UNIVERSITY OF DELHI

Syllabus for the

B.Sc. (Hons)
IN
Geology

(Six Semester Course)

Department of Geology
Centre of Advanced Studies
University of Delhi
Delhi- 110 007

Revised syllabus applicable for the students seeking admission to the B.Sc. in Geology course in the Academic Year 2010-2011

B.Sc. (Hons.) in Geology

Semester I

Paper GEHT101 Earth System Science	**Paper GEHT102** Mineralogy & crystallography	**Paper GEHT103** Geomorphology and Photogeology	**Paper GEHT104** Mathematics

Semester II

Paper GEHT201 Sedimentology	**Paper GEHT202** Paleontology	**Paper GEHT203** Physical Chemistry	**Paper GEHT204** Physics I	Field work I

Semester III

Paper GEHT301 Structural Geology	**Paper GEHT302** Igneous Petrology	**Paper GEHT303** Metamorphic Petrology	**Paper GEHT304** Physics-II

Semester IV

Paper GEHT401 Geology of India	**Paper GEHT402** Economic Geology	**Paper GEHT403** Engineering Geology	**Paper GEHT404** Probability and Statistics	Field work II

Semester V

Paper GEHT501 Hydrogeology	**Paper GEHT502** Geophysics	**Paper GEHT503** Computer Applications	**Paper GEHT504** Inorganic Chemistry-I

Semester VI

Paper GEHT601 Geology Elective Paper - I	**Paper GEHT602** Geology Elective Paper - II	**Paper GEHT603** Geology Elective Paper - III	**Paper GEHT604** Technical writing and communication in English	Field work III

Syllabus
B.Sc. (Geology) Honours course

Semester-1 1. Earth System Science (100 marks) 2. Mineralogy & crystallography (with practical – 100+50 marks) 3. Geomorphology and Photogeology (with practical – 100+50 marks) 4. Mathematics – I (100 marks	**Semester 2** 5. Sedimentology (with practical – 100+50 marks) 6. Paleontology (with practical – 100+50 marks) 7. Physical Chemistry 8. Physics - I a. Field work -I (50 marks)
Semester 3 9. Structural Geology (with practical – 100+50 marks) 10. Igneous Petrology (with practical – 100+50 marks) 11. Metamorphic Petrology (with practical – 100+50 marks) 12. Physics – II (with practical – 100+50 marks)	**Semester 4** 13. Geology of India (100 marks) 14. Economic Geology (with practical – 100+50 marks) 15. Engineering Geology (with practical – 100+50 marks) 16. Probability and Statistics (100 marks) a. Field Work – II (50 marks)
Semester 5 17. Hydrogeology (with practical – 100+50 marks) 18. Geophysics (with practical – 100+50 marks) 19. Computer Applications (with practical – 100+50 marks) 20. Inorganic Chemistry – I (with practical – 100+50 marks)	**Semester 6** 21. Geology Elective paper - I (100 marks) 22. Geology Elective paper - II (100 marks) 23. Geology Elective paper – III (100 marks) 24. Technical writing and communication in English (100 marks) (a) Field Work - III (50 marks)
Geology Optional Papers Applied River Science (100 marks) Environmental Geology (100 marks) Exploration Geology (100 marks) Introduction to Geochemistry (100 marks) Introduction to Petroleum Geology (100 marks) Quaternary Geology and Paleoclimate (100 marks)	

Scheme of Examinations

1. English shall be the medium of instruction and examination.

2. Examinatioins shall be conducted at the end of each semester as per the Academic Calendar notified by the University of Delhi.

3. 'Practicals' in each semester will include practical exercises related to all theory papers in the same semester (excluding the interdisciplinary course).

4. Each 5 credit course will carry 100 marks and will have two components:

Theory Papers

(i)	**Internal Assessment** (Attendance/Seminar/quiz/test etc.)	**30 marks**
(ii)	**End-Semester Examination**	**70 marks**

Each practicals and Field work will be of 50 marks. These 50 marks will be divided into the following two components -

Practicals

(i)	**Internal Assessment** (Attendance/ class performance/Lab Records)	**12 marks**
(ii)	**End-Semester Examination**	**38 marks**

Field Work

(i)	**Performance in field work &** **Field Report**	**38 marks**
(ii)	**Viva-voce**	**12 marks**

PAPER GEHT101: EARTH SYSTEM SCIENCE

A Holistic understanding of our dynamic planet through Astronomy, Geology, Meteorology and Oceanography. Introduction to various branches of Earth Sciences. General characteristics and origin of the Universe, Solar System and its planets. The terrestrial and Jovian planets. Meteorites and Asteroids. Earth in the Solar system, origin, size, shape, mass, density, rotational and revolution parameters and its age.

Earth's magnetic field, formation of core, mantle, crust, hydrosphere, atmosphere and biosphere. Convection in Earth's core and production of its magnetic field. Mechanical layering of the Earth. Introduction to geophysical methods of earth investigations.

Concept of plate tectonics; sea-floor spreading and continental drift. Geodynamic elements of Earth: Mid Oceanic Ridges, trenches, transform faults and island arcs. Origin of oceans, continents, mountains and rift valleys. Earthquake and earthquake belts. Volcanoes: types products and distribution.

Oceanic current system and effect of coriolis forces. Concepts of eustasy, tend - air-sea interaction; wave erosion and beach processes. Atmospheric circulation; weather and climatic changes. Earth's heat budget.

Soils: processes of formation, soil profile and soil types.

Nature of stratigraphic records, Standard stratigraphic time scale and introduction to the concept of time in geological studies. Introduction to geochronological methods in their application in geological studies. History of development in concepts of uniformitarianism, catastrophism and neptunism. Law' of superposition and faunal succession. Introduction to the geology and geomorphology of Indian subcontinent.

Distribution of elements in the solar system and in the Earth. Chemical differentiation and composition of the Earth. General concepts about geochemical cycles and mass balance. Properties of elements.

Geochemical behaviour of major elements. Mass conservation of elements and isotopic fractionation.

Suggested Readings

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

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

PAPER GEHT102: MINERALOGY AND CRYSTALLOGRAPHY

Elementary ideas about crystal morphology in relation to internal structures. Crystal parameters and indices. Crystal symmetry and classification of crystals into six systems and 32 point groups. Stereographic projections of symmetry elements and forms. Introduction to analytical techniques like XRD (X-ray diffraction), SEM (secondary electron microscopy) (Cornelis Klein and Barbara Dutrow, The Manual of Mineral Science, Wiley Publication 2007).

