

UNIVERSITY OF PUNE
Revised Credit base Syllabus of M.Sc. Geology
(From July 2008)

Department of Geology, University of Pune, Pune-411007

[A] Salient Features of the Credit System:

1. Master's degree course in Geology would be of 100 credits, where one credit course of theory will be of one clock hour per week running for 15 weeks and one credit for practical course will consist of 15 of laboratory exercise.
2. Student will have to take admission in Geology Department and complete 75 credits incorporated in the syllabus structure of Geology. The remaining 25 credits shall be chosen from courses offered by the Geology Department or other Departments of the University with credit system structure.
3. Four credits, one each in four semesters, have been allocated for Field work.
4. Every student shall complete 100 credits in a minimum of four semesters. All Semesters will have 25 credits each.
5. Academic calendar showing dates of commencement and end of teaching, internal assessment tests and term end examination will be prepared and duly notified before commencement of each semester every year.

INSTRUCTIONS FOR THE STUDENTS (CREDIT SYSTEM)

The students seeking admission to M.Sc. Geology course are hereby informed that they are supposed to adhere to the following rules:

1. Fieldwork is a compulsory component of the syllabi. The students are supposed to attend all the field tours / field-cum-Laboratory Workshops organized by the department from time to time to cover credit Nos. GL-106, GL-206, GL-306 and GL-406 related to field components. The students shall attend the tours at their own cost and risk.
2. A minimum of 80 % attendance for lectures / practicals is the pre-requisite for Grant of Terms.
3. There shall be 28 tutorial / practical tests as a part of internal assessment in each semester. The students are supposed to attend all the tests as per the timetable. The students should note that re-test will not be given to the student absent for the test/s.
4. The students opting for dissertation course shall follow the rules framed for the same.
5. The students are requested not to encourage friends to visit the department during working hours.
6. The students are supposed to read the notices placed on various notice boards to keep the track with the academic and administrative activities.

[B] M.Sc. Geology - Course structure & Credits Distribution.

Semester I (All courses compulsory)

- GL 101: Mineralogy (4 Credits)
- GL 102: Principles of Stratigraphy and Paleontology (4 Credits)
- GL 103: Physics and Chemistry of the Earth (4 Credits)
- GL 104: Sedimentology (4 Credits)
- GL 105: Practicals related to above courses (8 Credits)
- GL 106: Fieldwork component (1 credit)

Semester II (All courses compulsory)

- GL 201: Igneous Petrology (4 Credits)
- GL 202: Metamorphic Petrology (4 Credits)
- GL 203: Structural Geology and Tectonics (4 Credits)
- GL 204: Geomorphology and Remote Sensing in Geology (4 Credits)
- GL 205: Practicals related to above courses (8 Credits)
- GL 206: Fieldwork component (1 credit)

Semester III

- GL 301: Indian Stratigraphy (4 Credits) **Compulsory**
- GL 302: Exploration Methods (4 Credits)
- GL 303: Petroleum Geology (4 Credits)
- GL 304: Environmental Geology (4 Credits)
- GL 306: Fieldwork component (1 credit) **Compulsory**
- GL 307: Isotope Geochemistry (2 Credits)
- GL 308: Quaternary Geology and Climate Change (2 Credits)
- GL 309: Oil Field Services (2 Credits)
- GL 310: Natural Resource Management (2 Credits)
- GL 311: Computer Application in Geology (2 Credits)
- GL 305: Practicals related to above courses (8 Credits) **Compulsory**

Semester IV

- GL 401: Economic Geology (4 Credits) **Compulsory**
- GL 402: Marine Geology (4 Credits)
- GL 403: Geographical Information System (2 Credits)
- GL 404: Engineering Geology and Geotechniques (4 Credits)
- GL 406: Fieldwork component (1 credit) **Compulsory**
- GL 407: Hydrogeology (4 Credits)
- GL 408: Dissertation (4 Credits)
- GL 409: Watershed Management (2 Credits)
- GL 410: Disaster Management (2 Credits)
- GL 411: Gemmology and Industrial Mineralogy (2 Credits)
- GL 412: Mining Geology (2 credits)
- GL 405: Practicals related to above courses (8 Credits) **Compulsory**

[C] Evaluation of students:

The In-semester and End-semester examinations will be of 50% marks each.

a) **In-semester Assessment:** Internal assessment for each course would be continuous and dates for each tutorials/practical tests will be pre-notified in the time table for teaching or placed separately as a part of time table. Departmental Internal Assessment Committee will coordinate this activity.

i) **Theory Courses:** There will be a minimum one test of 10 marks for each credit in a theory course comprising of 4 credits (i.e. 4 tests per course) and will compose multiple choice and or short answer questions. The marks for each test will be displayed on the notice board within four days of conducting the test. Of the total period of 15 weeks of teaching, the internal assessment tests will commence after 3 weeks and 2 to 4 tests will be conducted per week. Hence a total of 16 tests will be conducted for the 16 credits covered in a Semesters (4 theory courses). In addition 10 marks oral examination will be conducted for each 4 credit theory course.

ii) **Practical Courses:** Practical courses will be evaluated on the basis of each practical. For 2 credit practical course 14 practicals will be conducted, there will be two practical tests of 10 marks each and 5 marks will be given for attendance and journal completion.

iii) **Field Work Components:** Four credits based on field work component, one in each semester, will constitute the compulsory part. There will be a continuous evaluation of the field work. The evaluation will be based on following four heads:

Heads	Marks	Evaluating Authority
Performance of the student in the field	5	by faculty members involved in conducting tour
Punctuality, enthusiasm, and aptitude of students while completing the report	5	by faculty
Tour report	10	By committee
Viva-voce	5	By committee

The final grade for fieldwork component – courses comprising of GL 106, GL 206, GL 306 and GL 406 will be awarded as a four credits course at the end of fourth semester.

b) **Term End Examination**- The term end examination for 50 marks per course, would be held about two weeks after completion of teaching for the semester. Paper setting and assessment for a particular course would be the responsibility of the course In-charge, and these activities would be co-ordinated by the Department Examination Committee. The Department Examination committee would undertake preparation of the result-sheets for the students.

GPA Rules:

1. The formula for GPA will be based on Weighted Average. The final GPA will not be printed unless a student passes courses equivalent to minimum 100 credit hours (Science). Total credits hours means the sum of credit hours of the courses which a student has passed.
2. A seven point grade system [guided by the Government of Maharashtra Resolution No. NGO – 1298 / [4619] / UNI 4 dt. December 11, 1999 and University regulations] will be followed. The corresponding grade table is attached herewith.
3. If the GPA is higher than the indicated upper limit in the third decimal digit then the student be awarded higher final grade (e.g. a student getting GPA of 4.492 may be awarded ‘A’)
For Semester I, II, III examinations, only the grade points will be awarded for each subjects. Final GPA along with final grade will be awarded only at the end of IVth semester. There is also a provision for verification and reevaluation. In case of verification, the existing rules will be applicable. The reevaluation result will be adopted if there is a change of at least 10% marks and in the grade of the course.
4. After the declaration of result, for the improvement of Grade, the student can reappear for the examination of 30 creditworth theory courses.

