M.Sc. (Tech) GEOLOGY
Department of Geology
Banaras Hindu University

Semesterwise Courses and Credits

SEMESTER – I		
Course Code	**Title**	**Credits**
GLM101	Structural Geology and Tectonics	3
GLM102	Mineralogy and Crystallography	3
GLM103	Igneous Petrology	3
GLM104	Metamorphic Petrology and Thermodynamics	3
GLM105	Practicals connected with GLM101	2
GLM106	Practicals connected with GLM102	2
GLM107	Practicals connected with GLM103	2
GLM108	Practicals connected with GLM104	2
GLM109M #	Minor Elective: Earth System – Frontier areas (*for students of other PG Programmes*) Minor Elective: (for Geology students)	3
	TOTAL	**23**
SEMESTER – II		
GLM201	Geomorphology and Remote Sensing	3
GLM202	Sedimentology	3
GLM203	General and Invertebrate Paleontology	3
GLM204	Stratigraphy	3
GLM205	Geological Field Training	5
GLM206	Practicals connected with GLM201	2
GLM207	Practicals connected with GLM202	2
GLM208	Practicals connected with GLM203	2
GLM209	Practicals connected with GLM204	2
GLM210M #	Minor Elective: Life through ages (*for students of other PG Programmes*) Minor Elective: (for Geology students)	3
	TOTAL	**28**
SEMESTER – III		
GLM301	Coal Geology	3
GLM302	Ore Geology	3
GLM303	Hydrogeology	3
GLM304	Micropaleontology and Oceanography	3
GLM305	Practicals connected with GLM301	2
GLM306	Practicals connected with GLM302	2
GLM307	Practicals connected with GLM303	2
GLM308	Practicals connected with GLM304	2
GLM309M #	Minor Elective: Environmental Geology (*for students of other PG Programmes*) Minor Elective: (for Geology students)	3
	TOTAL	**23**
SEMESTER - IV		
GLM401	Petroleum Geology	3
GLM402	Geochemistry	3
GLM403	Geological Field Training	5
GLM404	Practicals connected with GLM401	2
GLM405	Practicals connected with GLM402	2
MAJOR ELECTIVE (any two of GLM406, 407 & GLM408 and corresponding practicals**)**		
GLM406	Mineral Exploration and Mineral Economics	3
GLM407	Basin Analysis	3
GLM408	Applicative Paleobiology	3
GLM409	Practicals connected with GLM406	2
GLM410	Practicals connected with GLM407	2
GLM411	Practicals connected with GLM408	2
	TOTAL	**25**

SEMESTER - V		
MAJOR ELECTIVE: GROUP-A (**any three of GLM501, GLM502, GLM503 & GLM504 and corresponding practicals**)		
Course no.	**Title**	**Credit**
GLM501	Marine Geology	3
GLM502	Environmental Geology and Natural Hazards	3
GLM503	Elements of Mining, Ore Dressing and Surveying	3
GLM504	Engineering Geology and Geophysical Exploration	3
GLM505	Practicals connected with GLM501	2
GLM506	Practicals connected with GLM502	2
GLM507	Practicals connected with GLM503	2
GLM508	Practicals connected with GLM504	2
MAJOR ELECTIVE: GROUP-B (**any three of GLM509 to GLM516**)		
GLM509	Applicative Paleobotany and Palynology	3
GLM510	Applied Vertebrate Paleontology	3
GLM511	Gemology	3
GLM512	Computer Application and Instrumentation in Geology	3
GLM513	Soil Geology	3
GLM514	Sequence Stratigraphy	3
GLM515	Planetary Geoscience	3
GLM516	Paleobiogeography and Plate Tetonics	3
	TOTAL	**24**
SEMESTER - VI		
GLM601	**PROJECT ORIENTED DISSERTATION**	**22**
	GRAND TOTAL	**145**

M.Sc. (Tech) Geology students will opt 3 Minor Electives (3 credit each in semester I, II & III) offered by other PG Programmes of Faculty.

M.Sc. (Tech.) GEOLOGY
DEPARTMENT OF GEOLOGY
BANARAS HINDU UNIVERSITY

Candidates who have passed the three year and/or six semester B.Sc. (Hons.) Geology examination of the Banaras Hindu University or any other equivalent examination of other universities with Geology as one of the subjects will be considered eligible for admission to the Six Semester M.Sc. (Tech.) Geology.

The M.Sc. (Tech.) Geology shall be imparted to students for three academic sessions consisting of six semesters as given below. Candidates will be examined and evaluated on grade basis at the end of each semester in the different courses of theory and practical as per credits given against each course. The M.Sc. (Tech.) Geology will consist of (a) Core Courses, (b) Major Elective Courses, (c) Minor Elective Courses, (d) Geological Field Training and (e) Project Oriented Dissertation.

a) The Core courses will be compulsory for all the students admitted to M.Sc. (Tech.) Geology. There will be fourteen core courses, each of 5 credits (3 credits for theory and 2 credits for practical) covering major branches of Geology.

b) There are seven major elective courses, each of 5 credits (3 credits for theory and 2 credits for practical). Out of the seven major elective courses, two courses shall have to be opted in Semester - IV and three in Semester – V.

c) The M.Sc. (Tech.) Geology incorporates fourteen minor elective courses, each of 3 credits. These include i) three compulsory minor electives (each of 3 credits) of other departments for students of M.Sc. (Tech.) Geology respectively in Semester – I, Semester – II and Semester – III , ii) eight minor electives, each of 3 credits (2 credits for theory and 1 credit for practical) out of which three minor elective courses shall have to be opted in Semester – V by M.Sc. (Tech.) Geology students and iii) three compulsory minor electives, each of 3 credits are for students of sister departments. Any major/minor elective course shall run if opted by at least 15% students.

d) The compulsory geological field training includes two to three weeks field work and associated viva -voce examination at the end of Semesters - II and – IV, each of 5 credits (3 credits for field training,1 credit for viva-voce and 1 credit for detailed field report). The field training and viva-voce examination will be conducted by at least two internal examiners (faculty members). The semester breaks can also be utilized for the geological field training.

e) Along with the above courses, there shall be a Project Oriented Dissertation of 22 credits. It envisages i) geological field work (7 credits), ii) periodic presentations (5 credits) and iii) submission of thesis and final presentation of 10 credits (8 and 2 credits respectively for thesis and presentation) .The area of Dissertation shall be assigned to the students at the end of Semester - IV based on the merit of the students and expertise available in the Department. The project oriented dissertation thesis must be submitted by the end of Semester – VI through detailed field work, laboratory investigations, periodic seminar presentation followed by final presentation before the faculty members and the board of examiners for the purpose of evaluation.

Marks for theory and practical examinations shall be as per the following.

Exam. Components	Marks for Semester Exam.	**Sessional** Intra Semester Test + class assignment and regularity	**Sessional** Intra-semester practical assessment + class assignment and regularity	Total Marks
Theory	70	30 (20+10)	-	100
Practical	70	-	30 (20+10)	100

SEMESTER - I

Course No. GLM101: STRUCTURAL GEOLOGY **Credit: 3**

Unit-1
Mechanical principles, properties of rocks and their controlling factors; Concept of stress; Theories of rock failure; Two-dimensional stress analyses; Causes and dynamics of faulting, strike-slip faults, normal faults, thrust faults; Thin-skinned deformation; Decollement.

Unit-2
Concept of strain, two dimensional strain analysis; Types of strain ellipses and ellipsoids, their properties and geological significance; Methods of strain measurements in naturally deformed rocks; Mechanics of folding and buckling, superposed folding patterns, fold development and distribution of strains in folds.

Brittle and ductile shear zones, geometry and products of shear zones; Mylonites and cataclasites; Planar and linear fabrics in deformed rocks, their origin and significance.

Unit-3
Basic idea about petrofabrics and use of universal stage; Stereographic and equal area projections for representing different types of fabrics, π and β diagrams; Geometrical analysis of simple and complex structures on macroscopic scale.

Unit-4
Paleomagnetism, polar wandering and reversal of earth's magnetic field; Geomagnetic time scale; Concept of plate tectonics, nature and types of plate margins, geometry and mechanism of plate motion; Island arcs and mountain chains, their global distribution and evolution; Orogenic and epeirogenic phases; Plate tectonic evolution of India.

Books Recommended:
Condie, Kent. C. (1982): Plate Tectonics and Crustal Evolution, Pergamon Press Inc.
Gass I.G. (1982): Understanding the Earth. Artemis Press (Pvt) Ltd. U.K.
Ghosh, S.K. (1993): Structural Geology: Fundamental and Modern Development. Pergamon Press.
Hobbs, B.E., Means, W.D. and Williams, P.F. (1976): An outline of Structural Geology, John Wiley and Sons, New York.
Ramsay, J.G. (1967): Folding and fracturing of rocks, McGraw Hill.
Ramsay, J.G. and Huber, M.I. (1983): Techniques of Modern Structural Geology, Vol. I, Strain Analysis, Academic Press.
Ramsay, J.G. and Huber, M.I. (1987): Techniques of Modern Structural Geology, Vol. II, Folds and Fractures, Academic Press.
Ramsay, J.G. and Huber, M.I. (2000): Techniques of Modern Structural Geology, Vol. III (Application of continuum mechanics), Academic Press.
Turner, F.J. and Weiss, L.E. (1963): Structural analysis of Metamorphic Tectonites, McGraw Hill.
Windley B. (1973): The Evolving continents, John Wiley and Sons, New York.

Course No. GLM102: MINERALOGY AND CRYSTALLOGRAPHY **Credit: 3**

Mineralogy

Unit-1
Introduction to crystal chemistry, bonding in minerals, solid solution, polymorphism, isomorphism, pseudomorphism; Pauling's rules governing the ionic structures.