Elements of crystal chemistry and aspects of crystal structures. Minerals: definition and classification, physical and chemical composition of common rock-forming minerals. (Cornelis Klein and Barbara Dutrow, The Manual of Mineral Science, Wiley Publication 2007)

Nature of light and principles of optical mineralogy. Introduction to the petrological microscope and identification of common rock forming minerals. (P. K. Verma, Optical Mineralogy, CRC press 2009)

Practical.

1. Study of physical properties of minerals in hand specimen

- Silicates: Olivine, Garnet, Andalusite, Sillimanite, Kyanite, Staurolite, Beryl, Tourmaline, Augite, Actinolite, Tremolite, Hornblende, Serpentine, Asbestos, Kaolinite, Talc, Muscovite ,Biotite, Phlogopite, Quartz, Orthoclase, Plagioclase, Microcline, Nepheline, Sodalite, Zeolite.

Quartz varieties: Chert, Flint, Chalcedony, Agate, Jasper, Amethyst, Rose quartz, Smoky quartz, Rock crystal.

Native Metals/non-metals, Sulfides, Oxides: Copper,

Sulfur, Graphite, Pyrite, Corundum, Magnetite.

Hydroxides, Halides, Carbonates, Sulfates, Phosphates: Psilomelane, Fluorite, Calcite,
Malachite, Gypsum, Apatite.

2. Optical idetification of common rock forming minerals

Quartz, Plagioclase, Microcline, Muscovite, Biotite, Fluorite, Olivia Garnet.• Tourmaline, Staurolite, ndalusite, Kyanite, Sillimanite,Cordierite.• Hypersthene, Augite, Diopside, Hornblende, Tremolite- ctinolite.• Corundum, Beryl, Calcite, Barite.

3. Stereographic projection of face poles of crystals.

4. Study of elements of symmetry of normal classes of six crystal systems.

Suggested Readings

1. Cornelis Klein and Barbara Dutrow, The Manual of Mineral Science, Wiley Publication 2007.

2. P. F. Kerr Optical Mineralogy,1959

3. P. K. Verma , Optical mineralogy, CRC press 2009

4. Deer, W. A. , Howie, R. A. and Zussman, J., An introduction to the rock forming minerals, ELBS publication,1962-1963.

PAPER GEHT103: GEOMORPHOLOGY AND PHOTOGEOLOGY

Geomorphology

Nature and scope of geomorphology, evolution of geomorphological thoughts. Basic concepts of geomorphology, Overview of landscape evolution models, cycle of erosion, Introduction to global geomorphology, Mountains and relief (Bloom, 1998)

River basin and drainage network, river erosion and sediment transport. (Kale and Gupta, 2001)

Fluvial, glacial, Aeolian, coastal and karstic landforms, Slopes: stability and failures. (Bloom, 1998)

Geomorphology in the study of Natural Hazards and Environmental Management; Introduction to engineering geomorphology; (Bloom, 1998) Overview of Indian geomorphology. (Kale and Gupta, 2001)

Photogeology:

Types and acquisition of aerial photograph. Scale and resolution. Black and white, colour and infrared film. Photomosaics. Orthophotographs. Principles of stereoscopy, lens and mirror stereoscopes, image parallax, relief displacement, vertical exaggeration, distortion. Elements of airphoto interpretation. Identification of sedimentary, igneous and metamorphic rocks. Aeolian, glacial, fluvial and marine landforms. (Miller, 1961)

Physical principles of remote sensing. Early history of space imaging.Earth Resources Satellites characteristics: and applications of imageries of LANDSAT1 to 7, SPOT missions, Indian Remote Sensing Satellite mission. Basic idea of Radar Images. (Gupta, 2003; Bhatta, 2008)

Practical

Geomorphology

1. Analysis of geomorphological features from various morphogenetic regions of India; preparing elementary geomorphological maps on different scales (1:250000,1:50000).
2. Preparation of longitudinal and cross-valley profiles.
3. Preparation of superimposed profiles; methods for recognition of regional erosion surfaces.
4. Altimetric analysis. Hypsometric analysis. Exercises related to measurements of runoff dynamics, sediment and solute dynamics.
5. Morphometry of drainage basins. Analysis of drainage orientation structure.

Photogeology

1. Study of aerial photo-pairs using lens and mirror stereoscopes delineating geomorphic features (aeolian, fluvial, glacial and coastal), rock types (igneous, sedimentary and metamorphic and unconsolidated sediments) and structural features (fold, faults, joints, caverns, lineaments).
2. Two exercises on measurement of relief displacement on aerial photographs and estimation of the height of an object.
3. Analysis of different wavelength bands of satellite imageries for understanding their relative applicability in discrimination of rock types and mapping of soil, vegetation, water and geologic structure.

Suggested Readings

1. Bloom, A.L. 1998. Geomorphology: A systematic Analysis of Late Cenozoic Landforms (3rd Edition), Pearson Education, Inc.
2. Kale, VS. and Gupta, A. 2001. Introduction to Geomorphology. Orient Longman Ltd.
3. Miller, Victor, C. 1961. Photogeology. McGraw Hill Book Co., New York.
4. Gupta R.P. 2003. Remote Sensing Geology. 2nd Ed., Springer-Verlag, Heidelberg, Germany.
5. Bhatta, B., 2008. Remote Sensing and GIS. Oxford, New Delhi.

Paper GEHT104: MATHEMATICS
(Opted from paper 501 offered by Mathematics department)

Variables, Functions and Mapping: Variables and functions, Inverse functions, Common functions, Curves and Parameters, Exponential, Hyperbolic and Logarithmic Functions.

Sequences, Limits and Continuity: Sequences, Limits of sequences and functions, Functions of several variables – limits, continuity.

Differentiation of Functions: The derivative, rules of differentiation, Higher derivatives, Parital differentiation, change of variable, implicit functions, higher order partial derivatives.

Integral Calculus: Fundamental theorem of integral calculus, mean value theorems, evaluation of definite integrals, Convergence of improper integrals, tests of convergence, Differentiation of an integral containing a parameter, differentiation of integrals with variable limits - Leibnitz rule. Rectification, double and triple integrals, computations of area, surfaces and volumes. Integration by substitution, Integration by parts, Reduction formulae.

Differential Equations: Classification of differential equations, Arbitrary constants and the order of differential equations, Ordinary first order differential equations, Ordinary differential equations of the second and higher orders, Transforms of basic functions, Inversion, Solution of differential equations, Partial differential equations.