Explanation of Grade & Grade Point Average:

Marks Obtained	Grade	Grade Points
100 – 75	‘O’ Outstanding	06
74 – 65	‘A’ Very Good	05
64 – 55	‘B’ Good	04
54 – 50	‘C’ Average	03
49 – 45	‘D’ Satisfactory	02
44 – 40	‘E’ Pass	01
39 and less	‘F’ Fail	00

Final Grade Points:

Grade Points	Final Grade
5.00 – 6.00	O
4.50 – 4.99	A
3.50 – 4.49	B
2.50 – 3.49	C
1.50 – 2.49	D
0.50 – 1.49	E
0.00 – 0.49	F

Common Formula for GPA:

$$\text{GPA (Grade Point Average)} = \frac{\text{Total of (Grade Points earned x Credit hours for each course)}}{\text{(Total Credit hours)}}$$

B Grade is equivalent to at least 55% of the marks

SEMESTER – I

GL 101: MINERALOGY (4 Credits)

Crystallography: (1 Credit)

- Definition of Crystal - Classification of crystals into Crystal systems
- Concept of unit cell - Proper and improper symmetry operations
- Concept of Point Group - Classification of crystals into 32 Point Groups
- Concept of Space lattice - Derivation of 14 Bravais lattices – HCP
- Concept of Space Group - Symmorphic and Asymmorphic Space Groups
- X-ray diffraction methods in mineralogical investigations – Identification of X-ray patterns - Twinning in crystals
- Mineral Chemistry - Concepts and examples of Isomorphism, Polymorphism, solid solutions

Mineral Optics: (1 Credit)

- Plane polarized and cross polarized light-Isotropic and Anisotropic minerals Behavior of minerals in cross polarized light
- Birefringence - Uniaxial and Biaxial minerals - Uniaxial and Biaxial Indicatrixes - Orientation of indicatrixes as per the section
- Interference of light waves - Passage of light through doubly refracting minerals Generation of interference colours
- Conoscopic or convergent polarized light - Generation of Uniaxial and Biaxial interference figures - Forms of interference figures related to sections- Optical accessories like mica, gypsum and quartz plates - Determination of Optic sign of uniaxial and biaxial minerals
- True and apparent optic axial angle, $2V$ and $2E$, - Methods of determination of optic axial angle - Use of Universal stage
- Dispersion of light - its effect on interference figures
- Absorption of light by minerals - Scheme of pleochroism

Descriptive Mineralogy – I: (1 Credit)

- Structure, relation of Chemical composition with optical, physical properties, alteration products and paragenesis of following group of minerals.
- Olivine, Pyroxenes, Amphiboles, garnet, Mica, Alumino silicate, Epidote

Descriptive Mineralogy – II: (1 Credit)

- Structure, relation of Chemical composition with optical, physical properties, alteration products and paragenesis of following group of minerals.
- Feldspar, Felsparthoid, Zeolite and Clays

GL 102: PRINCIPLES OF STRATIGRAPHY AND PALAEOONTOLOGY (4 Credits)

Principles of Stratigraphy: (2 credits)

- History and development of Stratigraphy
- Stratigraphic procedures (Surface and Subsurface)
- Concept of Lithofacies & Biofacies
- Stratigraphic Correlation (Litho-, Bio- and Chronostratigraphic Correlation)
- Study of standard stratigraphic code (Lithostratigraphic, Biostratigraphic and Chronostratigraphic)
- Concepts of Magnetostratigraphy, Chemostratigraphy, Event stratigraphy, and Sequence stratigraphy

Palaeontology: (2 credits)

- Origin and evolution of life through the ages.
- Techniques in Palaeontology - mega fossils - microfossils - nannofossils - ichnofossils - collection, reformation & illustration - binomial nomenclature
- Invertebrate Palaeontology - A brief study of morphology, classification, evolutionary trends and distribution of Molluscs i.e. Bivalves and Gastropods, Echinoids, Corals & Brachiopods.
- Vertebrate Palaeontology - Evolution of reptiles and mammals
- Palaeontological perspective : Use of palaeontological data in a) Stratigraphy b) Palaeoecology and evolutions
- Introduction to Micropaleontology
- Types of Microfossils
- Palaeopalynology
- Foraminifera & Ostracods

GL 103: PHYSICS AND CHEMISTRY OF THE EARTH (4 Credits)

Gravity, Interior and Figure of the Earth (1 credit)

- Density distribution, Density vs. depth profile.
- The Earth's figure and Gravity, Gravity anomalies, Geoid and their interpretation.
- Introduction to Geodesy, Geodetic Datum and Co-ordinate Systems.
- Application of Global Positioning System in crustal deformation studies
- Seismology and interior of the Earth.
- Elastic Rebound Theory.
- Seismic waves and their propagation.
- Travel-time Tables and Velocity-depth Curves.
- Seismic waves and Internal Structure of the Earth.
- Concept of Seismic Tomography.
- Study of Seismograms

Thermal, electrical, mechanical properties of the Earth, and Geomagnetism (1 credit)

- Heat-flow measurements.
- Temperatures in the Primitive Earth and Core of the Earth.
- Heat-flow and Radioactivity, The thermal history of the Earth.
- Composition and evolution of the crust, mantle and core, Geoelectricity.
- Introduction to Rock Mechanics
- Geomagnetism and palaeomagnetism.
- Introduction to Geomagnetism and Magnetic Field of the Earth.
- Physics of Magnetism and Rock Magnetism.
- Palaeomagnetism- Principles, methods and applications.
- Rock Magnetic Applications in Geosciences.
- Magnetic Survey

Universe, Solar system and comparative planetary geology (1 credit)

- Origin and components of solar system
- Galaxies their classification, Stars and star formation processes.
- Meteorites and their classification.
- Theories of origin of solar system.
- Abundance of elements.
- Nucleosynthesis and stellar evolution.
- Orbital dynamics of earth-moon system

Geochronology and age of the Earth (1 credit)

- Geochemistry of hydrosphere and atmosphere.
- Law of Radioactivity. Principles of isotopic dating, decay schemes.
- Derivation of equation age.
- Rb/Sr, U-Rh-Pb methods of dating the rocks.
- Age of the earth.
- Geochemical classification and distribution of elements in the earth.
- Structure and atomic properties of elements.
- The periodic table.
- Laws of Thermodynamics and phase diagram.

GL-104: SEDIMENTOLOGY (4 Credits)

Procedures: (1 Credit)

- Field procedures in Sedimentary Petrology
- Geologic cycle
- Sedimentary textures (Granulometric analysis, shape and roundness studies, surface textures)
- Heavy mineral and Insoluble residue analysis

Petrography: (1 Credit)

- Petrography of rocks of clastic, chemical and biochemical origin (Conglomerates, Sandstone, Mudstone, Limestone & Dolomite)
- Evaporite, Phosphorite, Chert, Iron and Manganese rich sediments
- Volcanogenic sedimentary rocks

Hydraulic and Structure: (1 Credit)

- Clastic transport and fluid flow (fluid flow in theory and in nature, Reynold's Numbers, Froude Number, Sediment lift, transport, deposition, sedimentary gravity flow)
- Sedimentary structures (Physical structures, Biogenic sedimentary structures, Diagenetic structures)

Environment and Facies: (1 Credit)

- Concept of Sedimentary facies association models (Marine, Nonmarine, and Mixed Depositional Environment)
- Sedimentation and Tectonics
- Paleocurrents & Basin Analysis

SEMESTER – I

GL 105: Practicals related to GL 101 to GL 104

Practicals for GL 101: (2 Credits)

1. Study of interference figures - determination of optical sign of minerals, determination of 2V and 2E, determination of composition of plagioclase feldspars - determination of birefringence of minerals - Scheme of pleochroism
2. Construction of Stereograms and Gnomonograms - measurement of interfacial angle with contact goniometer - study of X-ray diffractograms
3. Study of rock forming minerals in thin sections
4. Study of rock forming minerals in hand specimens

Practicals for GL 102: (2 Credits)

1. Construction of rank charts for lithostratigraphy, biostratigraphy & chronostratigraphy
2. Construction of graphical logs from text descriptions
3. Exercises in correlation from given data or logs
4. Study of palaeontological technique related to megafossils.
5. Study of morphology of Bivalves, Gastropods Echinoids, Brachiopods
6. Separation, Processing, wet sieve analysis, preparation of slides of microfossils.
7. Morphology and morphological descriptions of planktonic and benthonic foraminifera, ostracods.

8. Morphology of Radiolaria, Diatoms, Pollen and Spores.
9. Identification of assemblage for different environment: Shallow, intermediate and deep water environments.
10. Construction of range charts

Practicals for GL 103: (2 Credits)

1. Rapid analyses of rocks for determination of major oxides by volumetric/gravimetric/colorimetric methods.
2. Introduction to the use of instrumental techniques of analyses of rocks, soils & water.
 - a. Spectrophotometry
 - b. Flame photometry
 - c. Atomic Absorption Spectrophotometry
 - d. High Performance Ion Chromatography
3. Plotting of chemical data on variation diagrams.
4. Problems related to seismic, geomagnetic, gravity data & its interpretation.
5. Problems related to use of isotopic methods & determinations of age of the rocks.

