

**Fergusson College, Pune**  
**Department of Geology**  
**M.Sc. Part I**  
**Syllabus**

**Preamble of the syllabus**

- 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 of practical course will consist of laboratory exercises of 15 clock hours.
- Student will have to take admission in Geology Department of the Fergusson College and complete 100 credits incorporated in the syllabus structure of Geology.
- Every student shall complete 100 credits in a minimum of four semesters. All Semesters will have 25 credits each.
- Four credits, one each in four semesters, have been allocated for Field work.
- Academic calendar showing dates of commencement and end of teaching, Continuous Internal Assessment (CIA) and End Semester Examination (ESE) will be prepared and duly notified before commencement of each semester every year.

**Eligibility**

- The Candidate should have a B.Sc. degree with Geology as principal subject  
OR
- B.Sc. (General) degree with Geology as one of the subjects at T.Y. B.Sc. level.
- **External Students:** External students are not admitted for this course.

**Terms and Conditions**

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

- A minimum of 80 % attendance for lectures / practicals is the pre-requisite for Grant of Terms.
- The students opting for dissertation course shall follow the rules framed for the same.
- To conduct optional theory credit courses minimum number of students required will be decided by the Departmental committee.
- **Field Work Component:** Fieldwork is a compulsory component of the syllabus. 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. Gly107, Gly207,

Gly307 and Gly407 related to field components. The students shall attend the tours at their own cost and risk.

- 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:

<b>Heads</b>	<b>Marks</b>	<b>Evaluating Authority</b>
Performance of the student in the field	5	By faculty members accompanying the study tour
Punctuality, enthusiasm, and aptitude of students while completing the report	5	By faculty members accompanying the study tour
Tour report	10	By members of Examination committee
Viva-voce	5	By members of Examination committee

- The final grade for fieldwork component - courses comprising of Gly107, Gly207, Gly307 and Gly407 will be awarded as a four credits course at the end of fourth semester.

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**Department of Geology**  
**M.Sc. Part I**  
**Proposed Syllabus**

<b>SEMESTER –I</b>		
<b>UNITS</b>	<b>TOPICS</b>	<b>NO. OF LECTURES</b>
<b>GLY4101: Planetary Science and Geodynamics (4 Credits) - Core</b>		
<b>Unit: 1</b>	<b>Planetary Science</b>	<b>15</b>

- Big Bang Theory
- Origin of Element
  - Nucleo synthesis
  - Abundance of the elements
  - Periodic Table
  - Atomic Structure and Properties
- Origin of Solar System and its components
  - Planets
    - Types
    - Comparison of internal structures of planets
    - Similarities and Differences
    - Origin of Moon
  - Comets and Asteroids
  - Meteorites and their types
- Formation of the Earth
  - Evolution of the earth from gaseous to current state
    - Segregation and Distribution of Elements
    - Formation of Oceans and Atmosphere
  - Earth's Shape, size, density distribution
  - Age of the Earth
    - Historical Perspective regarding 'Age of the earth'
    - U – Th –Pb Method
    - Fission Track Method

<b>Unit: 2</b>	<b>Physical Earth</b>	<b>15</b>
	<ul style="list-style-type: none"> <li>➤ Heat and Earth <ul style="list-style-type: none"> <li>○ Laws of thermodynamics</li> <li>○ Temperatures inside the earth</li> <li>○ Sources of Heat <ul style="list-style-type: none"> <li>▪ Remnant heat</li> <li>▪ Radioactive Elements</li> </ul> </li> </ul> </li> <li>➤ Internal Structure of the Earth <ul style="list-style-type: none"> <li>○ Seismic Tomography</li> <li>○ Discontinuities</li> <li>○ Formation, Structure ,Composition and Classification (Physical and chemical)</li> </ul> </li> <li>➤ Concept of Isostasy</li> <li>➤ Geomagnetism <ul style="list-style-type: none"> <li>○ Earth as a Magnet</li> <li>○ Changing Magnetic Field of the Earth <ul style="list-style-type: none"> <li>a. Rock Magnetism</li> <li>b. Palaeomagnetism</li> </ul> </li> </ul> </li> </ul>	
<b>Unit: 3</b>	<b>Plate Tectonics I</b>	<b>15</b>
	<ul style="list-style-type: none"> <li>➤ Continental movement <ul style="list-style-type: none"> <li>○ Historical Perspective of various hypotheses</li> <li>○ Plate Tectonics: Generalized theory</li> </ul> </li> <li>➤ Framework of Plate Tectonics <ul style="list-style-type: none"> <li>○ Tectonic Plates and their Properties</li> <li>○ Constructive and Destructive Margins</li> <li>○ Transform and Transcurrent Faults</li> </ul> </li> </ul>	

