Mafatlal Gagalbhai Science Institute (Autonomous)
(M. G. Science Institute), Ahmedabad
Accredited "A" level by NAAC (3rd Cycle)

Managed by The Ahmedabad Education Society

Affiliated to
Gujarat University
(Recognized by University Grants Commission)

SYLLABUS
(As per the guidelines of UGC)
(Outcome Based Education Pattern)

for

M. Sc. SEMESTER - I & II
based on
National Education Policy (NEP) 2020

For Post-Graduate Degree in

GEOLOGY
(Earth Sciences)
(In force from June, 2024)

Two year – four semester studies leading to degree of Master of Science (M. Sc.)

Submitted by

Geology Department
M. G. Science Institute
Navrangpura
Ahmedabad – 380 009.

PROGRAM SPECIFIC OUTCOMES (PSOs)

On completion of the course the learner will be able to

PSO 1: Academic skills:

(i) Understand the Geology as a subject and its branches- mineralogy, optical mineralogy, crystallography, palaeontology, structural geology and dynamics of the earth.

(ii) Recognize the fundamental knowledge of the stratigraphy, geochemistry, coal-, planetary-, marine- and mathematical geology.

(iii) Apply the knowledge of engineering geology, environmental geology, remote sensing & GIS and geomorphology.

PSO 2: Laboratory skills:

Identification of minerals at megascopic and microscopic level and of optical mineralogy; Crystallography. Skills developed in structural geology, palaeontology, geomorphology, remote sensing & GIS.

PSO 3: Field skills:

Compulsory field work, project work, summer/winter training, are the key features.

PSO 4: Personal skills:

Express the basic concepts of the subject, communication skills and collection of laboratory and field data. Presentation and participation in seminar/workshop/symposium etc.

PSO 5: Social skills:

Social relevance of earth systems and processes related to other subjects.

M. G. Science Institute (Autonomous)

Design and Structure of Geology (Earth Sciences) for PG Courses

Department	Semester	Course No.	Name	No. of Hours per week: Lectures	Others	Practicals	Total	Course credits
Geology	**I**	GEL 401	Global and Indian Tectonics	3	1		4	4
		GEL 402	Structural Geology	3	1		4	4
		GEL 403	Mineralogy and Crystallography	3	1		4	4
		GEL 404	Palaeontology (Principles, Vertebrates & Plants) and Micropalaeontology	3	1		4	4
		GEL 405 PR	Mineralogy and Palaeontology Lab.			6	6	4
		GEL 406 PR	Structural geology Lab. + Viva Voce			6	6	4
			Total	**12**	**4**	**12**	**28**	**24**
	II	GEL 407	Crystallography, Coal Geology and Planetary Geology	3	1		4	4
		GEL 408	Stratigraphy – General, Standard and Indian Stratigraphy	3	1		4	4
		GEL 409	Geochemistry, Engineering-, Marine- and Mathematical Geology	3	1		4	4
		GEL 410	Remote Sensing & GIS; Geomorphology and Environmental Geology	3	1		4	4
		GEL 411 PR	Crystallography Lab.			6	6	4
		GEL 412 PR	Geomorphology, Remote Sensing & GIS Lab.; Field work and Viva Voce			6	6	4
			Total	**12**	**4**	**12**	**28**	**24**

COURSE OUTCOMES (COs):

On completion of the course, students will be able to

CO 1: Gain a better understanding of the basic concepts of mineralogy and its branches like optical mineralogy and crystallography.

CO 2: Ability to articulate tectonic activities, structures and stratigraphy.

CO 3: Understand the planets, Moon and other objects of our solar system in addition to their distribution and dynamical relationships.

CO 4: Articulate the relationship between the geochemistry, palaeontology and environmental geology.

CO 5: Understand the basics of engineering geology, marine geology, mathematical geology, remote sensing, GIS and geomorphology.

CO 6: Ability to identify and to differentiate the minerals in hand specimen and microscopic level. Forms of crystals and classification of crystals.

CO 7: Identify and distinguish various fossil specimens of vertebrates and plants.

CO 8: Apply the knowledge and interpretation of geological maps, toposheets, geological cross section. Use of remote sensing and GIS as tools.

CO 9: Create the data from the field work studies and to prepare geological reports.

CO 10: Independent summer/winter training as well as participation/presentation of the research data collected.