Practicals for GL 104: (2 Credits)

1. Size Analysis (Procedures, Cumulative curve, Histogram, Visher's curve and Statistical calculation)
2. Shape analysis (Calculation and Classification)
3. Heavy mineral analysis (Procedure and identification)
4. Insoluble residue analysis (Procedure and identification)
5. Megascopic and studies of conglomerate and breccia
6. Megascopic and microscopic study of sandstone
7. Megascopic and microscopic study of limestone
8. Sedimentary structure (identification and classification)
9. Palaeocurrent and basin analysis calculation

Text books for Semester - I

Dana : Elements of Mineralogy
 Winchell : Elements of Optical Mineralogy
 Kerr : Optical Mineralogy
 Whalstrom : Optical crystallography
 Deer, Howie Zussman : Rock forming minerals, Vol. I - IV
 Cracknell : Crystals and their structure
 Frye Keith : Modern Mineralogy
 Krumbein and Sloss : Stratigraphy and sedimentation
 Dunbar and Rogers : Principles of Stratigraphy
 Weller : Stratigraphic principles and practice.
 Hedberg : International Stratigraphic guide
 Harland et al. : A geological time scale
 Lemon Roy R. : Principles of Stratigraphy
 Brenner and Mc Hargue : Integrative stratigraphy
 Boardman R.S., Cheetham A.H., Rowell A.J. : Fossil invertebrates
 Clarkson E.N.K. : Invertebrate Palaeontology & Evolution
 John R.Haynes, Hohn Wiley & Sons : Foraminifera
 M.D.Brasier : Microfossils
 Swinnerton : Outline of Palaeontology

Moore Lalicker & Figher : Invertebrate Palaeontology
 Remer : Vertebrate Palaeontology
 Shrock and Twenhofel : Principles of invertebrate Palaeontology
 Arnold : Introduction to Palaeobotany
 Bignot G : Elements of Micropalaeontology. The microfossils, their Geological and Palaeobiological applications
 Clobert E.H. : Evolution of the Vertebrates
 Brown and Mussett : The inaccessible Earth
 Jackson (ed.) : The Earths Mantle
 Stacy : Phsics of the Earth
 Melchior : The physics of the Earths Core : An Introduction
 Jacobs, Russels and Wilson : Physics and geology
 Sheidegger : Principles of Geodynamics
 Van Bemmelen : Developments in Geotectonics No.2 (Geodynamics Model : An evaluation and synthesis)
 Jeffreys : The Earth : Its origin, History & Physical constitution
 Kaula : An Introduction to Planetary Physics
 Physics and Chemistry of the Earth - Paragon Press
 Takanaki and Kanamori : Debate about the Earth
 Pettijohn : Sedimentary Rocks
 Blatt, Middleton and Murray : Origin of sedimentary rocks
 Reineck and Singh : Sedimentary Depositional Environments
 Carozzi : Petrography of Sedimentary Rocks
 Carver : Procedures in Sedimentary petrology
 Potter and Pettijohn : Paleocurrents and Basin analysis

SEMESTER – II

GL - 201: IGNEOUS PETROLOGY (4 Credits)

Role of Magma in Geological processes: (1 Credit)

- Magma definition
- Source Anatomy of the earth
- Geochemical and geophysical jargon
- Magmatism and Plate tectonics
- Physical properties of magma - geothermal gradient, heat source,
- Igneous activity at the present day
- Textures and structures of Igneous rocks
- Classification of Igneous rocks - historic perspective and the
- IUGS systematic
- Komatite and related classes of basalts

Geochemical tracers of mantle processes: (1 Credit)

- Introduction
- Continental and oceanic mantle lithosphere
- MORB and depleted mantle
- Evolution of depleted mantle
- OIB and Enriched mantle

- Evolution of the Enriched mantle - Metasomatic processes
- Island arc basalts
- Concept of Hot spots
- Mantle Plumes - Theory and structure
- Re-Os Isotope Systematics
- Trace element characterization of mantle domains
- References

Magma Crystallisation and Evolution: (1 Credit)

- Phase relations of silicates and silicate melts
- Binary and Ternary systems
- Partial melting
- Magmatic differentiation - Crystal fractionation, gravitational settling, flow
- Differentiation, flow crystallization, filter pressing, liquid immiscibility
- Zone melting
- Contamination
- Mixing of magmas
- Role of Volatile components
- Pyroclastic rocks

Petrogenetic Provinces: (1 Credit)

- Large Igneous Provinces: Volcanic - Flood basalts - Tholeiites (Deccan Trap, Columbia River basalts, Parna basalts)
- Layered gabbroic intrusions : The Bushveld Complex, Skaergaard intrusion, Still water complex
- Plutonic : Carbonatites and alkaline rock complexes of India
- Oceanic areas : Hawaiian, Kerguelen and Reunion Islands
- Oceanic Rift valleys : MORB-Tholeiites-Ophiolites
- Granites, andesites, kimberlites, anorthosites

GL 202: METAMORPHIC PETROLOGY (4 Credits)

Concepts and Theory: (1 Credit)

- Historical background
- Types of metamorphism and their controlling factors
- Common minerals of metamorphic rocks
- Field observations, petrographic classification of common metamorphic rocks
- Metamorphic facies and facies series

Effects of Metamorphism: (1 Credit)

- Phase diagrams and graphic representation of mineral assemblages
- Prograde and retrograde metamorphism, Metasomatism
- Deformation textures and textures related to recrystallisation
- Metamorphic reactions, elemental exchange and P-T conditions of isograds.

Metamorphism types & products: (1 Credit)

- Regional and thermal metamorphism of pelitic rocks
- Regional and thermal metamorphism of basic and ultra basic igneous rocks
- Regional and thermal metamorphism of impure, silicious carbonate rocks
- Metamorphism of Granitoides, Charnockites and Migmatites

Metamorphism in space and time: (1 Credit)

- Plate tectonics and metamorphic processes
- Paired metamorphic belts, Archaean and Proterozoic terrains
- Extraterrestrial Metamorphism (Impact and Shock Metamorphism) polymetamorphism

GL-203: STRUCTURAL GEOLOGY AND TECTONICS (4 Credits)

Structural Geology: (2 Credits)

- Behaviour of rock material under stress, strain analysis
- Classification and genesis of folds, faults, ductile shear zones, lineations, foliations, joints and fractures
- Scope of structural analysis , concept of Tectonite fabric and Tectonite Symmetry
- Structural analysis on microscopic, mesoscopic and macrosopic scales

Tectonics: (2 Credits)

- Structure and physical characters of continental and oceanic crust
- Continental drift, Sea - floor spreading and Plate Tectonics, Structure and Tectonics of divergent margins, transform faults, convergent margins
- Tectonic framework of India
- Neotectonics - Features and evidences-characteristic landforms, Methods of analysis
- Case studies of Orogenic belts

GL-204: GEOMORPHOLOGY AND REMOTE SENSING IN GEOLOGY (4 Credits)

Geomorphology: (2 Credits)

- Introduction: Development, Scope, Geomorphic concepts, Type and Tools
- Landforms: Role of lithology, peneplanation, endogenous and exogenous forces resp climate and tectonic factors and rejuvenation of landforms.
- Denudational processes: weathering, erosion, transportation, weathering products and soils - profiles, types, duricrusts
- Hillslopes: Their characteristics and development, fluvial processes on hill slopes
- River and Drainage basin: Drainage patterns, network characteristics, Valleys and their development. Process of river erosion, transportation and deposition
- Landforms produced by geomorphic agents: Fluvial, Coastal, Glacial and Aeolian landforms
- Geomorphic indicators of neotectonic movements: stream channel morphology changes, drainage modifications, fault reactivation, uplift-subsidence pattern in coastal areas.

- Applied Geomorphology : Application in geohydrology, engineering geology, and environmental studies
- Geomorphology of India : Geomorphological features and zones

Remote Sensing: (2 Credit)

- Basic concepts in remote sensing, electro-magnetic spectrum. energy sources, energy interaction in the atmosphere, atmospheric windows, atmospheric effects on remotely sensed data, signatures in remote sensing, sensors and sensor platforms.
- Introduction to aerial photographs, history of aerial photography, aerial camera, types of aerial photographs, classification, principles of stereoscopic viewing, conditions and cause for stereovision. Aerial photography mission.
- Use of pocket and mirror stereoscope, scale of aerial photographs, stereoscopic parallax, parallax bar, relief displacement, measurement of height of objects.
- Aerial photo interpretation, photo-recognition elements, methods of photo-interpretation, advantages and limitations of aerial photographs.
- Remote Sensing from space – space crafts and sensors.
- Visual image interpretation of satellite imagery, image enhancement, digital analysis, preparation of thematic maps.
- Thermal Infrared remote sensing, microwave remote sensing for geological applications.
- Remote sensing satellites, Indian Remote Sensing Satellite programme

SEMESTER – II

GL 205: Practicals related to GL 201 to GL 204

Practicals for GL 201: (2 Credits)

1. Characterization of igneous rocks, textures & structures.
2. Characterization of following rock types under microscope
 - a. Ultrabasic Rocks
 - b. Basic igneous rocks
 - c. Intermediate igneous rocks
 - d. Acid Igneous Rocks
 - e. Alkaline igneous rocks
3. CIPW normative calculation for igneous rocks.
4. Structural formula calculation of different mineral species.
5. Introduction to two mineral geothermometers, actual calculation and their application.
6. Use of trace elements in Igneous rock petrogenesis.

