Choice based Credit System (CBCS)
Scheme and course structure for
M.Sc. Applied Geology 1st semester effective from academic session 2014 and onwards

SEMESTER I						
Course Code	**Course Name**	**Paper Category**	**Hours per week**			**Credits**
			L	T	P	
GL14101CR	Structural Geology & Global Tectonics	Core	3	0	2	3+1=4
GL14102CR	Mineralogy	Core	3	0	2	3+1=4
GL14103CR	Igneous Petrology	Core	3	0	2	3+1=4
GL14104EA	Field Training (compulsory)*	Elective (Allied)	0	2	0	1
GL14105EA	Crystallography	Elective (Allied)	3	2	0	3+1=4
GL14106EA	Economic Geology	Elective (Allied)	3	2	0	3+1=4
GL14107EA	Climatology	Elective (Allied)	3	2	0	3+1=4
GL14108EA	Environmental Geology	Elective (Allied)	3	2	0	3+1=4
GL14109EA	Mining & Exploration Geology	Elective (Allied)	3	2	0	3+1=4
GL14110EA	Introduction to Geosciences	Elective (Open)	3	2	0	3+1=4
25Credit= 32 Contact Hours			18	8	6	25
L= Lecture; T= Tutorial; P= Practical; * Compulsory for the Applied Geology Students						

GL14101CR **Structural Geology & Global Tectonics**

Theory:

Unit	Course content
1.	Introduction: Mechanical properties of rocks and rock failure. Concepts of stress and strain, Different methods of stress and strain analyses in rocks. Concept and methods of structural analysis. Petro-fabric analysis and its significance.
2.	Folds: Geometry and mechanics of folding. Fractures and joints: classification, origin and significance. Faults: classification and mechanism of development of faults. Different type of Planar and linear structures in rocks.
3.	Global tectonics: Mechanical and compositional layering of earth. Isostasy and Paleomagnetism. Plate tectonics: concept, causes and examples.

Practical:

Unit	Course content
4.	Structural Geology: Preparation and interpretation of geological maps and sections. Exercises for determination of finite strain. Exercises of structural analysis. Plotting and interpretation of petro-fabric data and resultant diagrams

Books recommended:

Condie, K. C., 1976: *Plate tectonics and crustal evolution. Pergamon.*
Cox, A., 1996: *Plate Tectonics.* Blackwell.
Davis, G. R., 1984: *Structural Geology* of *Rocks and Region.* John Wiley.
Ghosh. S. K., 1995: *Structural Geology Fundamentals* of *modem Developments.* Pergamon Press.
Hobbs, B. E., Means, W. D. and Williams, P. F., 1976: *An Outline* of *Structural Geology*. John Wiley.
Kearey, P. and Vine, 2000: *Global Tectonics.* Black Well.
Meyerhoff et al., 1996 : *SurgeTectonics,* Kluwer Pub.
Price, N. J. and Cosgrove, J. W., 1990: *Analysis* of *Geological Structure.* Cambridge Univ. press.
Ramsay, J. G, 1967: *Folding and Fracturing* of *Rocks.* Mc Graw Hill.
Ramsay, J. G. and Huber, M. I.,: *Modem Structural Geology,* Vol. I, II, III. Academic Press.
Ragan, D. M. 2010 Cambridge Univ. Press

GL14102CR **Mineralogy**

Theory:

Unit	Course content
1.	Introduction to mineralogy, physical and chemical properties of minerals. Systematic mineralogy: Atomic structure, mineral chemistry and their PT-stability and mode of occurrence of silicates.
2.	Chemical composition, crystal structure, P-T stability and mode of occurrence of following groups of non-silicate minerals: Native elements, Sulfides, Sulfides, Sulfosalts, Oxides, Hydroxides, Carbonates.
3.	Optical Mineralogy: Concept and application of optical indicatrix. Interference phenomenon. Orthoscopic and conoscopic study of minerals. Optic figure, optic sign, dispersion, pleochroism and absorption. Determinative methods in mineralogy: Refractive index (Colored Backeline variation method), Pleochroism scheme and 2V Microscopic methods, Axiality and optic sign.

Practical

Unit	Course content
4.	Mineralogy: Megascopic and microscopic identification of important rock forming minerals. Exercises in mineral optics. Preparation of thin section and polished sections. Etching and staining.

Books recommended:

Berry & Mason, 1988: *Mineralogy.* CBS Pub.
Hutchinson, C. S., 1974: *Laboratory Handbook of Petrographic Techniques*. John Wiley.
Kerr, P. F., 1977: *Optical Mineralogy.* McGraw Hill.
Kerr, P. F., 1977: *Optical Mineralogy*. McGraw Hill.
Nesse, 1987: *Optical Mineralogy*.
Phillips, Wm, R. and Griffen, D.T., 1986: *Optical Mineralogy.* CBS Edition.
Putnis, A., 2001: *Introduction to mineral Science.* Cambridge University Press.
Putnis, A., 1992: *Introduction to mineral Science*. Cambridge University Press.
Richard, V. G., 1997: *Dana's new Mineralogy*. John Wiley.
Spear, F. S. 1993: *Mineralogical Phase Equilibria and Pressure-Temperature Paths*. Mineralogical Society of America
Read, H. H., 1986: *Rutleys Elements of Mineralogy*.
Winchell, A. N., 1968: *Elements of optical mineralogy.* Wiley Eastern Pvt Ltd.
Winchell, A. W., 1937: *Elements of Optical Mineralogy* (Principles & Methods). John Wiley Pvt Ltd.

GL14103CR **Igneous Petrology**

Theory:

Unit	Course content
1.	Introduction to igneous petrology: Magma: nature, cooling behavior, properties and chemistry; volatiles in silicate melts, magmatic crystallization, differentiation, magma mixing, mingling and partial melting;
2.	Rock associations and classification schemes of igneous rocks; IUGS and Chemical classification. Phase equilibria: Unary, Binary and Ternary systems
3.	Application of Geochemistry in evolution of magma. Genesis, source and tectonic setting of different Magma Types: Basaltic, granitic and alkaline magmas.

Practical:

Unit	Course content
4.	Igneous Petrology: Megascopic and microscopic study of igneous lithotypes. Modal analysis. Chemo-graphic diagrams (ACF & AFM ternary diagrams)

Books recommended:

Albert, J., 1967: Descriptive petrology of the Igneous Rocks.Mc-Graw Hill, New York.
Alexander, Mc. B., 1987: Igneous Petrology. Prentice Hall.
Barth, T. F. W., 1956: Theoretical Petrology.Mc-Graw Hill, New York.
Best, M. G., 1986: Igneous Petrology, CBS Pub.
Bose, M. K., 1997: Igneous Petrology. World Press.
Hall, A., 1988: Igneous petrology. ELBSI Longman.
Harker, A., 1944: Natural History of Igneous Rocks. McMillan Press.
Hatch & Wells, Text Book of Petrology. CBS Pub.
McBirney, A. R., 1993: Igneous Petrology. John Wiley.
Philpotts, A., 1992: Igneous and Metamorphic Petrology. Prentice Hall.
Turner, F. J., 1960: Igneous and Metamorphic Petrology. Mc-Graw Hill, New York.
Turner &Verhoogen, 1999: Igneous and Metamorphic Petrology. CBS Pub.
Shelley, D., 1995: Descriptive Petrology of the Igneous Rocks. Chapman & Hall.
Winter, J.D. 2010. Igneous and Metamorphic Petrology.
Blatt H. & Tracy R.J. 1995. Petrology: Igneous, Sedimentary and Metamorphic. W. H. Freeman & Company, New York.

GL14104EA **Field Training**

Geological Field Training shall be conducted on every alternate week in the valley.

GL14105EA **Crystallography**

Unit	Course content
1.	Nature of crystals: distinction between crystalline and amorphous material. Parallel growth, crystal form, crystal habit. Twining-types, causes and laws.
2.	External & Internal symmetry in crystals; Symmetry elements; Improper axis; Combination of symmetry elements.
3	Crystal Systems: 32 classes of crystals, spherical and stereographic projections.
4	Crystal structure of minerals: dimorphism, polymorphism, pseudomorphism, isomorphism, solid solution and exsolution.

Books recommended:

Berry & Mason, 1988: *Mineralogy.* CBS Pub.
Hutchinson, C. S., 1974: *Laboratory Handbook of Petrographic Techniques*. John Wiley.
Kerr, P. F., 1977: *Optical Mineralogy.* McGraw Hill.
Kerr, P. F., 1977: *Optical Mineralogy.* McGraw Hill.
Nesse, 1987: *Optical Mineralogy*.
Phillips, Wm, R. and Griffen, D.T., 1986: *Optical Mineralogy.* CBS Edition.
Putnis, A., 2001: *Introduction to mineral Science.* Cambridge University Press.
Putnis, A., 1992: *Introduction to mineral Science*. Cambridge University Press.
Richard, V. G., 1997: *Dana's new Mineralogy*. John Wiley.
Spear, F. S. 1993: *Mineralogical Phase Equilibria and Pressure-Temperature Paths*. Mineralogical Society of America Pub.
Read, H. H., 1986: *Rutleys Elements of Mineralogy*.
Winchell, A. N., 1968: *Elements of optical mineralogy.* Wiley Eastern Pvt Ltd.
Winchell, A. W., 1937: *Elements of Optical Mineralogy* (Principles & Methods). John Wiley Pvt Ltd.

GL14106EA **Economic Geology**

Unit	Course content
1.	Ore Geology: Space-time distribution of mineral deposits and global metallogeny with special reference to India. Processes of formation of different mineral deposits. Weathering and Placer deposits. Different types of ore reserves, Mineral economics and its significance. National Mineral Policy
2.	Ore Microscopy: Quantitative methods in ore microscopy–reflectivity and micro-indentation hardness, equipment and measurement techniques. Microchemical studies of ore minerals, Fluid inclusions: types, assumptions, techniques and limitations.
3.	Fuel Geology: Origin and occurrence of petroleum, migration and accumulation of petroleum, reservoir rocks and traps, petroliferous basins of India.
4.	Coal: origin and classification of coal. Macroscopic and microscopic constituents of coal. Geological and geographical distribution of coal deposits in India with emphasis on Gondwana coal fields of India. Mode of occurrence and association of atomic minerals in nature. Productive geological horizons of atomic minerals in India.