Matrices and Linear Algebra: Algebra of matrices, Determinants, linear transformations, rank and inverse of a matrix, solution of algebraic equations, Eigenvalues and eigenvectors, Tensors.

Vector Calculus: Scalar and vector fields, level surfaces, directional derivative, Gradient, Curl, Divergence, Laplacian, line and surface integrals, theorems of Green, Gauss and Stokes, line integrals independent of path.

Numerical Methods
Finding the roots, Newton-Rapson method, Numerical integration, Numercial soulution of ODEs – Euler Scheme, Runge-Kutta Method.

Books

PAPER GEHT201: SEDIMENTOLOGY

Sedimentary Processes: Introduction to basic concepts: Developments in sedimentology, description and classification of sedimentary rocks, sedimentary environments and facies, earth's sedimentary shell. Weathering and sedimentary flux: Physical and chemical weathering, submarine weathering, soils and paleosols. Fluid flow, sediment transport and sedimentary structures: Types of fluids, Laminar vs. turbulent flow, Reynolds number, Froude Number, Boundary layer effect, Particle entrainment, transport and deposition, sediment gravity flows, Concept of flow regimes and bedforms (Prothoreo and Schwab, 2004; Collinson, and Thompson, 1988).

Siliciclastic rocks: Sedimentary texture: Grain size scale, particle size distribution, statistical treatment of particle size data, particle shape and fabric. Sedimentary structure: Primary and secondary sedimentary structures, Paleocurrent analysis. Siliciclastic rocks: Conglomerates, sandstones, mudrocks (texture, composition, classification and origin and occurrence). Diagenetic processes. Introduction to coal and petroleum. (.Pettijohn, 1975)

Nonsiliciclastic rocks: Carbonate rocks, controls of carbonate deposition, components and classification of limestone, dolomite and dolomitisatiion, carbonate sedimentary environments. Chert and siliceous sediments, phosphorites, carbonaceous sediments, iron rich sediments and evaporites. (Tucker, 2006)

Practical

1. Exercises on sedimentary structures and their paleoenvironmental significance,
2. Particle size distribution and statistical treatment,
3. Heavy mineral analysis and provenance, paleocurrent analysis.
4. Exercises based on vertical sedimentary sequences of different terrestrial, coastal and marine environments,
5. Petrography of clastic and non-clastic rocks through handspecimens and thin sections.

Suggested Readings

1. Prothero and Schwab, 2004, Sedimentary Geology, Freeman and Co. New York, 557p

2. Maurice E. Tucker, 2006, Sedimenary Petrology, Blackwell Publishing, 262p.

3. Collinson, J.D. and Thompson, D.B. 1988, Sedimentary structures, Unwin- Hyman, London, 207p.

4. Pettijohn, F.J. 1975, Sedimentary rocks, Harper and Row Publ. New Delhi

PAPER GEHT202: PALEONTOLOGY

Introduction to fossils, fosslization processes (taphonomy), and modes of preservation; species concept, species problem in palaeontology, speciation; methods of description and naming of fossils, code of systematic nomenclature; theory of organic evolution and the fossil record; palaeoecology – principles and methods; application of fossils in the study of palaeoecology, palaeobiogeography and palaeoclimate.

***Invertebrate Palaeontology*:** Brief introduction to various invertebrate groups; significance of trilobites, brachiopods and graptolites in Palaeozoic biostratigraphy; brachipod and trilobite faunal provinces; significance of ammonoids in Mesozoic biostratigraphy and palaeobiogeography; functional adaptations in ammonoids (sutures) and trilobites (compound eye); ichnology – classification of trace fossils and their utility in palaeoenvironmental reconstructions

Vertebrate Palaeontology: Origin of vertebrates; major steps in vertebrate evolution; origin, evolution and extinction of dinosaurs, endothermy versus ectothermy in dinosaurs, dinosaurs as birds; adaptive radiation of mammals in the Tertiary, evolution of horse - role of climate and intercontinental migrations; evolutionary stages of proboscideans, causes of Pleistocene megafaunal extinctions; evolution of primates with special reference to human evolution, early human migrations; vertebrate fossil record from Gondwana formations, Deccan volcanic Province, Palaeogene and Neogene sequences of India and their evolutionary and palaeobiogeographic significance.

Palaeobotany: Early plant life, colonization of land, important stages in plant evolution; Carboniferous coal forests; Gondwana flora and role of climate in it's evolution; phytogeographic provinces; role of plant fossils in palaeoclimatic reconstructions; introduction to palynology, application of palynology in hydrocarbon exploration.

Practical

1. Study of fossils showing various modes of fossilization.

2. Study of diagnostic morphological characters, systematic position, Stratigraphic position and age of various invertebrate, vertebrate and plant fossils

Suggested Readings

1. Clarkson, E.N.K.1998. Invertebrate Palaeontology and Evolution, George Allen & Unwin.

2. Raup, D.M. and Stanley, S. M. 1971. Principles of Palaeontology, W.H. Freeman and Company.

3. Benton, M. 1997. Basic Palaeontology: An introductory text, D.Harker, Addision Wisely Longman.

4. Prothero, D.R. 1998. Bringing fossils to life – An introduction to Palaeobiology, McGraw Hill.

5. Benton, M.J. 2005. Vertebrate palaeontology (3rd edition). Blackwell Scientific, Oxford.

6. Willis, K.J. & McElwain, J.C. 2002. The evolution of plants, Oxford University Press.

7. Brenchley, P. J., and Harper, D. A. T. 1998. Palaeoecology: Ecosystems,Environments and Evolution. By Chapman and Hall.

PAPER GEHT203: PHYSICAL CHEMISTRY

The Primary objective of this course is to promote an understanding of the fundamental concepts of Chemistry and their applications while retaining the excitement of Chemistry. The course also emphasizes the development of problem solving skills in students.

Atomic Structure

Wave Mechanical Model of the Hydrogen Atom : Recapitulation of : Bohr's theory and its limitations, dual behaviour of matter and radiation, De-Broglie's relation, Hé is enberg Uncertainty principle. Need of new approach to the atomic structure.

Quantum mechanics (wave mechanics)? Time-independent Schrodinger equation and meaning of various terms in it. Significance of quantum numbers, orbital angular momentum and quantum numbers m1 and m1. Shapes of s, p and d atomic orbitals - charge cloud diagrams and boundary surface diagrams, nodal planes. Discovery of spin, spin quantum number (s) and magnetic spin quantum number (ms).

Multi-electron Atoms

Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous configurations.