Practicals for GL 202: (2 Credits)

1. Study of metamorphic rocks in hand specimens and thin sections: metamorphic mineral assemblages with respect to metamorphic facies and grades
2. Use of ACF, AKF and AFM diagrams
3. Use of rock composition diagrams
4. Calculation of P-T conditions from the composition of co-existing mineral assemblages serving as geothermometers and geobarometers
5. Calculation of mesonorms and use of Q-Ab-Or and Ab-Or-An diagrams in the study of granitic rocks

Practicals for GL 203: (2 Credits)

1. Solution to structural geology problems by orthographic and stereographic methods.
2. Completion of outcrops, construction of structural sections and interpretation of geological maps.
3. Plotting and interpretation of mesoscopic structural data
4. Demarcation of orthogonal axes, identification and description of different structural elements on mesoscopic scale with their interrelationship.

Practicals for GL 204: (2 Credits)

1. Determination of photo scale,
2. Determination of height of objects, dip of bed, slope and thickness of beds by Parallax bar.
3. Study of landforms and interpretation of lithology and structure from aerial photographs and satellite images,
4. Tracing of lineament rosettes and their interpretation
5. Drainage basin and network morphometry
6. Relief and slope analysis - Profiles and maps
7. Identification of landforms on toposheets, aerial photographs and satellite images
8. Soils : textural characteristics, study of representative soil profiles

Text books for Semester -II

Barker - Igneous Rocks
Magmatic Rocks - Middle most
Igneous Rocks - Rock
Philpot - Igneous & Metamorphic Petrology
Jackson (ed.) - Earths mantle
Davis - Earth Dynamics
Yoder - Basalt
Yoder & Tilly - Basaltic magmatism
Jackson Ian (Ed) - The Earth's Mantle : Composition, structure and Evolution
Davies G.F. - Dynamic Earth : Plates, plumes and Mantle convection
Turner and Verhoogen : Igneous and Metamorphic Petrology
Philpotts : Principles of Igneous and Metamorphic Petrology
Harker : Metamorphism
Turner : Metamorphic Petrogy
Wrinkler : Petrogenesis of Metamorphic Rocks
Miyashiro : Metamorphism and Metamorphic Belts
Yardley : An Introduction to Metamorphic Petrology
Spry : Metamorphic Textures
Best : Igneous and Metamorphic Petrology
Patwardhan : The dynamic Earth System
E.M.Moore & R.J.Twiss : Tectonics
Valdiya : Aspects of Tectonics - focus on south central Asia
V.V.Belousov : Geotectonics
Condie : Plate Tectonics & Crustal Evolution
Billings : Structural Geology
Badgley : Structural & Tectonic Principles
Turner & Weiss : Analysis of Metamorphic Tectonites
Ramsay : Folding & Fracturing of Rocks

De Sitter : Structural Geology
Sander : Introduction to Deformation of Geologic Bodies
Miller and Miller : Photogeology
Ramasay : Trends in Geological Remote Sensing
Lillysand & Kiefer : Remote Sensing and image interpretation
Pandey : Photogeology
Thornbury : Principles of Geomorphology
Rice : Fundamentals of Geomorphology
Kale & Gupta : Introduction to Geomorphology
A.D. Howard and I Remson : Geology in Environmental Planning

SEMESTER – III

GL 301 : INDIAN STRATIGRAPHY (4 Credits)

Precambrian Stratigraphy of India –Part 1- Archaeans

- Precambrian stratigraphic framework of India
- Classification, structure and tectonics of the Dharwar craton
- Ancient Supracrustal (Sargur Type)
- Gold bearing schist belts of Eastern Karnataka (Kolar Type)
- Younger Schist belts (Dharwar Type)
- Gneiss Complex, Granulites, charnockites
- Structure, tectonics and stratigraphy of the OMG, OMTG, Iron Ore Group (Singbhum Craton)
- Stratigraphy of the Sukma, Bengpal, and Bailadila series from Central India
- Ancient granites, viz. Singbhum, Chitradurga, etc.
- Archaeans of the Extra Peninsular region

Precambrian stratigraphy of India-Part 2- Proterozoic

- Archaean-Proterozoic boundary
- Stratigraphy, geology, tectonics and evolution of the following Proterozoic basins / Purana formations in India
 - ❑ Delhi-Aravalli Supergroup
 - ❑ Singbhum Group
 - ❑ Sausar-Sakoli Groups
 - ❑ Vindhya
 - ❑ Cuddapah
 - ❑ Pranhita-Godavari
 - ❑ Bhima
 - ❑ Kaladgi

Phanerozoic stratigraphy of the Extra peninsular region

- Paleozoic stratigraphy of Himalayan sequences from Kashmir, Spiti, Kumaon region, Cambrian of Spiti, Triassic of Spiti, Triassic of Pin valley
- Geology of the Indus Ophiolite belt, the Indus Group and Sangeluma Group
- Geology of the Shyok Ophiolite belt
- The Trans-Himalayan & Karakoram granite batholith
- Stratigraphy and tectonics of the Siwaliks

Phanerozoic stratigraphy of the Peninsular India

- Gondwana Nomenclature, litho-bio-stratigraphy, age limits, correlation
- Jurassic of Kutch
- Cretaceous of South India
- Cretaceous of Narmada valley
- Stratigraphy of the Deccan Volcanic Province
- Cretaceous-Tertiary boundary
- Quaternaries of Peninsular India
- Neogene-Quaternary boundary

GL 302 : EXPLORATION METHODS IN GEOLOGY (4 credits)

Gravity and Magnetic Methods

- Concept of scientific methods of exploration- Geophysical and Geochemical exploration
- Principles of Exploration Geophysics concept of Geophysical Anomaly – factors controlling Geophysical Anomalies
- Gravity method – Principles behind gravity method Relative measurement of earth gravity – Types of gravimeter – Field procedure corrections to gravity data – concept of Bouguer Anomaly - Generalized interpretation of Gravity data- salient case studies
- Magnetic Method Principles of magnetic method – main and anomalies magnetic field associated with the earth – concepts of total field intensity, intensity of magnetization and magnetic susceptibility measurement of magnetic field- Types of magnetometers – Magnetic anomalies and their interpretation – salient case studies

Seismic and Electric Methods

- Seismic Method Principles of seismic method – Types of seismic waves, movement of seismic waves within subsurface – Seismic instruments and field procedures
- Seismic Reflection Method : Principles of reflection method – zero offset time – NMO-CDP and multiple coverage techniques
- Seismic Refraction Method Principles of refraction method single and multiplayer refraction measurement of seismic velocities and layer thickness
- Processing of seismic data – salient case studies
- Electric Method – Principles of electrical method – electrical properties of rocks
- Resistivity Method – factors controlling resistivity of rocks measurement of resistivity – Electrode configurations and field procedures – Interpretation of resistivity data – salient case studies
- Self potential method – origin of self potential instrumentation and field procedure – salient case studies

Electrical Methods II and well logging

- Induced polarization method – electrolytic and electrode polarization – instruments and field procedure – salient case studies
- Electromagnetic Method – Principles – instruments – paralleline and Horizontal loop method-salient case studies
- Well logging – techniques – principles and instrumentation of electrical, radioactive, sonic, caliper logging techniques interpretation of logs

Geochemical Methods

- Geochemical methods – Geochemical cycle – Dispersion patterns – Geobotanical indicators of minerals – surface and subsurface methods of sampling
- Geological Principles of ore search – Introduction to Assaying and valuation of mineral deposits