Unit-2
A detailed study of following mineral groups with reference to their general formulae, classification, atomic structure, chemistry, experimental work and paragenesis:

a. Nesosilicates - Olivine group; Garnet group; Aluminosilicate group (kyanite, andalusite and sillimanite).
b. Cyclosilicates - Beryl
c. Inosilicates - Pyroxene group; Amphibole group.
d. Phyllosilicates - Kaolinite group; Serpentine group; Pyrophyllite, talc; Mica group; Chlorite group.

e.Tektosilicates - Feldspar group; Cordierite.

Crystallography and advanced mineral characterization techniques

Unit-3
Historical development of crystallography and its importance in mineralogy; Introduction to 32 classes of symmetry, description of holosymmetric class of various crystal systems, international system of crystallographic notation; Different types of crystal projections – spherical and stereographic, and their uses; Symmetry of internal structures – Bravais lattices; Twinning and twin laws, common types of twins and their examples in minerals; Liquid crystals and their applications.

Unit-4
Various sample preparation techniques in mineralogy; Historical development of X-ray crystallography and Bragg's equation, powder method in X-Ray crystallography; Electron probe micro analysis and scanning electron microscopy - principle, application and their utility in mineral sciences; Introduction to ion microprobe analysis and infra red spectroscopy; Introduction to mineral formulae calculation of important rock forming minerals.

Books Recommended:
Berry, L.G., Mason, B. and Dietrich, R.V. (1982): Mineralogy, CBS Publ.
Dana, E.S. and Ford, W.E.(2002): A textbook of Mineralogy (Reprint).
Kerr, P.F. (1977): Optical Mineralogy, McGraw Hill.
Moorhouse, W.W. (1951): Optical Mineralogy, Harper and row Publ.
Nesse, D.W. (1986): Optical Mineralogy, McGraw Hill.
Perkins, D. (1998): Mineralogy, Prentice Hall.
Phillips, F.C (1971): Introduction to Crystallography,Longman Group Publ.
Winchell, E.N. (1951): Elements of Optical Mineralogy, Wiley Eastern.

Course No. GLM103: IGNEOUS PETROLOGY **Credit: 3**

Unit-1
Nature and evolution of magma; Introduction to mantle petrology and mantle metasomatism, mantle heterogeneities; Plate tectonics and generation of magmas; Phase equilibrium - binary systems (Ab-An, Ab-Or, Di-An, Fo-Si) and their relations to magma genesis and crystallization in the light of modern experimental works.

Unit-2
Ternary systems (Di-Ab-An, Di-Fo-Si, Di-Fo-An, Ne-Ks-Si, Fo-An-Si) and their relations to magma genesis and crystallization in the light of modern experimental works; Interpretation of igneous textures in terms of rate of nucleation and crystal growth.

Unit-3
IUGS classification of the igneous rocks and CIPW norm; Petrology and petrogenesis of major igneous rock types with Indian examples of ultramafic, komatiite, basalt, granite, alkaline rocks, ophiolite, bornite, carbonatite, lamprophyre, lamproite, and kimberlite.

Unit-4
Plume magmatism and hot spots; Large igneous provinces and mafic dyke swarms; Partial melting (batch and fractional melting); Crystal fractionation (equilibrium and fractional (Rayleigh) crystallization); Contamination (AFC process) and dynamic melting.

Books recommended:
Bose, M.K. (1997): Igneous Petrology, World Press, Kolkata.
Best, Myron G. (2002): Igneous and Metamorphic Petrology, Blackwell Science.
Cox, K.G., Bell, J.D. and Pankhurst, R.J. (1993): The Interpretation of Igneous Rocks, Champman and Hall, London.
Faure, G. (2001): Origin of Igneous Rocks, Springer.

Hall, A. (1997): Igneous Petrology, Longman.
LeMaitre R.W. (2002): Igneous Rocks: A Classification and Glossary of Terms, Cambridge University Press.
McBirney (1994): Igneous Petrology, CBS Publ., Delhi.
Phillpotts, A.R. (1994): Principles of Igneous and Metamorphic Petrology, Prentice Hall of India.
Sood, M.K. (1982): Modern Igneous Petrology, Wiley-Interscience Publ., New York.
Srivastava, Rajesh K. and Chandra, R., (1995): Magmatism in Relation to Diverse Tectonic Settings, A.A. Balkema, Rotterdam.
Wilson, M. (1993): Igneous Petrogenesis, Chapman and Hall, London.
Winter, J.D. (2001): An Introduction to Igneous and Metamorphic Petrology, Prentice Hall, New Jersey.

Course No. GLM104: METAMORPHIC PETROLOGY AND THERMODYNAMICS Credit: 3

Unit-1
Mineralogical phase rule for closed and open systems; Nature of metamorphic reactions; Concept and classification of metamorphic facies and facies series; Introduction to ultrahigh temperature and ultrahigh pressure metamorphism.

Unit-2
Description of each facies of low, medium to high pressure and very high pressure with special reference to characteristic minerals, subdivision into zones/subfacies, mineral assemblages; Metamorphic reactions and pressure – temperature conditions of metamorphism.

Unit-3
Isograds and reaction isograds; Schrienemakers rule and construction of petrogenetic grids; Metamorphic differentiation, anatexis and origin of migmatites in the light of experimental studies; Regional metamorphism and paired metamorphic belts with reference to the theory of plate tectonics; Pressure – temperature – time paths.

Unit-4
Laws of thermodynamics; Gibb's free energy, entropy; Δ G of metamorphic reactions (solid-solid and dehydration reactions); Clausius – Clapeyron equation; Geothermobarometry.

Books Recommended:
Blatt, H. and Tracy, R.J. (1996): Petrology (Igneous, Sedimentary, Metamorphic), W.H. Freeman and Co., NewYork.
Bucher, K. and Martin, F. (2002): Petrogenesis of Metamorphic Rocks (7^{th} Rev. Ed.), Springer–Verlag,.
Kerr, P.F. (1959): Optical Mineralogy, McGraw Hill Book Company Inc., New York.
Philpotts, A.R. (1994): Principles of Igneous and Metamorphic Petrology, Prentice Hall.
Powell, R. (1978): Equilibrium thermodynamics in Petrology: An Introduction, Harper and Row Publ., London.
Rastogy, R.P. and Mishra, R.R. (1993): An Introduction to Chemical Thermodynamics, Vikash Publishing House.
Spear, F. S. (1993): Mineralogical Phase Equilibria and pressure – temperature – time Paths, Mineralogical Society of America.
Spry, A. (1976): Metamorphic Textures, Pergamon Press.
Winter, J.D. (2001): An introduction to Igneous and Metamorphic Petrology, Prentice Hall.
Wood, B.J. and Fraser, D.G. (1976): Elementary Thermodynamics for Geologists, Oxford University Press, London.
Yardley, B.W.D., Mackenzie, W.S. and Guilford, C. (1995): Atlas of Metamorphic Rocks and their textures, Longman Scientific and Technical, England.
Yardlley, B.W.D. (1989): An introduction to Metamorphic Petrology, Longman Scientific and Technical, New York.

Course No. GLM105: Practicals (connected with GLM101) Credit: 2

Preparation and interpretation of geological maps and sections; Structural problems concerning economic deposit based on orthographic and stereographic projections; Recording and plotting of the field data; Study of deformed structures in hand specimens; Strain estimation from the data already collected from the field; Study of dip-isogons from the fold profiles; Preparation of geotectonic maps.

Course No. GLM106: Practicals (connected with GLM102) **Credit: 2**

Mineralogy
Identification of rock forming minerals in hand specimens; Mineral formulae, calculation of important rock forming mineral groups; Microscopic identification of important rock forming minerals; Determination of length-fast and length-slow character of minerals; Determination of pleochroic scheme; Study of interference figures of uniaxial and biaxial minerals and determination of optic sign.

Crystallography
Use of goniometer and calculation of axial ratio; Stereographic projection of crystals.

Course No. GLM107: Practicals (connected with GLM103) **Credit: 2**

Megascopic and microscopic study of different igneous rocks; Calculation of CIPW norms.

Course No. GLM108: Practicals (connected with GLM104) **Credit: 2**

A detailed study of textures in rock sections with reference to time relations between the phases of deformation and recrystallization of minerals; Calculation of ACF, AKF and AFM values from chemical and structural formulation of minerals and their graphical representation; Study of metamorphic rocks in thin sections belonging to different facies with emphasis on texture/structure, mineral composition, parent rock, metamorphic facies/subfacies/zone to which the rock can be assigned and graphical representation of the assemblage in ACF, AKF and AFM diagrams; Study of metamorphic rocks of different metamorphic facies in hand specimens; Estimation of pressure and temperature from important models of geothermobarometry.

Course No. GLM109M: Earth System – Frontier areas (minor elective) **Credit: 3**

Unit 1
Geology and its perspective; Earth in the solar system - origin, size, shape, mass, density; Formation of core, mantle, crust, hydrosphere, atmosphere and biosphere and elemental abundance in each constituent.

Unit 2
Convection in the earth's core and production of earth's magnetic field; Magnetic polarity reversal; Radioactivity and age of the earth; Earthquakes and volcanoes.

Unit 3
Orogenic and epiorogenic phases, evidence of continental drift, and sea floor spreading; Origin and significance of mid oceanic ridges and trenches.

Unit 4
Plate Tectonics, nature and types of plate margins, evolution of oceans, continents and mountains.

Books Recommended:
Holmes, Arthur (1992): Principles of Physical Geology, Vol. 1, Chapman and Hall, London.
Leet, L.D. and Judson, S. (1969): Physical Geology, Prentice Hall.
McBride, N. and Gilmour, I (2003): An Introduction to the Solar System, Cambridge Univ. Press.
Ruhe, R.V. (1975): Geomorphology, Houghton Miffin Co., Boston.
Sparks (1960): Geomorphology, Longmans.