Books recommended:

Evan, A. M., 1983: *Ore Geology and industrial Minerals.* Blackwell.
Holson, G. D. and Tiratsoo, E. N., 1985: *Introduction Petroleum Geology.* Gulf Pub. Houston,
Jensen, M. L. and Bateman, A. M., 1981: *Economic Mineral Deposits,* John Wiley.
Keller, S. E., 1994: *Mineral Resources, Economic and the Environment.* McMillan College Pub.
Levarson, 1985: *Geology of Petroleum.* CBS Pub.
Prasad, U., 1996: *Economic Geology.* CBS Pub. N. Delhi.
Selley, R.C., 1998: *Elements of Petroleum Geology.* Academic Press.
Sinha, R. K. and Sharma, N. L. 1993: *Mineral Economics.* Oxford & IBH Pub. Co. Pvt. Ltd.
Stach, E. and Others, 1982: *Stach's Text Book of Coal Petrology.* Gebruder Borntraeger
Stanton, R. L, 1972: *Ore Petrology.* Mc-Graw Hill.
Tissot, B. P. and Welte, D. H, 1984: *Petroleum Formation and Occurrence.* Springer-Verlag.
Outlines of Geophysical Prospecting - A manual for geologists by Ramachandra Rao, M.B., Prasaranga, University of Mysore Mysore 1975.
Exploration Geophysics - An Outline by Bhimasarikaram Y.L.S., Association of Exploration Geophysicists, Osmania University, Hyderabad, 1990.
An introduction to Geophysical Prospecting by Oobrin, M.B. and Savit, C.H., McGraw Hill, New Delhi, 1988.
Applied Geophysics by Telford W.M. Geldart L.P., Sheriff, R.E. and Keys D.A. Oxford and IBH Publishing Co. Pvt., Ltd. New Delhi, 1976.

GL14107EA **Climatology**

Unit	Course content
1.	Atmospheric Layers and Thermal Variation: Nature, composition and layered structure of the atmosphere. Factors controlling insolation; heat budget of the atmosphere. Horizontal and vertical distribution of temperature; Inversion of temperature. Green house effect and importance of ozone layer.
2.	Atmospheric Layers and Wind Circulation: Global atmospheric pressure belts and their oscillation. General wind circulation. Jet stream and index cycle. Monsoon mechanism with reference to jet stream.General Circulation Models (GCM); Regional Climate Models; IPCCC climate Change scenarios. Climate Change Impact Studies; glaciers; water resources; food security; downscaling and upscaling of climate data; Paleo-climate inference from lake sediments, ice-core; paleosols.
3.	Precipitation and Air mass: Processes and forms of condensation. Mechanism and forms of precipitation- Ice Crystal theory, Collision-coalescence Theory. Airmass: typology, origin and characteristics. Warm and cold fronts; frontogenesis and frontolysis.
4.	Weather Disturbance and Climatic Classification: Tropical cyclone. Mid-latitude cyclone and anti-cyclone. Climatic classification after Koppen. Climatic Classification after Thornthwaite: 1931 and 1948.Hydrological cycle; Global climatic change and role and response of man in climatic changes, Applied climatology and Urban climate. Synoptic weather forecasting, prediction of weather elements such as rain, maximum and minimum temperature and fog; hazardous weather elements like thunderstorms, duststorms, tornadoes.

Books recommended:

Ahren, C.D., 2012: Meteorology Today, 10th edition, Cengage Learning.
Anthes, R. 1997: Meteorology, 7th edition, Prentice-Hall Inc., Upper Saddle River.
Barry, R.G. and Chorley, R.T. 1992: Atmosphere, Weather and Climate, 6th edition, Routledge, London.
Brigg, G.R. 1996: The Ocean and Climate, Cambridge University Press, Cambridge..
16Critchfield, H.J. 1983: General Climatology, 4th edition, Prentice Hall India Ltd., New Delhi.
Das, P.K. 1995: Monsoons, 2nd edition, National Book Trust, New Delhi.
Elsom, D.M. 1992: Atmospheric Pollution: A Global Problem, 2nd edition, Blackwell Pub. Co., London.
Lal, D.S. 1993: Climatology, 3rd edition, Chaitanya Pub. House, New Delhi.
Linacre, E. and Geerts, B. 1997: Climates and Weather Explained, Routledge, London.
Lutgens, F.K.. and Tarbuck, E.J. 1998 : The Atmosphere: An Introduction to Meteorology, 7th edition, Prentice-Hall Inc., Upper Saddle River.
McIlveen R., 2010: Fundamentals of Weather and Climate, 2nd edition, Oxford University Press, USA.
Moran, J.M. and Morgan, M.D. 1997: Meteorology: The Atmosphere and the Science of Weather, 5th edition, Prentice-Hall Inc., Upper Saddle River.
Oliver, J.E, Hidore, J.J., et al., 2009: Climatology, 3rd Edition, Prentice Hall.
Pant, G.B. and Kumar, R.K. 1997: Climates of South Asia, John Wiley and Sons Ltd., Chichester.
Roger G.B. and Richard, J.C., 2009: Atmosphere, Weather and Climate, 9th edition, Routledge.
Rohli, R.V. and Vega, A.J., 2011: Climatology, 2nd edition, Jones and Bartlett Publishers, Inc.
Smith, K. 1996: Environmental Hazards: Assessing Risk and Reducing Disaster, 2nd edition, Routledge, London.
Taylor, J.A. (editor) 1974: Climatic Resources and Economic Activity, David & Charles, London.
A.G. Pimente, J. D. (editor) 1993: World Soil Erosion and Conservation, Cambridge University Press, Cambridge.

GL14108EA **Environmental Geology**

Unit	Course content
1.	Environmental Geology: Introduction, Earth, man and environment – Basic environmental problems. Fundamental concepts of environmental geoscience. General relationship between landscape, climate and biomass. Geoscience factor in environmental planning. Earth processes; endogenic and exogenic
2.	Cenozoic climate extremes, their impact on evolution of life especially on human evolution. Health Geochemistry: essential and toxic elements & radon emission; impacts of aerosols including black carbon on environment.
3.	Impact assessment of degradation and contamination of surface water and groundwater quality due to industrialization and urbanization. Water logging problems due to the indiscrete construction of canals, reservoirs and dams. Soil profiles and soil quality degradation due to irrigation, use of fertilizers and pesticides.
4.	Seismic hazard assessment, seismic micro-zonation. Preparation of seismic hazard maps. Distribution, magnitude and intensity of earthquakes in Indian Himalayas. Tectonics and climate change. Disaster vulnerability assessment; earthquakes and floods.

Books recommended:

Lanen, F., Environmental Geology.
Lawrence, L. Environmental Geology.
Lundgren, L, 1986, Environmental Geology. Prentice Hall.
Michael, A., Basic of Environmental Science.
Parasnis, D. S., 1975: Principles of Applied Geophysics. Chapman Hall.
Pipkin, B. W. & Trent, D. D., 1997: Geology and the Environment. West wardsworth.
Singh, A., Modern Geo-Technical Engineering.
Smith, K., 1992: Environmental Hazards. Rutledge, London.
Valdiya, K. S., 1987: Environmental Geology -Indian Context. Tata McGraw Hill.
Venkat, R. D., Engineering Geology for Civil Engineers.
Waltham, A. C., 1997: Foundations of Engineering Geology. Blackie Academic & Professional.
Subramaniam, V., 2001: Textbook in Environmental Science-Narosa International

GL14109EA **Mining & Exploration Geology**

Unit	Course content
1.	Classification of mining methods, introductory geological and economic aspects of mine planning, developmental works for underground mining, mode of entry in mines, drift, crosscuts, winz, raise, ore bin and ore chuites. Surface mining methods; placer mining methods and open pit methods, ground sluicing, hydraulic mining, dredging, drift mining, shovel mining and multi bench, lateral advance mining method, their advantages and disadvantages.
2.	Underground mining methods; open stopes mining methods, supported stopes mining methods, shrinkage, cut and fill and square set mining methods, caving methods- top slicing sublevel caving and block caving, their advantages and disadvantages.
3.	Mining supports; support types with their merits and demerits. Stowing methods; subsidence – causes and prevention. Methods of breaking and blasting the rocks, types of explosives used; arrangements of drill holes for blasting in surface and underground mines. Mining atmosphere; ventilation in underground mines, types and arrangements of directing ventilations in underground mining.
4.	Exploration Geology: Concept of Geochemical Prospecting: dispersion, pathfinder elements, geochemical sampling, and geochemical field techniques. Geophysical prospecting: Basic principles, scope and application of geophysical prospecting. Principle, procedure, equipment used and applicability of gravity, magnetic, electrical, seismic and radiometric methods. Aerial geophysical surveys.

Books recommended:

Evan, A. M., 1983: *Ore Geology and industrial Minerals.* Blackwell.
Holson, G. D. and Tiratsoo, E. N., 1985: *Introduction Petroleum Geology.* Gulf Pub. Houston,
Jensen, M. L. and Bateman, A. M., 1981: *Economic Mineral Deposits,* John Wiley.
Keller, S. E., 1994: *Mineral Resources, Economic and the Environment.* McMillan College Pub.
Levarson, 1985: *Geology of Petroleum.* CBS Pub.
Prasad, U., 1996: *Economic Geology.* CBS Pub. N. Delhi.
Selley, R.C., 1998: *Elements of Petroleum Geology.* Academic Press.
Sinha, R. K. and Sharma, N. L. 1993: *Mineral Economics.* Oxford & IBH Pub. Co. Pvt. Ltd.
Stach, E. and Others, 1982: *Stach's Text Book of Coal Petrology.* Gebruder Borntraeger
Stanton, R. L, 1972: *Ore Petrology.* Mc-Graw Hill.
Tissot, B. P. and Welte, D. H, 1984: *Petroleum Formation and Occurrence.* Springer-Verlag.