GL-303 : PETROLEUM GEOLOGY (4 Credits)

Occurrence and Source rocks

- Classification and composition of Petroleum
- Physical properties of petroleum
- Occurrence of petroleum
- Nature of source rock, composition of biomass
- Kerogen : Composition and types

Reservoir, Traps, Origin & Migration

- Reservoir rocks, pore space and fluids
- Reservoir Traps
- Origin, migration and accumulation of petroleum

Prospecting, Drilling and Logging

- Geophysical prospecting for petroleum
- Drilling, logging and subsurface correlation

Indian Oil fields

- Oil bearing basins of India and the world
- India's position as regards to petroleum and natural gas future prospects

GL 304 : ENVIRONMENTAL GEOLOGY (4 CREDITS)

Introduction to Environmental Geology and its scope :

- Fundamental concepts of environmental geoscience, its scope and necessity
- Definition, structure, composition and general characteristics of lithosphere, hydrosphere, atmosphere and biosphere
- Concept of ecology, ecosystem, its structure and functions, types of ecosystem
- Biogeochemical cycles of carbon, nitrogen, phosphorus and sulfur

Environmental issues

- Water pollution and other issues : Drinking water sources, quality criteria and standards, characteristics of water, types of water pollution, groundwater pollution sources, pathways and mechanism, attenuation processes, case histories of natural (arsenic and fluoride poisoning) and

man-made water pollution water logging, causes, effects and remedial measures, declining groundwater tables, subsidence and compaction of aquifers

- Soil pollution : Soil formation, classification and properties, soil salinity and alkalinity, characteristics of saline / alkali soils, soil amendments. Soil pollution sources, causes and effects. Soil pollution control measures.
- Air pollution : definition, terminology, sources and classification of air pollutants, effects of air pollution, acid rain, green house effects and ozone layer depletion. Air pollution control and management

Natural hazards, zoning, risk assessment and management

- Extreme events and hazards, catastrophic geological hazards, study of landslides, subsidence, floods, droughts, earthquakes, volcanoes, their causes, classifications, assessment, prediction and prevention. Coastal hazards, cyclones, tsunamis, and shoreline and sea level changes. Strategies for hazard mitigation

Mining and Environment

- Mining and its impact on environment, wastes from mining industry, waste disposal methods, acid mine drainage, heavy metal pollution due to mining, environmental impacts of coal utilization, fly ash, recycling of resources and management

GL:306 FIELDWORK COMPONENT (1 CREDIT)

GL-307 : ISOTOPE GEOCHEMISTRY (2 Credits)

Fundamentals of Isotope Geochemistry & Geochronology

- Discovery of radioactivity, its impact on Geology
- Law of radioactivity & its mathematical base
- Nuclear systematics, atomic structure of atom
- Decay mechanisms of radioactive atoms
- Radioactive Decay and growth. Radioactive & stable isotopes
- Principles of mass spectrometry & its applications

Isotopic methods of age determinations of rocks

- Derivation of equation of age based on law of radioactivity
- Rb-SR, K-Ar, U-Th-Pb, C-14, U-Series disequilibrium methods of age determinations of rocks
- Applications of above methods for determining ages of igneous, metamorphic and sedimentary rocks
- Stable isotopes and their applications
- Oxygen and hydrogen in the hydrosphere and the atmosphere ;
- Fractionation of stable isotopes, Snow & ice stratigraphy,

- Palaeoclimatology geothermal waters etc & use of stable isotopes
- Oxygen & hydrogen in ore deposits, igneous and sedimentary rocks & petrogenesis etc.
- Sulfur isotopes their biogenic fractionation, sulfide ore, deposits & isotope fractionation
- Carbon in modern biosphere & fossil fuels, Marine and non-marine carbonates, carbon in igneous rocks, hydrothermal and ore deposits etc.

GL 308 : QUATERNARY GEOLOGY AND CLIMATE CHANGE (2 Credits)

The Concept of Quaternary Geology and Climate Change:

Quaternary as chronostratigraphic unit, Standard sub-divisions of the Quaternary period and their climatic significance, standard global stratotype sections, Plio-Pleistocene boundary, Glacial-Interglacial stages, Marine Oxy Isotope (MIS) stages and sea level oscillations, Archeological sub-divisions of Quaternary.

The concept of modern climate, climate dynamics, factors controlling the climate change, its cyclicality and climate deteriorations with special emphasis on Asian Monsoon.

Linkage of the modern climate to past climatic variations (with special emphasis on the Late Pleistocene-Holocene period)

The concept of local, regional and global climatic changes, the long term and abrupt changes during Quaternary with special emphasis to tropical-Subtropical climate.

An overview of the processes and mechanism of the Quaternary sedimentation over Indian sub-continent in relation to it's climatic and/or tectonic controls.

Stratigraphic relations of the Quaternary deposits in India with special emphasis on its regional and global correlations.

Fluvial, Fluvio-lacustrine, glacial and glacio-lacustrine-fluvial and Deserts and their response to tectono-climatic changes with special emphasis on Ganga basin, Thar desert and Himalayan Quaternary sequences.

Quaternary Records and Methods:

Mechanism and style of climatic response in the natural systems: a) Marine, b) Ice sheets/glaciers, c) Lacustrine, d) Fluvial and aeolian (including pedogenic), e) Tree rings/vegetation and f) migrations (/radiation) of animal, human and plant communities.

Research history and current trends in understanding the climate forcing mechanisms for major climatic changes.

Records of Climate change and Tectonics with special reference to Himalaya and Tibetan plateau.

Climate adaptability and extinction of species during Quaternary period.

Introduction to Quantitative methods in Quaternary Geology:

Quaternary Geochronology and Stratigraphic Correlation methods: Exposure dating methods (Luminescence Dating, Cosmogenic radionuclides, lichenometry, U-Series), Pb²¹⁰, ESR dating, Environmental Magnetism.

Magnetostratigraphy, Dendrochronology, Palynology, and other classical as well as advanced techniques in paleoclimate studies.

Landform evolution exploratory methods: GPR and other methods of Shallow subsurface studies, OSL, Gamma Ray logging. Mapping of the Quaternary landforms: Total station, DEM, remote sensing methods.

GL-309 OIL FIELD SERVICES (2 Credits)

Introduction to Oil Well Drilling:

- Types oil wells and geotechnical order
- Methods of Oil well drilling: Cable tool drilling and rotary drilling
- Components of rotary drilling system
- Monitoring of drilling process i.e depth ROP, WOB, sampling.
- Concept of Subsurface pressure.
- Types of Drilling Rigs: Onshore and offshore rigs
- Controlled Directional Rotary Drilling, Horizontal Drilling
- Drilling Mud: Mud hydraulics, uses and functions of drilling mud.
- Coring: Introduction, Techniques and Applications of Coring in Petroleum Geology.

Formation Evaluation:

- Wire line logs: Introduction
Basic Principles, tools of SP, gamma ray, Neutron, Density, Caliper, Dipmeter, Temperature and Sonic Logs and their interpretation.
- Mud logging: Principle, techniques and tools of mud logging.
Interpretation of gas, drilling and mud parameters.
- MWD (Measurement While Drilling)/LWD (Logging While Drilling):
Principle and tools of MWD/LWD, data analysis and interpretation.
- Formation (Drillstem) Testing:
Introduction
Tools and Techniques of DST.