SEMESTER - II

Course No. GLM-201: GEOMORPHOLOGY AND REMOTE SENSING **Credit: 3**

Geomorphology

Unit-1
Basic concepts and significance of geomorphology; Cycle of erosion, fluvial landforms and drainage patterns; Evolution of landforms in aeolian, marine, glacial and karst landscapes; An elementary idea about morphogenesis and morphography; Morphometric analysis, morphochronology; Neotectonics - geomorphological indicators, active faults, drainage changes, recurrent seismicity.

Unit-2
Geomorphology of India - Peninsular, Extra-peninsular and Indo-Gangetic plains; Application of geomorphology in mineral prospecting, civil engineering, military purposes, hydrogeology and environmental studies.

Remote Sensing

Unit-3
Electromagnetic radiation – characteristics, remote sensing regions and bands; General orbital and sensor characteristics of remote sensing satellites; Spectra of common natural objects – soil, rock, water and vegetation.

Aerial photos – types, scale, resolution, properties of aerial photos, stereoscopic parallax, relief displacement; Digital image processing - characteristics of remote sensing data, preprocessing, enhancements, classification; Elements of photo and imagery pattern and interpretation, application in Geology; Remote sensing applications in interpreting structure and tectonics; Lithological mapping, mineral resources, groundwater potentials and environmental monitoring.

Unit-4
Principles and components of GIS, remote sensing data integration with GIS, applications of GIS in various geological studies.

Books recommended:
Drury, S.A. (2001): Image Interpretation in Geology, Allen and Unwin.
Gupta, R.P. (1991): Remote Sensing Geology, Springer-Verlag.
Halis, J.R. (1983): Applied Geomorphology.
Holmes,A.(1992): Holmes Principles of Physical Geology, Edited by P. McL. D. Duff. Chapman and Hall.
Lillesand, T.M. and Kiefer, R.W. (1987): Remote Sensing and Image Interpretation, John Wiley.
Sharma, H.S. (1990): Indian Geomorphology, Concept Publishing Co., New Delhi.
Siegal, B.S. and Gillespie, A.R. (1980): Remote Sensing in Geology, John Wiley.
Thornbury, W.D. (1980): Principles of Geomorphology, Wiley Easton Ltd., New York.

Course No. GLM202: SEDIMENTOLOGY **Credit: 3**

Unit-1
Texture - shape, size, fabric and surface textures, methods of textural analysis, textural parameters and their significance.

Unit-2
Petrogesis of sandstones, Graywacke and graywacke problem; plate - tectonics and sandstones composition; Argillaceous rocks, their classification and genesis.

Unit-3
Dolomites, their petrographic characteristics and models of dolomitization; Study of evaporites such as gypsum, anhydrite and halite; Detailed study of siliceous, phosphatic and ferruginous rocks; Diagenesis - physical and chemical, processes and evidences of diagenesis in sandstones, mud rocks and carbonate rocks.

Unit-4
Fluid flow mechanics and formation of sedimentary bedforms; Implication of facies in environmental interpretation and basin analysis.

Books Recommended:
Blatt, H., Middleton, G.V. and Murray, R.C. (1980): Origin of Sedimentary Rocks, Prentice-Hall Inc.
Collins, J.D., and Thompson, D.B. (1982): Sedimentary Structures, George Allen and Unwin, London.
Lindholm, R.C. (1987) A Practical Approach to Sedimentology, Allen and Unwin, London.
Miall, A.D. (2000): Principles of Basin Analysis, Springer-Verlag.
Pettijohn;, F.J. (1975): Sedimentary Rocks (3rd Ed.), Harper and Row Publ., New Delhi.
Reading, H.G. (1997): Sedimentary Environments and facies, Blackwell Scientific Publication.
Reineck, H.E. and Singh, I.B. (1973): Depositional Sedimentary Environments, Springer-Verlag.
Selley, R. C. (2000) Applied Sedimentology, Academic Press.
Tucker, M.E. (1981): Sedimentary Petrology: An Introduction, Wiley and Sons, New York.
Tucker, M.E. (1990): Carbonate Sedimentolgy, Blackwell Scientific Publication.

Course No.GLM203: GENERAL AND INVERTEBRATE PALEONTOLOGY Credit: 3

General and Systematics

Unit-1
Modern systematics; Concept and kind of type specimens; Trans-specific evolution, speciation and radiation; Classification of Brachiopoda, Bivalvia and Cnidaria corals.

Unit -2
Evolutionary trends and geological history of Ammonoidea and Trilobita; Ichnofossils, their modes of preservation, behavioral classification and ichnofacies.

Applicative

Unit-3
Approaches to paleoecological and paleoenvironmental studies based on benthic communities, trace fossils and taphonomic record with Indian examples; Micro and macro-evolution, types of heterochrony in evolutionary lineages, and their application to biochronology with Indian examples.

Unit - 4
Distribution, migration and dispersal of organisms applied to paleobiogeography and plate-tectonics with Indian examples; Intra-basinal to regional spatio-temporal distribution of fossil record applied to sequence stratigraphy, depositional environment and basin analysis with Indian examples.

Books Recommended:
Boardman, R.S., Cheethan, A.M. and Rowell, A.J. (1988): Fossil Invertebrates, Blackwell.
Clarksons, E.N.K. (1998): Invertebrate Paleontology and Evolution, Allen and Unwin, London.
Dobzhansky, Ayala, Stebbins and Valentine (1977): Evolution, Freeman.
Horowitz, A.S. and Potter, E.D. (1971): Introductory Petrography of Fossils, Springer Verlag.
Mayr, E. (1971): Population, Species and Evolution, Harvard.
Prothero, D.R. (2004): Bringing Fossil to Life – An Introduction to Paleontology (2nd Ed.), McGraw Hill.
Raup, D.M. and Stanley, S.M. (1985): Principles of Paleontology ,CBS Publ..
Smith, A.B.(1994): Systematics and Fossil Record – Documenting Evolutionary Patterns, Blackwell.
Strean, C.W. and Carroll, R.L. (1989): Paleontology – the record of life, John Wiley.

Course No. GLM204: STRATIGRAPHY Credit: 3

General and Precambrian stratigraphy

Unit-1
Approaches to measurement of geological time; Concept of sequence stratigraphy; brief ideas of magneto-seismic- chemo- and event stratigraphy; Stratigraphic correlations; Approaches to paleogeography.

Precambrian geochronology; Precambrian chronostratigraphy of Rajasthan, Dharwar craton, Eastern Ghat belt, Southern Granulite belt and Singhbhum-Chotanagpur-Orissa belt; Proterozoic stratigraphy of Son valley, Cuddapah and Kurnool basins; Precambrian/Cambrian boundary.

Marine Palaeozoic and Gondawana stratigraphy

Unit- 2
Igneous activities and paleogeography during the Palaeozoic era; Stratigraphy, facies, and fossil contents of the Palaeozoic rock formations of India; Permian/Triassic boundary.

Concept, classification, fauna, flora and age limits of Gondwana supergroup and related paleogeography, paleoclimate, depositional characteristics and igneous activities.

Mesozoic and Cenozoic stratigraphy

Unit- 3
Classification, depositional characteristics, fauna, and flora of Triassic, Jurassic and Cretaceous systems in principal basins of India; Cretaceous/Tertiary boundary.

Unit- 4
Classification, depositional characteristics, fauna, and flora of the Palaeogene and Neogene systems in their type localities and their equivalents in India; Epoch boundaries of the Cenozoic in India.

Books Recommended:
Boggs, S. (2001): Principles of Sedimentology and Stratigraphy, Prentice Hall.
Danbar, C.O. and Rodgers, J. (1957): Principles of Stratigraphy, John Viley and Sons.
Doyle, P. and Bennett. M.R. (1996): Unlocking the Stratigraphic Record, John Viley and Sons.
Krishnan,M.S. (1982): Geology of India and Burma, C.B.S. Publ. and Distributors, Delhi.
Naqvi, S.M. and Rogers, J.J.W. (1987): Precambrian Geology of India, Oxford University Press.
Pascoe, E.H. (1968): A Manual of the Geology of India and Burma (Vols.I-IV), Govt. of India Press, Delhi.
Pomerol, C. (1982): The Cenozoic Era? Tertiary and Quaternary, Ellis Harwood Ltd., Halsted Press.
Schoch, Robert, M. (1989): Stratigraphy: Principles and Methods, Van Nostrand Reinhold, New York.

Course No. GLM205: GEOLOGICAL FIELD TRAINING **Credit: 5**

Course No. GLM206: Practicals (connected with GLM201) **Credit: 2**

Drainage and slope morphometry, hypsometry; Geomorphology through topo-sheets, aerial photos and satellite imagery; Terrain aspect mapping; Determination of scale in aerial photos, measurement of heights of objects from aerial photos, study and interpretation of single and stereo pair aerial photos; Preparation of interpretation keys, thematic mapping from aerial photos and satellite images – structure, lithology, landforms, minerals, soils, groundwater; Application of GIS in geological studies.

Course No. GLM207: Practicals (connected with GLM202) **Credit: 2**

Detailed study of clastic and non-clastic rocks in hand specimens; Study of assemblages of sedimentary structures in context of their paleoenvironmental significance; Microscopic examination of important rock-types; Heavy mineral separation, their microscopic characters, graphic representation and interpretation; Grain-size analysis by sieving method; Plotting of size-distribution data as frequency and cumulative curves, computation of statistical parameters and interpretation.