GL14110EO **Introduction to Geosciences**

Unit	Course content
1.	Introduction to Geology: Definition, branches and scope. Relationship with other subjects. Interior of earth. Isostasy. Continental Drift. Folds, faults and joints- definition and classification.
2.	Minerals: Definition, Classification, Physical and chemical properties. Rocks: Definition, Types. Description of common rock types: Basalt, Granite, Andesite, Peridotitie, Sandstone, Limestone, Shale, Conglomerate, Marble, Slate, Phyllite, Schist, Gneiss.
3.	Weathering: definition and types. Denudation agents: rivers, glaciers, wind, groundwater. Depositional and erosional features formed by denudation agents. Soils: formation, types, physical properties, engineering properties. Soils of Kashmir.
4	Radioactivity, radioactive isotopes, half life period, decay constant. Age of earth. Plate tectonic: concept, movement of plates and different plate boundaries.

Books recommended:

Holmes, A., 1996: Principles of Physical Geology, EUBS, Chapman.
Judson, S. and Kaufman, M. E., 1990: Physical Geology, Prentice Hall.
Press, F. and Seiver, R., 1989: The Earth, W. H. Freeman.
Terrly, G. W., 1958: Principles of Petrology, Mathuen.
Gribble, D. D., 1988: Rutley's Elements of Mineralogy, DBS Publications.
Tarbuck, E. J. and Lutgens, F. K., 1997: Earth Science, Prentice Hall.
Lutgens, F. K. and Tarbuck, E. J., 1998: Essentials of Geology, Prentice Hall.

General Instructions for the Candidates

1. The two year (4 semesters) PG programme is of 96 credit weightage i.e, 24 credits / semester (24x4=96).
2. A candidate has compulsorily to opt for 12 credits from the core component in each semester.
3. A candidate has a choice to opt for any 12 credits (3 papers) out of minimum of 16 credits (4 papers) offered as Electives (Allied), except for a particular semester as mentioned by the Department where a candidate is required to gain a minimum of 4 credits (1 paper) from Elective (open) offered by any other Department.
4. A candidate has compulsorily to obtain a minimum of 4 credits (1 paper) from Elective (open) from outside the parent Department in any of the semesters.
5. A candidate can earn more than the minimum required credits (i.e, more than 96 credits for four semester programme) which shall be counted towards the final result of the candidate.
6. Field Training (course code: GL-04-EA) is compulsory only for M.Sc. Applied Geology students. Every student of M.Sc. Applied Geology ought to opt for this course.

Choice based Credit System (CBCS)
Scheme and course structure for
M.Sc. Applied Geology 2nd semester effective from academic session 2014 and onwards

SEMESTER II

Course Code	Course Name	Paper Category	Hours per week			Credits
			L	T	P	
GL14201-CR	Sedimentology	Core	3	0	2	3+1=4
GL14202CR	Geochemistry	Core	3	0	2	3+1=4
GL14203CR	Paleontology & Stratigraphy	Core	3	0	2	3+1=4
GL14204EA	Field Training (compulsory)*	Elective (Allied)	0	4	0	2
GL14205EA	Oceanography	Elective (Allied)	3	2	0	3+1=4
GL14206EA	Disaster, risk & hazard Assessment	Elective (Allied)	3	2	0	3+1=4
GL14207EA	Geophysical Exploration	Elective (Allied)	3	2	0	3+1=4
GL14208EA	Engineering Geology	Elective (Allied)	3	2	0	3+1=4
GL14209EA	Marine Geology	Elective (Allied)	3	2	0	3+1=4
GL14210EA	Geology of Jammu and Kashmir	Elective (Open)	3	2	0	3+1=4
26 Credit= 34 Contact Hours			18	10	6	26
L= Lecture; T= Tutorial; P= Practical; * Compulsory for the Applied Geology Students						

GL14201CR **Sedimentology**

Theory:

Unit	Course content
1.	Sedimentary processes: Introduction, Flow regimes. Textures and structures of sedimentary rocks; Statistical techniques and interpretation; Physical properties of rocks. Classification of sediments. Sandstone – light and heavy minerals, their relationship with provenance. Carbonates – classification, environment of deposition. Mudstones – classification and identification. Diagenesis: Diagenesis of mudstones, sandstones and carbonate rocks.
2.	Classification of sedimentary environments: Lithologies, Structures and Vertical sequences formed in alluvial, deltaic, coastal, and deep sea, and glacial and aeolian environments, field recognition, micromorphological features and paleoclimatic significance. Sedimentary facies: Concept and definition; Facies association; Walthers Law of Facies and application. Sedimentary cycles and cyclothems. Facies models and environmental reconstruction.
3.	Paleocurrents and paleogeography, Bed thickness, isopach and basin analysis, Sedimentation and tectonics: Tectonic control on sedimentation, diastrophic cycle and sedimentation. Basin evolution in relation to plate tectonics.

Practical:

Unit	Course content
4.	Sedimentology: Megascopic and microscopic study of different types of sedimentary rocks and heavy mineral analysis. Paleocurrent analysis - collection of azimuthal data, graphical representation of data and determination of statistical parameters. Identification and study of feldspars and carbonate minerals (calcite, ferroan calcite, ferroan dolomite, aragonite & magnesite) by staining technique.

Books recommended:

Collinson, J. D, 1999: *Sedimentary Structures.* Springer Verlag.
Ehlers and Blatt, 1999: *Petrology, (Igneous, Sedimentary and Metamorphic).* CBS Pub.
Einsele, G., 1992: *Sedimentary Basins.* Springer Verlag.
Friedman, G. M. and Sander, J. E., 1978: *Principles of Sedimentology.* John Wiley.
Miall, A. D., 1999: *Principles of Sedimentary Basin Analysis.* Springer-Verlag.
Pettijohn, F. J., Potter, P.E. and Siever, R, 1990: *Sand and Sandstone.* Springer Verlag.
Reading, J. G. 1996: *Sedimentary Environment and Facies.* Black well.
Reineck, H. E. and Singh, I.B., 1975: *Deposition Sedimentary Environment.* Spring-Verlag.
Selley, R. C., 1976: *Introduction of Sedimentology.* Academic Press, London.
Sengupta, S., 1997: *Introduction to Sedimentology.* Oxford-IBH.

GL14202CR Geochemistry

Theory:

Unit	Course content
1.	Introduction to geochemistry: Origin and abundance of elements in the solar system and in the Earth. Geochemical cycle of elements. Geochemical classification of elements: major elements, trace elements and PGEs. Goldschmidt's classification of trace elements. Goldschmidt's rules for ionic substitution.
2.	Major, Trace & Rare Earth Element (REE) Geochemistry: Concepts of partitioning and distribution coefficients of trace elements between solid and liquid phases vis-à-vis partial melting and magma generation. Distribution of REE in earth's mantle and crust. Introduction to analytical methods
3.	Radiogenic and cosmogenic isotope geochemistry, Stable isotope geochemistry (oxygen, hydrogen, carbon & sulphur): nature, abundance, fractionation and applications.

Practical:

Unit	Course content
4.	Geochemistry: Calculation CIPW norms, preparation of variation diagrams. Calculation of weathering indices in soil and sediments. Presentation of analytical data.

Books recommended:

Attendron, H. G., 1997: *Radioactive and Stable Isotopes Geology*. Pergamon Press.
Cox, P. A., 1995: *Elements of Earth.* Oxford Univ. Press.
Faure, G., 1986: *Principles of Isotope Geology.* John Wiley.
Garrels& Christ, 1966: *Solution Minerals and Equalibria*. Pergamon Press.
Gunter, F., *Principles and Applications of inorganic Geochemistry*.
Henderson, P., 1987: *Inorganic Geochemistry.* Pergamon Press.
Hoefs, J., 1980: *Stable Isotope Geochemistry.* Springer Verlag.
Krauskopf, K. B., 1967: *Introduction to Geochemistry.* McGraw Hill.
Marshal, C. P. and Fairbridge, R. W., 1999: *Encyclopedia of Geochemistry*. Kluwer Academic.
Mason, B. and Moore, C. B., 1991: *Introduction to Geochemistry.* Wiley Eastern.
Nordstrom, D. K. and Munoz, J. L., 1986: *Geochemical Thermodynamics*. Blackwell.
Raid, C. E., *Chemical Thermodynamics*. Chapman & Hall.

GL14203CR **Paleontology & Stratigraphy**

Theory:

Unit	Course content
1.	General aspects of paleobiology: Modern concepts of origin of life. Precambrian fossil record and Origin of Metazoa. Taphonomy and Fossil communities.
2.	Micropaleontology: Introduction to various groups of microfossils, their importance in geology and hydrocarbon exploration. Important plant fossils from Indian stratigraphic horizons. Vertebrate paleontology: Vertebrate fossils of Siwalik Group and their stratigraphic significance
3.	Stratigraphy: Introduction to sequence stratigraphy. Outline idea about Seismic Stratigraphy, Magnetostratigraphy, Pre-Cambrian and Phanerozoic stratigraphy of India. Boundary problems: Boundary problems in stratigraphy with reference to Precambrian - Cambrian, Permian -Triassic, KT boundary, Pliocene - Pleistocene boundaries.

Practical:

Unit	Course content
4.	Paleontology & Stratigraphy: Identification, classification and morphological study of selected invertebrate fossils with lavelled diagrams. Taxonomic study of selected Gondwana plant fossils. Study of selected important rocks & fossils from Indian stratigraphic horizons and preparation of statigraphic column.

