

## PG 1<sup>st</sup> Semester

**Paper: GLG701C (Core)**

**Structural Geology**

**L+T+P=3+1+0= 4 credits**

Total Number of Theory classes (*Lectures*) : 48 (48 hours)

Total Number of Tutorial classes (*Tutorials*) : 16 (16 hours)

### **THEORY**

**Structural Geology:** *Number of Lectures: 48*

#### **Introduction :**

Concept of scale in rock structures; Continuum mechanics and Index notation; Material and spatial descriptions.

#### **Stress, Strain and Rheology :**

Stress tensor; Equations of equilibrium; Stress at a point; Stress on a surface; Isotropic and deviatoric stress; Stress quadric; Principal axes & principal stresses; Stress invariants; Maximum shear stress; Mohr's circle.

Deformation tensor: strain tensor & rotation tensor; Isotropic and deviatoric strain; Strain ellipsoid; Strain analysis: line & plane; Flinn's diagram; Pure and simple shear: Finite and progressive deformation; Estimation of strain in deformed rocks.

Rheological Models; Concept of Elasticity; Viscous rheology: Newtonian Viscosity, Navier-Stokes Equation, Non-Newtonian Viscosity, Power Law Viscosity; Plasticity: Material failure, Failure criterion, Role of pore fluid pressure; Brittle-ductile transition.

#### **Grain Scale Deformation :**

Crystal defects: vacancies & dislocations; Laws of diffusion; Creep behavior of rocks; Deformation mechanisms; Role of pressure & temperature; Deformation maps.

#### **Brittle Deformation in Rocks :**

Fracture mechanics & Dynamics of faulting; Coulomb Fracture Criterion; Griffith Theory of fracture; Fracture systems; Normal, Reverse & Strike-Slip Faults: Characteristics, Structural associations; Joints in rocks.

#### **Interpretations of Ductile Structures :**

Mechanism of folding: Buckle, Bending, & Passive folds; Flexure folds & Shear folds; Superposed folding: morphological types, & modes of superposed buckling; Outcrop patterns of interference folding.

Cleavage; Structural interpretation of foliation, lineation, boudinage; Tectonites: S-, L- and LStypes; Structural analysis of deformed terrain.

#### **Ductile Shear Zones :**

Types of shear zones; Shear zone rocks; Microstructures in sheared rocks; Models of shear zone generation; Structural fabrics in shear zone; Kinematic indicators in DSZ.

#### **Recommended Books:**

1. Folding and fracturing of rocks (1967) - J G Ramsay, *McGraw-Hill*.
2. Structural Geology (2007) - R J Twiss and E M Moores, *W.H.Freeman and Company*.

3. Structural Geology- Fundamentals & Modern Developments (1993) - S K Ghosh, *Pergamon Press*.
4. Structural Geology of Rocks and Regions (2011) - G H Davis, *John Wiley*.
5. Structural Geology (2010) - Haakon Fossen, *Cambridge University Press*.
6. Crystalline Plasticity and Solid State Flow in Metamorphic Rocks (1976) - A Nicolas & J P Poirier, *John Wiley*.
7. Elasticity, Fracture and Flow: With Engineering and Geological Applications (1956) - J C Jaeger, *Methuen & Co*.
8. Rheology of the Earth (1995) - G Ranalli, *Springer*.

**Paper: GLG702C (Core)**  
**Geochemistry and Mineralogy**  
**L+T+P=3+1+0= 4 credits**

Total Number of Theory classes (*Lectures*) : 48 (48 hours)

Total Number of Tutorial classes (*Tutorials*) : 16 (16 hours)

**THEORY**

**Geochemistry** : *Number of Lectures: 24*

Chemical differentiation of the Earth; Composition of Crust, Mantle and Core; Composition of the Earth as a whole; Composition and evolution of seawater; Composition and evolution of atmosphere; Geochemical cycle; Concept of biogeochemical cycle; Sedimentation as a geochemical process; Geochemistry of Martian rocks; Element partitioning and concept of distribution coefficient; Utility of trace and rare earth elements in petrogenesis of rocks  
 Principles and applications of analytical instruments in geochemistry and isotope studies- XRF, ICP-AES, ICP-MS, TIMS, EPMA and SHRIMP; Mass spectrometer- fundamentals, principles and application in geochronological study

Stability and abundance of radionuclides; Decay mechanism of radionuclides; Radioactive decay and growth rate of radiogenic decay; Decay constant, half-life and decay of radioactive parents to stable daughters; Principle and methodology of isotope dating- Rb-Sr, Sm-Nd, K-Ar, U-Th-Pb systematics in geochronological studies; Radiometric dating of single minerals and whole rocks; Petrogenetic implications of Sm-Nd and Rb-Sr systems

Stable isotope geochemistry of carbon, hydrogen and oxygen and its applications in geology; Introduction to cosmogenic isotope geochemistry.