<b>Unit: 4</b>	<b>Plate Tectonics II</b>	<b>15</b>
	<ul style="list-style-type: none"> <li>➤ Mechanism of Plate tectonics <ul style="list-style-type: none"> <li>○ Contracting and Expanding Earth</li> <li>○ Evidence of Mantle Convection</li> <li>○ Force acting on Plates</li> <li>○ Rifting Mechanics</li> </ul> </li> <li>➤ Tracing Plate Movement <ul style="list-style-type: none"> <li>○ Euclidean and Non- Euclidean Geometry</li> <li>○ Euler Theorem</li> <li>○ Absolute and Relative Plate Movement</li> <li>○ Geometric and Palaeomagnetic Plate Reconstruction and Example</li> </ul> </li> <li>➤ Precambrian Tectonics <ul style="list-style-type: none"> <li>○ Archean</li> <li>○ Proterozoic</li> <li>○ Supercontinent Cycle</li> </ul> </li> </ul>	
	<b>Total number of Lectures</b>	<b>60</b>
<b>Books</b>	<ul style="list-style-type: none"> <li>• Condie K.C., 1997, Plate Tectonics and Crustal Evolution, 4<sup>th</sup> Edition</li> <li>• Kearey P, Klepeis K.A., Vine F.J., 2009, Global Tectonics, Wiley-Blackwell, 3<sup>rd</sup> Edition</li> <li>• Stacey F.D., Davis P.M., 1969, Physics of the Earth</li> </ul>	
<b>GLY4102: Principles of Stratigraphy and Palaeontology (4 Credits) - Core</b>		
<b>UNIT-1</b>	<b>Principles of Stratigraphy- I</b>	<b>15</b>
	<ul style="list-style-type: none"> <li>➤ History and Development of Stratigraphy</li> <li>➤ Stratigraphic procedures <ul style="list-style-type: none"> <li>○ Surface</li> <li>○ Subsurface</li> </ul> </li> <li>➤ Concept of Lithofacies and Biofacies</li> <li>➤ Stratigraphic Correlation <ul style="list-style-type: none"> <li>○ Litho, Bio and Chronostratigraphic Correlation</li> </ul> </li> </ul>	
<b>UNIT-2</b>	<b>Principles of Stratigraphy- II</b>	<b>15</b>
	<ul style="list-style-type: none"> <li>➤ Study of standard stratigraphic code (Lithostratigraphic, Biostratigraphic and Chronostratigraphic)</li> <li>➤ Magnetostratigraphy,</li> <li>➤ Chemostratigraphy,</li> <li>➤ Event stratigraphy,</li> <li>➤ Seismic Stratigraphy,</li> <li>➤ Sequence stratigraphy</li> <li>➤ Cyclo stratigraphy</li> </ul>	

<b>UNIT-3</b>	<b>Invertebrate Palaeontology</b>	<b>15</b>
	<ul style="list-style-type: none"> <li>➤ Scope of Palaeontology and Organic evolution</li> <li>➤ Techniques in Palaeontology - collection, identification and illustration – binomial nomenclature <ul style="list-style-type: none"> <li>○ Mega fossils</li> <li>○ Microfossils</li> <li>○ Nanofossils</li> <li>○ Ichnofossils</li> </ul> </li> <li>➤ Study of Invertebrate fossils – morphology, classification, evolutionary trends, geological and geographic distribution and paleoecological and paleo-environmental study with Indian Examples <ul style="list-style-type: none"> <li>○ Bivalves</li> <li>○ Cephalopoda</li> <li>○ Gastropods</li> <li>○ Echinoids</li> <li>○ Corals and Brachiopods.</li> <li>○ Vertebrate Palaeontology</li> </ul> </li> </ul>	
<b>UNIT-4</b>	<b>Vertebrate Palaeontology and Micropalaeontology</b>	<b>15</b>
	<ul style="list-style-type: none"> <li>➤ Brief study of vertebrate life through ages.</li> <li>➤ Evolution of reptiles and mammals. <ul style="list-style-type: none"> <li>○ Dinosaurs</li> <li>○ Horses</li> <li>○ Elephants</li> <li>○ Man</li> </ul> </li> <li>➤ Introduction to Micropalaeontology</li> <li>➤ Types of Microfossils</li> <li>➤ Study of Microfossils–collection, separation, taxonomy, classification and significance <ul style="list-style-type: none"> <li>○ Foraminifera</li> <li>○ Ostracods</li> <li>○ Pollens and Spores</li> <li>○ Fossils calcareous algae</li> </ul> </li> </ul>	
	<b>Total number of Lectures</b>	<b>60</b>
<b>Books</b>	<ul style="list-style-type: none"> <li>• Krumbein and Sloss, 1963, Stratigraphy and Sedimentation, Wiley, UK</li> <li>• Nichols Gary, 2009, Sedimentology and Stratigraphy Wiley-Blackwell</li> <li>• Sam Boggs, Jr., 2005, Principles of Sedimentology and Stratigraphy, Merrill Publishing Company, Columbus, Ohio.</li> <li>• Brasier M.D., 1980, Microfossils, Chapman and Hall, UK</li> </ul>	