Books recommended:

Arnold, C. A., 1947: An introduction to Paleobotany. McGraw - Hill Book Co.
Bignot, G., 1985: *Elements of Micropaleontology.* Graham andTrotman.
Brasier, M. D., 1980: *Microfossils.* George Allen &Unwin.
Clerkson, E. N. K., 1998: *Invertebrate Paleontology and evolution.* Black Well
Colbert, E. H, 1955: *Evolution of Vertibrate.* Jhon Wiley & sons, London.
Dunbar, C. O, Rodger, J., 1957: *Principles of stratigraphy.* Wiley International.
Glassner, M. F., 1945: *Principles of Micropaleontology.* Hafner Pub.
Krishanan, M. S., 1968: *Geology of India and Burma.* Higginbothams Pvt. Ltd., Madras.
Kumar, R, 1998: *Fundamentals of Historical Geology and Stratigraphy.* Wiley Eastern Limited.
Shork & Twenholf, 1987: *Principles of invertibrate Paleontology.* CBS Pub., N. Delhi.
Wadia, D. N., 1957: *Geology of India.* Mcmillan, London.
Weller, J. M., 1960: *Stratigraphy Principles &Practice.* Harper & Row Pub.
Wood, H., 1968: Paleontology invertebrate. CBS Pub., N. Delhi.

GL14204EA **Field Training**

Geological Field Training of 4 to 6 weeks shall be conducted at different parts of India.

GL14205EA **Oceanography**

Unit	Course content
1.	Oceanography: Ocean circulation: Horizontal circulation, vertical circulation. Circulation in different Oceans. Coastal erosion and Wave study. Changing levels of the Shoreline. Ocean circulation and climate change
2.	Waves: Characteristics, Wind-generated waves, Tsunami, Internal waves. Tides: Characteristics and origin, Tidal currents, Tides as a source of power.
3.	Composition of seawater – Classification of elements based on their distribution; major and minor constituents; behavior of elements; chemical exchanges across interfaces and residence times in seawater.
4.	Chemical and biological interactions – Ionic interactions; cycling and air-sea exchange of important biogenic dissolved gases; carbon dioxide-carbonate system; alkalinity and control of pH; abiotic and biotic controls of trace elements in the ocean; biological pump and controls on atmospheric composition

Books recommended:

Kennett, J. P., 1982: *Marine Geology.* Prentice Hall.
Pinet, P. R., 1992: *Oceanography, An Introduction to the Planet Oceanus.* West Pub. Co.
Seibold, E. and Berger, W. H., 1982: *The Sea Floor.* Springer-Verlag.
Smoot, N. C., Choi, D. R & Bhat, M. I., 2002. *Marine Geomorphology.* XLIBRIS Corp.
Smoot, N. C., Choi, D. R. & Bhat, M. I., 2002. *Active Margin Geomorphology.* XLIBRIS Corporation
Thurman, H. B., 1978: *Introductory, Oceanography.* Charles, E. Merrill Pub. Co.

GL14206EA **Disaster, Risk & Hazard Assessement**

Unit	Course content
1.	Principles of Disaster Management: Natural disasters, anthropogenic disasters hazards, risks and vulnerabilities. Assessment of disaster vulnerability of a location and vulnerable groups. Preparedness and mitigation measures for various disasters. Earthquake, floods, fire, landslides and other natural calamities. Information systems &decision making tools. Disaster management with respect to seismic, flood and other disaster prone areas of Jammu and Kashmir.
2.	Global scenarios of natural disasters: Climatic change and global sea rise, coastal erosion, environmental degradation (deforestation, changes in larger biomes, wetlands, lakes, etc), large dams and earthquake, road building and landslide, ports in cyclonic path, reclamation of land, urbanization and its intensity in eco-fragile area. Glacier related disasters.
3.	Remote sensing for disaster management: Satellite remote sensing for disaster management, real time disaster analysis and management, identification of flood prone areas using remote sensing and other ancillary data, post disaster analysis of inundated areas, area estimations, crop loss estimates etc. Forest fire identification and zonation using remote sensing data. Forest fire prevention strategies. Remote sensing based surveys for seismic zonation, identification of probable seismically active zones using geological studies.
4.	Geoinformatics for disaster assessment and management: Organizational structure for disaster management, disaster management schemes. Natural disasters and mitigation efforts, flood control, drought management, cyclones, avalanches, land use planning, operations management (OM). GPS for early warning system for earthquakes. Risk assessment and disaster response, Quantification techniques. Recent trends in disaster information provider laser scanning applications in disaster management, Statistical seismology, Quick reconstruction technologies.

Books recommended:

Aki, K. and P.G. Richards (2002) Quantitative Seismology, University Science Books, Sausalito, CA.
Bolt, B.A. (1992). Inside the Earth, W.H. Freeman, San Francisco.
Building safer cities, 2003.Alcira Kreime, Margaret Arnold,Anee Carlin, New York United Nations Press.
Collaborative Decision Making: Perspectives and Challenges,2008,Pascale Zarate, James and James science Publisher.
Iyer, H.M. and K. Hirahara (Eds.) (1993) Seismic Tomography Theory and Practice, Chapman & Hall, New York.
Landslides-Risk reduction. Kyoji Sassa, Paolo Canuti.. 2008, Kluwer Academic Publishers.
Lay, T. and T.C. Wallace (1995) Modern Global Seismology, Academic Press, San Diego.
Natural Hazards and Human-Exacerabated disasters, Edgardo Latrubesse. National University of Colombia.
Risk management and Society-Eve Coles, Denis Smith,Steve Tombs,2000

GL14207EA **Geophysical Exploration**

Unit	Course content
1.	Interrelationship between geology and geophysics - Role of geological and geophysical data in explaining geodynamical features of the earth.
2.	General and Exploration geophysics- Different types of geophysical methods; Gravity, magnetic, Electrical, Seismic- their principles and applications. Concepts and Usage of corrections in geophysical data.
3.	Geophysical field operations: Different types of surveys, grid and route surveys, profiling and sounding techniques, scales of survey, presentation of geophysical data. Application of Geophysical methods - Regional geophysics, oil and gas geophysics, ore geophysics, groundwater geophysics, engineering geophysics.
4.	Geophysical anomalies: Correction to measured quantities, geophysical, anomaly, regional and residual (local) anomalies, factors controlling anomaly, depth of exploration. Integrated geophysical methods - Ambiguities in geophysical interpretation, Planning and execution of geophysical surveys.

Books recommended:

Outlines of Geophysical Prospecting - A manual for geologists by Ramachandra Rao, M.B., Prasaranga, University of Mysore Mysore 1975.
Exploration Geophysics - An Outline by Bhimasarikaram Y.L.S., Association of Exploration Geophysicists, Osmania University,Hyderabad, 1990.
An introduction to Geophysical Prospecting by Oobrin, M.B. and Savit, C.H., McGraw Hill, New Delhi, 1988.
Applied Geophysics by Telford W.M. Geldart L.P., Sheriff, R.E. and Keys D.A. Oxford and IBH Publishing Co. Pvt., Ltd. New Delhi, 1976.

GL14208EA **Engineering Geology**

Unit	**Course content**
1.	Principles of engineering geology: Engineering properties and classification of rocks. Factors affecting engineering properties of rocks. Rock stability tests. Engineering properties of soils. Soil liquefaction and creep. Stress distribution in soils and foundation failures.
2.	Geological considerations for construction of dams, reservoirs, and tunnels Tunnel alignment and transportation routes. Methods of tunneling and various types of tunnel support.
3.	Geological consideration for construction of roads, buildings and bridges
4.	Mass movements with special emphasis on landslides and slope stability. Earthquakes and seismic zones of India. Case history of engineering projects and geological causes for failures of engineering structures and remedial measures

Books recommended:

Arms, K., 1990: Environmental Science. Saunders College Pub.
Bell, F. G., Engineering Properties of Soils and Rocks.
Bell, F. G., 1999: Geological Hazards their assessment, Avoidance & Mitigation. E&FN Spon London.
Bell, F. G., 1999: Geological Hazards. Routledge, London.
Bryant, E., 1985: Natural Hazards. Cambridge University Press.
Goodman, R. E., Engineering Geology.
Keller, E. A., 1978: Environmental Geology. Bell and Howell, USA.
Krynine, D. H. and Judd, W.R., 1998: Principles of Engineering Geology. CBS Pub.

GL14209EA **Marine Geology**

Unit	Course content
1.	Morphologic and tectonic domains of the ocean floor. Structure, composition and mechanism of the formation of oceanic crust. hydrothermal vents-. Ocean margins and their significance. Tectonic evolution of the ocean basins. Mineral resources.
2.	Ocean Circulation, Coriolis effect and Ekman spiral, convergence, divergence and upwelling, El Nino. Indian Ocean Dipole Thermohaline circulation and oceanic conveyor belt.
3.	Formation of Bottom waters; major water masses of the world's oceans. Oceanic sediments: Factors controlling the deposition and distribution of oceanic sediments; geochronology of oceanic sediments, diagenetic changes in oxic and anoxic environments.
4.	Reconstruction of monsoon variability by using marine proxy records. Opening and closing of ocean gateways and their effect on circulation and climate during the Cenozoic. Sea level processes and Sea level changes. Methods of paleo Sea Surface temperature.

Books recommended:

Kennett, J. P., 1982: Marine Geology. Prentice Hall.
Pinet, P. R., 1992: Oceanography, An Introduction to the Planet Oceanus. West Pub. Co.
Seibold, E. and Berger, W. H., 1982: The Sea Floor. Springer-Verlag.
Smoot, N. C., Choi, D. R &Bhat, M. I., 2002. Marine Geomorphology. XLIBRIS Corp.
Smoot, N. C., Choi, D. R. &Bhat, M. I., 2002. Active Margin Geomorphology. XLIBRIS Corporation
Thurman, H. B., 1978: Introductory,Oceanography. Charles, E. Merrill Pub. Co.

GL14210EO **Geology of Jammu & Kashmir**

Unit	Course content
1.	Stratigraphy-definition and principles. Geological timescale. Stratigrapahic correlation. Fossils, their characters, conditions necessary for fossilization; types of preservation and occurrence, importance of fossils in stratigraphy. Order of superposition. Age determination of rocks.
2.	Precambrian rocks of Kashmir. Precambrian-Cambrian boundary type section of Kashmir.
3.	Paleozoic succession of Kashmir. Permo-carboniferous Panjal traps of Kashmir. Triassic limestone of Kashmir. P/T boundary type section of Kashmir. Karewas of Kashmir.
4	Himalaya: tectonic division, evolution and geology. Geology of Ladakh. Siwalik Group, its classification and fauna.