M. Sc. Semester I

GEOLOGY - THEORY and PRACTICALS
Course-wise detail syllabus

GEL 401: Global and Indian Tectonics:

Unit	Course details	Credits
Unit –1	Internal constitution of the earth – seismic, lithological and chemical. Dating of rocks. Heat flow from the earth. Palaeoclimates and ice ages. Plateaus. Rift valleys and shields.	**1**
Unit –2	Geosynclines and orogenic belts. Neotectonics: Active faults, geomorphological indicators, drainage changes, recurrent seismicity.	**1**
Unit - 3	Structure and origin of the Alpine-Himalayan belt, the Appalachian-Caledonian belt, The Andes, The North American Cordillera. Geotectonic framework of India – Indus suture zone, Himalayas and associated ranges, Indo-Gangetic plains, Peninsular India, Aravalli-, Singhbhum-, Dharwar- proto-continents, Narmada – Son lineament.	**1**
Unit - 4	Dynamic evolution of continental and oceanic crust. Proto plate tectonics.Tectonics of Precambrian Orogenic Belts of India.	**1**

Reference Books:

(1) Moores, E. and Twiss, R. J. 1995: Tectonics, Freeman.
(2) Keary, P. and Vine, F. J. 1990: Global Tectonics, Blackwell.
(3) Summerfield, M. A. 2000: Geomorphology and Global Tectonics, Springer Verlag.
(4) Ollier, C.: Tectonics and Landforms, Longman.
(5) Belousov: Basic Problems in Geo-Tectonics, McGraw Hill.
(6) Kent C. Condie**:** Plate Tectonics and Crustal Evolution, 4th Edition.
(7) Kearey P and F.J. Vine: Global Tectonics. Blackwell scientific Publications.
(8) Balasubrahmanian M.N.: Memoir No. 9. International Association of Gondwana Research; Geology and Tectonics of India.

GEL 402: Structural Geology:

Unit	Course details	Credits
Unit –1	Mechanical principles of deformation. Mechanical properties of rocks and their controlling factors. Kinetic and dynamic analysis of rocks. Theory of rock failure. Concept of stress and strain. Factors controlling the behaviour of material. Types of strain ellipses and ellipsoids, their properties and geological significance. Mechanics of plastic deformation. Strain markers in naturally deformed rocks.	**1**
Unit –2	Detailed description and classification of faults – causes and dynamics of faulting, strike-slip faults, normal faults, thrust, overthrusts, klippen, windows, nappes. Rose diagrams.	**1**
Unit - 3	Rock folding and buckling, morphology, classification, mechanism and causes, superimposed folding; Fold development and distribution of strains in folds. Salt domes. Plugs and plutons.	**1**
Unit - 4	Cleavage, boudinage, shears zones: types, geometry, structural analysis. Geometrical analysis of simple and complex structures on macroscopic scale. Structural petrology of the deformed rocks, planar and linear fabric in deformed rocks, their origin and significance. Influence of structures in mining. Planar and linear structures associated with rock folding in superimposed folds. **Extended syllabus:** Concept of petrofabrics and symmetry. Objective, field and laboratory techniques. Graphic treatment. Types of fabrics, fabric elements and interpretation of fabric data on microscopic and mesoscopic scale. Use of Universal Stage in petrofabrics. Significance and limitations of π- and β- diagrams.	**1**

Reference Books:

(1) Billings, M. P.: Structural Geology, Prentice Hall.
(2) Davis, G. R. 1984: Structural Geology of Rocks and Region, John Wiley.
(3) Ramsay, J. G. 1967: Folding and Fracturing of Rocks, McGraw Hill.
(4) Ramsay, J. G. and Huber, M. I. 1987: Modern Structural Geology, Vol. I & II, Academic Press.
(5) Ghosh, S. K. 1995: Structural Geology Fundamentals of Modern Developments, Pergamon Press.
(6) Price, N. J. and Cosgrove, J. W. 1990: Analysis of Geological Structure, Cambridge University Press.
(7) Hobbs, B.E., Means, W.D. and Williams, P.F. 1976: An outline of structural geology, John Wiley.

