DEPARTMENT OF GEOLOGY

KOHIMA SCIENCE COLLEGE

(An Autonomous Govt. PG College)

JOTSOMA

NAGALAND

SYLLABUS FOR

M.Sc in GEOLOGY

2019

M. Sc Syllabus
Kohima Science College Jotsoma
(An Autonomous Govt. PG College)
Nagaland

The Post Graduate Course in Geology will comprise of 4 (four) semesters for a duration of 2 (two) years. There will be a total of 12 (twelve) Core theory papers and 4 (four) Discipline Specific Elective with accompanying practical papers following the Choice Based Credit System (CBCS).

The course will comprise of8 (eight) Core Course papers in the 1st and 2nd Semesters. There will be 2 (two) Core papers and 2 (two) Discipline Specific Elective papers in the 3rd Semester based on the availability of specialized teachers. In the 4th Semester, there are 2 Core papers along with3 weeks training/fieldwork and a dissertation on a given project work.

Each theory paper will be for 100 marks. Out of 100 marks, 70 marks will be for End Semester Examination and 30 marks for Internal Assessment. Each paper will comprise of 5 (five) units. From each unit, 2 (two) questions of 14 marks each will be set. Students will have to answer 5 (five) questions, selecting 1 (one) from all the 5 (five) units.

There will be 2 (two) Internal Assessment Tests in every semester and average of the 2(two) will be taken for computation of final marks.

Practical papers will be for 50 marks each. There will be continues evaluation in Practical papers. Examination will be conducted only in the end Semester.

A student must secure at least 40% in both the Theory and Practical papers and in the Internal Assessment Test and End Semester Examination (External) along with a minimum 80% attendance to be declared pass.

SEMESTER	COURSE CODE	COURSE NAME	CREDIT
I	MGLC 1.11	Mineralogy, Crystallography and Analytical Techniques	**4**
	MGLC 1.21	Structural geology and Geodynamics	**4**
	MGLC 1.31	Igneous and Metamorphic Petrology	**4**
	MGLC 1.41	Sedimentology	**4**
	MGLC 1.12	Mineralogy, Crystallography and Analytical Techniques (Practical)	**2**
	MGLC 1.22	Structural geology and Geodynamics (Practical)	**2**
	MGLC 1.32	Igneous and Metamorphic Petrology (Practical)	**2**
	MGLC 1.42	Sedimentology(Practical)	**2**
II	MGLC 2.11	Palaeontology	**4**
	MGLC 2.21	Stratigraphy and Quaternary Geology	**4**
	MGLC 2.31	Mineral Exploration and Mining geology	**4**
	MGLC 2.41	Geomorphology and Oceanography	**4**
	MGLC 2.12	Palaeontology (Practical)	**2**
	MGLC 2.22	Stratigraphy and Quaternary Geology (Practical)	**2**
	MGLC 2.32	Mineral Exploration and Mining geology (Practical)	**2**
	MGLC 2.42	Geomorphology and Oceanography (Practical)	**2**
III	MGLC 3.11	Engineering Geology and Hydrogeology	**4**
	MGLC 3.21	Economic and Ore Geology	**4**
	GLD 3.11	a) Fuel Geology and Geochemistry b) Sedimentary Environment and Sedimentary Basins c) Advanced Hydrogeology	**4**
	GLD 3.21	a) Geology of North East India b) Petroleum Exploration c) Marine Geology	**4**
	MGLC 3.12	Engineering Geology and Hydrogeology(Practical)	**2**
	MGLC 3.22	Economic and Ore Geology (Practical)	**2**
	GLD3.12	a) Fuel Geology and Geochemistry (Practical) b) Sedimentary Environment and Sedimentary Basins (Practical) c) Advanced Hydrogeology (Practical)	**2**
	GLD 3.22	a)Geology of North East India (Practical) b) Petroleum Exploration (Practical) c) Marine Geology (Practical)	**2**
IV	MGLC 4.11	Environmental Geology and Climatology	**4**
	MGLC 4.21	Remote Sensing and GIS	**4**
	GLD 4.11	Fieldwork	**4**
	GLD 4.21	Dissertation	**4**
	MGLC 4.12	Environmental geology and Climatology (Practical)	**2**
	MGLC 4.22	Remote Sensing and GIS (Practical)	**2**
	GLD 4.12	Seminar	**2**
	GLD 4.22	Report and Presentation	**2**
TOTAL			**96**

