

**DEPARTMENT OF GEOLOGY**  
**B. Sc. Geology Syllabus**

<b>Semester I</b>		
GEOL-UG-O101	Geology-I (Earth System Science, Petrology and Mineralogy)	3L+1P
	Elective 1	4
	Elective 2	4
<b>Total</b>		<b>12</b>
<b>Semester II</b>		
GEOL-UG-O201	Geology-II (Physical Geology and Sedimentology)	3L+1P
	Elective 3	4
	Elective 4	4
<b>Total</b>		<b>12</b>
<b>Semester III</b>		
GEOL-UG-O301	Geology-III (Palaeontology and Stratigraphy)	3L+1P
	Elective 5	4
	Elective 6	4
<b>Total</b>		<b>12</b>
<b>Semester IV</b>		
GEOL-UG-C401	Geology-IV (Igneous and Metamorphic Petrology)	3L+1P
GEOL-UG-C402	Geology-V (Geology of India)	2L+2F
	English	4
<b>Total</b>		<b>12</b>
<b>Semester V</b>		
GEOL-UG-C501	Geology-VI (Structural and Engineering Geology)	3L+1P
GEOL-UG-C502	Geology-VII (Geochemistry and Hydrology)	3L+1P
HUR-UG-F106	Eastern Himalayan Studies	4
<b>Total</b>		<b>12</b>
<b>Semester VI</b>		
GEOL-UG-C601	Geology-VIII (Economic Geology and Coal & Petroleum Geology)	3L+1P
GEOL-UG-C602	Geology-IX (Mini Project/Industrial Training)	4
HUR-UG-F105	Environmental Studies	4
<b>Total</b>		<b>12</b>

- Minimum Credits for B.Sc. are Seventy Two (72)
- L – Lectures, P – Practical, F- Field Work

As at present very limited compatible UG elective courses are available for the students of the integrated courses at the University level. The department is required to offer options for the Elective Courses as well.

Elective Papers Department:

1. GEOL-UG-E102 Physical Sciences I (Physics)
2. GEOL-UG-E103 Physical Sciences II (Atmospheric, Oceanic and Planetary Sciences)
3. GEOL-UG-E202 Physical Sciences III (Chemistry)
4. GEOL-UG-E203 Computation I (Mathematics)
5. GEOL-UG-E302 Computation II (Computer Applications in Geosciences and Disaster Management)
6. GEOL-UG-E303 Computation III (Remote Sensing and GIS)

However the students are at liberty to choose any other available compatible elective courses. Students of other department also can choose these courses, as these papers are open papers.

## Semester I

### GEOL-UG-O101

#### Geology-I (Earth System Science, Petrology and Mineralogy)

Credit: 3L+1P

##### Module-I

Concept of earth system sciences and its branches.  
Formation of various spheres of Earth.  
Introduction to various branches of Earth Sciences.  
Solar System, Age of the earth, origin of solar system, meteors and meteorites.  
Introduction to Geological Time Scale.  
Internal structure of Earth. Concept of Plate Tectonics and its elements.  
Wilson Cycle, Orogeny, Earthquakes, Volcanoes, Tsunami  
Introduction to Hydrology: Hydrologic cycle.  
Introduction to Oceanography:

##### Module-II

Definition and classification of Rock and minerals.  
Formation of Igneous, Sedimentary and Metamorphic rocks and their classification.  
Rock Cycle. Common classification of minerals and their basis.  
Physical Properties of the minerals.  
Classification of major silicates and non silicate minerals:  
Silicates: Ortho silicates, Ring & Di silicates, Chain silicates, Sheet silicates and Framework silicates.  
Nonsilicates: Carbonates, Sulfates, Phosphates, Tungstates, Molybdates, Borates, Oxides, Hydroxides, Halides, Sulfides and Native elements.

##### Module-III

Fundamentals of Crystallography.  
Crystallographic axes, axial ratio, 32 crystal classes and classification in seven systems.  
Fundamentals of Properties of Light, Polarizing petrographic microscope.  
Optical properties of common rock forming silicate minerals.

##### Module-IV (Practical)

1. Field Based Practical for collection of samples and in-situ study.
2. Field Based Practical for identification of landforms and Earth processes.
3. Preparation of Thin and Polished sections of rock samples.
4. Study of Common Igneous, Sedimentary and Metamorphic Rocks.
5. Physical properties of common rock-forming and ore-forming minerals in hand specimen.
6. Study of common rock-forming minerals in thin section.
7. Study of optical properties of minerals under petrological microscope.
8. Study of crystal models of different classes.
9. Determination of Miller indices and zone axis calculations.

##### Suggested Readings

1. W. D. Nesse, (2000), Introduction to Mineralogy, Oxford University Press, ISBN 0-19-510691-1
2. Dana's New Mineralogy: The System of Mineralogy of James Dwight Dana and Edward Salisbury Dana by Richard V. Gaines, H. Catherine W. Skinner, Eugene E. Ford, Brian Mason, Abraham Rosenzweig, 1997, 1872 pages. Publisher: Wiley-Interscience; 8 edition, ISBN-10: 0471193100
3. P. F. Kerr Optical Mineralogy, 1959
4. Nesse W.D., Introduction to Optical mineralogy, 2008
5. Deer, W. A., Howie, R. A. and Zussman, J., An introduction to the rock forming minerals, ELBS publication, 1962-1963.

6. Rutleys Elements of Mineralogy, 1991, Publisher: Cbs Publishers & Distributors Pages: 482 ISBN10: 8123909160
7. Holme's Principles of Physical Geology. 1992. Chapman & Hall.
8. Emiliani, C, 1992. Planet Earth, Cosmology, Geology and the Evolution of Life and Environment. Cambridge University Press.

**Elective-I** **Credit: 4**

**Elective-II** **Credit: 4**

### **Semester II**

#### **GEOL-UG-O201**

**Geology-II (Physical Geology and Sedimentology)** **Credit: 3L+1P**

##### **Module-I**

Nature and scope of geomorphology. Evolution of geomorphological thoughts.  
 Basic concepts of geomorphology.  
 Overview of landscape evolution models, weathering and cycle of erosion.  
 Drainage classification and morphometry.  
 Geomorphic Processes and associated Landforms: Fluvial, Glacial, Aeolian, Coastal and Karstic landforms.  
 Structural and lithological controls on landforms.  
 Overview of Indian geomorphology.

##### **Module-II**

Sediment Size Classification. Various Classifications of Siliciclastic Sedimentary Rocks.  
 Sedimentary Processes: Fluid flow, sediment transport and sedimentary structures: Types of fluids, Laminar vs. turbulent flow, Reynolds number, Froude Number, Boundary layer effect, Particle entrainment, transport and deposition, sediment gravity flows.  
 Bouma's Sequence.