GEL 403: Mineralogy and Crystallography:

Unit	Course details	Credits
Unit –1	Mineral stability and phase diagram. Pauling's rules. Variation in chemical composition, solid solution and exsolution. Study of the following groups of rock forming minerals with reference to their structure, chemistry, and occurrence - Ortho and Ring Silicates: Olivine group, Garnet Group. Chain Silicates: Pyroxene group, Amphibole group.	**1**
Unit –2	Study of the following groups of rock forming minerals with reference to their structure, chemistry, and occurrence. Sheet Silicates: Mica Group. Framework Silicates: Feldspar group, Silica minerals. Mineral assemblages. A brief outline of gemology.	**1**
Unit - 3	Optical orientation. Uniaxial and biaxial minerals. Optic signature. Indicatrix. Dispersion, Principles of Federov stage (U stage). Methods of determination of refringence and birefringence, optic axial angle, apparent optical axial angle (2V and 2E), pleochroic scheme.	**1**
Unit - 4	Point groups; space groups; space lattices; crystal habit; zoning; etch marks;percussion figures. Crystal irregularities. X-ray crystal structure analysis. SEM, XRF etc. (use of high-performance instruments in crystallography).	**1**

Reference Books:

(1) Klein, C. and Hurlbut, Jr., C.S. 1993: Manual of Mineralogy. Twenty first Edition, John Wiley.
(2) Deer, W.A., Howie, R.A. and Zussman, J. 1996: The Rock Forming Minerals. Longman.
(3) Putnis, Andrew 1992: Introduction to Mineral Sciences. Cambridge Uni. Press.
(4) Phillips, Wm, R. and Griffen, D.T. 1986: Optical Mineralogy, CBS Edition.
(5) Hutchinson, C.S. 1974: Laboratory Handbook of Petrographic Techniques. John Wiley.
(6) Winchel N.H. and Winchell A.N. (1968): Elements of Optical Mineralogy, Wiley Eastern, Delhi.
(7) Berry, L.G. and Mason, B.: Mineralogy, Freeman, 19.
(8) Read H.H. (Rev. ed. C.D. Gribble) 1988: Rutley's Elements of Mineralogy (27th Edition), CBS Publications.
(9) Dana J.D. and Ford W.E. (rev. ed.) 2010: Dana's Manual of Mineralogy, J. Wiley & Sons.
(10) Rogers A.F. and Kerr P.F. (1942), Optical Mineralogy (2nd Edition), McGraw- HillCo. Inc., New York.

GEL 404: Palaeontology (Principles, Vertebrates & Plants) and Micropalaeontology:

Unit	Course details	Credits
Unit –1	Species concept. Collection and dressing of fossils. Rules of nomenclature. Bathymetric distribution of animals. Geographic distribution, migration and dispersal. Palaeobiogeographical provinces. Palaeogeography and organic evolution. **Invertebrates -** Evolutionary trends, stratigraphic and ecological significance of brachiopoda, bivalvia, echinoderms, anthozoa, graptolitoidea, trilobita and cephalopoda.	**1**
Unit –2	**Vertebrates -** Nature of vertebrate fossil records. Methods of collection and preparation of vertebrate fossil remains. Origin of vertebrates. General account of the Gondwana vertebrates and Siwalik mammals and the causes of their extinction. Dinosaurs and their extinction. Evolutionary trends in Proboscidae and Homonidae. Evolution of man. Study of important genera of vertebrates with reference to their distribution in the Indian subcontinent.	**1**
Unit - 3	**Palaeobotany –** Origin and distribution of plant life. Dispersion and migration of plants. Floral provinces. A brief morphological and taxonomic study of different plant fossils. Classification of fossil plants. Plant fossils and major divisions of the geological times. **Extended Syllabus:** Study of important world flora with special reference to Pre-Gondwana, Gondwana, Intertrappean and Tertiary flora of India. Evolution of flowering plants. Applications of Palaeobotany with reference to stratigraphic correlation and palaeoclimates. Dendrochronology.	**1**
Unit - 4	**Micropalaeontology -** Introduction. Methods and technique of Micropalaeontology. Synoptic classification of microfossils. Study of important groups of microfossils viz. foraminifera, conodonts, ostracods, radiolaria. Stratigraphical and environmental significance of microfossils. Role of Micropalaeontology in hydrocarbon exploration. Introduction to the study of microfossil algae and plant microfossils (spores and pollens). Ichnology, classification of trace fossils and their significance.	**1**

Reference Books:

(1) Shrock and Twenhofel: Priciples of Invertebrate Palaeontology. CBS.
(2) Sen A.K. 1987: Text book of Palaeontology. Modern Book Agency, Calcutta.
(3) Babin, C. 1980: Elements of Palaeontology, John Wiley.
(4) Carrol R.L. 1988: Vertebrate Palaeontology and Evolution. Cambridge Uni. Press.
(5) Clerkson E.N.K. 1998: Invertebrate Palaeontology and Evolution. Allen and Unwin, London.
(6) Haq, B.U. and Anne Boersma 1978: Introduction to Marine Micropalaeontology. Elsevier, NY.
(7) Stearn, C.W. and Carroll, R.L. 1989: Palaeontology- the record of life, John Wiley.
(8) Prothero, D.R. 1998: Bringing Fossils to Life – An Introduction to Palaeobiology. Mcgraw Hill.
(9) Raup, D.M. and Stanley, S.M. 1971: Principles of Paleontology, W.H. Freeman & Co.
(10) Haynes, J.R. 1981: Foraminifera, John Wiley.
(11) Woods, H. 1966: Palaeontology Invertebrate, International Book Bureau.
(12) Murray, J.W. 1985: Atlas of Invertebrate Macrofossils, Longman.
(13) Bromley, R.G. 1990: Trace Fossils (Biology and Taphonomy).
(14) Hanzchel 1975: Trace Fossils Part W.
(15) Bignot, G. 1985: Elements of Micropalaeontology. Graham and Trotman.

SEMINAR:

Course including GEL 401, 402, 403 and 404.
Presentation on a given topic and assignment submission.

GEL 405 PR: Mineralogy and Palaeontology Lab.:

Course details	Credits
MINERALOGY: Megascopic and microscopic studies of selected non-metallic minerals. OPTICS: Determination of optic orientation, Optic sign, Pleochroic scheme, 2V and 2E, Relative retardation and Birefringence (with the help of Berek Compensator). Working of Federov (U) stage.	**2**
PALAEONTOLOGY: Identification and morphological description of selected vertebrate and plant fossils. MICROPALAEONTOLOGY: Identification and morphological description of selected microfossils.	**2**
Viva voce.	

GEL 406 PR: Structural Lab.:

Course details	Credits
Graphical stereographic solutions of structural problems; pi and beta diagrams.	**2**
Viva voce.	

Course details	Credits
Preparation and interpretation of geological maps and sections (Plate's Elementary Series).	**2**

Semester II

GEOLOGY - THEORY and PRACTICALS
Course-wise detail syllabus

GEL 407: Crystallography, Coal Geology and Planetary Geology:

Unit	Course details	Credits
Unit –1	General principles and concepts of crystallography. International notations. Detailed study of Isometric and Tetragonal symmetry classes. Twin crystals.	**1**
Unit –2	Detailed study of Hexagonal, Orthorhombic, Monoclinic and Triclinic symmetry classes. Horizontal, Spherical, Stereographic and Gnomonic projections.	**1**
Unit - 3	**Coal Geology:** Definition and origin of kerogen and coal. Chemical characterization - proximate and ultimate analyses. Preparation of coal for industrial purposes, coal carbonisation (coke manufacture), coal gasification and coal hydrogenation. Coal bed methane: a new energy resource. Maturation of coal and generation of methane in coal beds. Fundamentals of coal bed methane exploration and production. Methods of coal prospecting and estimation of coal reserves. Coal production and problems of coal industry in India. Detailed geology for some important coal fields of India. Atomic fuel: Mode of occurrence and association of atomic minerals in nature. Atomic minerals as source of energy. Methods of prospecting and productive geological horizons in India. Nuclear power stations of the country and future prospects. Atomic fuels and environment.	**1**
Unit - 4	**Planetary Geology:** Planetary Geology as a Discipline. Future prospects of PlanetaryGeology. The origin of Solar System Theories: Laplace Nebula Theory, Jeans tidal Theory, Solar Nebula Theory, Capture Theory. Our Solar System: The terrestrial planets: Mercury, Venus, Earth and Mars, The Giant planets: Jupiter, Saturn, Uranus and Neptune. Satelliteand Pluto, Asteroids, Comets, Meteorites Dust in the solar system Introduction to planetary morphologic process Impact cratering, Endogenic process: Magmatism and volcanism, Surface process: Eolian, Fluvial, Mass-wasting, Space weathering and Plate tectonics.	**1**

Reference Books:

(1) Philips, F.C. 1964: Crystallography and Crystal Projection, Longman and Co.
(2) Read, H.H. 1960: Rutleys' Elements of Mineralogy, CBS Publishers and Distributors.
(3) Dana, W.W. and Ford, N.E. 1962: A textbook of Mineralogy, Asia Publishing House.
(4) Donald Bloss 1971: Crystallography and Crystal chemistry, Holt Rinehart and Winstar Jr.
(5) Chandra, D., Singh R. M. and Singh M. P. 2000: Textbook of Coal (Indian Context). Tara Book Agency, Varanasi.
(6) Eales, S. 2009: Planets and planetary systems. John Wiley & Sons.
(7) Greeley, R. 2013: Introduction to planetary geomorphology. Cambridge University Press.
(8) Faure, G., and Mensing, T. 2007: Introduction to planetary science. Springer.
(9) Cole, G. H., and Woolfson, M. M. 2013: Planetary science: the science of planets around stars. CRC Pres.

GEL 408: Stratigraphy - General, Standard and Indian stratigraphy:

Unit	Course details	Credits
Unit– 1	Development of historical geology. Principles of classification. International code of stratigraphic nomenclature. Principles of Lithostratigraphy, Biostratigraphy, Chronostratigraphy, Seismic stratigraphy, Sequence stratigraphy, Magneto-stratigraphy, Cyclo-stratigraphy, Event stratigraphy, Pedo-stratigraphy. Stratigraphic divisions. Time units and time-rock units. World Stratigraphy –Classification, Palaeogeography, Climate, Lithology, Orogeny and Life forms of the major divisions.	**1**
Unit– 2	Classification of Pre-Cambrian era. Pre-Cambrian crustal provinces – shields and platforms. Archaean and Dharwar provinces of India – structural framework, stratigraphy, geochronology, correlation. World distribution of Archaean and Dharwar rocks. Igneous activity in the Archaean.	**1**
Unit– 3	Proterozoic mobile belts and provinces of India – Aravalli -, Cuddapah -, Delhi – and Vindhyan – supergroups – their distribution, type sections, classification, age correlation and economic importance in Peninsula and Extra-Peninsula.	**1**

Unit– 4	Distribution, classification, lithology, correlation, life and Boundary problems of Palaeozoic, Mesozoic and Cenozoic era. Gondwana supergroup. Deccan Traps. Siwaliks. Quaternary deposits. Indo-Gangetic plains. Geology of Gujarat. Reviews on Gondwana, Himalayan and Peninsular geology.	**1**

Reference Books:

(1) Waller J.M. 1960: Stratigraphic Principles and Practice, Universal Book.
(2) Dunbar, C.O. and Rodger, J. 1960: Principles of Stratigraphy, Universal Book.
(3) Adams 1966: Fundamentals of Geology, Harper and Raw Company.
(4) Boggs, Sam Jr. 1995: Principles of Sedimentology and Stratigraphy. Prantice Hall.
(5) Weller Marvin. 1967: Principles of Stratigraphy, UBS. Publications.
(6) Miall, A.D. 1997: The Geology of Stratigraphic Sequences. Springer-Verlag.
(7) Ravindra Kumar 1992: Fundamentals of Historical Geology and Stratigraphy of India, Wiley Eastern Ltd.
(8) Wadia, D. N. 1978: Geology of India, Tata McGRaw Hill.
(9) Krishnan, M. S. 1968: Geology of India and Burma, Higgin Bothams.
(10) Gupta, V. J. 1977: Indian Precambrian Stratigraphy. Hindustan Publishing Corporation. Delhi.
(11) Naqvi, S. M. and Rogers, J. J. W. 1987: Precambrian Geology of India. Oxford Univ. Press.
(12) Naqvi, S. M. and Rogers, J. J. W. (Ed.) 1983: Precambrian of South India. Geological Society of India. Bangalore.
(13) Pitchamuthu, C. S. 1985: Archaean Geology. Oxford & IBH Publishing Co.
(14) Radhakrishna, B. P. and Vaidyanadhan, R. V. 1994: Geology of Karnataka. Geological Society of India. Bangalore.
(15) Roy, A. B. (Ed.) 1988: Precambrian of the Aravalli Mountain. Geological Society of India. Bangalore.
(16) Goodwin, A.M. 1991: Precambrian Geology: The Dynamic Evolution of Continental Crust. Academic Press.
(17) Pascoe, E.H. 1968: A manual of Geology of India and Burma. Vol. I-IV, Govt. of India Press.
(18) Merh, S.S. 1995: Geology of Gujarat, Geological Society of India. Bangalore.

Various publications of Geological Survey of India.