Books recommended:

Arnold, C. A., 1947: An introduction to Paleobotany. McGraw - Hill Book Co.
Clerkson, E. N. K., 1998: *Invertebrate Paleontology and evolution.* Black Well
Dunbar, C. O, Rodger, J., 1957: *Principles of stratigraphy.* Wiley International.
Krishanan, M. S., 1968: *Geology of India and Burma.* Higginbothams Pvt. Ltd., Madras.
Kumar, R, 1998: *Fundamentals of Historical Geology and Stratigraphy.* Wiley Eastern Limited.
Wadia, D. N., 1957: *Geology of India.* Mcmillan, London.
Weller, J. M., 1960: *Stratigraphy Principles &Practice.* Harper & Row Pub.

General Instructions for the Candidates

1. The two year (4 semesters) PG programme is of 96 credit weightage i.e, 24 credits / semester (24x4=96).
2. A candidate has compulsorily to opt for 12 credits from the core component in each semester.
3. A candidate has a choice to opt for any 12 credits (3 papers) out of minimum of 16 credits (4 papers) offered as Electives (Allied), except for a particular semester as mentioned by the Department where a candidate is required to gain a minimum of 4 credits (1 paper) from Elective (open) offered by any other Department.
4. A candidate has compulsorily to obtain a minimum of 4 credits (1 paper) from Elective (open) from outside the parent Department in any of the semesters.
5. A candidate can earn more than the minimum required credits (i.e, more than 96 credits for four semester programme) which shall be counted towards the final result of the candidate.
6. Field Training (course code: GL-14-EA) is compulsory only for M.Sc. Applied Geology students. Every student of M.Sc. Applied Geology ought to opt for this course.

Choice based Credit System (CBCS)
Scheme and course structure for
M.Sc. Applied Geology 3rd semester effective from academic session 2015 and onwards

Course Code	Course Name	Paper Category	Hours per week			Credits
			L	T	P	
GL14301CR	Metamorphic Petrology	Core	3	0	2	3+1=4
GL14302CR	Hydrogeology	Core	3	0	2	3+1=4
GL14303CR	Remote Sensing in Geosciences	Core	3	0	2	3+1=4
GL14304EA	Term Work (compulsory)*	Elective (Allied)	0	8	0	4
GL14305EA	Petroleum Exploration	Elective (Allied)	3	2	0	3+1=4
GL14306EA	Fundamentals of GIS	Elective (Allied)	3	2	0	3+1=4
GL14307EA	Hydroinformatics	Elective (Allied)	3	2	0	3+1=4
GL14308EA	Himalayan Geology	Elective (Allied)	3	2	0	3+1=4
GL14309EA	Glaciology	Elective (Allied)	3	2	0	3+1=4
GL14310EO	Land and water resources of Kashmir	Elective (Open)	3	2	0	3+1=4
28 Credit= 38 Contact Hours			18	14	6	28
L= Lecture; T= Tutorial; P= Practical; * Compulsory for the Applied Geology Students						

GL14401CR **Metamorphic Petrology**

Theory:

Unit	Course content
1.	Introduction to metamorphic petrology: Metamorphism and metamorphic processes, factor controlling metamorphism, types of metamorphism, Index minerals, Mineral assemblages, Metamorphic differentiation. Metamorphic textures, Projection in positive and negative space; ACF, AKF and AFM diagrams.
2.	Metamorphic facies classification and systematic description of different types of metamorphism of pelitic, basic, ultra-basic and calcareous rocks.
3.	Metamorphic reactions: Basic characteristics of metamorphic reactions, solid-solid reactions, dehydration reactions, decarbonization and oxidation-reduction reactions and their implications to geothermo-barometry. Metasomatism and anataxis. Regional metamorphism and paired metamorphic belts in reference to plate tectonics. P-T-t paths.

Practical:

Unit	Course content
4.	Metamorphic Petrology: Megascopic and microscopic study of metamorphic rocks of different facies. Interpretation of metamorphic textures. Modal analysis. Chemo-graphic diagram (ACF & AFM ternary diagrams).

Books recommended:

Bucher, K. and Frey, M., 1994: Petrogenesis of Metamorphic rocks. Springer-Verlag.
Miyashiro, A., 1994: Metamorphic Petrology. UCL Press Ltd., London.
Philpotts, A., 1992: Igneous and Metamorphic Petrology. Prentice Hall.
Turner, F. J., 1960: Igneous and Metamorphic Petrology. Mc-Graw Hill, New York.
Turner, F. J., 1980: Metamorehic Petrology. McGraw Hill, New York. ‘
Turner &Verhoogen, 1999: Igneous and Metamorphic Petrology. CBS Pub.
Tyrrell, G. W., 1987: Principles of Petrology.CBS Pub
Yardley, B. W., 1989: An Introduction to Metamorphic Petrology. Longman, New York.

GL14402CR **Hydrogeology**

Theory:

Unit	Course content
1.	Introduction: Groundwater in the hydrologic cycle. Groundwater table – Groundwater table fluctuations and controlling factors. Subsurface inflow and outflow; Period of re-charge and discharge. Average groundwater fluctuations, effluent and influent streams. Elementary theory of groundwater flow: Darcy's law and its range of validity. Steady and unsteady flow. Hydrological properties of water-bearing materials: Porosity and permeability, transmissivity, storage coefficient, their definition and methods of determination. Water table maps and flow net analysis; differential equation for controlling groundwater flow. Well hydraulics: Steady, unsteady and radial flow into a well. Confined and leaky confined and unconfined aquifers. Determination of aquifer characteristics from pump-tests.
2.	Groundwater development: Groundwater exploration methods – geological & geophysical (resistivity, magnetic and seismic) methods. Borehole geophysical logging – electrical, resistivity and SP; Radiation logging – gama, gama-gama, and neutron logging. Cliper and temperature logging. Preparation of strata charts, design of tube well assembly and water well design criteria. Water level development and yield tests, well completion reports. Groundwater modeling techniques, data requirement.
3.	Groundwater basin management methods: Basic ideas of groundwater management. Water logging – causes and remedial measures; artificial recharge. Fresh and saltwater relationship in coastal areas. Quality and geochemistry of water: Groundwater quality analysis – sampling methods, bacteriological, chemical and physical quality. Quality criteria for drinking, irrigation and industrial purposes. Pollution of groundwater. Groundwater and hydro-chemical provinces of India.

Practical:

Unit	Course content
4.	Hydrogeology: Delineation of hydrological boundaries on water-table contour maps and estimation of permeability. Preparation of isohytal maps, Theissen's polygonal method. Analysis of aquifer performance test data Thiem's, Theis's and Jacob's method. Design of water well screen and gravel pack on the basis of mechanical analysis data of aquifer material. Analysis of hydrographs and estimation of infiltration capacity. Study of geophysical well logs. Estimation of TDS using resistivity and SP logs. Plotting of groundwater provinces of India.

Books recommended:

Chow, V. T, 1988: *Advances in Hydrosciences,* McGraw Hill.
Freeze, R. A. & Cherry, J. A., 1979: *Ground Water.* Prentice Hall.
Fetter, C. W., 1990: *Applied Hydrogeology.* Merill Publishing.
Karanth, K. R., 1987: *Groundwater Assessment-Development and Management.* Tata McGraw Hill.
Todd, D. K.., 1980: *Groundwater Hydrogeology* John Wiley.
Raghunath, N. M., 1982: *Ground Water.* Wiley Eastern.
Ragunath, H. M., 1997: *Hydrology,* Principles, Analysis, Design. New Age Pub.
Roa, K. L., 1979: India's Water Wealth, Orient Blackswan.

GL14403CR **Remote Sensing in Geosciences**

Theory:

Unit	Course content
1.	Remote sensing: basic concepts, fundamentals, data sources, Types of scanners and image acquisition: History and scope of remote sensing, concepts of remote sensing, electromagnetic radiations, matter interactions with atmosphere and terrain atmospheric windows, spectral reflectance of vegetation, soils, minerals and rocks. Elements of visual image interpretation. Factors governing image interpretation., verification and validation of RS data (Ground Truthing).
2.	Digital analysis of remote sensing data: Picture element and image statistics, Geometric and Radiometric Distortions, Pre-processing of satellite data (radiometric and geometrical corrections).Image enhancements techniques. Image filtering techniques. Spectral ratios and indices. Digital image classification: Supervised and unsupervised classification. Accuracy assessment: Sources of errors and measurement of map accuracy, kappa coefficient.
3.	Remote sensing applications to geosciences: Earth sciences: Lithology and structure (faults, folds), Environmental: Land use and land cover changes, monitoring erosion, urbanization and deforestation. Survey: cadastral mapping, digital terrain models. Hydrology: hydrological modeling and ground water prospecting.

Practical:

Unit	Course content
4.	Remote Sensing in Geosciences: Tutorial on different modules of image processing software; Import and export of satellite data; Different image and remote sensing data formats; Familiarization with the earth surface features on the images; Preparation of satellite data for analysis like rotate, reflect, subset, layer addition; Pre-processing of satellite data like image registration, geo-correction, filtering, image enhancements, math operations; Image ratios and other remote sensing and geological indices like SAVI; Lithologic, land use/land cover feature identification Familiarization with GIS software systems.