**Mineralogy** : *Number of Lectures: 24*

Compositional classification of minerals into groups; Solid solution; Rules governing solid solution; Transformation processes of minerals: exsolution, transient- and structural- phase transformations; Examples from natural rocks: exsolution in pyroxenes and feldspars Nature of X-rays; Interaction of X-rays and atoms; Interference of X-rays; Diffraction of X-rays; Cell parameters; d-values; Principles of X-ray crystallography; Single crystal and powder methods; Mineral identification by X-ray diffractometry

Study of structures, chemical, physical and optical properties of the following rock-forming silicate mineral groups (Olivine, Garnet, Pyroxene, Amphibole, Mica, Feldspar and Quartz)

**Recommended Books:**

1. Robin Gill (2015) - Chemical Fundamentals of Geology and Environmental Geoscience, *John Wiley & Sons Ltd.*
2. Alan P. Dickins (2005) - Radiogenic Isotope Geology, *Cambridge University Press.*
3. Hoefs, J. (1980) - Stable Isotope Geochemistry, *Springer and Verlag.*
4. Hugh R. Rollinson (2007) - Early Earth Systems: A Geochemical Approach, *Blackwell Publishing Ltd.*
5. Gunter Faure (1977) - Principles of Isotope Geology, *John Wiley & Sons Ltd.*
6. Hugh R. Rollinson (1993) - Using Geochemical Data: Evaluation, Presentation and Interpretation, *Pearson Prentice Hall.*
7. Albarde Francis (2003) - Geochemistry- Introduction; *Cambridge University Press.*
8. Kula C Misra (2012) - Introduction to Geochemistry: Principles and Applications, *Wiley-Blackwell.*
9. Deer, Howie and Zussmann – An introduction to Rock forming minerals, *Mineralogical Society of Great Britain and Ireland*
10. Barry and Mason- Mineralogy, *CBS Publishers*
11. Klein and Hurlbut- Manual of mineralogy, *John Wiley and Sons, Inc.*
12. Cornelis Klein- Mineral Science, *John Wiley and Sons*

**Paper: GLG703C (Core)**  
**Geomorphology and Quaternary Geology**  
**L+T+P=3+1+0= 4 credits**

Total Number of Theory classes (*Lectures*) : 48 (48 hours)

Total Number of Tutorial classes (*Tutorials*) : 16 (16 hours)

**THEORY**

**Geomorphology and Quaternary Geology : Number of Lectures: 48**

Time scales of landscape analysis, landform as the unit of systematic analysis, energy flow in geomorphic systems, models of landform evolution, consideration of structure process and time. Mass wasting – mechanism and classification, hill slope morphology and processes, models of hill slope evolution.

Fluvial geomorphic system, channel geometry and drainage patterns and their significance, drainage basin morphometry, processes of transport, drainage basin evolution, structural control of fluvial erosion, fluvial erosional and depositional features – river terrace, natural levee, floodplain, fans and deltas.

Tectonic geomorphology: geomorphic markers, Holocene deformation and landscape responses, geomorphic indices of active tectonics, active tectonics and alluvial rivers

Coastal geomorphology: shore zone processes, wind generated waves and tsunamis, coastal landforms- erosional and depositional, coseismic deformation on coastal landforms

Quaternary climate and uplift – climate connection, glacial/interglacial cycles, Milankovitch hypothesis, Quaternary climate and sea level changes, climate records in sediments

Quaternary stratigraphy: basic principles, morphostratigraphy, pedostratigraphy, oxygen isotope stratigraphy, Pliocene-Pleistocene and Pleistocene-Holocene boundary problems.

Establishing timing in Quaternary landscape: Dating methods – radiocarbon dating, luminescence dating, AMS dating, cosmogenic radionuclide dating, dating from artefacts, human evolution and cultural evolution of human, limitations of dating techniques. Quaternary stratigraphy and evolution of Indo-Gangetic plain and Brahmaputra plain.

### **Recommended Books:**

1. Bloom, A. L., *Geomorphology: A Systematic Analysis of Late Cenozoic Landforms. Pearson Ed.*,
2. Fryirs, K. A., Brierley, G. J., *Geomorphologic Analysis of River Systems: An approach to reading the Landscape; Wiley-Blackwell*
3. Burbank, D. W., & Anderson, R. S., *Tectonic Geomorphology; Blackwell Science*
4. Keller, Edward A. and Pinter Nicholas, *Active Tectonics; Prentice Hall.*
5. Mathur, U. B., *Quaternary Geology: Indian Perspective. Geological Society of India*
6. Goswami, A. B., *Principles of Quaternary Geology and Environmental Study; Books Way.*

**Paper: GLG704C (Core)**  
**Sedimentology**  
**L+T+P=3+1+0= 4 credits**

Total Number of Theory classes (*Lectures*) : 48 (48 hours)

Total Number of Tutorial classes (*Tutorials*) : 16 (16 hours)

### **THEORY**

**Sedimentology** : *Number of Lectures: 48*

Weathering: Subaerial and submarine weathering processes and products, Soils.; Fundamentals of fluid flow; Particle transport by fluids; Sediment gravity flow.