GEL 409: Geochemistry, Engineering-, Marine- and Mathematical Geology:

Unit	Course details	Credits
Unit –1	Development and scope of geochemistry. Cosmic abundance of elements. Composition of meteorites. Geochemistry of magmatic crystallisation process. Geochemical aspects of metamorphism and metasomatism Sedimentation as a geochemical process. Application of trace elements, rare earth elements and stable isotope geochemistry to sedimentological problems. Chemistry of natural waters. Principles of instrumental analytical techniques – UV spectrophotometer, AAS, flame photometer. Methods of plotting of geochemical data.	**1**
Unit –2	Engineering properties of rocks and their applications in foundation for engineering structures and as material for construction. Elements of soil mechanics, soil as foundation and construction material, engineering classification of soils. Geology applied to engineering problems in planning, location, design, constructions and performance of major civil engineering structures. Rock Mass Classification and Rock Mass Rating. Rockmass improvement techniques; anchoring, bolting, grouting, various types of supports Landslides, rock slope stability, factors, failure mechanism, classification and controlling measures. Earthquake and seismicity, seismic zones of India. Aseismic design of building. Influence of geological conditions on foundation and design of buildings. Geotechnical studies of dam, tunnel alignment and reservoirs - Site selection, foundation evaluation, drilling, logging etc. Foundation stability, sliding, settlement, reservoir competency, silting, seismotectonic factors etc.	**1**
Unit - 3	Marine geology: Ocean morphology - continental shelf, continental slope, trenches and canyons, deep ocean floor and various topographic features: ridges, sea mounts. Oceanic circulation, waves and currents. Oceanic sediments and distribution of marine microfossils. Stratigraphy and geochronometry of deep-sea deposits. Chemistry of oceanic rocks; Mineral resources of the oceans.	**1**

Unit - 4	Introduction to applied mathematics and statistics as tools in geology. Elements of basic trigonometric functions, integral and differential calculus and its common use in the geological problem solving. Basic ideas of statistical properties - probability, frequency and frequency distributions. Scales – arithmetic and logarithmic. Statistical hypotheses – t-test, linear regression, multivariate regression. Computer programming of petrological data. Application of data display programmes.	**1**

Reference Books:

(1) Mason, B. and Moore, C. B. 1991: Introduction to Geochemistry. Wiley Eastern.
(2) Marshal, C. P. and Fairbridge, R. W. 1999: Encyclopaedia of Geochemisry. Kluwer Academic.
(3) Nordstrorm, D. K. and Munoz, J. L. 1986: Geochemical Thermodynamics. Blackwell.
(4) Henderson, P. 1987: Inorganic Geochemistry. Pergamon Press.
(5) Krynine, D.H. and Judd, W.R. 1998: Principles of Engineering Geology. CBS Edition.
(6) Kennett, J. P. 1982: Marine Geology. Prentice Hall.
(7) Pipkin, B. W., Gorsline, D. S., Casey, R. E. & Hammord, D. E. 1972: Laboratory Exercises in Oceanography. Freeman.
(8) Koch, G. S. and Link, R. F. 1970: Statistical Analysis of Geological Data. John Wiley.

GEL 410: Remote Sensing & GIS; Geomorphology and Environmental Geology:

Unit	Course details	Credits
Unit –1	Advantages of Remote Sensing over Conventional surveys - Aerial versus Satellite Remote Sensing. Electromagnetic Radiation: Physics of Remote Sensing - Energy sources - Radiation principles - Energy interaction with atmosphere - (Atmospheric windows, scattering, absorption) – Energy interaction with earth surface features - (Absorption, transmission, scattering & reflection). Spectral response patterns: Spectral reflectance of earth surface features in different wave length regions of EMR. Data structure: Data structure in GIS, yype of data (Points, lines and polygons), database structures - Raster data structures and vector data structures, data conversion (Vector to raster and Raster to vector). Data input, verification, storage and output: Data input processes and devices, different types of entering spatial and non-spatial data, data verification, correction, storage, data output processes and devices. GPS: Concepts of GPS - GPS Instruments - Applications of GPS.	**1**
Unit –2	Theories of landscape evolution, Typical erosional and depositional landforms produced by various physical agents. Weathering and soils. Use of soils in reconstructing geomorphic evolution and interpreting palaeoclimates. Role of tectonics, climate and sea level changes in geomorphic development.	**1**
Unit - 3	Concept of morphostratigraphy. Drainage pattern. Morphometric analyses of drainage basins. Geomorphic processes on slopes and mechanics of slope segment production. Role of geomorphology in civil engineering, environmental and landuse planing.	**1**
Unit - 4	Nature and scope of environmental geology. Influence of geological characteristics on human life and biodiversity. Earth resources – renewable and non-renewable. Catastrophic hazards – Environmental implications of floods, landslides, earthquakes, volcanism and avalanche. Environmental impact of mining, construction and land use. Waste disposal problems. Environmental planning and management. Environmental legislation in India. Geology as applied to urban planning.	**1**