##### **Module-III**

Introduction to Sedimentary environments and facies.  
 Sedimentary structure: Primary and secondary sedimentary structures.  
 Biogenic structures Paleocurrent analysis.  
 Siliciclastic rocks: Conglomerates, sandstones, mudrocks (texture, composition, classification, origin and occurrence).  
 Nonsiliciclastic rocks: Carbonate rocks, controls of carbonate deposition, components and classification of limestone, dolomite and dolomitisation, carbonate sedimentary environments. Chert and siliceous sediments, phosphorites, carbonaceous sediments, iron rich sediments and evaporites.  
 Diagenetic processes and its effects on siliclastic and carbonate rocks.

##### **Module-IV (Practical)**

1. Field Based Practical for collection of samples/data and in-situ study.
2. Identification of various sedimentary rocks and their features.
3. Petrographic study of clastic and non-clastic rocks in thin sections.
4. Identification of sedimentary structures by diagrams and samples.
5. Particle size distribution and statistical treatment and paleocurrent analysis.

##### **Suggested Readings**

1. Bloom, A.L. 1998. Geomorphology: A systematic Analysis of Late Cenozoic Landforms (3rd Edition), Pearson Education, Inc.
2. Singh, S. 1998. Geomorphology. Prayag PustakBhavan, Allahabad.

3. Kale, VS. and Gupta, A. 2001. Introduction to Geomorphology. Orient Longman Ltd.
4. Easterbrook, D.J. 1992. Surface processes and landforms. McMillan Publ.
5. Prothoreo and Schwab, 2004, Sedimentary Geology, Freeman and Co. New York, 557p
6. Sam Boggs, 1995, Principles of Sedimentology and Stratigraphy, Printice Hall, New Jersey, 765p .
7. Maurice E. Tucker, 2006, Sedimentary Petrology, Blackwell Publishing, 262p.
8. Collinson, J.D. and Thompson, D.B. 1988, Sedimentary structures, Unwin-Hyman, London, 207p.
9. Lindholm, R.C., 1987, A practical approach to sedimenmtology, Allen and Unwin, London
10. Pettijohn, F.J. 1975, Sedimentary rocks, Harper and Row Publ. New Delhi

**Elective-III**

**Credit: 4**

**Elective-IV**

**Credit: 4**

### **Semester III**

#### **GEOL-UG-O301**

**Geology-III (Palaeontology and Stratigraphy)**

**Credit: 3L+1P**

#### **Module-I**

Introduction to fossils.

Fossilization processes (taphonomy), and modes of preservation.

Basic Concepts of organic evolution and Species concept.

Methods of description and naming of fossils, code of systematic nomenclature.

Application of Fossils in the study of Palaeoecology, Palaeobiogeography and Palaeoclimate.

Palaeobotany: Early plant life, colonization of land, important stages in plant evolution.

Role of plant fossils in palaeoclimatic reconstructions.

Significance of Gondwana flora. Introduction to palynology.

#### **Module-II**

Invertebrate Palaeontology: Brief introduction to various invertebrate groups. Significance of Mollusca, trilobites, brachiopods graptolites, foraminifera and ammonoids. Classification of trace fossils

Vertebrate Palaeontology: Evolution and Classification of vertebrates.

Major steps in vertebrate evolution.

Origin, evolution and extinction of dinosaurs.

Evolution of primates with special reference to human evolution.

#### **Module-III**

Stratigraphic principles and correlation.

Unconformities and principle of cross-cutting Relationship. Facies concept.

Evolution of Geological Time Scale.

Significant events in geological time.

Introduction to lithostratigraphy, biostratigraphy and chronostratigraphy, magnetostratigraphy and chemostratigraphy.

Seismic stratigraphy, sequence stratigraphy and its application in hydrocarbon exploration.

Intoduction to Quaternary Geology and its applications.

Pleistocene Glacial-Interglacial cycles.

#### **Module-IV (Practical)**

1. Field Based Practical for collection of samples/data and in-situ study.
2. Study of fossils showing various modes of fossilization.

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

### **Suggested Readings**

1. Clarkson, E.N.K. 1998. Invertebrate Palaeontology and Evolution, George Allen & Unwin.
2. Raup, D.M. and Stanley, S. M. 1971. Principles of Palaeontology, W.H. Freeman and Company.
3. Benton, M. 1997. Basic Palaeontology: An introductory text, D.Harker, Addison Wesley Longman.
4. Prothero, D.R. 1998. Bringing fossils to life – An introduction to Palaeobiology, McGraw Hill.
5. Benton, M.J. 2005. Vertebrate palaeontology (3rd edition). Blackwell Scientific, Oxford.
6. Brenchley, P. J., and Harper, D. A. T. 1998. Palaeoecology: Ecosystems, Environments and Evolution. By Chapman and Hall.
7. Schoch, R. M. 1989. Stratigraphy, principles and methods. Van Nostrand Reinhold.
8. Roy R. Lemon. 1990 Principles of Stratigraphy, 512 pages, Publisher: Longman Higher Education. ISBN-10: 0675205379
9. Condie. K.C., & Sloan, R. 1998, Origin and Evolution of Earth: Principles of Historical Geology. Prentice Hall; 1st edition 498 pages ISBN-10: 0134918207
10. Weller, J. Marvin 1960. Stratigraphic principles and practice. Harper's Geoscience series.

**Elective-V**

**Credit: 4**

**Elective-VI**

**Credit: 4**

**Semester- IV**

**GEOL-UG-C401**

**Geology-IV (Igneous and Metamorphic Petrology)**

**Credit: 3L+1P**

#### **Module-I**

Introduction: Earth's interior structure.

Physical properties of magmas.

Volcanoes and types of volcanoes. Pyroclastic deposits.

Concept of intrusion and extrusion.

Forms and types of igneous bodies:- extrusive bodies-Flood basalts.

Intrusive bodies:- concept of concordant and discordant intrusion, Dikes and sills and types of dikes, breccia pipes, laccoliths, lopoliths, stocks and batholiths.

#### **Module-II**

Introduction: Definition of metamorphism. Factors controlling metamorphism.

Concept of metamorphic facies and grade.

Metamorphic zones and isograds.

Metamorphic facies series and paired metamorphic belts. Mineralogical phase rule of closed and open system.

Metamorphic mineral reactions (prograde and retrograde).

Relationship between metamorphism and deformation.

#### **Module-III**

Bowen's Reaction Series. Melting and crystallization.

Classification of igneous rocks.

Textures, structures and mineralogy of important igneous suites.

Types of metamorphism. Classification of metamorphic rocks.

Types of protoliths.  
Textures, structures and mineralogy of metamorphic rocks.

#### **Module-IV (Practical)**

1. Field Based Practical for collection of samples/data and in-situ study.
2. Study of igneous and metamorphic rocks in hand specimens and thin sections.
3. Plotting of modal analysis data of igneous rocks.
4. Calculation of CIPW norm for important igneous rocks.
5. Exercises in graphic plots for petrochemistry and interpretation of paragenetic diagrams.