	<ul style="list-style-type: none"> <li>• Clarkston E.N.K, 1998, Invertebrate Palaeontology and Evolution, Wiley, UK</li> <li>• Colbert E.H., Morales M., Mincoff E.C.,2001, Colbert's Evolution of the Vertebrates, Wiley-Liss, New York</li> <li>• Michael Benton, 2004, Vertebrate Palaeontology, 3rd Edition, Wiley-Blackwell, USA</li> <li>• Moore Lalicker and Fischer, 2004, Invertebrate Palaeontology, CBS Publishers and Distributors Pvt. Ltd, India</li> <li>•</li> </ul>	
<b>GLY4103: Mineralogy (4 Credits)– Core</b>		
<b>UNIT- 1</b>	<b>Crystallography and Determinative Mineralogy</b>	<b>15</b>
	<ul style="list-style-type: none"> <li>➤ Definition of Crystal <ul style="list-style-type: none"> <li>○ Classification of crystal into Crystal Systems</li> </ul> </li> <li>➤ Concept of Point Group <ul style="list-style-type: none"> <li>○ Unit cell</li> <li>○ Proper and improper symmetry operations</li> <li>○ Classification of crystals into 32 Point Groups</li> </ul> </li> <li>➤ Concept of Space lattice <ul style="list-style-type: none"> <li>○ Derivation of 14 Bravais lattices</li> </ul> </li> <li>➤ Concept of Space Group <ul style="list-style-type: none"> <li>○ Symmorphic and Asymmorphic Space Groups</li> </ul> </li> <li>➤ Mineralogical investigations methods <ul style="list-style-type: none"> <li>○ X- ray Diffraction (XRD)</li> <li>○ Electron Probe Micro Analysis (EPMA)</li> <li>○ Scanning Electron Microscope (SEM)</li> <li>○ Raman Spectroscopy</li> </ul> </li> </ul>	
<b>UNIT- 2</b>	<b>Mineral Optics</b>	<b>15</b>
	<ul style="list-style-type: none"> <li>➤ Isotropic and Anisotropic minerals <ul style="list-style-type: none"> <li>○ Behaviour of minerals in plane polarized light</li> <li>○ Behaviour of minerals in cross polarized light</li> <li>○ Interference of light waves – Passage of light through doubly refracting minerals, Generation of interference colours, Birefringence</li> </ul> </li> </ul>	



	<ul style="list-style-type: none"> <li>➤ Indicatrices <ul style="list-style-type: none"> <li>○ Uniaxial and Biaxial Indicatrices</li> <li>○ Orientation of indicatrices as per the section</li> </ul> </li> <li>➤ Conoscopic or convergent polarized light <ul style="list-style-type: none"> <li>○ Generation of Uniaxial and Biaxial interference figures – Forms of interference figures related to sections</li> <li>○ Optical accessories like mica, gypsum and quartz plates</li> <li>○ Determination of Optic sign of uniaxial and biaxial minerals.</li> </ul> </li> <li>➤ True and apparent optic axial angle, 2V and 2E, Methods of determination of optic axial angle.</li> <li>➤ Absorption of light by minerals – Scheme of pleochroism</li> </ul>	
<b>UNIT- 3</b>	<b>Descriptive Mineralogy –I</b>	<b>15</b>
	<ul style="list-style-type: none"> <li>➤ Structure, relation of Chemical composition with physical and optical properties, alteration products and paragenesis of following group of minerals. <ul style="list-style-type: none"> <li>○ Olivine</li> <li>○ Pyroxenes</li> <li>○ Amphiboles,</li> <li>○ Garnet</li> <li>○ Alumino silicate</li> </ul> </li> </ul>	
<b>UNIT- 4</b>	<b>Descriptive Mineralogy –II</b>	<b>15</b>
	<ul style="list-style-type: none"> <li>➤ Structure, relation of Chemical composition with physical and optical properties, alteration products and paragenesis of following group of minerals/minerals. <ul style="list-style-type: none"> <li>○ Epidote</li> <li>○ Mica</li> <li>○ Chlorite</li> <li>○ Feldspar</li> <li>○ Zeolite</li> <li>○ Clays</li> <li>○ Staurolite, Tourmaline, Topaz, Beryl</li> </ul> </li> </ul>	
	<b>Total number of Lectures</b>	<b>60</b>
<b>Books</b>	<ul style="list-style-type: none"> <li>• Deer W.A., Howie R.A., Zussman J.,1966, An Introduction to Rock forming minerals, Longman</li> <li>• Dexter Perkins,2011, Mineralogy, Prentice Hall,3<sup>rd</sup> edition</li> </ul>	

	<ul style="list-style-type: none"> <li>• Ford W.E.,2006, Dana's, A Textbook of Mineralogy, CBS Publishers and Distributors, Indian edition</li> <li>• Kerr, P.F, Rogers, A.F.,1959, Optical Mineralogy, McGraw-Hill Inc.,US</li> <li>• Nesse W.D.,1986, Introduction to Mineralogy, Oxford University Press, USA</li> <li>• Putnis A., 1992, An Introduction to Mineral Science, Cambridge University Press</li> </ul>	
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**GLY4104: Geomorphology and Remote Sensing in Geology (4 Credits) - Core**