Chemical Bonding and Molecular Structure

Ionic Bonding :General characteristics of ionic bonding Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds, Derivation of Born-Lande equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability, Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment, percentage ionic character.

Chemical Thermodynamics

Objectives and limitations of thermodynamics, state of system, state variables, thermodynamic equilibrium, thermodynamic properties, intensive and extensive properties, various types of systems and processes. First Law of Thermodynamics : Concepts of internal energy and enthalpy.

Thermochemistry : Laws of thermochemistry, intenal energy and enthaply changes for physical and chemical processes including formation, neutralisation, combustion, ionisation, fusion and vaporisation.

Second and Third Laws of Thermodynamics : Concepts of entropy, Gibbs free energy and Helmoltz free energy. Third Law of thermodynamics : Statement of the law, calculation of absolute entropies of substances.

Ionic Equilibria

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization. ionization constant and ionic product of water, ionization of weak acids and bases. pH scale, common ion effect, hydrolysis of salts, buffer solutions and solubility product.

Practical

Suggested Reading

PAPER GEHT204: PHYSICS - I

Thermodynamics:
Zeroth and first of thermodynamics. Reversible and irreversible processes, Engines and Refrigerators, Carnot's cycle, Carnot's theorem. Second law of thermodynamics and entropy. Thermodynamic temperature. Entropy change in reversible and irreversible processes.

Thermodynamic potentials. Enthalpy, Gibbs' and Helmholtz's functions. Joule's Thomson effect, cooling of Van der Waals gas, Maxwell relations and their applications. Claussius-Clapyron equation. Phase Rule, , Convection, Conduction, Geothermal Gradients.

Kinetic theory:
Derivation of Maxwell's law of distribution of velocities and its experimental verification. Mean free path. Law of equipartition of energy and its applications to specific heat of gases. Transport phenomenon ; viscosity, conduction and diffusion. Brownian motion.

Statistical mechanics:
Micro and Macro states, Thermodynamic probability. Partition Function, Entropy, Maxwell-Boltzmann distribution, Thermodynamic properties of ideal-gas Bose-Einstein Distribution Function, Thermodynamic properties of photon gas, Bose Einstein Condensation and its experimental verification (qualitative treatment only). Bose derivation of Planck's Law. Its special cases i.e. Rayleigh Jeans and Wein's displacement law. Stefan-Boltzman law

Practical

Suggested Reading

PAPER GEHT301: STRUCTURAL GEOLOGY

Theory

• Effects of topography on structural features; Topographic and structural maps;Importance of scale of the map. (Davis, G. R. 1984)

• Importance of top-bottom criteria in structural geology. (Ghosh, S.K. 1993)

• Concept of rock deformation. Stress and Strain in rocks, 2-D stress and strain analysis; Strain ellipses of different types and their geological significance. (Davis, GR. 1984)

• Fold morphology; Geometric and genetic classification of folds; Mechanics and causes of folding: Buckling, Bending, Flexural slip and flow folding etc. (Davis, G. R. 1984)

• Description and origin of foliations: axial plane cleavage and its tectonic significance; theory of cleavage formation in deformed rocks. (Davis, G. R. 1984)

• Description and origin of lineation and relationship with the major structures.

• Geometric and genetic classification of fractures and faults. Effects of faulting on the outcrops. Geologic/geomorphic criteria for recognition of faults. (Billings,M.P. 1987)

• Geometric and genetic classification of joints. (Ghosh, S.K. 1993)

• Introduction to ductile shear zones: significance of mylonite, cataclasite, gouge.(Ghosh, S.K. 1993)

• Stereographic projections and their use in structural analysis: Theory (Ghosh, S.K. 1993)

• Concept of Orogeny. Important Orogenic belts of the world. (Different sources including web)

• Neotectonics and its importance. Indian examples.

Practical

• Drawing profile sections and interpretation of geological maps of different complexities.

• Exercises of stereographic projections of mesoscopic structural data (planar, linear, folded etc.).

• Solving problems related to stress and strain measurements.

Suggested Readings

1. Davis, GR. 1984. Structural Geology of Rocks and Region. John Wiley

2. Billings, M.P. 1987. Structural Geology, 4th edition, Prentice-Hall.

3. Park, R.G. 2004. Foundations of Structural Geology. Chapman & Hall.

4. Pollard, D.D. 2005. Fundamental of Structural Geology. Cambridge University Press.

PAPER GEHT302: IGNEOUS PETROLOGY

Rock associations in time and space. Pressure-temperature variation with depth Physical aspects of magma generation in crust and mantle. Physical properties of magmas; Magma chamber processes, magma convection, igneous cumulates, liquid immiscibility, pneumatolitic action, magmatic assimilation and mixing of magmas Textures of igneous rocks and their significance in understanding magmatic crystallization history.

Classification of igneous rocks. Igneous rock associations: Igneous rocks of oceanic regions (Mid ocean ridge basalts, ocean island basalts), plate margin magmatic rocks (island arcs and continental arcs – basalts, andesites, dacites, rhyolite).

Igneous rocks of the continental regions – continental flood basalts, granite batholiths, Komatiites, gabbro-anorthosites, ophiolites, alkaline rocks, lamprophyres, kimberlites and carbonatites

Practical classes:

Megascopic and microscopic study (textural and mineralogical) of the following igneous rocks:
Granite, Syenite, Gabbro, Basalt, Peridotite, Pyroxenite, Dunite.
Lamprophyres, Dolerite, Phonolite, Rhyolite, Trachyte, Andesite,
Pitchstone, Anorthosite, Aplite, Pegmatite.
Introduction to modal analyses of Granite, Basalt and Gabbro.

1. John D. Winter 2001. An Introduction to Igneous and Metamorphic Petrology. Prentice Hall Inc

2. Loren A. Raymond 2002. Petrology: The study of Igneous, Sedimentary and Metamorphic rocks. Mc Graw Hill .New York

3. Bose M.K. 1997. Igneous Petrology. World Press

4. Cox, K.G. Bel, J.D. and Pankthrust, R.J. 2002. The interpretation of Igneous rocks. Allen and Unwin, London

PAPER GEHT303 : METAMORPHIC PETROLOGY

Introduction: Definition of metamorphism. Factors controlling metamorphism Types of metamorphism – contact, regional, fault zone metamorphism, impact metamorphism. Metamorphic zones and isograde. Concept of metamorphic facies and grade. Mineralogical phase rule of closed and open system. Structure and textures of metamorphic rocks (Yardley, 1990, Winter, 2001)).