Course No. GLM208: Practicals (connected with GLM203) **Credit: 2**

Study of the morphological characters of some important invertebrate fossils belonging to Brachiopoda, Bivalvia, Gastropoda, Ammonoidea, Trilobita, Echinoidea and corals; Determination of valves and dental formula of heterodont bivalves; Shell petrography of bivalves and brachiopods; Study of an assorted group of

trace fossils; Study of ammonoid suture pattern, coiling, whorl section and ontogenic variation; Exercises in ammonoid heterochrony; Measurements of dimensional parameters and preparation of elementary bivariate growth curves and scatter plots.

Course No. GLM209: Practicals (connected with GLM204) **Credit: 2**

Study of rocks in hand specimens from known Indian stratigraphic horizons and type localities; Exercises on stratigraphic classification and correlation, sequence, magneto and seismic stratigraphic interpretations; Study and understanding of plate-movements through important periods during Phanerozoic Eon; Evolution of ocean systems during Phanerozoic.

Course No. GLM210M: LIFE THROUGH AGES (minor elective) **Credit: 3**

Unit -1

Biosphere; Modern thoughts on origin of life; Chief characteristic of major phyla of organic world; Nature of primitive life (invertebrate, vertebrate and plants).

Unit -2

Rise and fall of dinosaurs; First flying birds; Mammalian explosion; Chance, coincidence and chaos in human evolution.

Unit -3

Mass extinctions, processes, causes and evidences; Ice age.

Unit -4

Techniques of dating ancient life; Relative dating - cultural affiliation, pollen analysis, varve analysis, rate of accumulation; Absolute dating - dendrochronology, recimization, oxidized carbon ratio, archeomagnetism; Potassium-Argon dating.

Books Recommended:

Egan, C. and Odier, G. (2006): The Jurassic Mammal Explosion, Victoria, BC, Trafford.
Garylane, N. (1986): Life of Past S.K. Donovan -Mass Extinction: Process and Evidences.
Knight, C.R. (2001): Life through Ages, Indiana Univ. Press.
Norman, D. (1992): Dinosaurs, New York.
Prothero, D.R. (2004): Bringing Fossil to Life – An Introduction to Paleontology (2nd Ed.), McGraw Hill.
Tarling,D.H (1984): Paleomagnetism: Principles and Applications in Geology, Geophysics and Archaeology, Chapman and Hall.

SEMESTER - III

Course No. GLM301: COAL GEOLOGY **Credit: 3**

Unit -1

Definition and origin of coal; Sedimentology of coal bearing strata; Types of seam discontinuities and structures associated with coal seams; Chemical analysis of coal (proximate and ultimate analysis).

Unit -2

Coal Petrology – concept of 'lithotype', 'maceral' and 'microlithotype; Classification and optical properties of macerals and microlithotypes; Techniques and methods of coal microscopy; Elementary knowledge of the application of reflectance and fluorescence microscopy; Applications of coal petrology.

Unit- 3

Classification of coal in terms of rank, grade and type; Indian classification for coking and non-coking coals; International classifications (I.S.O. and Alpern's classification); Elementary idea about coal preparation, coal carbonization, coal gasification, underground coal gasification (UCG), coal hydrogenation and coal combustion.

Unit -4

Coal Bed Methane (CBM) – An unconventional petroleum system; Elementary idea about generation of methane in coal beds; coal as a reservoir and coal bed methane exploration; Coal as a source rock for oil and

gas; Geological and geographical distribution of coal and lignite deposits in India; Coal exploration and estimation of coal reserves; Indian coal reserves and production of coal in India.

Books Recommended:

Chandra, D., Singh, R.M. Singh, M.P. (2000): Textbook of Coal (Indian context), Tara Book Agency, Varanasi.
Scott, A.C. (1987): Coal and Coal-bearing strata: Recent Advances, Blackwell Scientific Publications.
Singh, M.P. (1998): Coal and organic Petrology, Hindustan Publishing Corporation, New Delhi.
Stach;, E., Mackowsky, M-Th., Taylor, G.H., Chandra, D., Teichumullelr, M. and Teichmuller R. (1982): Stach Texbook of Coal petrology, Gebruder Borntraeger, Stuttgart.
Taylor,G.H., Teichmuller, M., Davis, A., Diessel, C.F.K., Littke, R. and Robert P. (1998): Organic Petrology, Gebruder Borntraeger, Stuttgart.
Thomas, Larry (2002): Coal Geology, John Wiley and Sons Ltd., England.
Van Krevelen, D. W. (1993): Coal :Typology-Physics-Chemistry-Constitution), Elsevier Science, Netherlands.

Course No. GLM302: ORE GEOLOGY **Credit: 3**

Unit-1

Concept of ore bearing fluids, their origin and migration; Wall rock alteration; Structural, physicochemical and stratigraphic controls of ore localization; Ore deposits in relation to plate tectonics; Organic matters in ores and their significance; Fluid inclusions in ore - principles, assumptions, limitations and applications.

Unit-2

Mineralogy, classification and genesis of ore deposits associated with orthomagmatic ores of ultramafic-mafic rocks; Ores of felsic-silicic igneous rocks; Ores of sedimentary affiliation - biochemical, chemical and clastic sedimentation, placers and residual concentration deposits; Ores of metamorphic affiliations.

Unit-3

Study of ore minerals related to the following metals with special reference to their mineralogy, genesis, specification (if any), uses and distribution in India:
Fe, Mn, Cr, Cu, Pb, Zn. Al, Mg, Sn, and W.

Unit-4

Introduction to ore microscopy, techniques, methods, textures and microstructures of ores, interpretation of ore texture and optical properties of common sulphide, oxide ore minerals; Industrial application of ore microscopy.

Books Recommended:

Branes, H.L. (1979): Geochemistry of Hydrothermal Ore Deposits, John Willey.
Cuilbert, J.M. and Park,Jr. C.F.(1986): The Geology of Ore Deposits, Freidman.
Evans, A.M. (1993): Ore Geology and Industrial Minerals, Blackwell.
James R. Craig and David J.Vaughan (1994): Ore Microscopy and Petrography.
Klemm, D.D. and Schnieder, H.J. (1977): Time and Strata Bound Ore Deposits, Springer-Verlag.
Mookherjee, A. (2000): Ore Genesis-A Holistic Approach, Allied Publisher.
Ramdhor, P. (1969): The Ore Minerals and their Intergowths, Pergamon Press.
Stanton, R.L. (1972): Ore Petrology, McGraw Hill.
Wolf, K.H. (1976-1981): Hand Book of Stratabound and Stratiform Ore Deposits, Elsevier Publ..

Course No. GLM303: HYDROGEOLOGY **Credit: 3**

Unit-1

Role of groundwater in the hydrological cycle; Controls of geology on groundwater occurrence and distribution; Classification of aquifers and aquifer systems, geological formations as aquifers; Mode of occurrence of groundwater in different geological terrains of India; Bernoulli's equation and hydraulic head; Darcy's law and Reynolds number; Hydraulic conductivity, transmissivity, storage coefficient and specific capacity; Water table contour maps and flow net analysis.

Unit-2

Pump tests and evaluation of hydrologic properties through various methods for steady and unsteady flow; Chemical characteristics of groundwater in relation to various uses – domestic, industrial and irrigation; Saline

water intrusion in coastal and other aquifers and its prevention; Radioisotopes in hydro-geological studies; Groundwater contamination and problems of arsenic, fluoride and nitrates.

Unit -3

Causative factors of groundwater level fluctuations and environmental influences; Artificial recharge to groundwater and rainwater harvesting; Management of groundwater resources; Conjunctive use of groundwater and surface water; Groundwater problems and management related to foundation work, mining, reservoirs, tunnels and effects of water in landslides; Environmental effects of over-exploitation of groundwater; Water logging problems; Groundwater legislation.

Unit - 4

Groundwater exploration; Geological and surface geophysical methods for the selection of suitable site for well construction; Type and design of wells, methods of well construction, well completion and well development.

Books Recommended:

C.F. Tolman (1937): Groundwater, McGraw Hill , New York and London.
D.K. Todd (1995): Groundwater Hydrology, John Wiley and Sons.
F.G. Driscoll (1988): Groundwater and Wells, UOP, Johnson Div.St.Paul. Min. USA.
H.M. Raghunath (1990): Groundwater, Wiley Eastern Ltd.,
H.S. Nagabhushaniah (2001): Groundwater in Hydrosphere (Groundwater hydrology), CBS Publ..
K. R. Karanth (1989): Hydrogeology, Tata McGraw Hill Publ..
S.N. Davies and R.J.N. De Wiest (1966): Hydrogeology, John Wiley and Sons, New York.

Course No. GLM304: MICROPALEONTOLOGY AND OCEANOGRAPHY Credit: 3

Micropaleontology

Unit-1

Definition and scope of the subject; Relationship of micropaleontology with ocean sciences; Modern field and laboratory techniques in the study of microfossils (collection, sampling and processing techniques, scanning electron microscopy and mass spectrometry); A brief account of the concepts and methods for the development of micropaleontological indicators useful in reconstruction of history of past, environmental changes and biostratigraphic correlation.

Types of Microfossils

Calcareous Microfossils:

(i) Foraminifera - planktic foraminifera, their modern biogeography, outline of morphology, significance in Cenozoic oceanic biostratigraphy and paleoceanographic, paleoclimatic interpretations; Benthic foraminifera - their brief morphology and application in bottom water paleoceanography and paleobathymetric reconstructions; Larger foraminifera, their outline of morphology and application in Indian stratigraphy; (ii) Calcareous nannofossils - outline of morphology, modern biogeography and their application in oceanic biostratigraphy and paleoceanographic, paleoclimatic reconstructions; (iii) Ostracoda - Outline of morphology and wall structure, their significance in environmental studies and oceanic biostratigraphy; (iv) Pteropoda - a brief introduction, application of pteropods in reconstruction of the Quaternary oceanography and climate; A brief introduction of calpionellids and calcareous algae.