<b>Unit 1</b>	<b>Geomorphology I</b>	<b>15</b>
	<ul style="list-style-type: none"> <li>➤ Introduction : Development, Scope, Geomorphic concepts, Types and Tools</li> <li>➤ Evolution of Landforms               <ul style="list-style-type: none"> <li>○ Endogenous and Exogenous forces</li> <li>○ Role of Lithology</li> <li>○ Peneplanation</li> <li>○ Rejuvenation of landforms- climatic and tectonic factors</li> </ul> </li> <li>➤ Denudational processes               <ul style="list-style-type: none"> <li>○ Weathering, erosion and transportation</li> <li>○ Weathering products and soils                   <ul style="list-style-type: none"> <li>▪ profiles, types, duricrusts</li> </ul> </li> </ul> </li> <li>➤ Hillslopes : Their characteristics and development, fluvial processes on hillslopes</li> </ul>	
<b>Unit 2</b>	<b>Geomorphology II</b>	<b>15</b>
	<ul style="list-style-type: none"> <li>➤ River and drainage basin: drainage pattern, network characteristics, valleys and their development, processes of river erosion, transportation and deposition</li> <li>➤ Depositional and erosional landforms- Fluvial, Coastal , Glacial and Aeolian</li> <li>➤ Geomorphic indicators of neotectonic movements Stream channel morphology changes , drainage modifications, fault reactivation, Uplift – subsidence pattern in coastal areas</li> <li>➤ Applied Geomorphology : Application in Geohydrology, Engineering Geology and Environmental studies</li> <li>➤ Geomorphology of India: Geomorphic features and zones</li> </ul>	

<b>Unit 3</b>	<b>Remote Sensing I</b>	15
	<ul style="list-style-type: none"> <li>➤ Remote Sensing – Principles and Processes</li> <li>➤ Electromagnetic radiation and spectrum</li> <li>➤ Interaction of EMR with earth <ul style="list-style-type: none"> <li>○ Reflectance, absorption, emittance and transmittance</li> </ul> </li> <li>➤ Interaction of EMR with atmosphere <ul style="list-style-type: none"> <li>○ Scattering, absorption</li> </ul> </li> <li>➤ Cartography and Projection systems</li> <li>➤ Aerial Photographs- photo recognition elements, Interpretation of different geological features on aerial photographs</li> <li>➤ Remote sensing from space – Platform, Sensors and Data Products, interpretation for geological and other studies <ul style="list-style-type: none"> <li>○ IRS – Cartosat, Resourcesat, Oceansat, SARAL</li> <li>○ Landsat7 and 8, IKONOS, Quickbrid.</li> </ul> </li> </ul>	
<b>Unit 4</b>	<b>Remote Sensing II</b>	15
	<ul style="list-style-type: none"> <li>➤ Thermal IR remote sensing and its applications</li> <li>➤ Microwave remote sensing and its applications</li> <li>➤ Hyper spectral remote sensing and its applications</li> <li>➤ LIDAR , ALTM, SONAR -Basic principles, Types and Platforms and their applications</li> <li>➤ GNSS- GPS and INSS, Principle, satellites and applications</li> <li>➤ Geological Applications of Remote Sensing data and case studies</li> </ul>	
	<b>Total number of Lectures</b>	<b>60</b>
<b>Books</b>	<ul style="list-style-type: none"> <li>• Kale VS, Gupta A,2005, Introduction To Geomorphology, Orient Blackswan Private Limited</li> <li>• Savindra Singh,1998, Geomorphology, CBS Publishers and Distributors Pvt. Ltd</li> <li>• Thornbury William D.,1958, Principles of Geomorphology, CBS Publishers and Distributors Pvt. Ltd</li> <li>• Gupta, R.P., 2008, Remote Sensing Geology, Springer.</li> <li>• Jensen J.R., 2014,Remote Sensing of the Environment, Pearson</li> <li>• Lillesand, T.M. and Kiefer, R.W., 1999,Remote Sensing and Image Interpretation, Sec. Ed., John Wiley and Sons, Inc.</li> </ul>	

**GLY4105: Practicals Related to GLY4101 and GLY4102 (4 Credits) - Core**

	<b>Practicals for GLY4101:</b>	<b>12</b>
	<ol style="list-style-type: none"><li>1. Palaeomagnetic reconstruction of a plate.</li><li>2. Based on given data of P waves and S waves velocities from interior of earth plot the velocity and depth curves and interpret the results.</li><li>3. Isostasy related problems.</li><li>4. Problems related to Palaeomagnetism.</li><li>5. Rapid analyses of rocks for determination of major oxides by volumetric /gravimetric/colorimetric methods.</li><li>6. Problems related to seismic, gravity data and its interpretation.</li></ol>	
	<b>Practicals for GLY4102:</b>	<b>12</b>
	<ol style="list-style-type: none"><li>1. Construction of rank charts for lithostratigraphy, biostratigraphy and chronostratigraphy.</li><li>2. Construction of graphical logs for text descriptions.</li><li>3. Exercises in correlation from given data or logs.</li><li>4. Construction of range charts</li><li>5. Study of morphology of Bivalves, Gastropods, Cephalopods, Echinoids, Brachiopods.</li><li>6. Separation, processing, wet sieve analyses, preparation of slides of microfossils.</li><li>7. Morphology and morphological descriptions of planktonic and benthonic foraminifera, Ostracodes.</li><li>8. Morphology of Radiolaria , Diatoms, pollen and spores</li></ol>	