Relationship between metamorphism and deformation; metamorphic mineral reactions (prograde and retrograde). Metamorphism and melting, origin of migmatities; Metasomatism, role of fluids in metamorphism (Vernon and Clarke, 2008)

Metamorphic rock associations - schists, gneisses, khondolites, charnockites, blue schists, eclogites. (Best, 2002)

Practical

- Megascopic and microscopic study (textural and mineralogical) of the following metamorphic rocks:
- Low grade metamorphic rocks: serpentinites, albite-epidote-chlorite-quartz schist, slate, talc-tremolite-calcite-quartz schist.
- Medium to high grade metamorphic rocks: Gneisses, amphibolite, hornfels, garnetiferous schists, sillimanite-kyanite-bearing rocks, Granulites, eclogite, diopside-forsterite marble.
- Laboratory exercises in graphic plots for petrochemistry and interpretation of paragenetic diagrams.

References:

1. Yardley, B W D. 1990. An introduction to metamorphic petrology. ELBS publication.

2. Best, M.G. 2002. Igneous and metamorphic petrology. Wiley publication.

3. Vernon R. H. and Clarke G. L. 2008. Principles of metamorphic Petrology. Cambridge publication.

4. John D. Winter 2001. An Introduction to Igneous and Metamorphic Petrology. Prentice Hall Inc

PAPER GEHT304: PHYSICS- II

Mechanics
Galilean invariance and Newton's Laws of motion. Dynamics of a system of particles, Conservation of momentum and energy, work energy theorem. Conservation of angular momentum, torque, Motion of a particle in central force field. Kepler's Laws, Satellite in circular orbit and applications (Synchronous satellite, GPS, Artificial gravity, apparent weightlessness). Physiological effects of acceleration and angular motion.

Fluid Mechamics
Fluid Flow, Density, Pressure, Viscosity, Archimedes' Principle, Ideal fluid in motion, Equation of continuity, Darcy's Law, Bernoulli's Theorem, The flow of real fluids.

Waves and Oscillations
Simple harmonic motion, damped and driven harmonic oscillator, coupled oscillator, energy relation and energy transfer, normal modes, Wave equation, Travelling waves, superposition principle, pulses. Doppler effect, effects of vibrations in humans, physics of hearing, heartbeat.

Electromagnetic Waves, Maxwell's equation, Travelling of EM waves, Energy transport, Polarization, Scattering.

Statistical Mechanics
Phase space, micro and macro states, Thermodynamic probability, Concept of entropy, Maxwell-Boltzmann distribution. Connection to thermodynamics.

Magentism
Magnetic field, The magnetic dipole, Current and the magnetic field, Magnetism, Gauss' law, Paramagnetism, Diamagnetism, Ferromagnetism, The magnetism of the Earth, and its causes,

Gravity
Earth's Gravitational field, Gravity and its measurement, Gravity anomaly, Free-air Correction, Bougyer Correction

Practical

Suggested Reading

PAPER GEHT401: GEOLOGY OF INDIA

Brief introduction to the concepts of litho-, bio- and chronostratigraphy and their subdivisions with Indian examples.

Physiographic and tectonic subdivisions of India; brief outline of regional geology and tectonic revolution of of cratons and mobile belts in peninsular India; geology of Proterozoic Cuddapah and Vindhyan sedimentary basins.

Palaeozoic succession of Kashmir and its correlatives from Spiti and Zanskar; stratigraphy and structure of Gondwana basins of peninsular India and correlatives from the Himalayan region, economic importance of Gondwana basins; marine Mesozoic formations with reference to the Triassic deposits of the Himalayan region and Jurassic rocks of Kutch and Jaisalmer basins of peninsular region; important marine incursions into peninsular India during Late Palaeozoic and Cretaceous periods; hydrocarbon potential of Gondwana and Cretaceous shallow marine sequences of India; distribution and age of Mesozoic volcanic provinces.

Sedimentation and evolution of Himalayan foreland basin; Palaeogene succession of the Himalayan belt, life and palaeogeography in the context of India/Asia collision recent advances in the stratigraphic and faunal studies of the Siwalik Group; stratigraphy and structure of Krishna-Godavari basin, Cauvery basin, Bombay offshore basin, and Kutch and Saurashtra basins and their potential for hydrocarbon exploration; stratigraphic boundary problems with special reference to Pc/C, P/T, and K/T boundaries in India.

Practical

1. Study of geological map of India and identification of major stratigraphic units.
2. Identification and delineation of lithotectonic units on map of India.
3. Exercises in preparation of charts to evaluate inter-regional correlations.
4. Drawing various palaeogeographic maps of the Phanerozoic time
5. Study of different Proterozoic supercontinent reconstructions.

Suggested Readings:

1. Krishnan, M.S. 1982. Geology of India and Burma, CBS Publishers, Delhi

2. Pascoe, E.H. 1968. A manual of the Geology of India and Burma (Vol.I-IV), Govt. Of India Press, Delhi.

3. Schoch, R.M. 1989. Stratigraphy, Principles and Methods.Van Nostrand Reinhold.

4. Doyle, P. & Bennett, M.R. 1996. Unlocking the Stratigraphic Record. John Wiley

5. Ramakrishnan, M. & Vaidyanadhan, R. 2008. Geology of India Volumes 1 & 2 geological society of India, Bangalore.

6. Valdiya, K.S. 2010. The making of India, Macmillan India Pvt. Ltd.

PAPER GEHT402: ECONOMIC GEOLOGY

General: ore and gangue, tenor and grade, ore bodies and lodes. Resources and reserves. Processes of formation of ores: Endogenous processes: magmatic concentration, contact metasomatic, skarns, greisens, pegmatites and hydrothermal deposits. Exogenous processes: sedimentation as a process of ore formation. Chemical and bacterial precipitation. Colloidal deposition. Weathering products and residual deposits: oxidation and supergene enrichment. Evaporation of brine and metamorphism as ore forming processes.

Metallic ores: oxides of Fe, Mn, Cr, W and sulphides of Cu, Pb, Zn, metallogenic provinces and epochs. Important deposits of India including atomic minerals.

Nonmetallic and industrial rocks and minerals, their nature and distribution in space and time in India: refractory, chemical, fertilizer, cement, chemical and gemstone industry including building stones.

Mineral Exploration: surface and subsurface exploration methods, sampling and assaying. Assessment of grade. Reserve estimation.