Books recommended:

Burrough, P.A., 2003: *Principles of Geographic Information* Systems. Oxford University Press.
Campbell, J., 2002: *Introduction to Remote Sensing.* Guilford Press, New York.
Demers, M. N., 1999: *Fundamentals of Geographic Information Systems.* John Wiley.
Jensen, J. R., 2004: *Remote Sensing of the Environment.* Prentice Hall, New Jersey.
John, A. Richards, 1993: *Remote Sensing Digital Image Analysis.* Springer-Verlag.
John, R. Jensen, 2000: *Introductory Digital Image Processing, A Remote Sensing Perspective.*
Lillesand, T. M. and Kiefer, R. W., 1987: *Remote Sensing in Geology.* John Wiley. Prentice Hall, New Jersey.
Lillesand, T. M. and Kiefer, R. W., 2002: *Remote Sensing and Image Interpretation, J. Wiley*
Rees, W. G., 2001: *Physical Principles of Remote sensing.* Cambridge University Press.
Sabbins, F. F., 1985: *Remote Sensing - Principles and Applications.* Freeman.

GL14304EA Term work (Compulsory only for Students of M.Sc. Applied Geology)

Term work shall be discipline centric, and each candidate (of Applied Geology) has to complete term work on his own with an advisory support by the concerned teacher. The objective of term work is that the students shall learn how to apply knowledge in solving /studying /exploring difficult scientific problem in a creative way.

GL14305EA **Petroleum Exploration**

Unit	Course content
1.	Source rocks, reservoir rocks and different types of traps. Amount, type and maturation of organic matter. Petroleum and source rock correlation. Locating petroleum prospects based on principles of petroleum generation and migration (geological modeling). Quantitative evaluation of Petroleum and gas prospects through geochemical modeling. Migration modeling. Inputs for the assessment of accumulation of petroleum
2.	Geophysical methods of Hydrocarbon exploration. Interpretation of seismic data in basin modeling and preparation of subsurface geological maps.
3.	Petroleum basins: Basin studies and basin analysis. Basin classification in plate tectonics. Fundamental types of petroliferous basin; relation between basin type and hydrocarbon richness. Factors favoring hydrocarbon abundance. Petroleum provinces of India and world Case studies of some giant oil fields
4.	Elements of well drilling: Cable-tool drilling, rotary drilling, various types of drilling units. Elements of logging. Electric, radioactive and sonic logs. Nuclear magnetic resonance and dielectric logging Application of logs in petro-physical analysis and facies analysis

Books recommended:

Guillemot, J., 1986: Oil and Gas Exploration Techniques. Additions Technip.
Glennie, K. W., 1998: Petroleum Geology of the North Sea. Blackwell Science.
Holson, G. D. and Tiratsoo, E.N., 1985: *Introduction Petroleum Geology.* Gulf Pub. Houston,
Keller, S. E., 1994: *Mineral Resources, Economic and the Environment.* McMillan College Pub.
Levarson, 1985: *Geology of Petroleum.* CBS Pub.
Landon, R. C., 1996: Principles of Petroleum Development Geology. Printice Hall.
North, F. K., 1985: *Petroleum Geology.* Allen &Unwin
Salley, R. C., 1988. *Elements of Petroleum Geology.* Academic Press.
Tedesco, S. A., 1995: Surface Geochemistry in Petroleum Exploration. Chapman Hall.
Tissot, B. P. &Welte, D. H., 1984: *Petroleum Formation and Occurrence*, Springer Verlag.

GL14306EA **Fundamental of GIS**

Unit	Course content
1.	GIS basics: Introduction, Definition, historical perspective, Components of GIS, types of GIS. Concept of data, information, knowledge and intelligence. Data acquisition, Spatial and non-spatial data; Data formats Modes of data acquisition - Primary and secondary data acquisition ; surveying, GPS, remote sensing. Data input: Method and Importance of integration of spatial and non spatial data
2.	Data models: Concept and types, Raster data model, Vector data model, Advantages and disadvantages of raster and vector data models, issue related to data model conversation. Topology Topological Relationships; topology building and its applications, Digitization, errors, editing
3	Geospatial analysis: Introduction, vector-based analysis (Non-topological and topological functions with examples of each type), Raster-based analysis (Local operations, neighborhood operations, extended neighborhood operations, regional operations with examples of each type). Network analysis: concept and applications. Applications of raster and vector data models
4	Utility mapping using GIS, Wild life habitat analysis, Land suitability analysis, Geoinformatics for Environmental impact analysis (EIA), Disaster vulnerability analysis (seismic microzonation, landslide hazard zonation), Geoinformatics for Land information System (LIS).

Books recommended:

Burrough, P. A., 2003: *Principles of Geographic Information* Systems. Oxford University Press.
Campbell, J., 2002: *Introduction to Remote Sensing.* Guilford Press, New York.
Demers, M. N., 1999: *Fundamentals of Geographic Information Systems.* John Wiley.
Jensen, J. R., 2004: *Remote Sensing of the Environment.* Prentice Hall, New Jersey.
John, A., Richards, 1993: *Remote Sensing Digital Image Analysis.* Springer-Verlag.
John, R., Jensen, 2000: *Introductory Digital Image Processing, A Remote Sensing Perspective.*
Lillesand, T. M. and Kiefer, RW., 1987: *Remote Sensing in Geology.* John Wiley. Prentice Hall,
Lillesand, T. M. and Kiefer, RW, 2002: *Remote Sensing and Image Interpretation,* John Wiley.
Rees, W. G., 2001: *Physical Principles of Remote sensing.* Cambridge University Press.
Sabbins, F. F., 1985: *Remote Sensing - Principles and Applications.* Freeman
Skidmore, A., 2002. *Environmental modeling with GIS and Remote Sensing.* Taylor& Francis, London.
Longley, D. A., Gordchild, M. F., Maguire, D. J. and Rhind, D. W., 2001: *Geographic Information System & Scien*
John Wiley & Sons.

GL14307EA **Hydroinformatics**

Unit	Course content
1.	Hydrological cycle and processes; Hydrological Processes: Precipitation, Evaporation, Transpiration, interception, Infiltration, Percolation and Groundwater recharge. Global water resources. Water resources in Kashmir Himalayas. Water resource assessment methods. Importance of hydrology to society w.r.t. Jammu and Kashmir state. Water Resources Planning and Management. Hydrometeorology. Biogeochemical cycling, Watershed management and conservation principles. Eco-hydrology, Land water interactions. Statistical analysis of hydro-meteorological data.
2.	Remote sensing for surface and ground water; Remote sensing techniques for water resources assessment: Interpretation of satellite data for water resources, impact of spatial resolution on water resources mapping, Monitoring the surface extent of water bodies. Surface water bodies mapping (visual interpretation and digital image processing for mapping irrigation tanks, ponds, reservoirs, lakes etc.). Role of remote sensing for quantifying the hydrological processes. Groundwater exploration using remote sensing and GIS. Geophysical investigations for Ground Water Hydrology.
3.	Geoinformatics for water resources; Watershed characterization and hydrological modelling. Concept of Runoff and overland flow, Factors affecting runoff processes. Watershed factors that affect runoff: size, topography, shape, orientation, aspect, geology, soil interflow and base flow. Geoinformatics for Watershed conservation and planning, DEM applications in water resources. Water quality and quantity modelling using remote sensing and GIS.
4.	Snow and Glacier studies using Geoinformatics: Snow and glacier resources of Kashmir. Climate change and glaciers. visible, infrared and microwave remote sensing for snow and glacier studies. Normalized Difference Snow Index (NDSI) and other ratio methods for snow/glacier mapping. Snow hydrology, snowmelt run-off modeling. Glacier inventory (areal extent, depth) Change detection studies of glaciers. Mass balance studies of glaciers. Traditional and remote sensing approaches for snow parameter retrieval (snow depth, snow water equivalence, snow density).

Books recommended:

Chow, V. T, 1988: *Advances in Hydrosciences,* McGraw Hill.
Freeze, R. A. & Cherry, J. A., 1979: *Ground Water*. Prentice Hall.
Fetter, C. W., 1990: *Applied Hydrogeology.* Merill Publishing.
Karanth, K. R., 1987: *Groundwater Assessment-Development and Management.* Tata McGraw Hill.
Todd, D. K.., 1980: *Groundwater Hydrogeology* John Wiley.
Raghunath, N. M., 1982: *Ground Water.* Wiley Eastern.
Ragunath, H. M., 1997: *Hydrology*, Principles, Analysis, Design. New Age Pub.
Roa, K. L., 1979: India's Water Wealth, Orient Blackswan.

GL14308EA **Himalayan Geology**

Unit	Course content
1.	Major lithotectonic divisions of India. The Himalaya: Formation of Tethys, its paleogeography. Geographical subdivisions, lithological units of Himalayas and their correlation.
2.	Geology of Outer Himalaya, Lesser Himalaya, Tethys Himalaya, Higher Himalayan Crystallines, Suture Zone and Trans-Himalaya,
3.	Tectonic evolution of the Himalaya with special reference to collision zone.
4.	Mineral resources of Himalaya. Major environmental issues in Himalaya: earthquakes, landslides, GLOFs, snow avalanches, floods, cloudburst. Glaciation in Himalaya

Books recommended:

Gass I.G. et al 1982: Understanding the Earth. Artemis Press (Pvt.) Ltd. U.K.
Windley B. 1973: The Evolving continents. John Wiley & Sons, New York.
Condie, Kent. C. 1982. Plate Tectonics and Crystal Evolution Pergamon Press Inc.
Gansser, A.Geology Of Himlayas,
Cox , Plate Tectonicsa and Geotectonic reversal,
Heim and Gansser, Central Himalaya,
Sinha, A.K., 1989. Geology of Higher Central Himalaya,
Sinha, A. K., Sassi, F. P. and Papinikolaou, D., 1997. Geodynamic domains in the Alpine- Himalayan Tethys,
Sinha, A.K., 1992. Himalayan Orogen and Global Tectonics.
Thakur, V. C., 1992. .Geology of Western Himalaya,
Sharma, K. K., 1991. Geology and Geodynamic evolution of the Himalayan Collission Zone.
Thakur, V. C. and Sharma, K. K., 1983. Geology of the Indus Suture Zone of Ladakh.

