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 (4 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 revaluation. In case of verification, the existing rules will be applicable. The revaluation 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 Asymomorphic 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 Indicatrises - Orientation of indicatrises 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, Fledspathoid, Zeolite and Clays

GL 102: PRINCIPLES OF STRATIGRAPHY AND PALAEONTOLOGY (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) Palaeoechology and evolutions
- Introduction to Micropaleontology
- Types of Microfossils
- Paleopalynology
- 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 birefriengence 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, ostracodes.
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, Cummulative curve, Histogram, Visher's curve and Statastical 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 conglomarate and breccia
6. Megascopic and microscopic study of sandstone
7. Megascopic and microscopic study of limestone
8. Sedimentary structure (identification and classification)
9. Paleocurrent 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
- differentation, flow crystallisation, 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 instrusions : The Bushweld 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.

Metramorphism 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-characterastic 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 responsible, 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. Characterisation of igneous rocks, textures & structures.
2. Characterisation 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 calcaluation 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 setions : 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 interrelatiohship.

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 : Ignesous and Metamorphic Petrology
Patwardhan : The dynamic Earth System
E.M.Moores & R.J.Twiss : Tectonics
Valdiya : Aspects of Tectonics - focus on south central Asia
V.V.Beloussov : Geotectonics
Condie : Plate Tectonics & Crustral 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. Howward and I Remson : Geology in Environmental Planning