1st SEMESTER

SEMESTER	COURSE CODE	COURSE NAME	CREDIT
I	MGLC 1.11	Mineralogy, Crystallography and Analytical Techniques	4
	MGLC 1.21	Structural geology and Geodynamics	4
	MGLC 1.31	Igneous and Metamorphic Petrology	4
	MGLC 1.41	Sedimentology	4
	MGLC 1.12	Mineralogy, Crystallography and Analytical Techniques (Practical)	2
	MGLC 1.22	Structural geology and Geodynamics (Practical)	2
	MGLC 1.32	Igneous and Metamorphic Petrology (Practical)	2
	MGLC 1.42	Sedimentology (Practical)	2
		TOTAL	**24**

1st SEMESTER

Course No. : MGLC 1.11
Course Title : Mineralogy, Crystallography and Analytical Techniques
Credit: 4

UNIT - I

Bonding in minerals, coordination number, solid solution, polymorphism, isomorphism and pseudomorphism. Structural classification of silicates. Systematic mineralogy (chemical composition, atomic structure, mineral chemistry, PT-stability and mode of occurrence of olivine, garnet, aluminosilicate (Al_2SiO_5), epidote groups.

UNIT - II

Systematic mineralogy of melilite, beryl, pyroxene and amphibole, kaolinite, mica, chlorite groups.

UNIT - III

Systematic mineralogy of feldspar group, cordierite, native elements (diamond and graphite), sulfides (pyrrhotite and sphalerite), sulfosalts (enargite), oxides (periclase and corundum), hydroxides (brucite and gibbsite) and carbonates (calcite, dolomite and aragonite).

UNIT - IV

Concept of symmetry. Space lattice and symmetry of internal structures - 14 Bravais lattices. Introduction to point group and space group. Twinning and twin laws - common types of twins and their examples in minerals. Optical crystallography of uniaxial and biaxial minerals: indicatrix, pleochroism, interference figures, 2V and 2E. Determination of optic sign.

UNIT - V

Gem and semi- Precious minerals. Basic principles and geological application of X-ray diffractometry, cathodoluminescence, thermo luminescence, atomic absorption spectrophotometry, inductively coupled plasma - atomic emission spectrometry, X-ray fluorescence spectrometry, scanning and transmission electron microscopy, and electron-probe microanalysis.

Course No. : MGLC 1.12
Course Title : Mineralogy, Crystallography and Analytical Techniques
Credit: 2

Study of important rock forming minerals in hand specimen and atomic structure models. Determination of extinction angle and composition of plagioclase. Microscopic study of common rock-forming minerals. Calculation of mineral formulae. Stereographic projection of crystals. Sample preparation for powder diffraction by XRD and interpretation of X-ray diffractograms of common minerals and components of bulk rocks. Preparation of thin and polished sections. Etching and staining.

Books Recommended

Deer, W.A., Howie, R.A. and Zussman, J. 1996: The rock forming minerals. Longman. ISBN-10: 0582300940.
Klein, C. and Hurlbut, C.S. (Jr) 1993: Manual of mineralogy. John Wiley. ISBN 0135615801.
Putnis, A. 1992: Introduction to mineral sciences. Cambridge University Press. ISBN-10: 9780521429474.
Spear, F.S. 1993: Mineralogical phase equilibria and pressure-temperature-time paths. Mineralogical Society of America Publications. ISBN 0-939950-34-0.
Phillips, W.R. and Griffin, D.T. 1986: Optical mineralogy. CBS Publishers. ISBN, 9788123910642
Hutchinson, C.S. 1974: Laboratory handbook of petrographic techniques. John Wiley. ISBN-10: 0471425508; ISBN-13: 978-0471425502.

Course No. : MGLC 1.21
Course Title : Structural Geology and Geodynamics
Credit: 4

UNIT – I

Stress: Concept and types of stress (hydrostatic, uniaxial, compressional, tensional, triaxial, deviatoric, differential and effective stress); Two dimensional stress analyses; Behaviour of rocks under stress: elastic, plastic and viscous materials.
Strain: Concept and types of strain; Principal axes of strain; Strain markers and methods of strain measurements in naturally deformed rocks.

UNIT – II

Mechanics of folding; Fold development and distribution of strain in folds; Causes and dynamics of faulting; Strike-slip faults, Normal faults, Thrust faults. Planar and linear fabrics in deformed rocks, their origin and significance; Stereographic and equal area projections for presenting different types of fabrics, and π and β diagrams.

UNIT -III

Phase transitions and seismic discontinuities in the earth. Heterogenity of earth's crust. Isostasy, Continental drift and sea floor spreading (geological and geophysical evidences). Mechanism of plate motion (mantle drag mechanism and edge force mechanism). Types of plate boundaries and their inter-relationship. Major tectonic features of the oceanic and continental crust.