Concept of grain size; techniques of size analysis; graphic presentation of grain size data; Particle morphology: shape forms, sphericity, roundness, surface textures and their significance; Primary grain fabric: orientation of sand grains, pebbles and fossils.

Genesis and significance of sedimentary structures: Inorganic and organic; Principles and statistical treatment of palaeocurrent analysis.

Sandstones: Framework mineralogy, classification, maturity and general characteristics of major classes of sandstones; Conglomerates: Composition, classification, origin and occurrence; Mudrocks: Composition, classification, origin and occurrence; Diagenesis of

clastic sedimentary rocks; Provenance of clastic sedimentary rocks; Processes and Characteristics of aeolian, glacial, fluvial, lacustrine, deltaic and marine environments.

Carbonate deposition and origin; Carbonate petrography and classification; Dolomite and dolomitisation; Diagenesis of carbonates; Carbonate Environments.

Sedimentary basins; Geosyncline and plate tectonic concept; Plate movements and basin formation, basin classification; Concept of basin analysis.

**Recommended Books:**

1. Sedimentary Petrology by F. J. Pettijohn; *CBS Publishers and Distributors*.
2. Introduction to Sedimentology by S. M. Sengupta; *CBS Publisher & Distributors*.
3. Petrology of Sedimentary Rocks by Sam Boggs, Jr.; *Cambridge University Press*.
4. Sedimentary Petrology: An Introduction to the Origin of Sedimentary Rocks by M. E. Tucker; *Blackwell Science*.
5. Sedimentology and Stratigraphy by G. Nichols; *Wiley and Blackwell*.
6. Sedimentary Structures by J. Collinson, N. Mountney and D. Thompson; *Terra Publishing*.
7. Carbonate Sedimentology by M. E. Tucker; *Blackwell Publishing Company*.
8. Sedimentary Geology: An Introduction to Sedimentary Rocks and Stratigraphy by D. R. Prothero & F. Schwab; *W. H. Freeman and Company*.
9. Depositional Sedimentary Environments by H. E. Reineck & I. B. Singh; *Springer*.
10. Principles of Sedimentary Basin Analysis by A. D. Miall; *Springer*.
11. Sedimentary Rocks in the Field by M. E. Tucker; *John Wiley & Sons Ltd*.
12. A Practical Approach to Sedimentology by R.C. Lindholm; *CBS Publishers and Distributors*.

**Paper: GLG705L (Lab)**

**Structural Geology Practical; Geochemistry Practical; Mineralogy Practical; Geomorphology and Quaternary Geology Practicals; Sedimentology Practical; Class Seminar (1 credit)**

$$L+T+P=0+0+(3+1)= 4 \text{ credits}$$

Total Number of Practical classes (*Lectures*) : 48 (96 hours)

**PRACTICAL**

**Structural Geology :**

Construction of Mohr's stress circle

Problems on Mohr envelope and frictional sliding envelope.

Measurement of strain from different deformed objects.

Construction of: dip isogons, folds of different morphologies.

Stereographic projection involving rotational techniques and solving advanced problems

Interpretation of geological maps with unconformity, fault, fold and igneous bodies.

**Geochemistry :**

Mineral formula calculations

Preparation of classificatory and variation diagrams and their interpretation

Preparation of spiderdiagrams and REE plots and their interpretation

**Mineralogy :**

Study of rock-forming minerals in hand specimen and under microscope

Numericals related to X-ray crystallography

**Geomorphology and Quaternary Geology :**

Interpretation of topographic maps, topographic profiles, drainage basin morphometry, hypsometric analysis.

Understanding active tectonism with the help of different geomorphic indices.

Estimation of incision deficit, rate of sedimentation and erosion, sediment rating curve.

Laboratory study of oriented samples of river sediment, preparation of litholog from vertical section, electrical log interpretation, vector analysis of paleocurrent data.

Problems on Quaternary chronological data.

Preparation of geomorphological maps from remote sensing data.

**Sedimentology :**

Thin section petrography of sandstones and limestone.

Separation of heavy mineral and their study under microscope.

Granulometric analysis and their interpretation.

Study of hand specimens of different types of sedimentary structures.

Paleocurrent analysis-field measurement procedures and laboratory techniques.

**Class Seminar : 1 credit**

(a) Each student must take part individually in seminar which includes the presentation and discussion on the seminar topic with maximum duration of 20 minutes.

(b) The tentative list of topics for Seminar shall be notified at the beginning of the semester. The students are advised to discuss with the concerned teacher and get it approved by the HOD.

(c) The students shall be required to submit the draft of the seminar topic within two weeks of the notification. The concerned teacher shall make suggestions for modification in the draft.

(d) The final write-up must be submitted by the student prior to the date of seminar presentation.