, batholiths, dyke, sill, fold fault, joint, unconformity.

Unit-IV

Earth's Atmosphere :

Structure and composition of atmosphere, Atmospheric circulation, Geological work of wind, Greenhouse effect and global warming, Carbon dioxide sequestration. Steps to maintain clean and pollution free atmosphere with governing laws, precautionary measures against disasters.

Unit-V

Biosphere:

Origin of life, Evolution of life through ages, Geological time scale, biodiversity and its conservation.

Natural Resources: Renewable and non-renewable resources, Mineral and fossil fuel resources and their geological setting, mining of minerals and conservation, effect of mining on surface environment

Text / References Books

Holme's Principles of Physical Geology. 1992. Chapman & Hall.

Emiliani, C, 1992. Planet Earth, Cosmology, Geology and the Evolution of Life and Environment. Cambridge University Press

14GS2 - WATERSHED MANAGEMENT

Unit - I

Introduction: Definition, concepts of watershed, major objectives of watershed management, effects of watershed on community, ecosystem, Monitoring and evaluation of watershed.

Unit - II

Principles of watershed management: Delineating the watershed. natural processes at work in watershed, common elements of watershed management, multidisciplinary approach in watershed management, participatory resources mapping and appraisal, benefits of watershed approach.

Unit - III

Degradation agents in watershed: Flood, drought, fire, wind storms, erosion and deposition. Climate change. Glacial movement, Tectonic activity. Volcanic eruption. Human-induced changes. Impact of the degradation of watersheds in hydrology.

Unit - IV

Engineering measures for soil conservation: Rainfall parameters. Types of soil erosion. contour bunding, Surplusing structures contour and straggled trenching, gully control structures, graded bunding, bench terracing, land leveling and grading.

Unit - V

Water Conservation and Harvesting: Water conservation methods for crop land, Treatment of catchments. *Rainwater harvesting structures:* Check dam, farm pond, percolation tank, basin, ditch and furrow, channel, flooding, irrigation, subsurface dyke, nalla bund and pit methods. Conjunctive use of surface and groundwater.

Text / References Books

- Rajora,R.,(1998),Integrated Watershed Management, Rewat Publications, New Delhi.
Tideman.E.M., (1996), Watershed Management: Guideline for Indian Conditions, Omega Scientific Publishers,372p.
Lal.S., (2004), Watershed, Development, Management and Technology, Mangal Deep Publications,358p.
Paranjape,S.et.al.,(1998), Watershed Based Development: A Source Book, Bharat Gyan Vigyan Samathi, New Delhi.
Suresh,R.,(2002), Soil and Water Conservation Engineering, Standard Publishers and Distributers, Delhi.
Kakade,B.K.,(2002), Soil and Water Conservation Structures in Watershed Development Programmes ,BAIF Development Research Foundation, Pune.

Self Study Courses
14AGSS1 - GEMMOLOY

Unit-I

Introduction to Gems - Basic properties of gems. Formation of gem stones. Nature of gem material: quality necessary in gems-beauty, rarity, durability. Distinction between crystalline, amorphous and metamict materials. Crystal form and habit. Classification of gem stones. Observations with hand lens (10x)-importance and uses. Units of measurement: metric scale, carat, pearl and grain.

Unit-II

Nature of crystals: distinction between crystalline and amorphous material, crystal symmetry, Twinning, parallel growth, crystal form, crystal habit, seven crystal system. Identification of rough stones.

Unit-III

Physical properties: hardness its applications in gemmology and limitations. Cleavage, Fracture, parting, and their importance in gemology and lapidary work. Specific gravity-utility and determination by hydrostatic weighing, heavy liquids, floatation and pycnometer. Inclusions and other features of gemstones.

Unit-IV

Optical properties: The electromagnetic spectrum, reflection and its importance in gemology-lustre, aventurescence, sheen, chatoyancy, asterism, luminescence, play of colours, labradorescence, inclusions etc.. Laws of refraction, refractive index (R.I), total reflection- in design of refractometer. Construction and use of refractometer. Polariscopes-construction and use in gemmology. Dichroscope-construction, use of Chelsea colour filter, Infra-red ultraviolet and x-rays in gem identification.

Unit-V

Enhancement and treatments- enhancement methods -coloured and colourless impregnation, dyeing, bleaching and its identification. Methods of treatment - laser drilling, irradiation, heat treatment, surface modifications, diffusion treatment and its identification. Composites - types, classification and identification.