Practical

1. Study of physical properties of ore forming minerals.
    - *Oxides:* Magnetite, Maghemite, Hematite, Martite, Goethite, Limonite, Psilomelane, Pyrolusite, Braunite, Hausmanite, Chromite, Ilmenite, Columbitetantalite, Cassiterite, Uraninite, Pitchblende.
    - *Sulfides:* Galena, Sphalerite, Pyrite, Pyrrhotite, Chalcopyrite, Bornite, Molybdenite, Realgar, Orpiment, Stibnite.

2. Study of optical properties of common ore forming minerals:
    - Galena, Sphalerite, Pyrite, Pyrrhotite, Chalcopyrite.
    - Magnetite, Hematite, Psilomelane, Pyrolusite.

3. Study of association of ore forming and typical gangue minerals.

4. Preparation of maps showing distribution of important ores and other economic minerals in India.

Suggested Readings

1. Guilbert, J.M. and Park Jr., C.F. 1986. The Geology of Ore deposits. Freeman & Co.

2. Bateman, A.M. and Jensen, M.L. 1990. Economic Mineral Deposits. John Wiley.

3. Gokhale, K.V.G.K. and Rao, T.C. 1978. Ore deposits of India their distribution and processing, Tata-McGraw Hill, New Delhi.

4. Deb, S. 1980. Industrial minerals and rocks of India. Allied Publishers.

PAPER GEHT403: ENGINEERING GEOLOGY

Geology vs. Engineering. Role of Engineering geologists in planning, design and construction of major man-made structural features. Elementary concepts of rock mechanics and rock engineering. Soil mechanics. Site investigation, characterization and problems related to civil engineering projects: foundation treatment, geological and geotechnical investigations for dams, reservoirs and spillways, tunnels, underground caverns, bridges, highways, shorelines. Environmental considerations related to civil engineering projects. Construction materials. Geological hazards (landslides and earthquakes) their significance, causes and preventive/remedial measures. Recent trends in geotechnical engineering. Case histories and Indian examples.

Practical

1. Selection of sites using topographic maps for dams, tunnels, bridges, highways and similar civil structures.
2. Computation of reservoir area, catchment area, reservoir capacity and reservoir life.
3. Index Tests for foundation strength evaluation.
4. Evaluation of mechanical properties of concrete aggregates.
5. Use of softwares for solving various geotechnical problems.
6. Evaluation of Atterberg limits.
7. Surveying related exercises

Suggested Readings

1. Krynin, D.P. and Judd W.R. 1957. Principles of Engineering Geology and Geotechnique, McGrawHill (CBS Publ).

2. Johnson, R.B. and DeGraf, J.V. 1988. Principles of Engineering Geology, John Wiley.

PAPER GEHT404: PROBABILITY & STATISTICS

Elementary understanding of data, Measures of central tendency and dispersion, Frequency curves, Empirical measures of location, spread; Empirical moments, Analysis of bivariate data. Spatial analysis of data, distribution of points, cluster analysis.

Curve fitting and method of least-squares, regression analysis, Correlation theory, simple linear regression, multiple regression. Residual analysis and its significance, Co-variance and correlation co-efficient, Introduction to the Markovian Chains.

Introduction to set theory, Permutations and combinations, Elementary probability theory, Conditional probability, Expectation, Introduction to Stochastic processes.

Random variables, probability distribution of finite random variables, discrete and continuous random variables, Normal distribution, Central limit theorem, Binomial distribution, Poisson distribution, t-Distribution, Chi-square distribution.

Organizations of sample surveys, simple random sampling with and without replacement, Inferential statistics for a single population: Confidence intervals for means, Hypothesis tests for Means. Inferential statistics for two populations: Hypotheses tests and confidence intervals for the difference of Means.

Suggested Reading

PAPER GEHT501: HYDROGEOLOGY

Introduction: Scope of hydrogeology and its societal relevance. Hydrologic cycle: precipitation, evapotranspiration, runoff, infiltration, subsurface movement of water, aquifer properties, vertical distribution of subsurface water (Reference book: Todd, D.K, Davis & De Weist , class notes).

Geological formations as aquifers, types of aquifers, geological classification of aquifers, springs. Groundwater occurrence in igneous, metamorphic and sedimentary rocks. Groundwater in non-indurated sediments. Darcy's law and its validity(Reference book: Todd, D.K, Davis & De Weist , class notes),Groundwater provinces of India (Reference book: Karanth K.R, class notes).

Theory of groundwater flow, elementary well hydraulics, surface and subsurface exploration of groundwater, drilling and construction of wells, pumping tests and analysis of test data for evaluation of aquifer parameters (Reference book: Todd, D.K & class notes).

Groundwater level fluctuations(Reference book: Todd, D.K, Karanth K.R , class notes), Physical and chemical properties of water and water quality(Reference book: Todd, D.K , class notes), Water balance studies: basic concept, development and management of groundwater resources. Surface and subsurface water interaction, Sea water intrusion in coastal aquifers. (Reference book: Todd, D.K, Fetter, C.W , class notes)

Practical

1. Preparation and interpretation of water table contour maps and depth to water level contour maps.

2. Study, preparation and analysis of hydrographs for differing groundwater conditions.

3. Water potential zones of India (map study) including saline water zones.

4. Graphical representation of chemical quality data and water classification (C-S and Trilinear diagrams).

Suggested Readings

1. Todd, D.K. 1980. Groundwater hydrology, 2nd Ed., John Wiley & Sons,N.Y.

2. Davis, S.N. and De Weist, R.J.M. 1966. Hydrogeology, John Wiley & Sons Inc., N.Y.

3. Karanth K.R., 1987. *Groundwater: Assessment, Development and Management*, Tata McGraw-Hill Pub. Co. Ltd.

4. Fetter, C.W. 1990. Applied Hydrogeology, CBS Publications.

PAPER GEHT502: GEOPHYSICS

Interrelationship between geology and geophysics - Role of geological and geophysical data in explaining geodynamical features of the earth.

General and Exploration geophysics- Different types of geophysical methods; Gravity, magnetic, Electrical, Seismic- their principles and applications. Concepts and Usage of corrections in geophysical data.

Geophysical field operations - Different types of surveys, grid and route surveys, profiling and sounding techniques, scales of survey, presentation of geophysical data.

Application of Geophysical methods - Regional geophysics, oil and gas geophysics, ore geophysics, groundwater geophysics, engineering geophysics.

Geophysical anomalies : correction to measured quantities, geophysical, anomaly, regional and residual (local) anomalies, factors controlling anomaly, depth of exploration.

Integrated geophysical methods - Ambiguities in geophysical interpretation, Planning and execution of geophysical surveys.