UNIT-IV

Rock magnetism and its origin; Paleomagnetism; magnetic and gravity anomalies at MOR, trenches, continental shield and mountain chains. Polarity reversals polar wandering and supercontinental cycles. Heat flow patterns at MOR.

UNIT-V

Brief study on geodynamic evolution of Indian Cratons (Dharwar, Singhbhum, Bastar and Bundelkhand). Structure and origin of Himalaya. Neotectonics concepts and evidences.

Course No. : MGLC 1.22
Course Title : Structural Geology and Geodynamics
Credit: 2

Preparation and interpretation of geological maps and sections. Study of map projections. Structural problems concerning economic mineral deposits. Recording and plotting of field data. Plotting and interpretation of petrofabric data and resultant diagrams. Study of large scale tectonic features of the earth. Drainage patterns and analysis.

Books Recommended:

Badgley, P.C. 1965: Structure and Tectonics. Harper & Row.

Bailey, B. 1992: Mechanics in Structural Geology. Springer Verlag. ISBN 9781461391661

Condie, K.C. 1982: Plate Tectonics and Crustal Evolution (2nd ed). PergammonPress. ISBN 0750633867

Davis, G.H. 1984: Structural Geology of Rocks and Regions. John Wiley. *ISBN*: 9780471152316

Fossen, H. 2010: Structural Geology. Cambridge University Press. *ISBN*: 9780511777806.

Ghosh, S.K. (1993): Structural Geology: Fundamental and Modern Developments. Pergamon Press.

Ghosh, S.K. 1995: Structural Geology - Fundamentals of Modern Developments. Pergammon Press. ISBN9780080418797, 9780080983998.

Hobbs, B.E., Means, W.D. and Williams, P.F. 1976: An Outline of Structural Geology. John Wiley.

Keary, P., Klepeis, K.A and Vine, F.J. 2009: Global Tectonics (3rd ed). Blackwell. ISBN: 9788126532957

Keary, P. and Vine, F.J. 1990: Global Tectonics. Blackwell.

Moores, E. and Twiss, R.J. 1995: Tectonics. Freeman.

Passchier, C.W. and Trouw, R.A.J. 2005: Microtectonics (2nd ed). Springer Verlag.

Pluijm, B.A. van der and Marshak, S. 1997: Earth Structure: An Introduction to Structural Geology and Tectonics. McGraw Hill.

Price, N.J. and Cosgrove, J.W. 1990: Analysis of Geological Structures. Cambridge University Press.
Ramsay, J.G. 1967: Folding and Fracturing of Rocks. McGraw Hill. ISBN 070511705
Ramsay, J.G. and Huber, M.I. 1987: Modern Structural Geology (vol. 1 & 2). Academic Press.
Ramsay, J.G. and Huber, M.I. (1987): Techniques of Modern Structural Geology. Vol. II. Folds and Fractures. Academic Press.
Storetvedt, K.N. 1997: Our Evolving Planet: Earth's History in New Perspective. Bergen (Norway), Alma Mater Fortag.
Summerfields, M.A. 2000: Geomorphology and Global Tectonics. Springer Verlag. ISBN 0471971936
Suppe, J. 1985: Principles of Structural Geology. Prentice Hall.
Twiss, R.J and Moores, E.M. 2007: Structural Geology (2nd ed), Freeman.
Valdiya, K.S. 1998: Dynamic Himalaya. University Press, Hyderabad.
Edwards J.Plate Tectonics and Continental Drift, Published by Creative Co. ISBN 10: 1583407308 ISBN 13: 9781583407301
Keary P. Klepels K.A and Nive F.J. Global Tectonic, Wiley & Sons, Incorporated, John ISBN 10: 0865429243 ISBN 13: 9780865429246
Valdiya. K.S, Aspects of Tectonics. McGraw-Hill Education (1 October 1985) ISBN-10: 0074519727: ISBN-13: 978-0074519721
Valdiya. K.S. Making of India, Springer (2015) ISBN 10: 3319250272 ISBN 13: 9783319250274.

Course No. : MGLC 1.31
Course Title : Igneous and Metamorphic Petrology
Credit: 4

UNIT-I

Magma: Factors affecting magma generation;Magmatism in relation to plate settings; Classification of Igneous rocks: CIPW norm and IUGS classification.

UNIT-II

Petrology and petrogenesis of Major Igneous rock types: Ultramafic rocks-Komatites, Flood Basalts (Deccan Trap, Sylhet Trap), Granite, Alkaline rocks, Carbonatites and Ophiolites.