<b>GLY4106: Practicals Related to GLY4103 and GLY4104 (4 Credits) - Core</b>		
	<b>Practicals for GLY4103:</b>	<b>12</b>
	<ol style="list-style-type: none"> <li>1. Study of interference figures – determination of optical sign of minerals.</li> <li>2. Determination of composition of plagioclase feldspars by Michel Levy method .</li> <li>3. Construction of Stereograms and Gnomonograms for Cubic, Tetragonal and Orthorhombic system.</li> <li>4. Study of rock forming minerals in thin sections</li> <li>5. Study of rock forming minerals in hand specimens</li> <li>6. Calculation of mineral formulae based on weight percentage</li> <li>7. Interpretation of XRD data</li> </ol>	
	<b>Practicals for GLY4104:</b>	<b>12</b>
	<ol style="list-style-type: none"> <li>1. Drainage analysis- Basin characteristic factor, Stream characteristic factor, Stream order analysis and Slope analysis</li> <li>2. Hypsometry, GAT indices and longitudinal profiling</li> <li>3. Tracing of lineament and analysis by plotting rosette diagrams</li> <li>4. Study of landforms and interpretation of lithology and structure from aerial photograph and satellite images</li> <li>5. Image classification</li> <li>6. Generation of DEM from SRTM data (Demonstration)</li> <li>7. Scale measurement, conversion and preparation of basemap from Image, Toposheet and DEM</li> <li>8. Generating False Colour Composite (Demonstration)</li> </ol>	
<b>GLY4107: Fieldwork Component - Core</b> ➤ Flow mapping of a suitable section in Deccan Volcanic Province		

**SEMESTER –II**

<b>UNITS</b>	<b>TOPICS</b>	<b>NO. OF LECTURES</b>
<b>GLY4201: Igneous Petrology (4 Credits) - Core</b>		
<b>Unit 1</b>	<b>Role of magma in Geological processes</b>	<b>15</b>
	<ul style="list-style-type: none"> <li>➤ Magma definition and source of magma</li> <li>➤ Anatomy of the earth</li> <li>➤ Magmatism and plate tectonics</li> <li>➤ Physical properties of magma-Geochemical gradient</li> <li>➤ Heat source</li> <li>➤ Igneous activity of the present day</li> <li>➤ Textures and structures of Igneous rocks</li> <li>➤ Classification of Igneous rocks-historic perspective and the IUGS system.</li> </ul>	
<b>Unit 2</b>	<b>Geochemical tracers of mantle processes</b>	<b>15</b>
	<ul style="list-style-type: none"> <li>➤ Introduction</li> <li>➤ Continental and oceanic mantle lithosphere</li> <li>➤ MORB and depleted mantle</li> <li>➤ Evolution of depleted mantle</li> <li>➤ OIB and Enriched mantle</li> <li>➤ Evolution of Enriched mantle – metasomatic processes</li> <li>➤ Island arc basalts</li> <li>➤ Mantle Plumes-Theory and structure</li> <li>➤ Concept of hot spots</li> <li>➤ Re-Os Isotope systematics</li> <li>➤ Trace element characterizations of mantle domains</li> </ul>	
<b>Unit 3</b>	<b>Magma Crystallization and Evolution</b>	<b>15</b>
	<ul style="list-style-type: none"> <li>➤ Phase relations of the silicates and silicate melts</li> <li>➤ Binary and Ternary systems</li> <li>➤ Partial melting</li> <li>➤ Magmatic differentiation – Crystal fractionation, gravitational</li> <li>➤ Settling, flow differentiation, flow crystallisation, filter pressing, liquid immiscibility.</li> </ul>	