Suggested Readings

1. Outlines of Geophysical Prospecting - A manual for geologists by Ramachandra Rao, M.B., Prasaranga, University of Mysore, Mysore, 1975.

2. Exploration Geophysics - An Outline by Bhimasarikaram V.L.S., Association of Exploration Geophysicists, Osmania University, Hyderabad, 1990.

3. An introduction to Geophysical Prospecting by Dobrin, M.B. McGraw Hill, New Delhi, 1984.

4. Applied Geophysics by Telford W.M. Geldart L.P., Sheriff, R.E. and Keys D.A. Oxford and IBH Publishing Co. Pvt., Ltd. New Delhi, 1976

PAPER GEHT503: COMPUTER APPLICATIONS

Introduction to computer hardware.

Statistical analysis using various statistical softwares including Excel, Origin and SPSS. Introduction to MATLAB, Writing codes in MATLAB, applications in geosciences.

Introduction to Rockworks, working on different exercises in Rockworks.

Computer programming. Writing small codes in FROTRAN or C language.

Suggested Readings:

1. Merriam D.F., (Ed.) 2000. Computer methods in the Geosciences, Elsevier.

2. Chapman, S.J., 2008 Fortran for Scientists and Engineers (3rd Edn.) McGraw-Hill.

PAPER GEHT504: INORGANIC CHEMISTRY

General Principles of Metallurgy

Chief modes of occurrence of metals based on standard electrode potential. Hydrometallurgy. Methods of refining and purification of metals.

Complexes of *s*- and *p*- block elements.

Hydrides and their classification (ionic, covalent and interstitial), structure and variations in properties with respect to stability, reducing behaviour and acid/base strength of hydrides of various Groups of *p*- block elements.

Bio-Inorganic Chemistry

A brief introduction to bio-inorganic chemistry. Role of metal ions present in biological systems with special reference to Na2, K2,Mg2- ions : Na/K pump; role of Mg2 ions in energy production transmission of impulses along nerve fibers and chlorophyll; role of ca2- ions in blood clotting, muscle contraction, stabilization of protein structures and structural role (bones).

Chemistry Toxicity : Toxicity of As, Cd, Pb. Hg, CO, NOx, SOx, H2S, their sources of contamination. Causes of toxicity (biochemical effects) and antidotes.

Kinetic Theory of Gases

Collision cross section, collision number, collision frequency, collision diameter and mean free path of molecules and also effects of temperature and pressure on them (for ideal gases). Viscosity of gases, relation between mean free path and coefficient of viscosity. Temperature and pressure dependence of coefficient of viscosity. Degrees of feedom of motion, principle of equipartition of energy.

Liquids

Surface tension and its determination using stalagmometer. Viscosity of a liquid and determination of coefficient of viscosity using Ostwald viscometer. Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only).

Systems of Variable Composition and Solutions

Partial molar quantities and their physical significance. Chemical potential, variation of chemical potential with temperature and pressure. Free Energy and entropy of mixing of ideal gases.

Thermodynamics of Ideal Solutions : ideal Solutions and Raoult's law. Deviations from Raoult's law - non-ideal solutions. Isothermal vapour pressure - composition (and isobaric boiling point-composition) curves of ideal and non-ideal solutions. Distillation of ideal and non-ideal solutions. Partial miscibility of liquids. Critical solution temperature. Immiscibilty of liquids.

PAPER GEHT601 / GEHT602/ GEHT 603: GEOLOGY OPTIONAL PAPERS

(i) **APPLIED RIVER SCIENCE**

Basic stream hydrology, Physical properties of water, sediment and channel flow, River discharge, River hydrographs (UH, IUH, SUH, GIUH) and its application in hydrological analysis, Flood frequency analysis. (Davie, 2008)

River basin, Sediment source and catchment erosion processes, Sediment load and sediment yield, Sediment transport process in rivers, Erosion and sedimentation processes in channel. (Knighton, 1998)

Drainage network, Quantitative analysis of network organization - morphometry, Random Topology (RT) model and fractal analysis, Role of drainage network in flux transfer, Evolution of drainage network in geological time scale. (Knighton, 1998)

River diversity in space, Patterns of alluvial rivers - braided, meandering and anabranching channels, Dynamics of alluvial rivers, Channel patterns in Stratigraphic sequences, Different classification approaches in fluvial geomorphology and its applications. (Julilen, 2002; Robert, 2003)

Bedrock channels, Bedrock incision process, River response to climate, tectonics and human disturbance, Bedrock channel processes and evolution of fluvial landscapes. (Tinklerand Wohl, 1998)

Fluvial hazards, Integrated approach to stream management, Introduction to river ecology.(Robert, 2003; Research papers)

Suggested Readings

1. Davie, T., 2008. Fundamentals of hydrology. Routledge Publications.

2. Knighton, D., 1998. Fluvial forms and processes: A new perspective. Arnold Pubs.

3. Julien, P.Y., 2002. River Mechanics. Cambridge University Press.

4. Robert, A., 2003. River Processes: An introduction to fluvial dynamics. Arnold Publications.

5. Tinkler, K.J., Wohl, E.E. (eds.) 1998. Rivers over rock. American Geophyscial UnionMonogrpah, Washington, DC.

(ii) ENVIRONMENTAL GEOLOGY

Concept and definition of Environmental Geology. Processes of soil formation, types of soils, soil degradation and changing land use pattern. Concepts of natural ecosystems on the Earth and their mutual inter-relations and interactions (atmosphere, hydrosphere, lithosphere and biosphere). Environmental changes due to influence of human-dominated environment over nature-dominated system. Concept of biodiversity. Mobility of elements.

Impact assessment of water availability, quality and contamination of surface water and groundwater. Atmosphere and air pollution. Soil contamination due to urbanization, industrialization and mining. Basic tenets of environmental laws.

Distribution, magnitude and intensity of earthquakes. Neotectonics and seismic hazard assessment. Preparation of seismic hazard maps. Impact of seismic hazards on long and short term environmental conditions. Mechanism of landslides, causes of major floods, cyclones and storms. Deforestation and land degradation.

Practical

1. Study of maps of seismic zones, earthquake-prone, landslide-prone and flood-prone areas in India.
2. Methods of water analyses for physical, chemical and biological parameters.
3. Classification of groundwater for use in drinking and industrial purposes.
4. Evaluation of environmental impact of air pollution, groundwater pollution, landslides, deforestation.