GL : 310 NATURAL RESOURCE MANAGEMENT (2 CREDITS)

Introduction to Natural Resources

- Description of the Resources
- Classification of the Natural Resources
- Exhaustible resources – Minerals and Mining
- Energy Resources- Oil, Coal, Natural Gas, atomic minerals
- Soil as resource – types of soils
- Rivers resources
- Coastal resources, Coastal Processes
- Renewable resources
- Water resources
- Land resources
- Function and values of the resource
- Human use and impact on the resource
- Supply and demand of the resources

Development and Management of Natural Resources

- Management tools and techniques – Natural Resources Policy
- Watershed Management

- Methods of soil Conservation
- Flood Control Measures
- Coastal Zone Management
- Application of Remote Sensing Techniques in resource management
- Environmental Impact Analysis
- Mineral Resources: Conservation and Management
- Policies and legislation concerning natural resources

GL-311 : COMPUTER APPLICATIONS IN GEOLOGY (2 Credits)

- Computer Fundamentals – Basic Computer Organization, Data Representation: Non – positional and Positional Number Systems, Binary, Octal and Hexadecimal Number Systems, Computer Arithmetic
- Computer Codes, Boolean Algebra and Logic Circuits, Computer Software, Operating Systems. Planning the Computer Programme, Algorithms
- Introduction to Computer Graphics – Scientific visualization based on computer graphics technologies, Computer Graphics Applications, Display Technologies, Random – Scan Display Processing Unit, Raster – Scan Display Processing Unit, Mathematical Modeling in Geosciences

SEMESTER – III

GL : 305 PRACTICALS RELATED TO GL 301 TO GL 311 (8 Credits)

Practicals for GL 301 : (2 Credits)

1. Study of typical hand specimens of rocks from different lithological units of Indian stratigraphy
2. Preparation and study of Palaeogeographical maps of India for different geological periods
3. Study of geological maps of different unit of Indian stratigraphy and construction of geologic cross-sections

Practicals for GL 302 : (2 Credits)

1. Study of patterns of geophysical responses from various geological mediums.
2. Plotting a Drift curve for a gravimeter application of elavation correction to observed gravity data – plotting and interpretation of gravity profiles – simulation of causative bodies
3. Analysis of seismic refraction data for velocities and thickness of subsurface layers.
4. Plotting and interpretation of resistively data
5. Plotting and analysis of self potential data
6. Simple interpretation of geophysical well logs

Practicals for GL 303 : (2 Credits)

1. Lithofacies analysis
2. Preparation of structural contour maps
3. Preparation of isopach maps

4. Preparation of carbonate concentration maps
5. Correlation of electrical logs
6. Preparation of geologic crosssection from well data

Practicals for GL 304 : (2 Credits)

1. Water and Soil analysis
2. Plotting the geochemical data on variation diagrams
3. Preparation of map showing hazards
4. Preparation of hazard zonation maps

Practicals for GL 307 : (1 Credits)

1. Preparation of samples for geochronological analysis
2. Study of fission tracks
3. Calculation of dates from the isotope data
4. Calculations pertaining to binding energies of the elements

Practicals for GL 308 : (1 Credit)

1. Deducing climate cyclicity (/Mylankowitch) using time series methods on the NOAA, GISP database.
2. Calculation of CAI from geochemical data and interpret the elemental mobility to infer climate/weathering trends.
3. Calculation of Oxy Isotope and deducing the MIS stages for climatic inferences.
4. Calculation of ages using luminescence dating, Pb²¹⁰, tree rings etc.
5. Calculation of ages using magnetostratigraphy.
6. Reading and interpretation of GPR profiles for subsurface interpretations.
7. Clay mineralogy from XRD data and its relation to weathering pattern
8. Environmental Magnetism practicals.
9. Total station survey practicals.
10. Multiparametric inferences using proxy climatic parameters

Practicals for GL 309 : (1Credit)

1. Description and identification of well cuttings based on physical properties, calcimetry and fluorescence.
2. Percentage lithology and Master log preparation.
3. Gas curve identification and gas ratio plotting.
4. Description of core samples.
5. Wire line log interpretation.
6. Well hydraulic calculations such as annular volume, lag time calculations.
7. Calculations of Shale factor and shale density.
- 8.

Practicals for GL 310 : (1Credit)

1. Introduction to the methods of Environmental Impact assessment
2. Assessment of Soil – Water – Energy Mineral Resources
3. Delineation of natural resources by using remote sensing techniques
4. Study of physical properties of Coal
5. Study of physical properties of Atomic Minerals

Practicals for GL 311 : (1 Credit)

1. Designing a Logical Database
2. Querying and Reporting
3. Preparation of computer maps and terrain models
4. Piper and Stiff diagrams
5. Conversion of data into vector, wire frame, image, shaded relief and post maps.
6. Statistical data analysis in Geosciences

Text books for Semester – III

Wadia: Geology of India and Burma

Krishnan: Geology of India

Naqui and Rogers: Precambrian Geology of India

Saha A.K.: Crustal Evolution of Singhbhum North Orissa

Geological Society of India: Purana Basins of India

Geological Society of India: Quaternary of India

Geological Society of India: Precambrian of the Aravalli Mountain

Geological Society of India: Geology of the Central and Western India.

Geological Society of India: Geology of Karnataka.

Dobrin : Introduction to geophysical prospecting

Kearey and Brooks: An Introduction to Geophysical Exploration

Parasnis D.S. : Principles of Applied Geophysics

Hawkes and Webb : Geochemistry in mineral exploration

Telford : Applied Geophysics

Brown and Day : India's Mineral Wealth

Levenson : Geology of Petroleum

Russel : Petroleum Geology

Keller : Environmental Geology

Tank : Environmental Geology

A.D.Howward and I. Remson : Geology in Environmental Planning

Strahler and Strahler : Environmental Geology

Ordway : Earth Science and Environment

Turk and Turk : Environmental Geology

K.S.Valdiya : Environmental Geology

Faure : Principles of Isotope Geology

Lowe, J.J. & Walker, M.J.C., 1997: reconstructing Quaternary Environments Longman. ISBN 0-582-100166-2. Pp. 1-16, 148-373.

Bradley, 1999, Paleoclimatology.

Peixoto and Oort, 1992, Physics of Climate.

Ruddiman: "Earth's Climate, Past and Future"

Bell, M. & Walker, M.J.C. 1992. Late Quaternary Environmental Change; Physical and human perspective. Longman Scientific and Technical, New York.

Bradely, R.S. 1985/1999. Palaeoclimatology; reconstructing climates of the Quaternary. 2nd Edition Harcourt Academic Press: San Diego.

Ice Age Earth: Late Quaternary Geology and Climate (Physical Environment) by Alastair G. Dawson

Late Quaternary Environmental change: Physical and Human Perspectives by Martin Bell

Many Research articles and special publications on each of the above issues available in:

- Journal of Quaternary Science
- Boreas
- The Holocene
- Quaternary Science Reviews

- Quaternary Science
- Palaeogeography, Palaeoclimatology, Palaeoecology
- Journal of Archaeological Science

Primer of Oil well drilling : By IADC

Bhagwan Sahay : Mud logging

Person : Geological Well drilling technology

Cray and Cole : Oil & well drilling technology

Hearst & Nelson : Well logging for physical properties

Leroy & Leroy: Subsurface Geology

Holechek, J. L., R. A. Cole, J. T. Fisher, and R. Valdez. 2003. *Natural Resources Ecology, Economics and Policy* (2nd Edition). Prentice Hall Education.

Shenk, T. M., and A. M. Franklin. 2001. *Modeling in Natural Resource Management Development, Interpretation, and Application*. Island Press.

Wondolleck, J. M. and S. L. Yaffee. 2000. *Making Collaboration Work Lessons from Innovation in Natural Resource Management*. Island Press

Paine, D. P. 1981. Aerial Photography and Image Interpretation for Resource Management. John Wiley and Sons. New York, New York. 571 p.

Rajaraman V. Fundamentals of Computers

Shrivastava C. Fundamentals of Information Technology

Sinha Pradeep Computer Fundamentals

Tonge. Fred M. : Computing – Introduction to Procedures

Roger C Parker : MS Office for Windows 95

Tom Badgett : Compact Guide to Word

Dan Gookin : Word for Windows 95

Greg Harvey : Excel for Windows 95

Rick Altman : Mastering Corel Draw 6

Jinjer L Simon : VB Script Superbible – The complete reference to Programming in
Microsoft VB Scripting edition

Noel Jerke : Visual Basic 6 : The Complete Reference

John C Davis : Statistics and Data Analysis in Geology

Association of Indian Universities : Handbook of Computer Education

James H Earle : Graphics Technology

SEMESTER – IV

GL 401 : ECONOMIC GEOLOGY (4 Credits)

Ore forming processes (I)

- Scope and application of economic geology
- Genetic classification of ore deposits
- Concept of the terms ore, gangue, grade, tenor, resources, reserves etc.
- Mineralisation related to Plate tectonics Structural controls on ore localization
- Broad tectonic setting and magmatism associated with various types of ore deposits

Ore forming processes (II)

- Magma and its relation to mineral deposits
- Ore forming fluids: origin, types, nature and migration
- Magmas as ore forming fluids
- Hydrothermal fluids, types composition and transport, wall rock alteration
- Physico-chemical principles of ore-deposition
- Primary and secondary ore forming processes