Text / References Books

Karanh R.V.(2000),Gem and gemindustry in India,Memoir 45,Geological Society of India,Bangalore., Anderson,B.W(1990).Gem testing (10th edition),Butterworth Scentific,London., Babu,T.M.(1998) Dimands in India.Geological society of India, Bangalore., Hall,C.(1994).Gemstone,Dorling Kindsley,London.
Deer,W.A., Houre,R.A abd zussman.S.(1992).An introduction to rock forming minerals,ELBS,London.

M.Sc Applied Geology Syllabus 2014-2015 onwards

Kerr, P.F.(1997).Optical mineralogy,4th Ed.McGrow Hill Book & Co New York., Gemmology 2nd Ed.-Peter Read (1991) Butter worth-Heinemanu Ltd.Lundu., Gems 5th Ed. Peter Read. Buurerworth, London

Hand book of gem idendification-Richard Laddicoat (1987), G.I.A. Santa Monica., Photo Atlas of Including in Gem Stones-Edward Gubelin 1986 ABC Edition Zurich., Gem Testing 10th Ed. B.W. Anderson (1990) Butterworth Scientific London., Gemstone Enhancement 2nd Edition, K.Nassan. 1994 Butterworths London., Gems 5th Ed. Webster Butterworths London., Hall, C. Gemstones. ISBN 1564584992. Published by Dorling Kindersley, (1994)., Read, P. Gemmology. ISBN 0750644117. Butterworth Heinemann, (1999)., O' Donoghue, M. Identification of Gemstones. ISBN 0750655127. Published by Butterworth Heinemann, (2003)., Schumann, W. Gemstones of the World. ISBN 0806994614. Sterling Publishing Co INC, (revised edition 2001).

14AGSS2 - Rainwater Harvesting

Unit I:

Over-exploitation of groundwater - Need for artificial recharge and rainwater harvesting - types of wells - drilling technology - design, construction and development of water wells: dugwells and borewells; direct and reverse rotary drilling; cable tool and DTH hammer drilling; gravel packing and well development procedures.

Unit II:

Types of pumps - various artificial recharge structures: recharge ponds - recharge pits - percolation ponds - basin spreading - surface and subsurface dykes - recharge wells - recharge borewells. Rainwater harvesting in urban areas : RWH structures - design - construction.

Unit III:

Estimation of probable runoff from an area including from roof tops - maintenance and monitoring of RWH structures. Study of benefits - effects on local groundwater environments - remedial measures. Recycling of domestic water - sources of water for recharge in urban areas.

Unit IV:

Precautions for source, construction and establishing RWH structures. Exploration techniques and selection of artificial recharge zones - electrical resistivity investigations using horizontal profiling and vertical sounding techniques: interpretation of resistivity data in terms of subsurface geology.

14AGSS3 - GEOHAZARDS

Unit I

Internal structure of the Earth. Endogenic and exogenic earth processes. Earth as a dynamic and continuously evolving system as a result of interactions between lithosphere, hydrosphere, atmosphere and biosphere.

Unit II

Definition, types and genesis of natural geohazards - Earthquake, Volcanism, Landslide, Tsunami, Flood, Drought, Cyclone, Forest Fire, Meteorite impact, land subsidence, Quick sand, Heat wave, coastal erosion and inundation. Primary, secondary and tertiary impacts of geohazards.

Unit III

Causes and consequences of geohazards. Anthropogenic intervention with natural processes and exacerbation of hazard vulnerability. Man made hazards.

Unit IV

Hazard zonation, hazard mitigation. Tools and methods. Relief and rescue operations.

Unit V

Hazard vulnerability classification of Indian sub-continent. Indian scenario of hazard preparedness. Command structure and operations of National Disaster Management Agency.

Text / References Books

- Bandibas, J.C., Wakita, K. and Kato, H., 2003 Interactive presentation of geological hazard maps using Geohazardview. Jour.Nat.Dis.Sci. v.25. pp.75-83.
- Government of India, 2004 Disaster management in India - A status report. 88p.
- Government of India, 2007 National disaster management guidelines. 72p.
- Hamilton, R., 1997 Report on early warning capabilities for geological hazards. IDNDR. 35p.
- Kato, H., Wakita, K. and Bandibas, J.C., 2003 Eastern Asia geological hazards map: Paper and digital versions. Jour.Nat.Dis.Sci.v.25. pp.65-74.
- Ramkumar, M. and Neelakantan, R., 2007 GIS technology based geohazard zonation and advance warning system for geohazard mitigation and information dissemination towards relief and rescue operations. Jour.Earth.Sci. v.1. pp.65-70.
- Ramkumar, Mu., 2008 Geohazards: Causes, consequences and methods of mitigation. New India Publishers, New Delhi.