UNIT-III

Geochemical characteristics of Igneous rocks: Chemical analyses, REE, major, trace and isotopic composition of Igneous rocks; Application of trace elements and isotope geology in Petrogenesis and source characterization.

UNIT-IV

Metamorphic textures, P-T-t path,Metamorphic reactions, Barrovian Zones of metamorphism; Elemental exchange and P-T conditions of Isograds; Regional metamorphism of pelitic and basic metamorphic assemblages; metamorphic reaction involved during regional metamorphism of rocks.

UNIT-V

Metamorphic Facies: low pressure (albite-epidote-hornfels, pyroxene-hornfels), medium-high pressure (greenschist, granulite) and very high pressure (eclogite) with special reference to charateristic minerals and PT conditions; Application of geo-thermometry and geobarometry.

Course No. : MGLC 1.32

Course Title : Igneous and Metamorphic Petrology

Credit: 2

Megascopic and microscopic study of Igneous andMetamorphic rocks.Graphic construction of ACF, AKF and AFM diagrams. Estimation of pressure and temperature from important models of geothermobarometry. Interpretation of reaction textures.

Books Recommended

Best, M. G. 1986: Igneous and metamorphic petrology. Blackwell Publishers. ISBN: 1-40510-588-7.

Kretz, R. 1994: Metamorphic crystallization. John Wiley. ISBN: 0471942146, 9780471942146.

Philipotts, A, R. and Ague, J. J. 1990: Principles of Igneous and metamorphic petrology. Prentice Hall. ISBN: 9780521880060.

Raith, M.M, Raase, P. and Reinhardt, J. 2012: Guide to thin section microscopy. 2nd Edition.ISBN: 9783000376719.

Turner, F.J. and Verhoogen, J. 1960: Igneous and Metamorphic petrology. CBS Publishers. ISBN: 8123911017.

Winter, J. D. 2014: Principles of Igneous and Metamorphic Petrology.2nd Edition. Pearson Education Limited. ISBN 10: 1-292-02153-5; ISBN 13: 9781292021539.

Yardley, B.W. D. 1989: An Introduction of metamorphic petrology. Longman. ISBN: 0582300967.

Course Code : MGLC 1.41

Course Title : Sedimentology

Credit: 4

UNIT-I

Liberation of flux of sediments: Physical and chemical weathering, submarine weathering. Fluid flow and sediment transport: laminar Vs turbulent flow, Reynolds number, Froude number and Hjulstrom effect. Concept of flow regimes and bedforms. Classification of primary and secondary sedimentary structures.

UNIT-II

Sedimentary environments and facies: classification, lithofacies assemblages from fluvial, deltaic, marine, glacial and arid environment. Ichnofossilsand their significance in depositional environments.

UNIT- III

Tectonics and sedimentation: tectonic control of sedimentation, plate tectonics and sediment accumulation, sedimentary basins and their classifications, Basin analysis,Palaeoclimate and palaeoenvironment analyses.

UNIT-IV

Shallow coastal clastics and shallow water carbonates, Deep water sedimentation, Volcaniclastic- land and marine, Diagenesis of sandstones and carbonate rocks.

UNIT- V

Field and laboratory techniques in sedimentology: Recording of sedimentary structures and preparation of litho-logs. Palaeocurrent analysis, Provenance determination using heavy minerals, quartz, feldspars and rock fragments.

Course Code : MGLC 1.42
Course Title : Sedimentology
Credit: 2

Study of primary, secondary, and biogenic sedimentary structures in hand specimens, in photographic atlases, field photographs, and wherever possible on outcrops. Exercises related to palaeocurrent data from different environments. Tilt corrections of palaeocurrent data. Exercises related to analysis and interpretation of depositional sedimentary environments using actual case histories from the Indian stratigraphic records. Determination of porosity in clastic and chemical sedimentary rocks. Detailed study of diagenetic features in thin sections, Separation and study of heavy minerals. Exercises on mineralogical and geochemical data plots for environmental interpretations.

Books recommended:

Allen, J.R.L. 1985: Principles of physical sedimentation. George Allen & Unwin.*ISBN* 978-1-4613-2545-1

Allen, P. 1997: Earth surface processes. Blackwell. . *ISBN* 0 632 03507 2.