#### **Suggested Readings**

1. John D. Winter 2001. An Introduction to Igneous and Metamorphic Petrology. Prentice Hall Inc
2. Loren A. Raymond 2002. Petrology: The study of Igneous, Sedimentary and Metamorphic rocks. Mc Graw Hill .New York
3. Cox, K.G. Bel, J.D. and Pankthrust, R.J. 2002. The interpretation of Igneous rocks. Allen and Unwin, London
4. Pankthrust, 2000. Igneous and Metamorphic rocks. Prentice Hall.
5. Phillipots, A.R., and Ague, S.J., 2009. Principles of igneous and metamorphic petrology (2<sup>nd</sup> Edn.) Cambridge.
6. Gill, Robin, Igneous rocks and processes-A practical guide. Wiley-Blackwell
7. Wilson, M. Igneous Petrogenesis, Wiley-Blackwell.
8. Yardley, B W D. 1990. An introduction to metamorphic petrology. ELBS publication.
9. Bucher K. and Martin F. 2002. Petrogenesis of Metamorphic rocks. Springer-Verlag Publication.
10. Best, M.G. 2002. Igneous and metamorphic petrology. Wiley publication.
11. Vernon R. H. and Clarke G. L. 2008. Principles of metamorphic Petrology. Cambridge publication.

### **GEOL-UG-C402**

#### **Geology-V (Geology of India)**

**Credit: 2L+2F**

#### **Module-I Geology of Indian Peninsula**

Physiographic and tectonic subdivisions of India.  
Tectonic evolution of cratons and mobile belts in peninsular India.  
Introduction to important Hadean, Archaean, Proterozoic, Palaeozoic, Mesozoic and Cenozoic Successions of Indian Peninsula.  
Quaternary stratigraphy of India.  
Concept of Gondwana and its significance.  
Volcanic provinces of India.  
Stratigraphic boundary problems with special reference to Precambrian / Cambrian boundary, P / T and K / T boundaries in India.  
Petroliiferous basins of India.

#### **Module-II Geology of Himalayas**

Physiographic and lithotectonic subdivisions of the Himalaya.  
Major thrusts and their boundaries.  
India & Asia collision.  
Lithological characteristics of subdivisions of the Himalaya.  
Sedimentation and evolution of Himalayan foreland and intracratonic basins  
Palaeozoic, Mesozoic and Cenozoic succession of the Himalayas.  
Stratigraphy of the Siwalik Group.  
Introduction to Geology of Eastern Himalaya.  
Stratigraphy of the Sikkim – Darjeeling Himalaya.

Inverted metamorphic Sequence.  
Quaternary geology and Neotectonics of Eastern Himalaya.

### **Module-III & Module-IV**

Introduction to geological mapping techniques.

Field training to acquaint the students with geological characteristics of type outcrops of important geological formations of Indian peninsula and Himalayas.

#### **Suggested Readings:**

1. Krishnan, M.S. 1982. Geology of India and Burma, CBS Publishers, Delhi
2. Pascoe, E.H. 1968. A manual of the Geology of India and Burma (Vol.I-IV), Govt. Of India Press, Delhi.
3. Doyle, P. & Bennett, M.R. 1996. Unlocking the Stratigraphic Record. John Wiley
4. Ramakrishnan, M. & Vaidyanadhan, R. 2008. Geology of India Volumes 1 & 2, geological society of India, Bangalore.
5. Valdiya, K.S. 2010. The making of India, Macmillan India Pvt. Ltd.
6. Naqvi S.M. 2007: Geology and evolution of Indian Plate
7. Bigg, G., 1999 Ocean and Climate. Springer-Verlag
8. Bradley, F., 2000. Paleoclimatology: Reconstructing Climates of the Quaternary. Springer-Verlag
9. Maher and Thompson, 2000. Quaternary Climates, Environments and Magnetism. Cambridge University Press.
10. Williams, Durnkerley, Decker, Kershaw and Chhappell, 1998. Quaternary Environments. Wiley and Sons.

### **English**

#### **Unit I: Elementary Grammar**

Articles

Tense

Direct and Indirect Speech

Prepositions

#### **Unit: II: Composition**

Essay Writing

Letter Writing

Comprehension

Precis/ Report writing

#### **Unit III: Poetry**

**John Donne** - "Death be not Proud"

**Oliver Goldsmith** - "The Village Schoolmaster"

**Robert Frost** - "Stopping by woods on a Snowy Evening"

**Nsssim Ezekiel** - "Night of the Scorpion"

#### **Unit IV: Short Story**

**Leo Tolstoy** - "How Much Land Does a Man Need"

**Rabindranath Tagore** - "Kabuliwala"

**Ernest Hemingway**- "In Another Country"

**R.K Narayan** - "A Horse and Two Goats"

### **Suggested Readings:**

1. Eastwood, John . *Oxford Practice Grammar* (OUP)
2. Robert W. Bly. *Webster's New World Letter Writing Handbook*
3. Duigu,Gabi. *Essay Writing for English Test*

**Credit: 4**

### **Semester-V GEOL-UG-C501**

### **Geology-VI (Structural Geology and Engineering Geology)**

**Credit: 3L+1P**

#### **Module-I**

Concept of rock deformation. Stress and Strain in rocks.  
Strain ellipses of different types and their geological significance.  
Importance of top-bottom criteria in structural geology.  
Geometric and genetic classification of  
i. Folds, ii. Boudins iii. Fractures iv. Faults, v. Joints, vi. Shear zones, vii. Cataclastic and Ductile deformation products.

#### **Module-II**

Mechanics of folding: Buckling, Bending, Flexural slip and flow folding etc.  
Origin of foliations: axial plane cleavage. Origin of lineation.  
Mechanics of Faulting, Mohr Circle of failure.  
Effects of topography on structural features.  
Rule of V. Effects of deformation on topography.  
Stereographic projections and their use in structural analysis.

#### **Module-III**

Role of engineering geology in planning, design and construction of engineering structures.  
Geomechanical classification of rock mass (RMR, RQD, SMR).  
Engineering classification of Soils.  
Geotechnical components and classification of dams, reservoirs, spillways, tunnels, underground caverns, bridges, highways and shorelines.  
Geological structures and discontinuities, engineering properties of rocks, engineering properties of jointed rocks.  
Classification of construction materials and aggregates.  
Geological hazards (landslides and earthquakes) their significance, causes and preventive/remedial measures.  
Seismic zones of India, soil liquefaction.