Siliceous Microfossils:

Radiolaria, diatoms and silicoflagellate - outline of morphology, modern biogeography, their environmental significance and application in biostratigraphy.

Phosphatic Microfossils:

Conodonts - outline of morphology, paleoecology, geological significance and biological affinities; Stratigraphic significance of conodonts with special reference to India.

Unit-2

Organic Walled Microfossils:

Organic walled microfossils and their significance, outline morphology of spores, pollen, dinoflagellates and acritarchs; Factors controlling distribution of dinoflagellates, biostratigraphic significance of spores, pollen, dinoflagellates and acritarchs; Types of organic matters, concept of palynofacies and its application in paleoenvironment interpretation.

Application:

Micropaleontology in petroleum exploration; Environmental significance of microfossils; Geochemical study of microfossil tests (stable isotopes, radiocarbon isotopes and elemental composition) and its application in

paleoceanography and paleoclimatology and tracing history of marine pollution; Determination and correlation of paleofacies by microfossils; Interpretaion of sea floor tectonism from micropaleontological evidence; Application of palynology in identifying ancient coast lines; Role of micropaleontology in marine geology and oceanography.

Oceanography

Unit-3
History of development of oceanography; Sampling of modern ocean biogenic flux including sediment trap sampling; Methods of measuring properties of sea water; Temperature and salinity distribution (horizontal and vertical) in ocean waters; Dissolved gases in sea water, factors affecting the concentration of gases in sea water; Carbon dioxide equilibria, precipitation and dissolution of carbonates; Biological - chemical - physical interactions in the oceans; Oxygen minimum layer in the ocean.

Unit-4
Scientific ocean drilling and its major accomplishments; Ocean circulation, surface circulation; Concept of mixed layer, thermocline and pychnocline, Coriolis force and Ekman spiral, upwelling, El nino, deep ocean circulation, concept of thermohaline circulation, formation of bottom waters, water masses of the world oceans, oceanic sediments.

Books recommended:
Alfred Traverse (1988): Paleopalynology, Unwin Hyman, USA.
Arnold (2002): Quaternary Environmental Micropaleontology (Ed. Simon K. Haslett), Oxford University Press, New York.
Bignot, G., Grahm and Trottman (1985): Elements of Micropaleontoogy, London.
David Tolmazin (1985): Elements of Dyanamic Oceanography, Allen and Unwin
Grant Gross, M. (1977): Oceanography; A view of the Earth, Prentice Hall.
John Houghton (1997): Global Warming, Cambridge Univ. Press.
Jones, T.P. and Rowe, T.P. (1999): Fossil plants and spores, Modern Techniques, Geological Soc. of London.

Course No. GLM305: Practicals (connected with GLM301) **Credit: 2**

Macroscopic characterization of banded coals; Completion of outcrop in the given maps and calculation of coal reserve; Preparation of polished particulate mounts of coal; Microscopic examination of polished particulate mounts (identification of macerals); Proximate analysis of coal.

Course No. GLM306: Practicals (connected with GLM302) **Credit: 2**

Megascopic study of Indian metallic ores and industrial minerals in hand specimens; Study of ore structures in hand specimens; Study of optical properties and identification of important ore minerals under ore-microscope; Preparation of maps showing distribution of metallic and industrial minerals in India and also classical world mineral deposits.

Course No. GLM307: Practicals (connected with GLM303) **Credit: 2**

Delineation of hydrological boundaries on water table contour maps; Laboratory estimation of water quality parameters; Presentation of chemical data and their uses in different purposes; Determination of activity coefficient of ions from Debye-Huckel equation and calculation of saturation index; Estimation of aquifer (hydrologic) properties such as hydraulic conductivity, transmissivity and storage coefficient.

Course No. GLM308: Practicals (connected with GLM304) **Credit: 2**

Micropaleontology
Techniques of separation of microfossils from matrix; Types of microfossils - calcareous, siliceous, phosphatic and organic walled microfossils; SEM applications in micropaleontology; Study of surface ultrastructures of foraminifera; Study of important planktic foraminifera useful in surface water, paleoceanography and oceanic biostratigraphy; Study of larger benthic foraminifera useful in Indian stratigraphy with special reference to Cenozoic petroliferous basins of India; Important palynomorphs of Cretaceous and Paleogene age.

Oceanography
Depth biotopes and estimation of palelodepth of the ocean using benthic foraminiferal assemblages; Identification of modern and ancient surface water mass with the help of planktic foraminiferal assemblages; Identification of benthic foraminifera characteristic of low oxygen environment; Identification of Planktic foraminifera characteristic of warm and mixed layer, thermocline and deep surface water of the modern oceans; Study of modern surface water, mass assemblages of planktic foraminifera from Indian ocean, Atlantic ocean and Pacific ocean.

Course No. GLM309M: ENVIRONMENTAL GEOLOGY (Minor Elective) Credit: 3

Unit -1
Fundamentals of environmental geology; Domains of environment and its relationship with earth system; Earth surface processes – weathering and erosion; Development of different types of landforms and soil profiles.

Unit -2
Composition and characteristics of terrestrial and marine environment; Types of supra-crustal rocks and their interaction with surface and ground water; Surface and ground water pollution and their major causes; Environmental pollution as a consequence of mining, processing and utilization.

Unit -3
Earthquake and tsunami – causes of occurrence and their impact as natural hazard; Natural hazard associated with volcanic eruptions.

Unit -4
Major river belts of India, flood hazards and their mitigation; Landslides and avalanches – causes and mitigation.

Books Recommended:
Bryant, E. (1985): Natural Hazards, Cambridge Univ. Press.
Keller, E.A.(1978): Environmental Geology, Bell and Howell, USA.
Nagabhushaniah, H.S. (2001): Goundwater in Hydrosphere, CBS Publ.
Perry, C.T. and Taylor, K.G. (2006): Environmental Sedimentology, Blackwell Publ.
Singh, S. (2001): Geomorphology, Pustakalaya Bhawan, Allahabad.
Todd, D.K. (1995): Groundwater Hydrology, John Wiley and Sons.
Valdiya, K.S.(1987): Environmental Geology – Indian Context, Tata McGraw Hill.

SEMESTER - IV

Course No. GLM401: PETROLEUM GEOLOGY Credit: 3

Unit -1
Petroleum – its composition, origin (formation of source rocks - kerogen, organic maturation and thermal cracking of kerogen); Migration of petroleum; Reservoir rocks - petrology of reservoir rocks, porosity and permeability; Reservoir traps – structural, stratigraphic and combination traps.

Unit -2
Petroleum exploration; Identification and characterization (petrographic and geochemical) of petroleum source rocks; Amount, type and maturation of organic matter; Oil and source rock correlation; Locating petroleum prospects based on principles of petroleum generation and migration (geological modeling).

Unit -3
Elementary knowledge of geophysical methods in exploration; Magnetic, gravity and seismic methods; Elementary knowledge of well drilling, cable-tool drilling, rotary drilling and various types of drilling units; Elementary knowledge of logging, electric, radioactive and sonic logs; Application of logs in petrophysical and facies analyses.

Unit- 4

An outline of the oil belts of the world; Onshore and offshore petroliferous basins of India; Geology of productive oilfields of India; Elements of unconventional petroleum systems; Basin-centered gas, fractured-shale gas system, shallow biogeneic gas and natural gas hydrates.

Books Recommended:

Barker, C. (1996): Thermal Modeling of Petroleum Generation, Elsevier Science, Netherlands.
Holson, G.D. and Tiratso, E.N. (1985): Introduction of Petroleum Geology, Fulf Publishing, Houston, Texas.
Hunt, J.M. (1996): Petroleum Geochemistry and Geology (2nd Ed.), Freeman, San Francisco.
Jahn, F., Cook, M. and Graham, M. (1998): Hydrocarbon exploration and production, Eslevier Science.
Makhous, M. (2000): The Formation of Hydrocarbon Deposits in North African Basins, Geological and Geochemical Conditions, Springer–Verlag.
North, F.K. (1985): Petroleum Geology, Allen Unwin.
Selley, R.C. (1998): Elements of Petroleum Geology, Academic Press.
Tissot, B.P. and Welte, D.H. (1984): Petroleum Formation and Occurrence, Springer–Verlag.

Course No. GLM402: GEOCHEMISTRY **Credit: 3**

Unit-1

Introduction and principles of geochemistry; Introduction, chemical composition and properties of atmosphere, hydrosphere and lithosphere; Geochemial cycles; Concepts of biogeochemical cycle; Geochemical classification of elements; Periodic table with special reference to transition and trace (including rare-earth) element geochemistry.

Unit-2

Stable isotope geochemistry of carbon and oxygen and its applications to geology; Radiogenic isotopes; Decay scheme of K-Ar, U-Pb and Rb–Sr and Sm-Nd; Petrogenetic implications of Sm-Nd, Rb-Sr; Radiometric dating of single minerals and whole rocks.

Unit-3

Element partitioning in mineral/rock formation and concept of distribution coefficient; Mineral stability in Eh-Ph diagrams; Sampling procedures and introduction to analytical techniques used in geochemistry; A brief introduction to geochemistry of natural waters and sedimentary rocks; Geochemical processes involved in rock weathering and soil formation; Principles of ionic substitution in minerals.

Unit-4

Crystal structure of some simple compounds – AX structures (NaCl, CsCl, ZnS, NiAs), AX_2 structure (fluorite, rutile); A brief idea about some other commpounds such as A_2X_3 (corrundum), ABX_3 (calcite, ilmenite) and AB_2X_4 (Spinel).