Nichols, G. 1999: Sedimentology and stratigraphy. Blackwell.*ISBN* 978-1-4051-9379-5

Reading, H.G. 1996: Sedimentary environments. Blackwell. Publisher: *Blackwell* Scientific Publications; 2 edition (1986); Language: English; *ISBN*-10: 0632015721

Davis, R.A. (Jr) 1992: Depositional systems. Prentice Hall. *ISBN*-10: 9780132029124

Einsele, G. 1992: Sedimentary basins. Springer Verlag. *ISBN* 0-387-54743-6

Reineck, H.E. and Singh, I.B. 1980: Depositional sedimentary environments. Springer Verlag.*ISBN* 978-3-642-81498-3

Prothero, D.R. and Schwab, F. 1996: Sedimentary geology. Freeman. *ISBN* 0716727269. - Volume 134

Miall, A.D. 2000: Principles of sedimentary basin analysis. Springer Verlag.*ISBN* 978-3-662-03999-1

Pettijohn, F.J., Potter, P.E. and Siever, R. 1990: Sand and sandstone. Springer Verlag. 978-0-387-96350-1, Springer-Verlag New York

Blatt, H., Murray, G.V., and Middleton, R.C. 1980: Origin of sedimentary rocks.

Bhattacharya, A. and Chakraborti, C. 2000: Analyses of sedimentary successions. Oxford-IBH. *ISBN*: 978-3-319-20576-2

Boggs, S. (Jr) 1995: Principles of Sedimentology and Stratigraphy. Prentice Hall.*ISBN*-13: 978-0321643186

Sengupta, S. 1997: Introduction to sedimentology. Oxford-IBH. ISBN: 9789054102304

2ND SEMESTER

SEMESTER	COURSE CODE	COURSE NAME	CREDIT
II	MGLC 2.11	Palaeontology	**4**
	MGLC 2.21	Stratigraphy and Quaternary Geology	**4**
	MGLC 2.31	Mineral Exploration and Mining geology	**4**
	MGLC 2.41	Geomorphology and Oceanography	**4**
	MGLC 2.12	Palaeontology (Practical)	**2**
	MGLC 2.22	Stratigraphy and Quaternary Geology (Practical)	**2**
	MGLC 2.32	Mineral Exploration and Mining geology (Practical)	**2**
	MGLC 2.42	Geomorphology and Oceanography (Practical)	**2**
		TOTAL	**24**

2ND SEMESTER

Course Code : MGLC 2.11
Course Title : Palaeontology
Credit: 4

UNIT- 1

General principles of palaeontology: Origin of life and mechanisms of evolution. Trace fossils and their classification. Concept of Taphonomy. Environmental factors controlling distribution and abundance of life.

UNIT- II

Functional morphology and evolutionary trends in molluscs (Pelecypoda, Gastropoda, Cephalopoda), Brachiopoda, Echinodermata and Trilobites.

UNIT- III

Major events in the history of Precambrian and Phanerozoic life.Vertebrate fossil records of Siwaliks. Evolution of horses and elephants.

UNIT- IV

Sampling methods and processing of microfossils. Classification, morphology and palaeoecological significance of Foraminifers, Ostracods and Conodonts. Morphology, classification and biogeography of Radiolarians. Application of micropalaeontology in hydrocarbon exploration.

UNIT- V

Morphology, classification and application of pollen and spores. Morphology, environmental application and stratigraphic significance of dinoflagelates, Calcareous nannofossils and Calcareous algae.

Course Code : MGLC 2.12
Course Title : Palaeontology
Credit: 2

Recognition of fossil groups in an assorted assemblage and identification of their classes.
Study of morphological features, systematic classification and stratigraphic age of Molluscs, Brachiopods, Echinodermata and Trilobites.
Identification of important Calcareous, Siliceous, phosphate and organic walled microfossils, plant fossils and vertebrate fossils.

Books Recommended:

Clarkson, E.N.K., 1998: *Invertebrate Palaeontology and Evolution*. IV Ed. Blackwell. ISBN: 9780632052387.
Stearn, C.W. & Carroll, R.L., 1989: *Palaeontology -the Record of Life*. John Wiley. ISBN: 9780865424395.
Smith, A.B., 1994: *Systematics and the Fossils Record*-Documenting Evolutionary Patterns. *Blackwell. ISBN-10: 0632036427.*
Prothero, D.R., 1998: Bringing Fossils to Life -An Introduction to Palaeobiology. *McGraw Hill*.
Pomerol, C., 1982: *The Cenozoic Era*: Tertiary and Quaternary. Ellis Harwood Ltd. ISBN 9780939950812.
Brasier, M.D. (1980). Microfossils. Unwin Hyman, London.ISBN 13: 1598000530140.
Kethal, P.K. (1998). Microfossils and their applications. CBS Publishers & Distributors. ISBN: 9788123905921.
Jones, R.W. (1998). Micropalaeontology in petroleum exploration. Oxford University Press.ISBN 10: 0198526474, ISBN 13: 9780198526476.
Brooks, J. (1981). Organic Maturation studies and fossil fuel exploration. Academic Press.SBN-10: 9780121357603.
Traverse, A. (1994) Sedimentation of organic particles. Cambridge University Press. ISBN 10: 0521384362 / ISBN 13: 9780521384360.
Foote, M & Miller, A.I. (2001). Principles of Palaeontology. W.H. Freeman & Company.ISBN 10: 0716702479 / ISBN 13: 9780716702474.
Doyle, P. (2002). Understanding fossils an introduction to invertebrate palaeontology. Wiley, ISBN-10: 9780471963516.
Bignot, G. (1985).Elements of Micropalaeontology. Graham & Trotman, Paris, ISBN 10: 0860104907 / ISBN 13: 9780860104902.
Traverse. A (2007). Palaeopalynology. Springer.SBN 9781402056109 (e-book) ISBN 9781402066849 (PB), ISBN 9781402056093 (HB).
Haslett, S.K. (2002). Quaternary environmental micropalaeontology. Arnold. ISBN: 0340761970 9780340761977 0340761989 9780340761984.
Ray, A.K. (2008). Fossils in Earth Sciences. Prentice Hall of India Private Limited, New Delhi. ASIN: B00K7YG2H4
Skelton, P.W., Spicer, R.A., Keller, S.P. and Gilmour, L. (2003). The Cretaceous world. Cambridge University Press.ISBN-10: 0521538432; ISBN-13: 9780521538435.

Course Code : MGLC 2.21
Course Title : Stratigraphy and Quaternary Geology
Credit: 4

UNIT - I

Controls on the development of stratigraphic records. Lithostratigraphy: correlation and stratigraphic code. Biostratigraphy: controlling factors, zonation, time significance, quantitative stratigraphy. Pedostratigraphy. Geochronology and Chronostratigraphy. Completeness/ incompleteness of stratigraphic records.

UNIT - II

Event stratigraphy, Magnetostratigraphy, Cyclostratigraphy, Seismic Stratigraphy, and Sequence Stratigraphy. Geophysical and chemostratigraphic correlation.

UNIT - III

Stable isotopes and palaeoclimates. Study of palaeogeography,palaeoclimate, igneous and mountain building activities in the Indian subcontinent.

UNIT – IV

The Quaternary Period and its division, Neogene-Quaternary and Pleistocene-Holocene boundary, the Anthropocene, Quaternary dating methods-Cosmogenic radionuclides-C^{14}, Luminescence chronology, Dendrochronology (principles, application and limitations).

UNIT – V

Quaternary sedimentary records from India- Himalayan foreland, Son-Narmada valley, Gangetic plains, coastal plains, Brahmaputra plains and other parts of NE India.

Course Code : MGLC 2.22
Course Title : Stratigraphy and Quaternary Geology
Credit: 2

Exercises on stratigraphic classification and correlation. Exercises on interpretation of seismic records of stratigraphy. Study of palaeogeographic maps of all geological periods.
Quaternary chronology, preparation oflitholog in Quaternary stratigraphic sections/fluvial sequences. Soil profile/ weathering profile analysis.

Books Recommended:

Ager, D.V. 1980: Introduction to Palaeoecology. McGraw Hill.
Bayer, U. and Seilacher, A. 1985: Sedimentary and Evolutionary Cycles. Springer Verlag. *ISBN* 978-3-540-39162-3;
Boggs, S. (Jr) 1995: Principles of Sedimentology and Stratigraphy. Prentice Hall. *ISBN*-13: 978-0321643186
Dasgupta, A.B. and Biswas, A.K. 2000: Geology of Assam. Geological Society of India. *ISBN* No: 81-85867-44-5.
Dodd, J.R. and Stanton, R.J. 1983: Palaeoecology: Concepts and Application. John Wiley. *ISBN*: 978-0-471-85711-2
Doyle, P. and Bennet, M.R. 1996: Unlocking the Stratigraphic Record. John Wiley. ISBN 0-471-97463-3