Reference Books:

(1) Curran, P. 1985: Principles of Remote Sensing, Longman, London.
(2) Sabbins, F.F. 1985: Remote Sensing - Principles and Applications. Freeman.
(3) Lo.C.P. 1986: Applied Remote Sensing, Longman, London.
(4) Rao, D. P. (Editor) 1999: Remote Sensing for Earth Resources, Association of Exploration Geophysicists, Hyderabad, India.
(5) Drury, S. A. 1987: Image Interpretation in Geology, Allen & Unwin, London.
(6) Jensen, J.R 1986: Introductory Digital Image Processing: A Remote Sensing Perspective, Prentice-Hall, New York.
(7) P. Nag & M. Kndrat: Digital Remote Sensing, Concept publishing.
(8) M. Anji Reddy. 2008: Text book of Remote Sensing and Geographic Information System, BS publications.
(9) Ian Heywood, Sarah Cornelius and Steve Carver. 2003: An Introduction to Geographical Information Systems, Pearson Education.
(10) Burrough, P.A. 1986: Principles of Geographical Information Systems for Land Resources Assessment, Clarandone Press, Oxford.
(11) Graeme F. & Bonham – Carter: Geographic Information Systems for Geoscientists; Modelling with GIS, Pergamon.
(12) Thornbury, W. D. 1969: Principles of Geomorphology, John Willey Inc.
(13) Ahmed E. 1972: Geomorphology of Indian Coast. Orient Longman.
(14) Allen, P. 1997: Earth Surface Processes. Blackwell.
(15) Bloom, A.L. 1978: Geomorphology. Prentice Hall, New York.
(16) Coates, D.R. 1973: Environmental Geomorphology and Landscape Conservation, Benchmark Paper in Geology.
(17) Sharma H.S. (Ed) 1980: Perspective in Geomorphology, Concept Publishingcompany, New Delhi.
(18) Valdiya, K.S. 1987: Environmental Geology – Indian Context. Tata McGraw Hill.
(19) Keller, E.A. 1978: Environmental Geology, Bell and Howell, USA.
(20) Bryant, E. 1985: Natural Hazards, Cambridge University Press.
(21) Patwardhan, A.M. 1999: The Dynamic Earth System. Prentice Hall.
(22) Subramaniam, V. 2001: Textbook in Environmental Science, Narosa International.
(23) Bell, F.G. 1999: Geological Hazards. Routledge, London.
(24) Smith, K. 1992: Environmental Hazards. Routledge, London.
(25) Sharma, P.V. 1997: Environmental and Engineering Geophysics, Cambridge Univ. Press.

SEMINAR:

Course including GEL 407, 408, 409 and 410.
Presentation on a given topic and assignment submission.

GEL 411 PR: Crystallography Lab.:

Course details	Credits
Study of crystal models belonging to 32 classes. Stereographic and clinographic projections of selected crystal models of 6 crystal systems.	**2**
Viva Voce	**2**

GEL 412 PR: Geomorphology, Remote Sensing and GIS Lab.:

Course details	Credits
Identification of various landforms from topographical maps, satellite images and aerial photographs. Preparation and interpretation of geomorphic maps. Morphometric analysis of drainage basins. Marginal Information of IRS data. Identification of elements of visual interpretation from IRS data. Visual interpretation of IRS data for, lineament, geomorphology, hydro-geomorphology and landuse pattern. Visualizing image data, geo-referencing and projection of the data, image reading, import & export, to set brightness & contrast, to see the histogram, to edit LUT, to apply filter, to see the profile, to subset an image, unsupervised classification, supervised classification, digitization and managing attribute, generate map lay out.	**2**
Preparation and interpretation of geological maps and sections (Plate's Selected series).	**2**

Field work:

Course details
Geological field work in any suitable area and submission. Viva voce.