	<ul style="list-style-type: none"> <li>➤ Zone melting</li> <li>➤ Contamination</li> <li>➤ Mixing of magmas</li> <li>➤ Role of volatile components</li> </ul>	
<b>Unit 4</b>	<b>Petrogenetic provinces</b>	<b>15</b>
	<ul style="list-style-type: none"> <li>➤ Continental areas: Volcanic- Flood basalts- Tholeiites(Deccan Trap, Columbia River basalts, Parna basalts)</li> <li>➤ Layered gabbroic intrusions: The Bushveld complex, skaergaard intrusion, Still water complex.</li> <li>➤ Plutonic: Carbonatites and alkaline rock complexes of India</li> <li>➤ Oceanic Rift valleys: MORB- Tholeiites-Ophiolites</li> <li>➤ Granites, andesites, kimberlites, anorthosites.</li> </ul>	
	<b>Total No. of Lectures</b>	<b>60</b>
<b>Books</b>	<ul style="list-style-type: none"> <li>• Best Myron G., 1982, Igneous and Metamorphic Petrology, CBS Publishers and Distributors Pvt. Ltd.</li> <li>• Philpotts A, 1990, Principles of Igneous and Metamorphic Petrology, Prentice Hall</li> <li>• Winter J D, 2010, Principles of Igneous and Metamorphic Petrology, CBS Publishers and Distributors Pvt. Ltd, 2<sup>nd</sup> Edition</li> <li>• Wilson Marjorie, 1987, Igneous Petrogenesis, Unwin Hyman</li> </ul>	
<b>GLY4202: Metamorphic Petrology (4 Credits) - CORE</b>		
<b>Unit 1</b>	<b>Concepts and Theory</b>	<b>15</b>
	<ul style="list-style-type: none"> <li>➤ Historical background</li> <li>➤ Types of Metamorphism and their controlling factors</li> <li>➤ Common minerals of metamorphic rocks</li> <li>➤ Field observations, petrographic classification of common metamorphic rocks</li> <li>➤ Metamorphic facies and facies series</li> </ul>	
<b>Unit 2</b>	<b>Effects of Metamorphism</b>	<b>15</b>
	<ul style="list-style-type: none"> <li>➤ Phase diagrams and graphic representation of mineral assemblages</li> <li>➤ Prograde and retrograde metamorphism, Matasomatism</li> <li>➤ Deformation textures and textures related to recrystallisation</li> </ul>	

	➤ Metamorphic reactions, elemental exchange and Pressure – Temperature conditions of Isograds	
<b>Unit 3</b>	<b>Metamorphism types and products</b>	<b>15</b>
	<ul style="list-style-type: none"> <li>➤ Regional and thermal metamorphism of pelitic rocks.</li> <li>➤ Regional and thermal metamorphism of basic and ultrabasic rocks</li> <li>➤ Regional and thermal metamorphism of impure, silicious carbonate rocks</li> </ul>	
<b>Unit 4</b>	<b>Metamorphism in space and time</b>	<b>15</b>
	<ul style="list-style-type: none"> <li>➤ Metamorphism of Granitoides, Charnockites and Migmatites</li> <li>➤ Plate tectonics and metamorphic processes</li> <li>➤ Paired metamorphic belts, Archaean and Proterozoic terrains</li> <li>➤ Extraterrestrial Metamorphism (Impact and Shock Metamorphism) polymetamorphism</li> </ul>	
	<b>Total No. of Lectures</b>	<b>60</b>
<b>Books</b>	<ul style="list-style-type: none"> <li>• Best Myron G., 1982, Igneous and Metamorphic Petrology, CBS Publishers and Distributors Pvt. Ltd.</li> <li>• Miyashiro A., 1994, Metamorphism and Metomorphic Belts, Springer</li> <li>• Winter J D, 2010, Principles of Igneous and Metamorphic Petrology, CBS Publishers and Distributors Pvt. Ltd, 2<sup>nd</sup> Edition</li> <li>• Yardly B.W.D., 1989, An Introduction to Metamorphic Petrology, Longman Scientific and Technical</li> </ul>	



<b>GLY4203: Structural Geology (4 Credits)- Core</b>		
<b>Unit 1</b>	<b>Rock Deformation</b>	<b>15</b>
	<ul style="list-style-type: none"> <li>➤ Theories of rock failure; Mechanical principles, properties of rocks and their controlling factors;</li> <li>➤ Concept of stress and strain: Types of stress; stress ellipsoid; strain ellipsoid, Stress-strain relationship; Strain parameters</li> <li>➤ Mohr circle construction; 2 D and 3 D</li> <li>➤ Progressive deformation, significance of geological structures in relation to strain, pore pressure, failure of rocks due to differential stress</li> <li>➤ Co axial and non-coaxial deformation</li> <li>➤ Mechanism of rock fracturing</li> </ul>	
<b>Unit 2</b>	<b>Deformation structures</b>	<b>15</b>
	<ul style="list-style-type: none"> <li>➤ Fractures and joints: classification, nomenclature, relationships and significance; Joints/fractures in relation to stresses and their geometrical relationship with folds and faults.</li> <li>➤ Faults: Causes, mechanism and dynamics of faulting, strike-slip faults, normal faults, reverse faulting</li> <li>➤ Shear Zones: Brittle and ductile shear zones, geometry and products of shear zones; Mylonites and cataclasites: their origin and significance.</li> <li>➤ Folds; Geometric and genetic classification, Superimposed folding, structures associated and significance</li> <li>➤ Unconformity and Basement Cover relationship</li> </ul>	
<b>Unit 3</b>	<b>Structural Analysis</b>	<b>15</b>
	<ul style="list-style-type: none"> <li>➤ Scope of structural analysis, MACRO-MESO-MACRO.</li> <li>➤ Concept of Tectonites and their types.</li> <li>➤ Planar and Linear structures, classification, origin, systematic mapping in field using standard terminology, measurement and recognition of domains, eigen value.</li> <li>➤ Plotting of linear and planar structures, <math>\pi</math> and <math>\beta</math> diagrams; significance in regional studies</li> </ul>	