Suggested Readings

1. Seismotectonic Atlas. 2000. GSI Publication.
2. Kellar, E. A. 2000. Environmental Geology. Prentice Hall, N. Jersey.
3. Merritts, D., de Wet, A. and Menking, K. 1998. Environmental Geology: an earth system science approach. W.H. Freeman & Co., N. Y.
4. Strahler, A.N. and Strahler, A.H. 1973. (Revised Ed.) Environmental Geoscience: interaction between natural systems and man. Hamilton Pub, USA.

(iii) EXPLORATION GEOLOGY

Resourse reserve definitions; mineral resources in industries – historical perspective and present. A brief overview of classification of mineral deposits with respect to processes of formation in relation to exploration strategies. (Arogyaswami, 1996).

Principles of mineral exploration, Prospecting and exploration- conceptualization, methodology and stages; Sampling, subsurface sampling including pitting, trenching and drilling, core and non-core drilling, planning of bore holes and location of boreholes on ground. Core-logging. geochemical exploration- nature of samples, anomaly, strength of anomaly and controlling factors, coefficient of aqueous migration. Introduction to geophysical methods of exploration (Moon et al., 2006)

Evaluation of sampling data. Mean, mode, median, standard deviation and variance, symmetrical and non symmetrical variation, krigging, evaluation of assay values and determination of one sided cut off grade. (Moon et al., 2006)

Principles of reserve estimation, density and bulk density, factors affecting reliability of reserve estimation, reserve estimation based on geometrical models (square, rectangular, triangular and polygon blocks), regular and irregular grid patterns, statistics and error estimation (Clark, 1967; Moon et al., 2006)

Suggested Readings

1. Clark, G.B. 1967. Elements of Mining. 3rd Ed. John Wiley & Sons.

2. Arogyaswami, R.P.N. 1996 Courses in Mining Geology. 4th Ed. Oxford-IBH.

3. Moon, C.J., Whateley, M.K.G., Evans, A.M., 2006, Introduction to Mineral Exploration, Blackwell Publishing.

(iv) INTRODUCTION TO GEOCHEMISTRY

Introduction to properties of elements: The periodic table, chemical bonding, states of matter and atomic environment of elements, geochemical classification of elements, the composition of different Earth reservoirs and the nucleus and radioactivity. Conservation of mass, isotopic and elemental fractionation. Concept of radiogenic isotopes in geochronology and isotopic tracers: dating by radioactive nuclides, Carbon 14, Beryllium 10, K-Ar method, radiogenic tracers.

Element transport: advection, diffusion. Chromatography. Aqueous geochemistry: basic concepts, speciation in solutions, elements of marine chemistry. Mineral reactions- Diagenesis and hydrothermal reactions.

The solid Earth – geochemical variability of magma, melting of the mantle and growth of continental crust. The Earth in the solar system, the formation of solar system, composition of the bulk silicate Earth. Meteorites.

Geochemical behavior of selected elements like Si, Al, K, Na etc.

Suggested readings:

1. Mason, B (1986). Principles of Geochemistry. 3rd Edition, Wiley New York.

2. Hugh Rollinson (2007) Using geochemical data – evaluation, presentation and interpretation. 2nd Edition. Publisher Longman Scientific & Technical.

3. Walther John, V., 2009. Essentials of geochemistry, student edition. Jones and Bartlett Publishers.

4. Albarede, F., 2003. An introduction to geochemistry. Cambridge University Press.

(v) INTRODUCTION TO PETROLEUM GEOLOGY

Petroleum: its different states of natural occurrence, chemical composition and physical properties of crudes in nature. Origin of petroleum (Organic and Inorganic theories), Bitumen and Kerogen; Types of kerogen; Maturation of kerogen.

Reservoir rocks: General attributes and petrophysical properties. Porosity (Primary and Secondary) and Permeability (Absolute, Relative, Effective). Control of sediment character (grain size, texture) on petrophysical property. Classification of reservoir rocks - fragmental reservoir rocks and chemical reservoir rocks.

Migration of oil and gas: geologic framework of migration; short and long distance migration, primary and secondary migration; geologic factors controlling hydrocarbon migration; forces responsible for migration, migration routes and barriers.

Hydrocarbon traps: definition; anticlinal theory and trap theory, classification of hydrocarbon traps - structural, stratigraphic and combination; time of trap formation and time of hydrocarbon accumulation. Cap rocks - definition and general properties.

Suggested Readings

1. Bjorlykke, K. 1989. Sedimentary and Petroleum Geology. Springer

2. F.K.North, 1985. Petroleum Geology. Allen & Unwin.

3. Hobson, G.D. and Tiratsoo, E.N. 1975 Introduction to Petroleum Geology and Geochemistry. Gulf Publishers.

4. R.C. Shelley, 1997. Elements of Petroleum Geology. Academic Press

(vi) QUATERNARY GEOLOGY AND PALAEOCLIMATE

Quaternary Geology

Definition of Quaternary, The Character of Quaternary, Duration of the Quaternary and development of Quaternary studies. Quaternary stratigraphy- Oxygen isotope stratigraphy, biostratigraphy and magnetostratigraphy. Response of geomorphic, neotectonic, active tectonics and their application to natural hazard assessment.

Quaternary dating methods: Radiocarbon, Uranium series Luminescence, Amino Acid,

Relative dating methods. Application of pollen, spores and phytoliths in Quaternary stratigraphy.

Quaternary stratigraphy of India. Continental records (fluvial, glacial, Aeolian, Paleosols and duricrust); marine records; continental marine correlation of Quaternary record. Evolution of Man and Stone Age culture. Plant and animal life in relation to glacial and interglacial cycles during Quaternary.

Paleoclimatology:

Introduction to climate and climate systems, Global climate pattern, Climate controlling factors. Global energy budget, Plate tectonics and climate change, Milankovitch cycles, Atmosphere and Ocean interaction and its effect on climate.

An Overview of Paleoclimatic reconstruction; Pleistocene Glacial-Interglacial cycles; Future Climate: Anthropogenic activity and its effect on Global climate

Suggested Readings

1. Ruddimen, Earths climate past and future By
2. Bigg, G., Ocean and Climate
3. Bradley, Paleoclimatology Reconstructing Climates of The Quaternary.
4. Maher and Thompson, Quaternary Climates, Environments and Magnetism.

PAPER GEHT604: TECHNICAL WRITING AND COMMUNICATION IN ENGLISH

Field Works

Field Work I:

Geological field work related to subjects of Semester I and II.

Field Work II:

Geological field work related to subjects of Semester III and IV.

Field Work III:

Geological field work related to subjects of Semester V and VI including Hydrogeology, Engineering Geology and other optional papers.