#### **Module-IV (Practical)**

1. Field Based Practical for collection of samples/data and in-situ study.
2. Drawing profile sections and interpretation of geological maps of different complexities.
3. Study of 3D models of various geological structures.
4. Exercises of stereographic projections of mesoscopic structural data (planar, linear, folded etc.).
5. Solving problems related to stress and strain measurements.
6. Preparation and study of geological sections for feasibility and selection of sites for dams, tunnels, bridges, highways and similar civil structures.
7. Use of softwares for solving various geotechnical problems (Slope Stability etc).
8. Evaluation of mechanical properties of concrete aggregates.
9. Index Tests for soil, rocks and debris.
10. Evaluation of Atterberg limits and shear strength parameters.



### **Suggested Readings**

1. Price, N.J., & Cosgrove, J.W.: Analysis of Geological Structures. 1990. Cambridge University Press.
2. R.G.Park: Fundamentals of Structural Geology.
3. Davis, GR. 1984. Structural Geology of Rocks and Region. John Wiley
4. Weijermars, R. 1997. Structural Geology and Map Interpretation, Alboran Science Publishing.
5. Billings, M.P. 1987. Structural Geology, 4th edition, Prentice-Hall.
6. Hatcher, Jr., R.D. 1995. Structural Geology - Principles, Concepts and Problems, Merrill Publishing Company.
7. Ghosh, SK. 1993. Structural geology: fundamentals and modern developments, Pergamon Press, London
8. Krynin, D.P. and Judd W.R. 1957. Principles of Engineering Geology and Geotechnique, McGrawHill (CBS Publ).
9. Johnson, R.B. and DeGraf, J.V. 1988. Principles of Engineering Geology, John Wiley & Sons, N.Y.
10. Goodman, R.E., 1993. Engineering Geology: Rock in Engineering constructions. Jonh Wiley & Sons, N.Y.
11. Waltham, T., 2009. Foundations of Engineering Geology (3<sup>rd</sup> Edn.) Taylor & Francis.

### **GEOL-UG-C502**

#### **Geology-VII (Geochemistry and Hydrology)**

**Credit: 3L+1P**

#### **Module-I**

Stellar evolution and origin of elements.  
Different processes of nucleosynthesis.  
Abundances of elements and Oddo-Harkin's Law,  
Meteorites, Chondrites and chondritic ratios.  
Geochemical Distribution of elements in solar system.  
Geochemical classification of elements.  
Geochemical Structure of Earth  
Geochemical Properties of elements (volatiles, semi-volatiles, alkalis, alkaline earths, REE, HFS, Transition metals and noble metals).  
Trace elements: Raoult's and Henry's Law.  
Introduction to Radioactive and Stable Isotopes and applications.

#### **Module-II**

Hydrologic cycle.  
Vertical distribution of subsurface water.  
Groundwater - Aquifer properties.  
Geological classification of aquifers.  
Darcy's law and its validity, free and confined aquifers, phreatic and piezometric level, analysis of piezometric surface, groundwater level fluctuations.  
Aquifer's hydraulic parameters. Springs.  
Groundwater occurrence in igneous, metamorphic and sedimentary rocks.  
Physical and chemical properties of water.  
Effect of geological environment on groundwater quality.  
Surface and subsurface water interaction,  
Sea water intrusion in coastal aquifers.  
Groundwater provinces of India.

#### **Module-III**

Molarity and molality, solubility product and solubility.  
Acids and bases, dissociation constant, pH, hydrolysis, ionic concentration.  
CO<sub>2</sub>-H<sub>2</sub>O interaction to form carbonic acid, dissolution of calcite, weathering reactions.  
Ground water quality and contamination.

Introduction to surface and subsurface exploration of groundwater.  
Drilling and construction of wells.

#### **Module-IV (Practical)**

1. Field based practical for sample/Data collection and in-situ study.
2. Determination of morphometric parameters of watersheds.
3. Graphical representation of chemical quality data and water classification (C-S and Trilinear diagrams).
4. Numerical problems based on Darcy's Law
5. Preparation and interpretation of water table contour maps and depth to water level contour maps.
6. Water potential zones of India (map study) including saline water zones.
7. Plotting of Geochemical analyses on various geochemical discrimination plots.
8. Calculation of Half life and age of the samples by Isochron and Model age method.
9. Plotting of Normalised Trace element and Rare earth element plots.
10. Demonstration of Geochemical analytical methods.

#### **Suggested Readings:**

1. Walther John, V., 2009. Essentials of geochemistry, student edition. Jones and Bartlett Publishers.
2. Faure, Gunter. Inorganic Geochemistry.
3. Faure and Mensing: Early Earth Systems
4. Mason, B (1986). Principles of Geochemistry. 3<sup>rd</sup> Edition, Wiley New York.
5. Hugh Rollinson (2007) Using geochemical data – evaluation, presentation and interpretation. 2<sup>nd</sup> Edition. Publisher Longman Scientific & Technical.
6. Todd, D.K. 2006. Groundwater hydrology, 2nd Ed., John Wiley & Sons, N.Y.
7. Davis, S.N. and De Weist, R.J.M. 1966. Hydrogeology, John Wiley & Sons Inc., N.Y.
8. Karanth K.R., 1987, Groundwater: Assessment, Development and management, Tata McGraw-Hill Pub. Co. Ltd.
9. Raghunath, Hydrology
10. Fetter, C.W. 2001. Applied Hydrogeology, Prentice Hall Inc., N.J

### **EHS-UG-F106: Eastern Himalayan Studies**

**Credit: 4**

#### **Unit I: Geography and Environment of the Eastern Himalayas [Sikkim, Darjeeling, Bhutan, Arunachal Pradesh]**

Delineation of the Eastern Himalaya as a region  
Physiography; Climate; Drainage; Biodiversity and overview of Natural Resources

#### **Unit II: Historical background**

Brief History of Sikkim and Darjeeling  
Spatial relations (Trade and Religious linkages) of Sikkim with its Neighbours- Tibet, Bhutan and Nepal.

#### **Unit III: Society, Economy and Polity**

Society and Culture in Sikkim;  
Economy and Livelihood in Sikkim with emphasis on Agriculture, Industry and Tourism;  
Social and Political dimensions of Sikkim and Darjeeling Himalaya

## Unit IV: Critical Environmental Issues

Development Bottlenecks: Potentials, Prospects and Implications with special reference to Hydro-resources, Communication and Industrial Development.  
Climate Change, Natural Hazards and Disaster Management, Degradation of Bio-Resources

### Essential Readings:

1. Bose, S.C (1968). *Land and people of the Himalaya*. Indian Publications, Calcutta.
2. Karan, P.P and Jenkins, W.M (1963). *The Himalayan Kingdoms*. Princeton
3. 3.Risley, H.H., *The Gazetteer of Sikkim* (1989), B.R. Publishing Corporation
4. Rustomji, N (1971). *Enchanted Frontiers: Sikkim, Bhutan and India's North-Eastern Borderland*. Bombay: Oxford University Press.
5. Sarkar, RL and Mahendra P Lama (ed.1986). *The Eastern Himalayas: Environment and Economy*, Atma Ram, New Delhi.
- 6.Waddell, L.A (1979). *Among the Himalayas*. New Delhi: Mittal Publication