Indian ore deposits (I)

- Mode of occurrence, geological and geographic distribution, classification and genesis of the following mineral deposits
 - ❑ Chromium
 - ❑ Iron
 - ❑ Manganese
 - ❑ Copper
 - ❑ Skarn Deposits

Indian ore deposits (II)

- Mode of occurrence, geological and geographic distribution and genesis of the following mineral deposits
 - ❑ Lead and Zinc
 - ❑ Gold
 - ❑ Aluminum (Bauxite)
 - ❑ Barite
 - ❑ Uranium
 - ❑ Coal
 - ❑ Introduction to Mineral Economics

GL-402 : MARINE GEOLOGY (4 Credits)

Morphology, Stratigraphy and Tectonics of Oceans

- Geophysics and Ocean morphology
- Marine Stratigraphy
- Tectonic history of the oceans

Ocean Circulation

- Oceanic Crust
- Ocean circulation
- Sea level history and seismic Stratigraphy
- Near shore geological processes and the continental shelf

Ocean margins and Oceanic sediments

- Continental margin type
- Terrigenous deep sea sediments
- Biogenic and authigenic oceanic sediments

Bottom currents and Paleoceanography

- Geological effects of bottom currents
- Approaches to Paleoceanography
- Palaeo oceanographic and sediment history of ocean basins
- Critical events in ocean history

GL 403 : GEOGRAPHICAL INFORMATION SYSTEM (2 CREDITS)

Introduction to GIS

- Definition, scope, history application
- Hardware & software requirements
- Spatial and non-spatial data, attributes
- GIS data modes - VECTOR & RASTER

Analysis in GIS

- Digitization & Rasternization
- Overlay analysis
- Buffer analysis
- Digital Terrain Model
- Multi-criteria analysis
- Query analysis

GL 404 : ENGINEERING GEOLOGY & GEOTECHNIQUES (4 Credits)

Introduction to Engineering Geology

- Scope of Engineering Geology
- Engineering properties of rocks
- Methods of determining engineering properties of rocks
- Behavior of rocks under stress
- Rock failure mechanisms
- Engineering properties of soils
- Methods of Site Investigations

Geology and Engineering Structures

- Geological considerations for the selection of sites
- Dam sites and types of Dams & Spillways
- Forces acting on Dam wall
- Reservoir competency
- Silting of reservoirs
- Tunnels: Tunnel sites & Tunnel alignment
- Bridges, Y ducts, Roads & similar structures
- Slope stability analysis
- Types of remedial measures

Geo-material in Engineering Construction

- Building stones and road metals
- Characteristics of rocks as building stones and road metals
- Aggregate and its classification
- Rock testing: Mechanical test, Chemical test , Durability test
- Aggregate resource development
 1. Requirement of primary fragmentation
 2. Planning of quarry, hill slope side or open pit.
 3. Removal of overburden and its disposition at suitable site
 4. Selection of drilling, blasting method for main blasting and secondary breaking for given size of fragmentation
- Selection of equipment's for drilling, loading, hauling to crusher site
- Methods of extraction of aggregate resources

Geo-techniques

- Introduction to the methods of Geophysical exploration
- Seismic Method
- Gravity Method
- Electrical Surveying
- Magnetic surveying
- Use of Remote Sensing methods in engineering Geology
- Types of synthetic materials used as remedial measures
- Estimation of overburden thickness & rock strata classification
- Preparation of Report and Presentation of Engineering data
-

GL 406 : FIELDWORK COMPONENT (1 CREDIT)

GL- 407 : HYDROGEOLOGY (4 Credits)

Hydrosphere and Groundwater exploration

- Scope and importance of Groundwater,
- Hydrosphere – Evaporation, condensation, precipitation, interception, runoff (surface, subsurface and groundwater), infiltration,
- Factors that affect occurrence of groundwater – Climate, topography, geology
- Exploration techniques - Integrated approach to groundwater prospecting: Role of toposheets and Remote sensing in groundwater exploration, Hydrochemical methods, surface and subsurface Geophysical methods, Tracer techniques, Exploratory Borewell programme, use of computer software in exploration of groundwater.

Occurrence and distribution of Groundwater

- Vertical distribution of groundwater. Hydrologic properties of Rocks – Porosity, Hydraulic conductivity, Derivation of Darcy's Law. Aquifers – Characteristics of unconfined and confined aquifers
- Aquifer properties – Concepts of Transmissivity and Storativity
- Behaviour of sedimentary, crystalline and volcanic rocks as aquifers – factors controlling hydrologic, aquifer properties and yield of wells in different rock types
- Impact of drought and groundwater overexploitation on aquifers.

Groundwater flow and Pumping tests

- Principles of groundwater flow : concept of groundwater potential, validity of Darcy's law for laminar and turbulent flow – Tracing of groundwater movement with flow nets
- Pumping tests – principles – types of pumping tests, procedures, concept of well hydraulics, determination of aquifer properties and well characteristics by simple graphical methods – significance of transmissivity and storativity data.
- Introduction to software in pumping tests.

Groundwater Recharge and Quality of groundwater

- Measurement of groundwater recharge, Artificial recharge techniques, surface water harvesting techniques, structures for developing groundwater, Conjunctive use of surface and groundwater.
- Quality of groundwater – Geochemical processes in the groundwater, water types and water quality classification -Interaction of water with its ambient environment, Types of interaction: chemical, physical, kinetic- Assessment of groundwater quality, Use of software in water quality assessment.
- Seawater intrusion – Ghyben Herzberg relation – remedial measures
- Groundwater provinces of India. Groundwater in Maharashtra state. Concept of groundwater legislation

GL 408: DISSERTATION (4 Credits)

Field studies, Laboratory studies / data processing, reference work and presentation of the thesis are four major components of the course. Students opting for this course should adhere to the following procedure.

1. Precise title and outline of work is to be submitted to the Head of the Department.
2. The student shall spend about one week in the field.
3. The field work shall be carried out only during vacation or holidays, and in no case student will be permitted to be absent from regular teaching on account of dissertation.
4. The student shall maintain field diaries and other record relevant to dissertation.
5. Every month the student shall submit the progress report and laboratory work done, through the supervisor to Head of the Department.
6. The student shall do dissertation at his own cost. The department will not spare funds for this purpose.
7. The student shall give a seminar before the submission of the dissertation.
8. The student shall submit the dissertation before the commencement of practical examination.
9. The supervisor shall submit the practical sets based on topic of dissertation develop for the students to Head of the Department prior to the commencement of practical examination.
10. Non compliance of any of the above rules will disqualify students for grant of terms.

Three copies neatly typed on thesis size paper, well bound together with maps and illustrations of the Dissertation, on the basis of the work carried out by the student, will be submitted, through the supervisor concerned, to the Head of the Department of Geology, before the commencement of the practical examination, for being forwarded to the Board of Examiners.

In case of student receiving help (training and / or participation in ongoing research activities) from other Institution / Organization for their dissertation work, the associated scientist from that Institute / Organization will function as co-supervisor.

Assessment of Dissertation will be out of 100 marks and shall include a viva-voce examination carrying 20 marks. The Dissertation will be examined at the time of the practical examination at the end of IVth Semester, by the board of examiners. The board of examiners consist of supervisor, Head of the Department and one teaching faculty member appointed by Head of Department in consultation with the supervisor.

GL 409 : WATERSHED MANAGEMENT(2 Credits)

Watershed Development

- Concept of watershed - watershed characteristics – Importance of water resources in watershed – concept of watershed development in relation to water resources – salient features of development measures like counter bunding, gully plugs, stream bunds, percolation tank, subsurface dams, afforestation etc. - significance of geology in watershed development measures – Role of NGO's and State Government in watershed development.

Watershed Management

- Concept of watershed management in relation to water resources –water balance equation for watershed – sustainability of water resources - conjunctive use of surface and groundwater resources – concepts of peoples participation in community based watershed management – concept of water users group – Role of NGO's and State Government in watershed management.