GL14309EA Glaciology

Unit	Course content
1.	Glaciers: Glacier Formation, glacier features and types. Movement of glaciers and transport by glaciers. Glacier and ice sheet reconstructions. Glacial deposits, Glacial and interglacial periods. Glacial Sedimentation and landforms of glacial deposition on land. Subglacial landforms formed by ice or sediment flow. Glacial sedimentation in water. Landforms of glacial deposition in water.
2.	Himalayan cryosphere; extent, status and behavior; Glacier surge phenomena, Last glacial maximum with special references to alpine glacial system; Glacier dynamics: ELA, AAR, velocity; Glaciers as fresh water reserves, contribution of glacier and snow to stram-flows. Instrumentation for glacier studies;
3.	Mass balance studies of glaciers; geological, photogrammetric, GPS/GPR mass balance. Use of remote sensing for snow and glacier studies; glacier geometry and dynamics, mass balance, remote sensing approaches for snow parameter retrieval (snow cover, snow depth, snow water equivalence, snow density). Snow depletion curves., Glacier Facies.ice sheets and fluctuations in sea levels.
4.	Snow and glacier resources of Kashmir. Climate change and glaciers. Snow hydrology, snowmelt run-off modeling. Black carbon deposition on glaciers and its impacts on melting, and other feedbacks. Impacts of changing Himalayan cryosphere on political stability in south Asia.

Books recommended:

Bennett, M. R. and Glasser, N. F., 2000. Glacial Geology Ice Sheets and Landforms. Wiley
Sharp, M., Richards, K. S. and Tranter M., 1998. Glacier Hyrology and Hydrochemistry. Wiley
Allan, T. D.: Satellite microwave remote sensing. Chichester, Ellis Hardwood
Benn D.I. and Evans J A D., 1997. Glaciers and Glaciation.Woody's Books USA
Hubbard, B. and Glasser N. F. 2005. Field Techniques in Glaciology and Glacial Geomorphology. Wiley

GL14310EO **Land and water resources of Kashmir**

Unit	Course content
1.	Renewable resources: Forests: definition, types and distribution in Kashmir. Soil: definition, classification, formation and distribution in Kashmir.
2.	Economic mineral resources: Origin of petroleum. Reservoir and Source rocks – definition and types. Oil traps-definition and types. Coal: formation and classification of coal. Petroleum prospecting in Kashmir.
3.	Ore minerals and gangue. Mineral deposit classification. Mode of occurrence, uses and distribution of following minerals in Kashmir: Iron, Copper, Lead-Zinc, Gold, Sapphire. Uses and distribution of Marble, Granite, Basalt, Limestone and Slate in Kashmir.
4	Water resources: Rivers- types and major rivers of Kashmir. Glaciers- types and major glaciers of Kashmir. Lakes-types and major lakes of Kashmir. Springs-types and major springs of Kashmir. Ground water: concept and scope. Hydrological cycle and its components. Water quality standards for drinking purposes.

Books Recommended:

Bamzai, P. N. K (1994), Culture And Political History Of Kashmir (3 Vols. Set), M.D. Publications, ISBN 978-81-85880-31-0.
Sir Walter Roper Lawrence (1895). The Valley of Kashmir. Asian Educational Services, 1895. ISBN 9788120616301.
Raina A. N. (2002) Geography of Jammu & Kashmir State . Radha Krishan Anand & Co. Pacca Danga, Jammu.
Qazi S.A. (2005). Systematic Geography Of Jammu And Kashmir. APH Publishing, 2005. ISBN 8176487864, 9788176487863.
Evan, A. M., 1983: *Ore Geology and industrial Minerals.* Blackwell.
Holson, G. D. and Tiratsoo, E. N., 1985: *Introduction Petroleum Geology.* Gulf Pub. Houston,
Jensen, M. L. and Bateman, A. M., 1981: *Economic Mineral Deposits,* John Wiley.
Keller, S. E., 1994: *Mineral Resources, Economic and the Environment.* McMillan College Pub.
Levarson, 1985: *Geology of Petroleum.* CBS Pub.
Prasad, U., 1996: *Economic Geology.* CBS Pub. N. Delhi.

General Instructions for the Candidates

1. The two year (4 semesters) PG programme is of 96 credit weightage i.e, 24 credits / semester (24x4=96).
2. A candidate has compulsorily to opt for 12 credits from the core component in each semester.
3. A candidate has a choice to opt for any 12 credits (3 papers) out of minimum of 16 credits (4 papers) offered as Electives (Allied), except for a particular semester as mentioned by the Department where a candidate is required to gain a minimum of 4 credits (1 paper) from Elective (open) offered by any other Department.
4. A candidate has compulsorily to obtain a minimum of 4 credits (1 paper) from Elective (open) from outside the parent Department in any of the semesters.
5. A candidate can earn more than the minimum required credits (i.e, more than 96 credits for four semester programme) which shall be counted towards the final result of the candidate.
6. Term work (course code: GL-24-EA) is compulsory only for M.Sc. Applied Geology students. Every student of M.Sc. Applied Geology ought to opt for this course.

Choice based Credit System (CBCS)
Scheme and course structure for
M.Sc. Applied Geology 4th semester effective from academic session 2015 and onwards

Course Code	Course Name	Paper Category	Hours per week			Credits
			L	T	P	
GL14401CR	Geomorphology	Core	4	0	0	4
GL14402CR	Project work	Core	0	16	0	8
GL14403EA	Rock Deformation and Structural Analysis	Elective (Allied)	3	2	0	3+1=4
GL14404EA	Sedimentary Environment and Sedimentary Basins	Elective (Allied)	3	2	0	3+1=4
GL14405EA	Advanced Hydrogeology	Elective (Allied)	3	2	0	3+1=4
GL14406EA	Advanced Remote Sensing and GIS	Elective (Allied)	3	2	0	3+1=4
GL14407EA	Himalayan Tectonics	Elective (Allied)	3	2	0	3+1=4
GL14408EO	Natural Disasters	Elective (Open)	3	2	0	3+1=4
24 Credit= 35 Contact Hours			13	22	0	24
L= Lecture; T= Tutorial; P= Practical						

GL14401CR **Geomorphology**

Unit	Course content
1.	Overview of geomorphology: Geomorphic processes and resulting landforms. Geomorphological cycle. Soils: development and classification. Morphometric analysis of basins, relationship of morphometric parameters with discharge and sediment yield characters of basins. Morphometric evolution of Western Himalaya.
2.	Introduction to Tectonic Geomorphology: Energetics, Active Tectonics & Models of landscape development. Controversies in tectonic geomorphology. Geomorphic Markers: Planer and linear geomorphic markers. Landform dating techniques: Relative – Clast seismic velocity method, Weathering rinds, Obsidian hydration rinds, Soil development and Carbonate coating method, Lichenometry; Absolute – Tree rings, Luminescence dating.
3.	Geomorphic Expression of Faults.Palaeoseismology. Field techniques in Paleoseismology: Principles and practice. Use of liquefaction-induced features for Paleoseismic analysis. Quaternary geomorphology: Cycles of climatic change (glacial and interglacial, pluvial and interfluvial) and their effect on landforms. Geomorphic sub-divisions of Indian subcontinent and their geomorphic features and evolution with special reference to Himalaya.

Books recommended:

Bloom, A. L., 2002: *Geomorphology, A Systematic Analysis of Late CenozoicLand Forms.* Prentice Hall Pvt. Ltd., N. Delhi.
Burbank, D. W. and Anderson, R.S., 2001: *Tectonic Geomorphology* Blackwell Sciences Easterbrook, Easterbrook, 1994: *Surface Processes and Land Forms.* Prentice Hall.
McCalpin, J., 1996: *Paleoseismology* Academic Press.
Pitty, A. F, 1982: *Nature of Geo-Morphology.* University Paper Backs.
Ritter, D. F., 1978: Process Geomorphology. Wm. C. Brown Publishers, Lowa
Sharma, V. K., 1986: *Geomorphology.* Tata McGraw Hill.
Thorrenberry, W. D., 1997: *Principles of Geomorphology* New Age International, Delhi.
Vishwas, S. K and Gupta, A., 2001: *Introduction to Geomorphology* Orient Longman.

GL14402CR **Project work**

Project work shall be discipline centric, and every student shall do the project work under the supervision of a teacher. The Dissertation must be typed and be limited to 50-75 pages of A4 size. The project work must be evaluated by one external and one internal examiner followed by presentation of work and viva voce.

GL1403EA **Rock Deformation and Structural Analysis**

Unit	Course content
1.	Deformation behavior of rocks, Stress and strain in rocks, principles and methods of stress and strain analysis. Different mechanism of deformation in rocks.
2.	Classification and characteristic structure and textures of different types of fault rocks. Ductile shear zones: types, criteria for sense of shear and mechanism of development.
3.	Fault related folding: geometry and mechanism of development of different types of fault related folds and other structures in compressional regimes, extensional regimes and strike slip regimes.
4.	Exercises on stress and strain analysis and balanced cross-sections. Interpretation of different types of deformation mechanism in thin sections.

Books recommended:

Davis, G.R., 1984: Structural Geology of Rocks and Region. John Wiley.
Ghosh. S. K., 1995: Structural Geology Fundamentals of Modem Developments. Pergamon Press.
Hobbs, B. E., Means, W. D. and Williams, P.F., 1976: An Outline of Structural Geology. John Wiley.
Lisle, R. J., 1988: Geological Strain Analysis. Pergamon.
Price, N. J. and Cosgrove, J. W., 1990: Analysis of Geological Structure. CambridgeUniv. Press.
Ramsay, J. G. and Huber, M. I., 1987: Modem Structural Geology, Vol. 1&/1. Academic Press.
Ramsay, J. G., 1967: Folding and fracturing of Rocks. McGraw Hill. ,
Turner, F. J. and Weiss, L. E., 1963: Structural Analysis of Metamorphic Tectonites. McGraw Hill.