### Suggested Readings and Documentaries

1. *Bulletin of Tibetology*, Namgyal Institute of Tibetology
2. Denjongpa, Anna Balikci and Mckay, Alex (2011), *Buddhist Himalaya: studies in Religion, History and Culture, Volume II: The Sikkim Papers*
3. *Grazing on the Border: the Yak Herders of North Sikkim*, (2017) ,Namgyal Institute of Tibetology
4. Mullard, S.(2009) *Opening of the Hidden, Land: State Formation and Construction of Sikkimese History*, University of Oxford
5. *Pang Lhabsol: Sikkim's national Ritual of the Land and its Guardian Deities*, (2015), Namgyal Institute of Tibetology
6. Satyajit(1971), *Sikkim*
7. *Tingvong: A Lepcha Village*, (2005), Namgyal Institute of Tibetology

## Semester-VI

### GEOL-UG-C601

#### Geology-VIII (Economic Geology, Coal and Petroleum Geology)

Credit: 3L+1P

##### Module-I Economic Geology

Definition of Ore and gangue, tenor and grade, ore bodies and lodes.

Resources and reserves. Classification of economic deposits.

Introduction to processes of formation and enrichment of economic deposits.

Metallogeny and Plate tectonics.

Distribution of economic deposits in India.

Metallic ores: Native metals, oxides of Fe, Mn, Cr, W and sulphides of Cu, Pb, Zn, metallogenic provinces and epochs.

Atomic minerals.

Nonmetallic and industrial rocks and minerals, their nature and distribution in space and time in India:

Refractory, chemical, fertilizer, cement, chemical and gemstone industry including building stones.

##### Module-II Coal Geology:

Coal Classification and ranks of coal.

Coalification process and its causes;

Lithotypes, microlithotypes and macerals: their physical, chemical and optical properties.

Mineral and organic matter in coal.

Proximate and ultimate analyses.

Introduction to geology of different Tertiary and Gondwana coalfields of India.

Uses of coal for various industries e.g. carbonization, liquefaction, power generation, gasification and coal-bed methane production.

##### Module-III Petroleum Geology:

Origin of petroleum, Maturation of kerogen.

Classification of Crude oil.

Reservoir rocks: general attributes

Classification of reservoir rocks - fragmental reservoir rocks and chemical reservoir rocks; Migration of oil and gas: primary and secondary migration; geologic factors controlling hydrocarbon migration.

Classification of hydrocarbon traps - structural, stratigraphic and combination.

Cap rocks - definition and general properties.

Formation water characteristics.

Plate tectonics and global distribution of hydrocarbon reserves.

Introduction to petroleum geology of Assam, Bengal, Cauvery, Krishna-Godavari, Cambay and Bombay offshore basins.

##### Module-IV (Practical)

1. Field based practical for sample/Data collection and in-situ study.
2. Megascopic identification of different varieties of coal.
3. Interpretation of geologic structures from surface geological maps and bore hole data;
4. Construction of Panel and Fence diagram.
5. Preparation of structure contour and isopach maps of reservoir facies and drawing oil/water contact from bore hole data.
6. Problems on porosity and permeability
7. Calculation of oil reserves in defined structure.
8. Study of physical properties of ore forming minerals.
9. Study of optical properties of common ore forming minerals.
10. Study of association of ore forming and typical gangue minerals.
11. Preparation of maps showing distribution of important ores and other economic minerals in India.

**Suggested Readings:**

1. Evans, A.M. 1993. Ore Geology and Industrial Minerals. Blackwell ScLPubl.Guilbert, J.M. and Park Jr., C.F. 1986. The Geology of Ore deposits. Freeman & Co.
2. Bateman, A.M. and Jensen, M.L. 1990. Economic Mineral Deposits. John Wiley.Gokhale, K.V.G.K. and Rao, T.C. 1978. Ore deposits of India their distribution and processing, Tata-McGraw Hill, New Delhi.Deb, S. 1980. Industrial minerals and rocks of India. Allied Publishers
3. Mukherjee Ashok
4. Coal Geology: Larry Thomas, 2002, Wiley and Sons.
5. Coal: it's composition, analysis, utilisation and valuation.: E.E.Somermier 2008, Mc GrawHill
6. Petroleum Geology: F.K.North, 1986, Allen and Unwin
7. Petroleum Formation and Occurrence: B.P.Tissot and D.H.Welte 1978, Publisher: Springer-Verlag
8. Elements of petroleum Geology: R.C.Shelley 1998, Academic press
9. Petroleum Development Geology: P.A.Dickie, 1986, Publisher: Pennwell Publishing, Tulsa, Oklahoma
10. Petroliferous basins of India: Publisher: KDMIPE, ONGC, 1986.

**GEOL-UG-C602****Geology-IX (Mini Project/Industrial Training)****Credit: 4**

For Mini Project the student may carry out a study of geological interest (petrology, landslides, hydrological, environmental problems etc) in consultation with the course supervisor and submit a project report and make presentations.

For industrial training the student may undergo a short training at DST & CSIR labs or in organizations such GSI, NHPC, CGWB etc and submit a report and make presentations.

**Syllabus of Elective Papers**

1. GEOL-UG-E102 Physical Sciences-I (Physics)
2. GEOL-UG-E103 Physical Sciences-II (Atmospheric, Oceanic and Planetary Sciences)
3. GEOL-UG-E202 Physical Sciences-III (Chemistry)
4. GEOL-UG-E203 Computation-I (Mathematics)
5. GEOL-UG-E302 Computation-II (Computer Application in Geosciences and Disaster Management)
6. GEOL-UG-E303 Computation-III (Remote Sensing and GIS)

**GEOL-UG-E102****Physical Sciences-I: Physics****Credit: 3L+1P****Module I: Introduction to Mechanics**

Scalar and vector fields, Scalar and vector products, polar and axial vectors, triple products, directional derivative, Gradient, Curl, Divergence, Laplacian, line and surface integrals, theorems of Green, Gauss and Stokes, line integrals independent of path.

Newton's laws of motion, conservation of linear momentum, centre of mass, work energy theorem, Rotational motion, torque and angular momentum, kinetic energy of rotation, rigid body rotation dynamics, moment of inertia, conservation of angular momentum, comparison of linear and angular momentum, Simple harmonic motions.

Concept of Gravitational force and acceleration, Keplers' Laws, Gravitational Potential energy, Earth satellites,

Mechanical properties of solids (Elasticity, stress and Strain, Hooke's Law, Stress strain Curve, elastic moduli) and liquids (pressure, streamline flow, Bernoulli's principle, viscosity, Reynolds, Surface tension).