Karunakaran, C. 1972: Geology and Mineral Resources of the States of India. Misc. Publ., GSI, vol. 30.
Kennett, P. and Ross, C.A. 1983: Palaeoecology. Longman.
Krishnan, M.S. 1982: Geology of India and Burma (6th ed). CBS Publishers.
Kumar. G. 1997: Geology of Arunachal Pradesh. Geological Society of India.
Kumar, R. 1985: Fundamental of Historical Geology and Stratigraphy of India (3rd ed). Wiley Eastern. *ISBN* 0 85226 745.
Ladd, H.S. 1957: Treatise on Marine Ecology and Palaeoecology (vol. 2). Palaeoecology
Moullade, M. and Nairn, A.E.M. 1983: Palaeozoic, Mesozoic and Cenozoic (vol. 1-3). Elsevier.
Nandy, D.R. 2001: Geodynamics of Northeastern India and the Adjoining Region. ACB Publications. *ISBN*, 8187500042.
Naqvi, S.M. 2005: Geology and Evolution of the Indian Plate (4 Ga to 4 Ka). Capital Publishing Co.*ISBN*: 8185589399 9788185589398.
Naqvi, S.M. and Rogers, J.J.W. 1987: Precambrian Geology of India. Oxford University Press.
Pascoe, E.H. 1968. A Manual of Geology of India and Burma (vol. 1-4). GoI Press.
Pomerol, C. 1982: The Cenozoic Era: Tertiary and Quaternary. Ellis Harwood.
Sheriff, R.E. 1980: Seismic Stratigraphy. International Human Resources Dev. Corp., Boston. *ISBN* 10: 0934634084.
Tarling, D.H. 1983: Palaeomagnetism - Principles and Applications in Geology, Geophysics and Archaeology. Chapman & Hall.*ISBN* 0412239205 (hardback), 0412251000 (paperback).
Wadia, D.N. 1957: Geology of India (3rd ed). Macmillan. *ISBN*: 9781330260791.

Course Code: MGLC 2.31
Theory: Mineral Exploration and Mining geology
Credit: 4

UNIT- I

Concept of prospecting and exploration. Criteria and guides to prospecting. Geological models in exploration planning. Geological exploration methods: Regional and detailed geological mapping, pitting, trenching, drilling and sampling methods.

UNIT- II

Seismic methods: Seismic waves used in seismic survey and their velocities in different rocks, basic principles of seismic wave reflection and refraction seismic methods, data acquisition, processing, interpretation and applications. Concept and principle of gravity method of prospecting.

UNIT- III

Basic concepts and principles of magnetic, electrical resistivity and radioactive methods of prospecting. Introduction to airborne geophysical survey.

UNIT- IV

Basic principles of exploration geochemistry: geochemical environment, geochemical dispersion and association of elements. Geochemical rock surveys: types of geochemical survey. Geobotanical methods: plants as indicators of mineralization, biogeochemical methods. Application of remote sensing in mineral exploration.

UNIT- V

Mining strategies: Planning, exploration and exploratory mining of surface and underground mineral deposits involving diamond drilling, shaft sinking, drifting, cross-cutting, winzing, stoping, room and pillaring, top-slicing, sub-level caving and block caving. Mining hazards: mine inundation, fire and rock burst.

Course Code: MGLC 2.32
Course Name: Mineral Exploration and Mining Geology
Credit: 2

Interpretation of underground structure on the basis of seismic data.
Study of prospecting procedures of some important deposits.
Study and interpretation of geological maps/mine plans and sections of mineral deposits.
Calculation of assay values, ore and mineral reserves from maps and data.
Study of geochemical and geophysical anomalies, and their interpretation.

Books Recommended:

Evans, A.M. 1995: Introduction to mineral exploration. Blackwell Science.ISBN-10: 0632024275.
Rose, A.W., Hawkes, H.E. and Webb, J.A. 1979: Geochemistry in mineral exploration. Academic Press.ISBN-13: 9780060427108.
Govett, G.J.S. 1983: Handbook of exploration geochemistry. Elsevier. ISBN: 9780444818546, 9781483290461.
Levinson, 1974: Introduction to exploration geochemistry.ISBN-10: 0915834014; ISBN-13: 978-0915834013
Sharma, P.V. 1986: Geophysical methods in geology. Elsevier ISBN:9780080220727, 9781483293486.
Vogelsang, D. 1995: Environmental geophysics - A practical guide. Springer Verlag.ISBN: 3540579931 9783540579939.
Dobrin, M.B. 1976: Introduction to geophysical prospecting. McGraw Hill.ISBN 10: 0070171955.
Stanislave, M. 1984: Introduction to applied geophysics. Reidel Publications.ISBN-10: 0393926370.
Peters, W.C. 1978: Exploration and mining geology. John Willey and Sons.ISBN-10: 0471838640; ISBN-13: 978-0471838647.
McKinstry, H.E. 1962: Mining geology (2nd ed). Asia Publishing House.ASIN: B003I2VY84.
Clark, G.B. 1967: Elements of mining (3rd ed). John Wiley.ISBN-10: 0471533319; ISBN-13: 978-0471533313.
Arrogyaswami, R.N.P. 1996: Courses in mining geology (4th ed). Oxford IBH. ISBN: 9788120409378.