<b>Unit 4</b>	<b>Deformation and Metamorphism</b>	<b>15</b>
	<ul style="list-style-type: none"> <li>➤ Introduction, basic principles of deformation mechanism, concept of microtectonics. Behavior of important minerals.</li> <li>➤ Porphyroblasts: origin and relationship with planar structures, <math>S_i</math> and <math>S_e</math>.</li> <li>➤ Dilation sites- Veins, Strain Shadows, Fringes and Boudins, origin and significance.</li> <li>➤ Microscopic Shear sense indicators, integrating information with MESO and MACRO.</li> <li>➤ Special Techniques in microtectonics</li> </ul>	
<b>Books</b>	<ul style="list-style-type: none"> <li>• Fossen H,2010 – Structural Geology, Cambridge University Press, 1<sup>st</sup> edition</li> <li>• Ghosh S.K.,2014 – Structural Geology Fundamentals and Modern Concepts, Permagon Press UK Indian edition</li> <li>• Passchier C.W. and Throuw R.A.J.,2005 – Microtectonics, Springer-Verlag, Heidelberg- 2<sup>nd</sup> edition</li> <li>• Ramsay J.G.,1967 - Folding and Fracturing of Rocks, McGraw-Hill New York,N. Y.</li> <li>• Ramsay J.G and Huber M.I., 1983- Techniques of Modern Structural Geology, Volume 1- Strain Analysis, Academic Press</li> <li>• Ramsay J.G and Huber M.I., 1983- Techniques of Modern Structural Geology, Volume 2- Folds and Fractures, Academic Press</li> <li>• Turner, F.J and Weiss,L.E.,1963-Structural Analysis of Metamorphic Tectonites, McGraw-Hill New York,N.Y.</li> </ul>	

**GLY4204: Sedimentology (4 Credits)- Core**

<b>UNIT-1</b>	<b>Origin of sediments and transport</b>	<b>15</b>
	<ul style="list-style-type: none"> <li>➤ Introduction: Definition of Sedimentology, Sedimentary Petrology and Applications                             <ul style="list-style-type: none"> <li>○ Definition of weathering, erosion, denudation. Types and Products of weathering, Mineral stability index</li> <li>○ Origin of sediments: siliciclastics, volcanoclastics, carbonates, chemical precipitates</li> </ul> </li> <li>➤ Sediment transport by fluid motion:                             <ul style="list-style-type: none"> <li>○ Fluid properties and fluid motion: a) Physical properties of fluid b) Laminar and Turbulent flow, c) Stokes law d) Reynolds and Froude numbers</li> <li>○ Modes of sediment transport</li> <li>○ Hydrodynamic factors and Bed forms                                     <ul style="list-style-type: none"> <li>a) Concept of flow regime; b) Classification and characteristics of Flow regimes; c) Bed forms characterizing different flow regimes. d) Sedimentary Structures – their Genesis and Stratigraphic Significance.</li> </ul> </li> </ul> </li> <li>➤ Diagenesis: Processes, Types, Clastic and carbonate diagenesis</li> <li>➤ Classification and Petrography of Sedimentary rocks                             <ul style="list-style-type: none"> <li>○ Classification of terrigenous clastic sediments and sedimentary rocks (Breccias, Conglomerates, Sandstones, argillites).</li> <li>○ Classification of Biogenic, Chemical and Volcanogenic sediments and sedimentary rocks (Carbonates, evaporates, volcanoclastics, phosphorites, carbonaceous etc)</li> </ul> </li> </ul>	
<b>Unit 2</b>	<b>Depositional Systems and Facies</b>	<b>15</b>
	<ul style="list-style-type: none"> <li>➤ Classification of Depositional Systems                             <ul style="list-style-type: none"> <li>○ Siliciclastic Depositional environments.</li> <li>○ Carbonate Depositional Systems</li> <li>○ Chemical and Other depositional systems</li> </ul> </li> <li>➤ Facies concept                             <ul style="list-style-type: none"> <li>○ Concepts of accommodation, base-levels, transgressions and regressions, shore-line trajectories, absolute and relative sea-levels, uplift and subsidence.</li> </ul> </li> </ul>	