### **Module II: Optics**

Geometrical Optics: Reflection and refraction from plane and curved surface.

Wave optics: Interference, division of amplitudes, Young's double slit, Fresnel's biprism, and interference in thin films, Fraunhofer diffraction, single slit, double slit, plane transmission grating, Rayleigh's criteria of resolution, resolving power of a telescope and a microscope, resolving and dispersive power of a plane transmission grating.

Polarization: Polarization by reflection and refraction, Brewster's law, double refraction, nicol prism, quarter and half-wave plates, Production and analysis of circularly and elliptically polarized light.

Photoelectric Effect, Wave particle Duality.

### **Module III: Electromagnetism and Electronics**

Electric Charge, Coulombs law, Electric field, potential due to a charge distribution and due to a dipole, electrical potential energy, flux, Gauss's law, electric field in a dielectric, polarization, energy stored in an electric field.

Conductors and insulators, Electric current, ohms law, resistivity and resistance.

Magnetic Field, Biot-Savart law, magnetic force on a current, Lorentz force, electromagnetic induction, Lenz's law, magnetic properties of matter, para- dia- and ferromagnetism, magnetic dipole.

Electromagnetic Radiation and Introduction to Maxwell's equations.

Introduction to electronic devices e.g. Capacitor, Resistance, Diode, transistor and ICs, Number systems (binary, BCD, octal and hexadecimal), 1's and 2's complements. Logic gates, AND, OR, NAND, NOR, XOR and NXOR. Boolean algebra (Boolean laws and simple expressions), binary adders, half adder, half subtractor, full adder and full subtractor.

### **Module-IV (Practical)**

1. Determination of spring constant of a spring by (i) static, and (ii) dynamic methods.
1. Determination of  $g$  by Simple Pendulum.
2. Determination of  $g$  by Kater's pendulum or Bar pendulum.
3. Measurement of Resistance by Meter Bridge.
4. Series and Parallel Combination of Resistances by PO box
5. To determine resistance per unit length of a given wire by plotting a graph of potential difference versus current.
6. Determination of Viscosity of a liquid using Stokes Law.
7. Determination of Young's Modulus of a solid.
8. To find the focal length of a convex lens by plotting graphs between  $u$  and  $v$  or between  $1/u$  and  $1/v$ .
9. To find the focal length of a concave mirror.
10. Determination of wavelength of light by Fresnel's biprism.
11. Determination of wavelength of sodium light using a plane transmission grating and resolving power of a diffraction grating.
12. Determination of specific rotation of cane sugar solution using a polarimeter
13. To verify experimentally OR, NAD, NOT, NOR, NAND gates.
14. Study of Half-Adder/ Subtractor.

### **Suggested Readings:**

1. Spiegel, M. R. Vector Analysis Schaum's Outline Series. McGraw-Hill Book Co.: Singapore (1974)
2. Beiser, A. Concepts of Modern Physics McGraw-Hill Education (2002).
3. Resnick, R., Halliday, D. & Krane, K. S. Physics Vol. I and II 5th Ed. John Wiley & Sons (2004)
4. Serway, R. A. & Jewett, J. W. Physics for Scientists and Engineers 6th Ed.
5. Ghosh, N.N. Introductory Physics, Part-I & II. Bharati Bhawan, 1997.

6. Griffiths, D. J. Introduction to Electromagnetism 3rd Ed. Prentice-Hall (1999).
7. Malvino, A.P. & Leach, D. P. Digital Principles and Applications, Tata McGraw-Hill (2008).
8. Ryder, J. D. Electronic Fundamentals and Applications: Integrated and Discrete Systems. 5th Ed. Prentice-Hall, Inc. (2007).
9. Floyd, T. L. & Buchla, D. M. Electronics Fundamentals: Circuits, Devices and Applications (8th Ed.) Prentice-Hall (2009).21

## **GEOL-UG-E103 Physical Sciences-II**

### **Atmospheric, Oceanic and Planetary Sciences**

**Credit4L**

#### **Module-I: Planetary Sciences**

General characteristics and Origin of the Universe.  
 Solar System its planets and satellites.  
 Meteorites, Asteroids and Comets.  
 Earth in the Solar system, origin, size, shape, mass, density, rotational and revolution parameters and its age.  
 Earth and Moon System: Origin and Characteristics.  
 Initiation of plate tectonics movements and origin of Earth's early atmosphere.  
 Artificial satellites – Polar orbiting and geostationary satellites.

#### **Module-II: Atmospheric Sciences**

Thermal structure of the atmosphere and its composition.  
 Insolation, solar constant, albedo, radiation windows, radiative transfer, Greenhouse effect, net radiation budget, Rayleigh and Mie scattering, multiple scattering.  
 Latitudinal and seasonal variation of insolation, and different meteorological parameters.  
 Thermodynamics of dry and moist air: specific gas constant.  
 Adiabatic and isentropic processes, Vertical stability of the atmosphere.

#### **Module-III: Climatology**

Classification of Cloud, Condensation and Precipitation.  
 Air masses, monsoon, Jet streams, tropical cyclones, and ENSO.  
 Classification of climates – Koppen's and Thornthwaite's scheme of classification.  
 Basic equations and fundamental forces: Pressure, gravity, centripetal and Coriolis forces, continuity equation in Cartesian and isobaric coordinates.  
 Geostrophic, gradient winds and thermal wind.

#### **Module-IV: Oceanic Sciences**

Introduction to Oceanography.  
 Major Oceans of the world. Major physical divisions of the ocean basin.  
 Properties of Sea Water  
 Temperature and salinity distribution in surface of the ocean.  
 Dissolved gases in seawater. Carbon dioxide and carbonate cycle.  
 Major currents of the world's ocean.  
 The Ocean Conveyor belt and its role in controlling world's climate.  
 Surface circulation, concept of mixed layer, thermocline and pycnocline, Coriolis Force and Ekman Spiral and Upwelling.  
 Deep-sea sediments and Calcite and Aragonite Compensation depth and significance.  
 Mineral resources of the ocean including polymetallic nodules. Marine Gas Hydrates and their economic potential.

#### **Suggested Readings:**

1. Fischer, G. and Wefer, G., 1999. Use of Proxies in Paleoceanography: Examples from the South Atlantic, Springer.

2. Gross, M.G., 1977. Oceanography: A view of the Earth, Prentice Hall.
3. Haq and Boersma, 1978. Introduction to Marine Micropaleontology, Elsevier.
4. Tolmazin, D., 1985. Elements of Dynamic Oceanography, Allen and Unwin.

### GEOL-UG-E202 Physical Sciences-III

#### Chemistry

Credit: 3L+1P

#### Module I

Atomic Structure. Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de Broglie equation, Heisenberg's uncertainty principle and its significance, Schrodinger's wave equation, significance of  $\psi$  and  $\psi^2$ . Quantum numbers and their significance. Radial and angular wave functions. Radial and angular distribution curves. Shapes of s, p, d and f orbitals. Pauli's exclusion principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations, Variation of orbital energy with atomic number.