Books Recommended:

Bloss, F.D. (1971): Crystallography and Crystal Chemistry, Holt, Rinehart, and Winston, New York.
Evans, R.C., (1964): Introduction to Crystal Chemistry, Cambridge Univ. Press.
Hoefs, J. (1980): Stable Isotope Geochemistry, Springer-Verlag.
Klein, C. and Hurlbut, C.S. (1993): Manual of Mineralogy, John Viley and Sons, New York.
Krauskopf, K.B. (1967): Introduction to Geochemistry, McGraw Hill.
Mason, B. and Moore, C.B. (1991): Introduction to Geochemistry, Wiley Eastern.
Rollinson, H.R. (1993): Using geochemical data: Evaluation, Presentation, Interpretation. Longman U.K.
Shikazono, N. (2003): Geochemical and Tectonic Evolution of Arc-Backarc Hydrothermal Systems - Implication for the Origin of Kuroko and Epithermal Vein-Type Mineralizations and the Global Geochemical Cycle, Eslevier Science.

Course No. GLM403: GEOLOGICAL FIELD TRAINING **Credit: 5**

Course No. GLM404: Practicals (connected with GLM401) **Credit: 2**

Megascopic and microscopic study of cores; Preparation of geological maps, sections and derivation of geological history in relation to petroleum prospects; Calculation of oil reserves; Exercises on maturation studies; Petrographic characterization of petroleum source rocks; Study of seismic maps; Preparation of SP and resistivity logs for hydrocarbon reservoirs.

Course No. GLM405: Practicals (connected with GLM402) **Credit: 2**

Rock analyses (rapid method of silicate analysis) and FeO determination by titration method; Determination of loss on ignition (LOI) of rock samples; Presentation of analytical data; Preparation of classificatory and variation diagrams and their interpretation; plotting of REE data and their interpretation; Calculation of weathering indices in soil and sediments.

Course No: GLM406: MINERAL EXPLORATION AND MINERAL ECONOMICS **Credit: 3**

Mineral Exploration

Unit-1
Selection of minerals for exploration; Role of GIS and remote sensing in mineral exploration; RP, PL and ML stages of mineral exploration in India; Criteria and guidelines for search of minerals; Field observations and field equipments and geological modeling for mineral exploration.

Unit-2
Geochemical exploration, mobility of elements and their primary and secondary dispersion; Geochemical approaches, mapping and sample material; Introduction to geo-botanical exploration methods; Use of geostatistics in exploration.

Unit-3
Objectives of drilling, types of drilling for exploration and their advantages; Concept of slice plan/bench plan and calculation of geological resource and mineable ore reserves; Concept of atomic energy; Mode of occurrence and exploration of atomic minerals.

Mineral Economics

Unit-4
Mineral economics and its concepts; Tenor, grade and specification; Strategic, critical and essential minerals; National mineral policy; United Nations Framework Classification (UNFC).

Books Recommended:
Arogyaswami, R.P.N. (1996): Courses in Mining Geology, Oxford and IBH Publ.
Bagchi, T.C., Sengupta, D.K., Rao, S.V.L.N. (1979): Elements of Prospecting and Exploration, Kalyani Publ.
Banerjee , P.K. and Ghosh, S. (1997): Elements of Prospecting for Non-fuel Mineral deposits, Allied Publ.
Chaussier, Jean – Bernard and Morer, J. (1987): Mineral Prospecting Manual., North Oxford Academic.
Dhanraju, R. (2005): Radioactive Minerals, Geol. Soc. India, Bangalore.
Mineral Concession Rules 1960 (2005), IBM, Nagpur.
Rajendran, S. (2007): Mineral Exploration: Recent Strategies.
Sinha, R.K. and Sharma, N.L. (1976): Mineral economics, Oxford and IBH Publ.

Course No: GLM407: BASIN ANALYSIS **Credit: 3**

Unit –1
Concept of basin analysis; Tectonic classification and geothermal evolution of sedimentary basins; Allogenic and autogenic controls on sedimentation.

Unit-2
Sedimentary facies and facies models with Indian analogues; Paleocurrent analysis and sediment dispersal patterns; Quaternary Sedimentology.

Unit-3
Processes and characteristics of depositional environments such as fluvial, estuarine, deltaic, lagoonal, barrier beach, tidal flats and deep-sea environments.

Unit-4
Concept of sequence stratigraphy, regional unconformities, systems tracts and parasequences.

Books Recommended:

Allen P. A. and J.R.L. Allen (2005): Basin Analysis: Principles and Application, Blackwell Publ.
Miall, A.D. (2000): Principles of Basin Analysis, Springer-Verlag.
Perry, C.T. and Taylor, K.G. (2006): Envoronmental Sedimentology, Blackwell Publ., U.K.
Reading, H.G. (1996): Sedimentary Environments and facies, Blackwell Scientific Publ.
Reineck, H.E. and Singh, I.B. (1978): Depositional Sedimentary Environments, Springer-Verlag.

Course No. GLM408: APPLICATIVE PALEOBIOLOGY **Credit: 3**

Unit-1

Species concepts; Origin and diversity of life; Changes of ecosystems and habitat through time.

Unit- 2

Paleobiogeography; Aims, methodologies and theories; Numerical paleobiology; Cladestic and phylogenetic biogeography.

Unit- 3

Precambrian and Phanerozoic biogeography; Evolution of earth and its biota.

Unit- 4

Paleoecology — approaches, concepts and applications; Taphonomy — principles and practices; Fossil assemblages; Concept of time averaging; Shell concentration and stratigraphy of shell concentration.

Books Recommended:

Allison, P.A. and Briggs, D.E.G. (1991): Taphonomy. Releasing the data locked in the fossils record, Plenum Press.
Dord, J.R. and Stanta, R.J. (1981): Palaeoecology concepts and applications, John Wiley and Sons.
Patnaik, R. (2003): Reconstruction of Upper Siwalik palaeoecology and palaeoclimatology using microfossil palaeocommunities, Palaeogeography, Palaeoclimatology, Palaeoecology, Vo. 197.

Course No. GLM409: Practicals (connected with GLM406) **Credit: 2**

Mineral Exploration

Marking of different benches and stripping boundary on cross section; Calculation of ore grade, total geological resource and mineable reserves, total waste (inside, stripping and OB); Concept of ore dilution; Interpretation of remote sensing data for mineral exploration.

Mineral Economics

Preparation of mineral maps of India; Graphical representation of production, export and import of important minerals.

Course No. GLM410: Practicals (connected with GLM407) **Credit: 2**

Paleocurrent analysis; Preparation of facies maps and facies diagrams; Study of vertical profile sections of some selected sedimentary environments; Study of significant system tracts.

Course No. GLM411: Practicals (connected with GLM408) **Credit: 2**

Exercises on paleobiogeography, paleoecology and taphonomy.

SEMESTER - V

Course No: GLM501: MARINE GEOLOGY **Credit: 3**

Unit-1

History of development of marine geology; Origin of ocean basins; A brief account of tectonic history of the oceans; Oceanic crust; Deep ocean-floor topography; Morphology of ocean margins.

Unit-2

Marine sediments, sources and composition, sediment types and distribution; Oceanic sediments and microfossils; Deep sea sediments and their relation to oceanic processes such as productivity, solution and dilution; Sedimentation rates; Calcite and aragonite compensation depth.

Unit-3

Oceanic circulation - Surface, intermediate and deep ocean circulation; Forces that produce and effect circulation patterns in world oceans; Important phenomena associated with surface circulation; Formation and movement of deep and bottom waters.

Unit-4

Methods and instruments for exploring the ocean floor; Deep Sea Drilling Project (DSDP), Ocean Drilling Programme (ODP) and Joint Global Flux Studies (JGOFS) and their major accomplishments. Integrated Ocean Drilling Programme (IODP) and its aims and objectives; Sediment distribution in time and space as related to tectonic models; Marine stratigraphy, correlation and chronology; Deep sea hiatuses and their causes; Approaches to paleoceanographic and paleoclimatic reconstructions; Paleoceanographic changes in relation to earth system history including impact of the oceans on climate change; Evolution of oceans through the Cenozoic; Ocean gateways and their role in controlling global climates; Sea level changes during Quaternary with special reference to India; Reconstructing Quaternary climatic and oceanographic history on shorter time scales using marine records; Mineral resources of the ocean including polymetallic nodules; Hydrocarbons beneath the sea floor; Marine gas hydrates and their economic potential; Marine pollution and interpreting marine pollution with the help of microfossils.

Books Recommended:

Arnold (2002): Quaternary Environmental Micropaleontology (Ed. Simon K. Haslett), Oxford Univ. Press, New York.
Kennett, J.P. (1982): Laboratory Excercises in Oceanography Marine Geology, Prentice Hall,.
Seibold, E. and Berger, W.H. (1982): The Sea Floor, Springer-Verlag.

Course No: GLM502: ENVIRONMENTAL GEOLOGY AND NATURAL HAZARDS **Credit: 3**

Unit- 1

Components of environmental geology; Time scales of global changes in the ecosystem and climate; Major icehouse and greenhouse periods; Impact of oceanic and atmospheric circulation on climate and rain fall;
Methodologies for estimation of present and past atmospheric carbon-dioxides; CO_2 increase and global warming in the present and past atmospheres.

Unit -2

Physical, chemical and biological domains of environment; Air, water and noise pollution, their causes and remedial measures**;** Surface weathering, development of soil and soil pollution; Pollution in the mining areas.

Unit-3

Distribution, magnitude and intensity of earthquakes; Seismic hazard zones; Neotectonics in seismic hazard assessment; Landslide, floods and volcanic hazards their causes and control; Coastal erosion, its causes and control.

Unit-4

Problems of urbanization, human population and their impact on environment; Alternative sources of energy; Waste disposal and related problems; Environmental legislations.