	<ul style="list-style-type: none"> <li>○ Concept of Walther's Law of facies succession; progradation, aggradation and retrogradation of facies; Concepts of lateral and vertical facies associations; Concept of facies architecture eg. Miall's fluvial facies architecture</li> <li>○ Concept of Depositional rhythms and Cycles</li> </ul>	
<b>Unit 3</b>	<b>Basin Evolution and Basin Fills</b>	<b>15</b>
	<ul style="list-style-type: none"> <li>➤ Classification of sedimentary basins based on tectonic settings</li> <li>➤ Pre-,Syn-, and Post depositional basins.</li> <li>➤ Basin Morphology and Depositional Environments.</li> <li>➤ Tectonics of sedimentary basins in Convergent, Divergent and shear settings</li> <li>➤ Basin Fill models of <ul style="list-style-type: none"> <li>○ Basins in Divergent settings (Continental and Oceanic rifts, passive margins)</li> <li>○ Convergent settings (deep sea trenches, forearc and backarc basins)</li> <li>○ Pull apart basins</li> <li>○ Remnant and Foreland basins.</li> </ul> </li> <li>➤ Basin Type Transitions (polyhistory Basins)</li> </ul>	
<b>Unit 4</b>	<b>Methods in Sedimentary Basin Analysis</b>	<b>15</b>
	<ul style="list-style-type: none"> <li>➤ Provenance Analysis using Clastic petrographic data</li> <li>➤ Paleocurrent Analysis</li> <li>➤ Facies Analysis</li> <li>➤ Recognition of cycles and rhythms in sedimentary sequences</li> <li>➤ Concept of Geohistory Analysis (Subsidence analysis)</li> </ul>	
	<b>Total number of Lectures</b>	<b>60</b>
<b>Books</b>	<ul style="list-style-type: none"> <li>• Sam Boggs Jr.,2005, Principles of Sedimentology and Stratigraphy, Pearson</li> <li>• Gary Nichols,2009,Sedimentology and Stratigraphy,Wiley-Blackwell</li> <li>• Donald R. Prothero and Fredric Schwab,1996, Sedimentary Geology, W. H. Freeman</li> <li>• Maurice E. Tucker,1982,Sedimentary Rocks in the field: A practical guide,Wiley-Blackwell</li> <li>• Andrew D. Miall ,1984,Principles of Sedimentary Basin Analysis,Springer</li> <li>• Gerhard Einsele, 1992,Sedimentary Basins: Evolution, Facies and sediment budget, Springer-</li> </ul>	

	<p>Verlag</p> <ul style="list-style-type: none"> <li>• H.E. Reineck and I.B. Singh,1973, Depositional Sedimentary Environments: with reference to clastics. Springer-Verlag</li> <li>• Harold Reading,1996, Sedimentary Environments: Processes, Facies and Stratigraphy. Wiley-Blackwell</li> </ul>	
<b>GLY4205: Practicals Related to GLY4201 and GLY4202(4 Credits)-Core</b>		
	<b>Practicals for GLY4201</b>	12
	<ol style="list-style-type: none"> <li>1. Study of Igneous rocks in hand specimen</li> <li>2. Characterisation of following rock type under microscope <ol style="list-style-type: none"> <li>a. Ultrabasic rocks</li> <li>b. Basic Igneous rocks</li> <li>c. Intermediate Igneous rocks</li> <li>d. Acid Igneous rocks</li> <li>e. Alkaline Igneous rocks</li> </ol> </li> <li>3. CIPW normative calculations for Igneous rocks</li> <li>4. Use of Geochemical analysis in Igneous Petrogenesis</li> </ol>	
	<b>Practicals for GLY4202</b>	12
	<ol style="list-style-type: none"> <li>1. Study of metamorphic rocks in hand specimens</li> <li>2. Study of metamorphic rocks in thin sections</li> <li>3. Metamorphic mineral assemblages with respect to metamorphic facies and grades</li> <li>4. Use of ACF, A'KF and AFM diagrams</li> <li>5. Calculation of mesonorms</li> </ol>	

**GLY4206: Practicals Related to GLY4203 and GLY4204 (4 Credits)-Core**

	<b>Practicals for GLY4203</b>	12
	<ol style="list-style-type: none"> <li>1. Solution to structural geology problem by orthographic projection</li> <li>2. Solution to structural geology problem by using equal area net</li> <li>3. Completion of outcrops</li> <li>4. Construction of geological cross sections and interpretation of geological maps</li> <li>5. Statistical use of equal area net, beta and pi diagrams</li> <li>6. Fault plane solutions</li> <li>7. Fold reconstruction using Busk Method</li> <li>8. Analysis of strain from deformed fossils</li> <li>9. Mesoscopic analysis</li> <li>10. Analysis of deformation and Metamorphism using thin sections</li> </ol>	
	<b>Practicals for GLY4204</b>	12
	<ol style="list-style-type: none"> <li>1. Shape (Calculation and Classification)</li> <li>2. Size analysis</li> <li>3. Megascopic and Microscopic studies of sandstones and carbonates</li> <li>4. Study of sedimentary structures (Primary and Secondary) and their environmental significance</li> <li>5. Construction of lithofacies maps for environmental interpretations</li> <li>6. Construction and Study of vertical profile section of some selected sedimentary environments</li> <li>7. Provenance Analysis (a)using sandstone compositions; (b) using heavy minerals</li> <li>8. Paleocurrent Analysis</li> </ol>	
<p align="center"><b>GLY4207: Fieldwork Component - Core</b></p> <p align="center">➤ Field Tour of minimum 7 days in a suitable geological terrain to learn the methods of geological mapping.</p>		