Periodicity of Elements: s, p, d, f block elements and its general physical properties e.g Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table. Atomic radii (van der Waals), Ionic and crystal radii, Covalent radii (octahedral and tetrahedral), Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy, Electron gain enthalpy, trends of electron gain enthalpy. Electronegativity.

Pauling's and Mulliken's electronegativity scales. Introduction of chemical bonding.

#### Module II

Chemical Thermodynamics. State of a system, state variables, intensive and extensive variables, concept of heat and work, thermodynamic equilibrium, thermodynamic properties, various types of systems and processes.

First Law of thermodynamics. Calculation of work (w), heat (q), changes in internal energy (NU) and enthalpy (NH) for expansion or compression of ideal gases under isothermal and adiabatic conditions for both reversible and irreversible processes. Calculation of w, q, NU and NH for processes involving changes in physical states.

Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data.

Various statements of Second Law of thermodynamics, concept of entropy, Gibbs free energy and Helmholtz energy, Calculations of entropy change and free energy change for reversible and irreversible processes under isothermal and adiabatic conditions. Criteria of spontaneity. Gibbs – Helmholtz equation. Maxwell's relations.

Introduction to Chemical kinetics 1st order, 2nd order reactions. Rate law, molecularity & order. Arrhenius Equation.

#### Module III

Chemical Equilibrium: Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium, Le Chatelier's principle. Relationships between  $K_p$ ,  $K_c$  and  $K_x$  for reactions involving ideal gases.

Ionic Equilibrium: Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and 31 bases, pH scale, common ion effect, Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

Phase Equilibrium: Ehrenapst classification of Phases, Solid –Liquid, Solid-Solid and Liquid-Liquid Mixtures. One Component and Two Component System, Eutectic and Peritectic system, classical Nucleation Theory.



#### Module IV (Practical)

1. Physical & Chemical parameters of Water
1. Estimation of Fe content in Haematite.
2. Mg & Ca ions Hard water
3. Estimation of Cu in Chalcopyrite
4. Estimation of Ca & Mg in Dolomite
5. Estimation of Fe in cement
6. Estimation of Fe using UV-VIS spectrophotometer.
7. Preparation of solutions of different Molarity/Normality of titrants
8. Estimation of carbonate and hydroxide present together in mixture.
9. Estimation of carbonate and bicarbonate present together in a mixture.
10. Estimation of oxalic acid and sodium oxalate in a given mixture.
11. Determination of heat capacity of calorimeter for different volumes.
12. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
13. Determination of enthalpy of ionization of acetic acid.
14. Determination of integral enthalpy of solution of salts (KNO<sub>3</sub>, NH<sub>4</sub>Cl).
15. Determination of enthalpy of hydration of copper sulphate.
16. Study of the solubility of benzoic acid in water and determination of pH
17. Introduction to different analytical Instruments like UV-VIS, FTIR and P-XRD.

#### Suggested Readings:

1. Lee, J.D. Concise Inorganic Chemistry, ELBS, 1991.
2. Douglas, B.E. and Mc Daniel, D.H., Concepts & Models of Inorganic Chemistry, Oxford, 1970
3. Atkins, P.W. & Paula, J. Physical Chemistry, Oxford Press, 2006.
4. Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications 1962.
5. Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS.
6. Barrow, G. M. Physical Chemistry Tata McGraw-Hill (2007).
7. Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
8. Mahan, B. H. University Chemistry 3rd Ed. Narosa (1998).

### GEOL-UG-E203 Computation-I

#### Mathematics

Credit: 4L

#### Module I

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

Functions and their graphs: polynomial, sine, cosine, exponential and logarithmic functions.

Motivation and illustration for these functions through projectile motion and simple pendulum, Simple observations about these functions like increasing, decreasing and, periodicity.

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

#### Module II

Differentiation of Functions: The derivative, rules of differentiation, Higher derivatives, Partial differentiation, change of variable, implicit functions, higher order partial derivatives. Use of methods of differentiation like Chain rule, Product rule and Quotient rule. Second order derivatives of above functions

Integration as reverse process of differentiation. Integrals of the functions introduced above. Fundamental theorem of integral calculus, mean value theorems, evaluation of definite integrals, Convergence of improper integrals, tests of convergence, Differentiation of an integral containing a parameter, differentiation of integrals with variable limits - Leibnitz rule. Rectification, double and

triple integrals, computations of area, surfaces and volumes. Integration by substitution, Integration by parts, Reduction formulae.

### **Module III**

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

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

Points in plane and space and coordinate form.

### **Module IV**

Elementary understanding of data, Measures of central tendency and dispersion. Curve fitting and method of least-squares, regression analysis, Correlation theory, simple linear regression, multiple regression, Co-variance and correlation co-efficient.

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

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

#### **Suggested Readings:**

1. H. S. Bear: Understanding Calculus, John Wiley and Sons (Second Edition); 2003.
2. E. Batschelet : Introduction to Mathematics for Life Scientists, Springer Verlag, International Student Edition, Narosa Publishing House, New Delhi (1971, 1975).
3. Introduction to probability and statistics. Schumm's Outlines.
4. Davis, JC Statistics and data analysis in geology. John Wiley & Sons. 2002.
5. H. S. Bear: Understanding Calculus, John Wiley and Sons (Second Edition); 2003.
6. E. Batschelet : Introduction to Mathematics for Life Scientists, Springer Verlag, International Student Edition, Narosa Publishing House, New Delhi (1971, 1975)

## **GEOL-UG-E302 Computation-II**

**Computer Application in Geosciences and Disaster Management**

**Credit: 3L+1P**

### **Module-I Computer Applications in Geosciences**

Introduction to computer applications in geosciences.

Geological Data compilation, processing and presentation.

Introduction to Computer programming. Basic programming codes.

Statistical analysis using various statistical softwares including Excel, Origin and SPSS.

Introduction to MATLAB.

Introduction to Rockworks, Slope Stability and hydrological modeling softwares.

### **Module-II Computer Applications in Hazard Assessment**

Concept of Disaster and Hazard.

Types, Causes, Factors and Consequences of i. Geological ii. Hydro-meteorological iii. Biological, iv Technological and v. Man-made Hazards. Global and National distribution of different Hazards

Computer Applications in Disaster Risk Management.

Pre-disaster phase – Hazard, Vulnerability and Risk Zonation; Monitoring, Warning and Alert System; Awareness, Preparedness, Planning and Capacity Development.

During Disaster phase – Incident Command System (ICS) and Emergency Operations Centre (EOC), Emergency communication, transportation, rescue, relief, damage and needs assessment, rehabilitation, and restoration of basic facilities and infrastructure.

Post-disaster phase – Reconstruction, Relocation, Recovery and Redevelopment.