Books Recommended:

Bell, F.G. (1999): Geological Hazards, Routledge, London.

Bryant, E. (1985): Natural Hazards, Cambridge Univ. Press.
Keller, E.A. (1978): Environmental Geology, Bell and Howell, USA.
Lal, D. S. (2007): Climatology, Sharda Pustak Bhawan, Allahabad.
Patwardhan, A.M. (1999): The Dynamic Earth System, Prentice Hall.
Smith, K. (1992): Environmental Hazards, Routledge, London.
Subramaniam, V. (2001): Textbook in Environmental Science, Narosa International.
Valdiya, K.S. (1987): Environmental Geology – Indian Context, Tata McGraw Hill.

Course No: GLM503: ELEMENTS OF MINING, ORE DRESSING AND SURVEYING Credit: 3

Elements of Mining

Unit-1
Classification of mining methods, placer mining methods, open pit methods, underground mining methods, coal mining methods and ocean bottom mining methods, their advantages and disadvantages; Ventilation in underground mining; Purpose, types and arrangements of ventilation in underground mining; Mining hazards and safety measures.

Ore Dressing

Unit-2
Ore dressing and its importance, low grade ores and their beneficiation; ore microscopy and its contribution to ore dressing techniques; Mineral properties and their consideration in ore dressing techniques.

Unit-3
Basic ore dressing operations viz. crushing, grinding, sizing, screening and classification; Concentration processes; Magnetic and electrostatic separation, gravity concentration; Froth Floatation, amalgamation and agglomeration.

Surveying

Unit-4
Surveying - its uses and importance in Geology, common methods of surveying, chain surveying , prismatic compass, plane table, theodolite surveying; Concept of Global Positioning System (GPS).

Books Recommended:
Arogyaswami, R.P.N. (1996): Courses in Mining Geology, IV Ed. Oxford IBH.
Clark, G.B. (1967): Elements of Mining, (3rd Ed.), John Wiley.
Mookherjee, A. (2000): Ore Genesis-A Holistic Approach, Allied Publisher.
Roy Chowdhary, K.P. (1987): Surveying (Plane and Geodetic), Oxford and IBH Publ.
Shahani, P.B. (1978): Text book of Surveying Vol. 1, Oxford and IBH Publ.

Course No: GLM504: ENGINEERING GEOLOGY AND GEOPHYSICAL EXPLORATION Credit: 3

Unit-1
Role of engineering geology in civil construction and mining industry; Various stages of engineering geological investigations for civil engineering projects; Engineering properties of rocks, rock discontinuities, physical characters of building stones, concrete and other aggregates; Influence of geological structures (fold, fault and joint) on different civil engineering constructions; Mass movements – causes of landslides and their remedial measures.

Unit-2
Different types of dams and geotechnical investigation for dam and reservoir site; Geotechnical evaluation of tunnel alignment, methods of tunneling, classification of ground for tunneling purposes and various types of support system; Geological considerations involved in the construction of roads, railways and bridges; Earthquake resistance (aseismic) design of building and influence of geological condition on foundation; Shoreline engineering geology; Improvement of sites for engineering projects.

Unit- 3

Gravity methods - general principles (Newton's law, Gauss's law), gravity field of the earth, instruments; Gravity surveying, rock densities, gravity data reduction, interpretation of gravity data; Magnetic methods - general principles, earth's magnetic field, field instruments, rock magnetism; Surveying, airborne magnetic, interpretation of anomalies and potential field data (magnetic); Electrical methods - general principles, introduction to resistivity, self potential methods and induced potential; Resistivity surveying and resistivity data interpretation.

Unit – 4

Seismic Methods - general principles of seismic wave propagation, field procedures, equipment, seismic velocities, Snell's law, basic travel time relationships; General principles of seismic reflection and diffraction, seismic processing, seismic reflection interpretation; Geophysical well-logging - general principles and introduction to well logging.

Books Recommended:

Dobrin, M. B.; Savit, C. H. (1988): Introduction to Geophysical Prospecting, McGraw-Hill.
Keary, P., Brooks, M. and Hill, I. (2002): An introduction to geophysical exploration, (3rd Ed.), Blackwell.
Krynine, D.H. and Judd, W.R. (1998): Principles of Engineering Geology, CBS Publ..
Rider, M. H. (1986): Whittles Publishing, Caithness. The Geological Interpretation of Well Logs, (Rev. Ed.).
Robert, D. (1985): Encyclopedia of Well Logging.
Schultz, J.R. and Cleaves, A.B. (1951): Geology in Engineering, John Willey and Sons, New York.
Singh, P. (1994): Engineering and General Geology, S.K. Kataria and Sons, Delhi.
Telford, W.M., L.P. Geldart, R.E. Sherrif and D.A. Keys (1976): Applied Geophysics, Cambridge Univ. Press.

Course No. GLM505: Practicals (connected with GLM501) **Credit: 2**

Study of topographic features of ocean floor; Preparation of bathymetry maps; Study of subsurface geological conditions and structures using seismic depth sections of selected oceanic regions; Evolution of ocean circulation system during the Cenozoic; Estimation of sedimentation rates, exercises on identification of condensed zones, deep sea hiatuses in deep sea sedimentary sections; Determination of physical and textural properties of marine sediments.

Course No. GLM506: Practicals (connected with GLM502) **Credit: 2**

Preparation of seismic zonation maps of India and world; Demarcation of landslide prone areas in the Himalaya; Demarcation of flood prone areas in the outline map of India; Preparation of volcanic hazard zonation map; Presentation of chemical analysis data and plotting chemical classification diagrams; Preparation of oceanic and atmospheric circulation maps.

Course No. GLM507: Practicals (connected with GLM503) **Credit: 2**

Elements of Mining

Study of various methods of metal and local mining and their diagrammatic representation; Exercises on mine sampling and determination of tenor, cut-off grades, ore reserves, etc.

Ore Dressing

Study of flow sheets of important metallic and non-metallic ores and minerals with particular reference to Indian ores and minerals.

Surveying

Survey of a plot of land by means of common methods of surveying using different instruments: chain, prismatic compass, plane table, dumpy level, theodolite and GPS.

Course No. GLM508: Practicals (connected with GLM504) **Credit: 2**

Study of properties of rocks with reference to their use in engineering projects; Study of models and maps of important engineering structures such as tunnels and dams; Interpretation of geological maps for landslide problems.

Course No. GLM509: APPLICATIVE PALEOBOTANY AND PALYNOLOGY Credit: 3

Paleobotany

Unit-1
Introduction and approach to paleobotany; occurrence of plant fossils, their collection and preparation techniques; Principles of nomenclature (concept of genera and form genera); A brief idea about morphology of different plant parts; Evolutionary trend in angiosperms plants; A brief idea about Indian pre-Gondwana; Gondwana and Paleogene flora.

Unit-2
Application of paleobotany in assessing paleoclimate and paleoenvironment; Dendrochronology and its application; Phytoliths and their application in understanding paleoecology.

Palynology

Unit-3
Definition and scope of palynology, techniques in palynology; Introductory taxonomic classification of spores, pollen, dinoflagellates and acritarchs; Basics of spores/pollen biology and morphology; Pollen evolution, gymnosperm and angiosperm pollen through time; Production, dispersal and sedimentation of palynomorphs.

Unit-4
Holocene palynology and its application; Application of palynology in geochronology, paleoclimate and paleoenvironment interpretation; Significance of palynology in source rock evaluation and organic matter maturation; Fluorescence palynology and its application.

Books Recommended:
Alfred Traverse (1988): Paleopalynology, Unwin Hyman, USA.
Bergland, B.E. (1986): Handbook of Holocene paleoecology and paleohydrology, John Wiley, New York.
Jones, T.P. and Rowe, T.P. (1999): Fossil Plants and Spores Modern Techniques, Geological Soc. of London.
Pipero, Dologes, R. (1988): Phytolith analysis: an Archaeobiological and Geological perspective, Academic Press.
Prothero, D.R. (2004): Bringing Fossil to Life – An Introduction to Paleontology (2nd Ed.), McGraw Hill.
Seaward, A.C. (1991): Plant fossils, Today's and Tomorrow, New Delhi.
Shipad N. Agashe (1995): Paleobotany, Oxford and IBH Publ., New Delhi.
Stewart, Wilson N. and Rothwell Gar W. (1993): Paleobotany and the Evolution of Plants, Cambridge Univ. Press.

Course No. GLM510: APPLIED VERTEBRATE PALEONTOLOGY Credit: 3

Unit-1
Origin of vertebrates, general characteristics of vertebrates, vertebrate skeleton, division and components of graniate skeleton; Classification of vertebrates, jawless vertebrates, origin of jaws; Pisces – placodermi, chondrichthyes, osteichthyes; parts of pisces preserved as fossils.

Unit-2
Amphibia - Labyrinthodont and their trends in evolution; Frogs and toads; Reptilia, marine reptiles, flying reptiles, mammal like reptiles; Dinosaurs and their causes of extinction; Aves – Archaeopteryx.

Unit-3
Mammalia - Origin and evolution of the mammals, mammalian characters, classification of mammals; Gondwana vertebrates; Siwalik mammals; Vertebrate life through ages; Evolutionary changes in Equidae, Proboscidae; Evolution of Homo, phases and culture chronology.

Unit-4
Placental mammals - basic characters, tooth morphology and classification; Age of mammals; Microvertebrates - collection, maceration, and their identification; Rodents - characters, classification and evolution.

Books Recommended:
Benton, M.J. (1990): Vertebrate Paleontology. Unwin Hyman, Lindon.