GL 410 : DISASTER MANAGEMENT (2 Credits)

Fundamentals, Types and Remedies

- Concepts related to physical system and human interference
- Types and genesis of atmospheric, hydrospheric, biospheric and lithospheric disasters
- Remedial measures for preventing and minimizing disasters
- Hazard zonation maps : preparation and utilization

Preparedness and Awareness

- Mitigation strategy : Relief measures, community health, casualty management Role of Government, Non Governmental and media agencies, Reconstruction and Rehabilitation
- Awareness through print and electronic media, involving youth in field observations

GL 411 : GEMMOLOGY AND INDUSTRIAL MINERALOGY (2 Credit)

Gemmology

- Introduction to Gems - basic properties of gems – Formation of gem stones - Use of refractometers, Polariscope, Dichroscope - Methods of Specific Gravity determination - Causes of colours in gemstones - Introduction To special optical properties like chatoyancy, asterism, luminescence, play of colours, labradorescence, inclusions etc. Distinction between synthetic and natural gem stones

Industrial Mineralogy

- Industrial Mineralogy - Introduction to industrial specifications of raw materials used in following industries - Outline of techniques used in testing raw materials
Ceramics and Refractories, Abrasive, Construction, Cement, Fertilizers, Paints, Electronics etc (<http://www.madehow.com/forum/forum-1.html>)

GL 412 : MINING GEOLOGY (2 Credit)

Guides to ore :

- Ringed Target and Intersecting loci
- Regional and Topographical Guides
- Mineralogical Guides
- Structural Guides
- Stratigraphic Guides

Drilling Methods :

- Percussion Drills – Jumper bar drills- Pneumatic drills - Churn drills-Reichdrills
- Rotary Drills -Auger drills -Colyx drills-Turbo drills- Diamond drills
- Miscellaneous Drills - Jet drills-High temp. flame drills- Banka drills (Empire drills)- Burnside drills
- Mining Methods - Alluvial Mining- Open Cast Mining - Under ground Mining
- Ore Dressing-Crusher's-Grinder's-Jiggings & Takling-Flotation

SEMESTER – IV

GL : 405 PRACTICALS RELATED TO GL 401 TO GL 412 (8 Credits)

Practicals for GL 401 : (2 Credits)

1. Study of ores in hand specimens
2. Preparation of charts showing distribution of important ore deposits in India
3. Mineralogical and textural study of common ores under microscope
4. Chemical analysis of ore minerals assaying
5. Megascopic characterisation of banded coals
6. Proximate analysis of coal
7. Microscopic examination of polished coals (Identification of macerals in coal)

Practicals for GL 402 : (2 Credits)

1. Study of rocks of ocean floor
2. Study of hand specimens and thin sections of Beach rocks
3. Study of heavy minerals of offshore sands
4. Study of maps related to morphology and tectonic history of ocean basins
5. Distribution of carbonate and siliceous oozes
6. Identification and description of microfossils
7. Patterns of sediment distribution in Indian ocean
8. Pattern of distribution of glacio-marine pelagic clay, and volcanogenic sediments

Practicals for GL 403 : (2 Credits)

1. Nature of sources of geographical data
2. Sources of errors in GIS database
3. Data quality parameters
4. Information of various scales
5. Need of projection
6. Spherical co-ordinate system
7. Properties of map projections
8. Preparation of vector database and maps: manual method for point line and area entities
9. Preparation of a raster database and map : manual method for point line and area entities
10. Measurement of distance between two points for vector and raster data
11. Measurement of area – vector and raster data

Practicals for GL 404 : (2 Credits)

1. Various methods of Surveying used in engineering geology
2. Chain Surveys
3. Plane table surveys
4. Use of Surveying equipments
5. Determination of Engineering properties of Geological materials
6. Interpretation of borehole data
7. Preparation of bore logs / Lithologs.

Practicals for GL 407 : (2 Credits)

1. Analysis of rainfall data
2. Preparation of water level contour maps and their interpretation
3. Analysis of pumping test data by simple graphical methods for determination of aquifer and well characteristics
4. Plotting and analysis of hydrogeochemical data
5. Hydrogeological significance of morphometric parameters of a watershed
6. Use of computer

Practicals for GL 409 : (2 Credits)

1. Salient points for the constructive of contour bunds, stream bunds, percolation tank subsurface dams etc.
2. Use of morphometric analysis in planning watershed development
3. Calculation of water balance for a watershed

Practicals for GL 410 : (2 Credits)

1. Worldwide distribution of disasters
2. Mapping of disaster-prone zones with the use of toposheets / remote sensing tools
3. Preparing questionnaires, getting feedback, analyzing and interpreting the data about impact / socio-economic aspects etc

Practicals for GL 411 : (2 Credits)

1. Visual observation of gem stones
2. Use of refractometers
3. Identification of Anisotropic and Isotropic gem stones
4. Determination of specific gravity
5. Observation of inclusions to identify synthetic from natural gem stones.
6. Study of physical properties of industrial minerals and materials in hand specimens with respect to industrial specifications,
7. Preparation of charts showing specifications of materials required for different industries,
8. Determination of specific gravity, use of DTA and DTG techniques in characterizations of raw materials

Practicals for GL 412 : (2 Credits)

1. Mine Valuation and Calculation :
2. Uniform spacing on rectangular co-ordinate (Extended area)
3. Included area problems related to valency
4. Area influenced methods of combining irregular spaced assay
5. Triangle grouping of irregular spaced assayed
6. Veins problems (linear groups, minimum stopping widths)
7. Cross section of faulted ore bodies
8. Mine survey problems
9. Flow sheets of important ore deposits

Text books for Semester – IV

Craig and Vaughan, 1981: Ore Petrography and Mineralogy, John Wiley
Mookherjee, 2000: Ore Genesis – a holistic approach. Allied. Publ. New Delhi
Sawkins, 1984: Metal deposits in relation to plate tectonics
Stanton, 1972: Ore petrology, McGraw Hill, New York
Guilbert and Park, 1986: Geology of Ore deposits
Taylor et al, 1998: Organic Petrology, Gebruder Borntraeger, Stuttgart
Singh (ed), 1998: Coal and Organic Petrology
Chandra, 2000: Textbook of Coal (Indian context). Tara Book Agency, Varanasi
Dahlkamp, 1993: Uranium ore deposits Springer Verlag, Berlin.
Kennet : Marine Geology
Menard : Marine Geology
Richason, B. F., Jr. ed. 1978. Introduction to Remote Sensing of the Environment. Kendall/Hunt Publishing Company. Dubuque, Iowa. 496 p.
Spurr, S. H. 1960. Photogrammetry and Photo-Interpretation. The Ronald Press Company. New York, New York. 472 p.
Burroughs, P.A. (1986) : Principles of Geographical Information Systems for land Resources Assessment, Oxford University Press
Environmental Systems Research Institute (1993) : Understanding GIS : The Arc Info method Training Course for GIS for resource management and development planning : Lecture notes, V1 : GIS Fundamentals and Techniques, Government of India
Berhardsen Tor (1999):Geographic Information Systems : An Introduction, John Wiley and Sons
Clarke, Keith C. (1999) : Getting Started with Geographic Information Systems, Prentice Hall
Demers, Michael N. (2000) : Fundamentals of Geographic Information Systems, John Wiley
Haywood, Ian (2000) : Geographical Information Systems, Longman
Chang, Kang-taung (2002) : Introduction to Geographic Information Systems, Tata McGraw-Hill
Soroie: Geology for Engineers
Krynine and Judd: Principles of Engineering Geology and Geotechniques
Rise and Wateson: Elements of Engineering Geology
Todd, D.K. – Groundwater Hydrology
Karanth K.R. – Groundwater Assessment Development and Management
Raghunath H.M. – Groundwater
Davis S.n. and Dewiest R.J.M. – Hydrogeology
Freeze and Cherry – Groundwater
Dhravabaraya V.V., Sastry and patnaik V.S. - Watershed Management
Bryant E. : Natural Hazards, Cambridge University Press
Bell F.G. : Geological Hazards
Smith K. : Environmental Hazards
Books on Disaster Management course of IGNOU
Read : Beginners Guide to Gemmology
Webster Anderson : Gems
Anderson B.W. : Gem Testing
Webster R. : Practical Gemmology
Bates : Geology of industrial rocks and minerals
Roy : Indian Mineral Resources
Baungart, Dunham, and Amstutz : Process Mineralogy of Ceramic Materials
Panigrahi D.C. : Mine Environment and Ventilation
Singh B. : Blasting in Ground Excavation and Mines
Sinha R.K. Mineral Economic
Goulelin : Ore Dressing
Banter & Parks : Examination and Valuation of Mineral Property
Macnestry : Mining Geology