### **Module-III Geohazards and risk assessment**

Lithospheric Hazards: Earthquakes and Faults, Measures of an Earthquake, Earthquake Hazards, Earthquake Control and Prediction. Seismic zonation map of India.

Landslides, Types of slope failure, Slope Mass Rating (SMR) classification, Causative factors, Landslide Hazard Zonation, Factor of Safety analysis, Slope stabilization measures.

Volcanic Hazard: Origin and Types, Products and Hazards, Monitoring, Risk Evaluation, Prediction, Tectonics and Climate, Meteorite Impacts.

Atmospheric Hazards: Cyclones and Anticyclones, Thunderstorms and Lightning, Hail, Flash Flooding GLOF. Drought.

Hydrospheric Hazards: Fluvial hazards: Flooding, channel migration, bank erosion, catchment erosion. Snow avalanches – snow packages and density, avalanche types, characteristics of avalanche, avalanche prone areas and their mitigation

Coastal Hazards: Tsunamis, Sea Level fluctuation

### **Module-IV (Practical)**

1. Application of listed softwares for Hazard assessment and Risk Management.
2. Case Studies related various Disasters.

### **Suggested Readings:**

1. Bell, F.G., 1999. Geological Hazards, Routledge, London.
2. Bryant, E., 1985. Natural Hazards, Cambridge University Press.
3. Patwardhan, A.M., 1999. The Dynamic Earth System. Prentice Hall.
4. Smith, K., 1992. Environmental Hazards. Routledge, London.
5. Subramaniam, V., 2001. Textbook in Environmental Science, Narosa International
6. Merriam D.F., (Ed.) 2000. Computer methods in the Geosciences, Elsevier.
7. Chapman, S.J., 2008 Fortran for Scientists and Engineers (3<sup>rd</sup> Edn.) McGraw-Hill.

## **GEOL-UG-E303 Computation-III**

### **Remote Sensing and GIS**

**Credit: 3L+1P**

#### **Module I Concept and Foundation of Remote Sensing & Photogrammetry:**

Electromagnetic radiations, Radiation Principles.

Interaction of energy with Atmosphere and Earth Surface features.

Different component of Remote sensing (Source of Energy, Data acquisition, Data interpretation and Reference Data).

An Ideal Remote Sensing System.

Characteristics of Real Remote sensing System.

Introduction to Global Positioning System and DGPS.

Application of Remote Sensing.

Characteristics and applications of imageries of LANDSAT1 to 7, SPOT missions,

Indian Remote Sensing Satellite mission.

Basic idea of hyperspectral image.

Elements of photo interpretation,

Basic characteristics of aerial photographs and camera.

Photographic scales, ground coverage of aerial photographs. Area Measurements, Relief displacement, vertical exaggeration and, distortion of aerial photographs, Image parallax.

#### **Module II Visual image interpretation and Digital Image processing**

Fundamental of visual image interpretation,

Land use land cover mapping,

Geologic and soil mapping

Introduction to Digital Image processing.

Image rectification and restoration  
Image Enhancement  
Contrast manipulation  
Spatial Feature Manipulation  
Multi Image Manipulation  
Image Classification

### **Module-III: GIS and Surveying**

Introduction to GIS, Spatial data types  
Principles and use of the vocabulary of GIS,  
Nature of geographic phenomena and their representation in the context of geo-informatics; Principal data models for spatial and non-spatial data used in GIS databases;  
Basic data preparation  
Geo-referencing and Data entry into a GIS.  
Significance and Principles of Surveying,  
Geodetic survey, Datum, Projection and Coordinate System.  
Different type of maps: base maps, thematic maps.  
Main categories of thematic maps used in earth sciences;  
Techniques for legend and symbols in the maps;  
Scale & Representative Fraction of maps,  
Classification of maps according to the scale, effect of the scale on the level of details of the information;  
Introduction to Survey methods and application of Compass, Tape, Chain, Plain Table, Theodolite, Electronic Distance Meter, Total Station.  
Contouring and Plotting, Measurement of slope heights, aspects and gradients; Use of abney level, pedometer,

### **Module-IV (Practical)**

1. Application of RS & GIS softwares : i. ArcGIS, ii. ERDAS, iii. ILWIS, iv. ENVIS
2. Hand on Practice on Remote Sensing and GIS softwares as mentioned in different Modules
3. Field Survey by using : Compass and Tape Survey, Plain Table Survey, and Total Station

### **Suggested Readings:**

1. Avery, T.U. and Berlin, G.L. 1992 Fundamentals of remote sensing and air photo interpretation, McMillion Publishing Co., New York.
2. Campbell, J. B. (1996) Introduction to Remote Sensing. 622pp.
3. Drury, S.A. 1987. Image interpretation in Geology. Chapman and Hall.
4. Gupta, R.P. (1991) Remote Sensing Geology. Springer-Verlag. 356pp.
5. Miller, V.C. & Miller, C.F. 1961. Photogeology. McGraw Hill, New York.
6. Pandey, S.N. 1987. Principles and applications of photogeology. Wiley Eastern, New Delhi.
7. Ray, R.G. 1969 Aerial photographs in geologic interpretation. USGS Professional Paper 373.
8. Punmia, b. C. , Jain, A. K. & Jain, A.K., Surveying (Volume - 1), 2005, Laxmi Publication Ltd.
9. Basak N N., Surveying and Levelling , 2001 (1st Edition) Tata Mcgraw Hill Education Private Limited
10. Bannister, A., Raymond, S. & Baker, R. Surveying 7th Edition, 2006, Pearson Education Singapore Pte Ltd

## **ENV-UG-F105: Environmental Studies**

### **Unit I: Environment and Ecosystem**

Introduction, Importance and Scope of Environmental Studies

Components of Environment; Atmosphere, Hydrosphere, Lithosphere and Biosphere

Ecosystems: Concept, Structure and Function of an Ecosystem; Energy Flow, Food Chains, Food Webs, Ecological Pyramids, Ecological Niche and Keystone Species.

### **Unit II: Resources and Conservation**

Introduction and Classification of Resources

Problems Associated with Resources and Conservation; Forest resources, Water Resources, Energy Resources, Land Resources

Biodiversity: Introduction, Issues and Conservation

### **Unit III: Environmental Pollution and Issues**

Introduction to Environmental Pollution

Causes, Effects and Control Measures of: Air Pollution, Water Pollution, Soil Pollution, Noise Pollution, Nuclear Pollution

Environmental Issues; Climate Change, Global Warming, Acid Rain, Ozone Layer Depletion etc. Firecracker and Associated Issues

### **Unit IV: Human and Environment**

Human-Environment Relationship, Sustainable Development: Concept and Issues

Role of Information Technology in Environmental Management

Solid Waste Management

Environmental Refugees

Environmental Ethics: Issues and possible solutions