Colbert, E.H. (1984): Evolution of Vertebrates. Willey Eeastern Ltd.
Harris, J.M. and Leakey, M.G.(2003): Geology and Vertebrate Paleontology of Early Pliocene Site of Kanapoi, N. Kenya, Vol. 498, Natural History Museum, Lons Angeles.
Olson, E.G. (1971): Vertebrate Palaeozoology, Wiley, New York.
Romer, A.S. (1966): Vertebrate Paleontology (3rd Edn.) Chicago University Press.
Swnnerton, H.H. (1950): An outline of paleontology, Edward Arnold and Co.

Course No. GLM511: GEMOLOGY **Credit: 3**

Unit-1
Gem and gemstones; General characteristics and chemical composition of gemstones; Application of gemstones; Technical application, application as jewels; Physical characteristics - form, cleavage, fracture, hardness, specific gravity and tenacity.

Unit-2
Optical characteristics - colour, luster, play of colour, refractive index, reflectivity, diaphaneity pleochroism, dispersion; Application of ultraviolet rays, x-rays and infra red rays in gem identification; Electrical thermal and magnetic characters of gems; Classification of gemstones.

Unit-3
Systematic description, genesis, mode of occurrence, distribution in India and also important world occurrences of important precious and semi-precious stones.

Unit-4
Synthetic gemstones - methods of synthesis, and its characteristics and identification; Gem enhancement methods and their identification; Colourless/coloured impregnation, head treatment, coating, irradiation, diffusion, treatment, etc.

Books Recommended:
Brocardo, G. (1981): Minerals and Gemstone- An identification guide, David and Charles, London.
Bruton Eric F.G.A. (1970): Diamonds, Chilton Book Company.
Max Bauer (1968): Precious Stones, Vol. I and II, Dover, New York.
Orlov Yu L (1973): The Mineralogy of the Diamond, John Wiley.
Rajendran S. (2007): Mineral Exploration: Recent Strategies.
Vilson, M. (1967): Gems, Heinemann, London.

Course No. GLM512: COMPUTER APPLICATION AND INSTRUMENTATION IN GEOLOGY
Credit: 3

Computer Application

Unit-1
Use of computers and software as tools in the areas of geological problem-solving, report-writing, and presentations; Windows-based software applications, including word-processing, spreadsheets.

Unit-2
Graphing, image manipulation, drawing, presentations (MS-Excel, Power Point, Adobe Illustrator, CorelDraw, Photoshop).

Instrumental techniques in Geosciences

Unit-3
Role and importance of instrumentation techniques in Geology; Brief introduction to the instrumental techniques with emphasis on their applicational aspects.

Unit-4
X-ray diffractometer, image analyzer, electron probe micro analyzer, scanning electron microscope, transmission electron microscope, isodynamic separator, ultra violet lamp, infrared spectrometry, atomic absorption spectrometer, x-ray fluorescence spectrometer, inductively coupled plasma analyzer, mass spectrometer and various mineral dressing and geophysical instruments.

No Textbook - only handouts and web pages

Course No. GLM513: SOIL GEOLOGY **Credit: 3**

Unit-1
Concept of soil, components of soil, soil profile; Process of soil formation, pedogenic processes; Classification of soil, mineral and chemical composition of soils, mineral stability during weathering; Soil organic matter form and function; A brief introduction to methods of soil conservation.

Unit-2
Fabric analysis - size and shape, concepts of size and shape, grade scale, methods of analysis, presentation of data, analysis and field grading; Concepts of structure fabric: Soil fabric, soil structure, soil texture and field grading units; Peds and pedalilty, size and shape of peds, pedality, primary, secondary and tertiary structures and their interpretation; Voids - concepts, size, shape, arrangement and morphological classification.

Unit-3
Paleosols - field recognition, description, origin and causes; Paleosol in stratigraphic records; Significance of paleosol study; Paleosols and human evolution.

Unit-4
Calcrete - definition, classification, calcrete formation, pedogenic calcrete soil profile, macro features in calcretes, micromorphology (petrography), calcretes from Quaternary and ancient sedimentary sequences; significance of calcretes; Laterite - characteristics, genesis, Indian occurrences.

Books Recommended:

Boul, S.W., Hole, F.D., McCraken, R.J. and South, R.J. (1997): Soil Genesis and classification. 4th Edition, State University Press.
Braddy, N.C. (2002): Nature and Properties of Soils.
Govinda Rajan, S.V. and Gopala Rao, K. H.G. (1979): Studies of Soils of India.
Sposito, Garrison. (1989): The Chemistry of Soils, Oxford Univ. Press.
Terzaghi, K. and Pock, R.G. 1996): Soil Mechanics in Engineering (3rd Ed.), John Wiley.
Wright; V. Paul (1992): Paleosols: their recognition and interpretation, Blackwell Scientific Publ.
Wright, V. Paul and Tucker, M.E. (1991): Calcretes. Blackwell Scientific Publ..

Course No. GLM514: SEQUENCE STRATIGRAPHY **Credit: 3**

Unit -1
Sequence stratigraphy, its concept and evolution; Order and duration of sequences; Application and significance of sequence stratigraphy.

Unit - 2
Fundamentals of sequence stratigraphy, depositional sequence, sequence architecture, types and boundaries, condensation and starvation; Conformity and types of sequence unconformities; Flooding surface, maximum flooding surface, marine flooding surface; Bed, bedset, parasequence, parasequence boundary, parasequence set; System tracts - lowstand system tract, transgressive system tract, transgressive surface and highstand system tract, overlap, offlap, toplap and onlap, aggradation, progradation, retrogradation, transgression and regression; Eustatic sea level changes, sediment supply, basin subsidence rate, and accommodation.

Unit - 3
Outcrop, subsurface and offshore sequence stratigraphy and their integration; Seismic stratigraphy; Sequence stratigraphy in well sections and application of well logs.

Unit – 4
Sequence stratigraphic approach in basin analysis with Indian examples.

Books Recommended:

Boggs, S. (2001): Principles of Sedimentology and Stratigraphy, Prentice Hall.

Coe, Angela, Dan Bosence, Kevin Church, Steve Flint, John Howell and Chris Wilson (2002): The Sedimentary Record of Sea Level Change , Cambridge Univ. Press.
Emery, D, (1996): Sequence Stratigraphy, Blachwell Scientific Publ.
Miall, A.D. (1997): The Geology of Stratigraphic Sequence, Springer-Verlag.
Reineck, H.E., and Singh, I.B. (1980): Depositional Sedimentary Environments, Springer-Verlag.
Vail, P.R., Mitchum, R. M., Todd, R. G., Widmier, J. M., Thompson, S., Sangree, J.B., Bubb, J.N.and Hatlelid, W.G. (1977): Seismic stratigraphy and global changes of sea level: American Association of petroleum Geologists, Vol.26.

See web pages

Course No. GLM515: PLANETARY GEOSCIENCE **Credit : 3**

Unit-1
Origin of solar system; Geology of solar system and abundances of the elements; Importance of planetary geosciences.

Unit-2
Meteoritic impacts and terrestrial catastrophes; Shock metamorphism; Definition, falls, finds, and parent bodies of meteorites.

Unit – 3
Classification of meteorites, chondrites, achondrites, iron and stony-iron meteorites.

Unit – 4
Classification, petrology, chemistry and genesis of chondirtes and achondrites (asteroidal, lunar and martian); Case study of important Indian meteorites; Indian space mission – Chandrayan.

Books Recommended:
Davis, A. M. (2005): Meteorites, Comets, and Planets, Elsevier.
Harry, Y. Mc Sween, Jr. (1999): Meteorites and Their Parent Planets (Second edition), Cambridge Univ. Press.
Hutchinson, R. (2004): Meteorites A petrologic, Chemical and Isotopic synthesis, Cambridge Univ. Press.
McBride, N. and Gilmour, I (2003): An Introduction to the Solar System, Cambridge Univ. Press.
Norton, O. R. (2002): The Cambridge Encyclopedia of Meteorites, Cambridge Univ. Press.
Rollinson, H. (2007): Early Earth System A Geochemical Approach, Blackwell Publ.
Zanda, B. and Rotaru, M. (2001): Meteorites Their Impact on Science and History, Cambridge Univ.Press.

Course No. GLM516: PALEOBIOGEOGRAPHY AND PLATE-TECTONICS **Credit: 3**

Unit-1
Paleobiogeography, its methodologies and applications; Paleobiogeographic principles and practices; Origin and diversity of life; Species concepts.

Unit-2
Paleobiogeographic analyses, paleobiogeographic units - realms and provinces, similarity coefficients; Role of tectonics on Paleobiogeography.

Unit-3
Distribution, migration and dispersal of organisms; Application to Paleobiogeography, plate-tectonics – examples from Indian Phanerozoic.

Unit-4
Case sheets from Indian Phanerozoic geological record.

Books Recommended:
Bird, J.M. (1980): Plate Tectonics, American Geophysical Union, Washington D.C.
Briggs, J.C. (1987): Biogeography and Plate Tectonics, Elsevier.
Lieberman, B. L.(2000): Paleobiogeography: using fossils to study Global Change, Plate Tectonics and Evolution, Plenum Publ., New York.

Jacquelyne Kious, J. and Tilling, R.I. (2007): This Dynamic Earth: The story of Plate Tectonics, USGS Information Services.

SEMESTER - VI

Course No. GLM601: Project Oriented Dissertation **Credit: 22**

It envisages geological field work (7 credits), periodic presentations (5 credits) and submission of thesis and final presentation of 10 credits (8 and 2 credits respectively for thesis and presentation). The area of Dissertation shall be assigned to the students at the end of Semester - IV based on the merit of the students and expertise available in the Department. The project oriented dissertation thesis must be submitted by the end of Semester – VI through detailed field work, laboratory investigations, periodic seminar presentation followed by final presentation before the faculty members and the board of examiners for the purpose of evaluation.