GL14404EA Sedimentary Environment and Sedimentary Basins

Unit	Course content
1.	Kinds of sedimentary particles: Morphology of clastic, nonclastic and pyroclatic particles and their use in provenance studies. Study of laboratory techniques in sedimentological studies.
2.	Processes of dolomitization and Phosphatization. Origin of various types of cements. Use of trace fossils, stramatolites, thrombolites and related structure in palaeo-environmental analysis. Methods of palaeocurrent determination and basin analysis.
3.	Tectonic evolution of the sedimentary basins. Sedimentary cycles, rhythemes and cyclothems. Analysis of sedimentary facies.
4.	Sedimentation pattern and depositional environment of selected sedimentary basins with special reference to Karewas, Indo-Gangetic plain and Siwaliks.

Books recommended:

Bhattacharya, A. and Chakraborti, C., 2000: Analysis of Sedimentary Successions. Oxford
Blatt, H., Murray, G. V. and Middleton, R. C., 1980: Origin of Sedimentary Rocks. CBS, N. Delhi.
Davis, R. A. Jr., 1992: Depositional Systems. Prentice Hall.
Einsele, G., 1992: Sedimentary Basins. Springer Verlag.
Friedman, G. M. and Sander, J. E., 1978: Principles of Sedimentology John Wiley.
Miall, A. D., 2000: Principles of sedimentary Basin Analysis. Springer-Verlag.
Prothero,D. R.Schwab, F., 1996: Sedimentary Geology. Freeman.
Reading, J. G. 1996: Sedimentary Environment and Facies. Black well.
Reineck, H. E. & Singh, I. B., 1975: Deposition Sedimentary Environment. Springer-Verlag.
Tucker, M. 1988: Techniques in Sedimentology. Blackwell.

GL14405EA **Advanced Hydrology**

Unit	Course content
1.	Hydrographic analysis: Annual, seasonal and storm hydrographs; Water balance studies; Hydrological equilibrium equations, determination of various components at watershed and basin scale, determination of recharge by stream hydrograph and base flow separation; Geological and structural controls of groundwater occurrence (give some case studies); Water level maps; groundwater-surface water interaction.
2.	Partial differential equations governing groundwater flow; Groundwater hydraulics: Groundwater system, groundwater flow equations, Darcy's law, steady and transient unidirectional and radial flow to a well in confined and unconfined conditions, estimation of aquifer parameters with the help of pumping tests.
3.	Groundwater modeling and management: Groundwater budgets, artificial recharge, conjunctive use of surface and groundwater, trends in water resources management; Mathematical modeling: concept, boundary conditions, analytical and numerical methods of solution, Finite element and finite difference models for steady state and transient flow, MODFLOW- introduction, Indian case studies.
4.	Groundwater chemistry: groundwater solution and its chemical constituents, Mineral dissolution, chemical reactions and chemical equilibrium, water-rock interactions, ion exchange; Environmental isotopes in hydrogeology: stable isotopes (oxygen and deuterium), radioisotopes (tritium and carbon-14), isotope fractionation, Global meteoric water line, regional/local meteoric water line, stable isotopes in precipitation- continental, seasonal and altitude effects.

Books recommended:

Chow, V. T., 1988: Advances in Hydrosciences, McGraw Hill.
Fetter, C. W., 1990: Applied Hydrogeology, Merill Publishing.
Freeze, R. A. & Cherry, J. A., 1979: Ground Water. Prentice Hall.
Karanth, K. R, 1987: Groundwater Assessment-Development and Management. Tata McGraw Hill.
Raghunath, N. M., 1982: Ground Water. Wiley Eastern.
Todd, D. K., 1980: Ground water Hydrogeology. John Wiley.
Walton, W. C., 1988: Ground Water Resources Evaluation. McGraw Hill.

GL14406EA **Advanced Remote Sensing & GIS**

Unit	Course content
1.	Space borne remote sensing system and platforms: IRS, LANDSAT, SPOT, and IKONOS. Multi-spectral and hyper-spectral remote sensing, Geophysical Remote Sensing, Active Microwave remote sensing: SAR images, wavelength, penetration, polarization, topographic influences on SAR images, radar interferometry. Thermal remote sensing: Thermal infrared radiation properties, thermal radiation laws and thermal properties of the terrain.
2.	Multivariate image statistics, Optical remote sensing data filters, radar speckle/noise removal techniques, image data formats (BSQ, BIP and BIL), image ratios, Georeferencing and mosaicing of satellite data, data fusion techniques: integration of optical, radar and geospatial data. Knowledge based image classification, Post classification processing of data, classification accuracy estimation.
3.	Remote sensing application to geosciences: Complimentary use of remote sensing, GIS and field observations. Geological mapping (lithology, structural mapping of faults, folds and suture zones). Use of remote sensing data for snow and glacier mapping, change detection studies (deforestation), Remote sensing for crustal deformation, morphometric and hydrological analysis.
4.	Geospatial data representation techniques, database management systems, Surface mapping and interpolation methods, Digital Elevation Model (DEM) and its development from point, contour and stereo-image data, raster and vector data analysis, Applications of GIS for drainage analysis and active tectonics, use of GIS for flood risk assessment and landslide hazard zonation.

Books recommended:

Burrough, P. A., 2003: Principles of Geographic Information Systems. Oxford University Press.
Campbell, J., 2002: Introduction to Remote Sensing. Guilford Press, New York.
Demers, M. N., 1999: Fundamentals of Geographic Information Systems. John Wiley.
Jensen, J. R., 2004: Remote Sensing of the Environment. Prentice Hall, New Jersey.
John, A., Richards, 1993: Remote Sensing Digital Image Analysis. Springer-Verlag.
John, R., Jensen, 2000: Introductory Digital Image Processing, A Remote Sensing Perspective.
Lillesand, T. M. and Kiefer, R W., 1987: Remote Sensing in Geology. John Wiley. Prentice Hall,
Lillesand, T. M. and Kiefer, RW, 2002: Remote Sensing and Image Interpretation, John Wiley.
Rees, W. G., 2001: Physical Principles of Remote sensing. Cambridge University Press.
Sabbins, F. F., 1985: Remote Sensing - Principles and Applications. Freeman
Skidmore, A., 2002. Environmental modeling with GIS and Remote Sensing. Taylor& Francis, London.
Longley, D. A., Gordchild, M. F., Maguire, D. J. and Rhind, D. W., 2001: Geographic Information Systems and Science. John Wiley & Sons.

GL14407EA **Himalayan Tectonics**

Unit	Course content
1.	Diastrophism: Introduction to Epeirogenic and Orogenic movements, Orogenies in space and time. Fundamental concept of Continental Drift, Sea floor spreading, Palaeomagnetism, Polar Wandering and reversal of earth's magnetic field. Geomagnetic time scale. Plate Tectonics: Concept of Plate Tectonics, Nature and types of Plate Margins, Geometry and Mechanism of Plate Motion.
2.	The Himalaya: Origin and evolution of Himalaya, Phases of upheaval of Himalaya. Longitudinal, latitudinal and geotectonic division of Himalaya. Brief introduction about the geology and regional framework of different tectono-units of Himalaya.
3.	Tectonic framework and geological features of of Mollase Zone of Siwalik foothills. Paleographic, paleoecology and paleoclimatic reconstruction of Outer Himalaya. Tectonic framework and geological features of Kashmir Lesser Himalaya with special reference to biostratigraphy of Kashmir Himalaya.
4.	Tectonic framework and geological features of Crystalline rocks of Higher Himalaya crystalline and Tethyan sediments of NW Himalaya. Tectonic framework and geological features of Flysh & Mollase sediment Indus Suture Zone, Indus ophiolies and ophiolitic Melange, Petrology and Geochemical characterization of Granitic, volcanic rocks of NW Trans-Himalaya.

Books recommended:

Gass I.G. et al 1982: Understanding the Earth. Artemis Press (Pvt.) Ltd. U.K.
Windley B. 1973: The Evolving continents. John Wiley & Sons, New York.
Condie, Kent. C. 1982. Plate Tectonics and Crystal Evolution Pergamon Press Inc.
Gansser, A.Geology Of Himlayas,
Cox , Plate Tectonicsa and Geotectonic reversal,
Heim and Gansser, Central Himalaya,
Sinha, A.K., 1989. Geology of Higher Central Himalaya,
Sinha, A. K., Sassi, F. P. and Papinikolaou, D., 1997. Geodynamic domains in the Alpine- Himalayan Tethys,
Sinha, A.K., 1992. Himalayan Orogen and Global Tectonics.
Thakur, V. C., 1992. .Geology of Western Himalaya,
Sharma, K. K., 1991. Geology and Geodynamic evolution of the Himalayan Collission Zone.
Thakur, V. C. and Sharma, K. K., 1983. Geology of the Indus Suture Zone of Ladakh

GL14408EO Natural Disasters

Unit	Course content
1.	Earthquake: definition, types, magnitude and intensity. Seismic waves: types. Seismographs and seismograms. Elastic rebound theory. Earthquake location: Focus, epicentre and hypocenter; Earthquake belts; Focal depth of earthquakes. Earthquake Prediction and precautionary measures. History of earthquakes in Kashmir.
2.	Landslides: definition, classification, prevention measures/ methods. Landslide prone areas along Srinagar to Jammu national highway.
3.	Floods: definition, classification, prevention and precautionary measures. History of floods in Kashmir. Coastal hazards, Hazards on Indian coasts, Cyclones and their mitigation methods.
4	Cloudburst: definition, types, causes, prediction, precautionary measures. Sea level rise: impacts and risks. Desertification: causes, impact and assessment.

Books Recommended:

Natural Hazards-Cambridge University Press, by Bryant, E., 1985.
The Dynamic Earth System-Prentice Hall, by Patwardhan, A.M., 1999.
Geological Hazards-Routledge, London, by Bell, F.G., 1999.
Natural Hazards: Earth's Processes as Hazards, Disasters, and Catastrophes (3rd Edition) by Edward A. Kellerand Duane E. DeVecchio, 2011.
Natural Hazards and Disasters by Donald Hyndman and David Hyndman, 2013.
The Disaster Diaries: How I Learned to Stop Worrying and Love the Apocalypse by Sam Sheridan, 2013

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