Course Code : MGLC 2.41
Course Title : Geomorphology and Oceanography
Credit: 4

UNIT-I

Concept and perception of geomorphology. Landscape development:Davisian model and its merits and demerits. Penck's and King's models geomorphic process: endogenetic and exogenetic; anthropogenic: biological and extra-terrestrial.

UNIT-II

Morphometric analysis: Drainage patterns, drainage basin asymmetry, stream length-gradient index. Slope: types and evolution. Tectonic geomorphology, geomorphic indices of active tectonics: Hypsometric curve and Hypsometric integral, mountain-front sinuosity and ratio of valley-floor width to valley heights.

UNIT-III

Applied geomorphology: regional planning, hazard management: hydrogeology, urbanization, engineering works and mineral exploration.

UNIT-IV

History of development of marine geology and oceanography. Ocean floor morphology, Zones of marine environment and its communities (Pelagic and Benthic). Ocean sediments.Factors controlling deposition and distribution of oceanic sediments. Law of the sea.

UNIT-V

Ocean circulation: Corioliseffect and Ekman spiral;convergence and downwelling, divergence and upwelling; El Nino. Thermohaline circulation and oceanic conveyor belt and its role in global climate change. Concept of mixed layer, thermocline and pynocline. Formation of bottom water,major water masses of world's ocean.

Course Code : MGLC 2.42
Course Title : Geomorphology and Oceanography
Credit: 2

Drainage patterns and morphometric analysis.
Geomorphic indices.
Identification of ocean currents(warm-water and cold-water currents) in Northern Hemisphere and Southern Hemisphere.
Global conveyor Belt and its path.

Books recommended:

Summerfield M.A (1991) *geomorphology and global tectonics* Wiley and sons ISBN 10: 0471971936 ISBN 13: 9780471971931

Summerfield, M. Global Geomorphology, Longmans (1991)ISBN 10: 0582301564
ISBN 13: 9780582301566
Valdiya K.S 1998, Dynamic Himalayas. Universities Press (India) Pvt. Ltd.ISBN 10: 8173710945 ISBN 13: 9788173710940
Edward A. Keller and Nicholas Pinter, Active Tectonic- Earthquakes, Uplift and Landscape Prentice Hall, ISBN 10: 0023632615 ISBN 13: 9780023632617
W.Burbank and Robert S.Anderson, Tectonic Geomorphology, Douglas Blackwell Science, ISBN 10: 0632043865 ISBN 13: 9780632043866
Gross, M.G, 1977. Oceanography: A view of the Earth, Prentice Hall. ISBN 10: 0136307167 ISBN 13: 9780136307167
Tolmazin, D. 1985. Elements of Dynamic Oceanography,
Springer (1985)ISBN 10: 0045510709 ISBN 13: 9780045510702
Tom S. Garrison,Essentials of oceanography,Cengage LearningISBN 10: 0534392598 ISBN 13: 9780534392598

3RD SEMESTER

SEMESTER	COURSE CODE	COURSE NAME	CREDIT
III	MGLC 3.11	Engineering Geology and Hydrogeology	**4**
	MGLC 3.21	Economic and Ore Geology	**4**
	GLD 3.11	a) Fuel Geology and Geochemistry b) Sedimentary Environment and Sedimentary Basins c) Advanced Hydrogeology	**4**
	GLD 3.21	a) Geology of North East India b) Petroleum Exploration c) Marine Geology	**4**
	MGLC 3.12	Engineering Geology and Hydrogeology (Practical)	**2**
	MGLC 3.22	Economic and Ore Geology (Practical)	**2**
	GLD3.12	a) Fuel Geology and Geochemistry (Practical) b) Sedimentary Environment and Sedimentary Basins (Practical) c) Advanced Hydrogeology (Practical)	**2**
	GLD 3.22	a)Geology of North East India (Practical) b) Petroleum Exploration (Practical) c) Marine Geology (Practical)	**2**
		TOTAL	**24**

3RD SEMESTER

Course Code : MGLC 3.11
Course Title : Engineering Geology and Hydrogeology
Credit: 4

UNIT-I

Soil mechanics, Soil profile and classification, engineering properties of soils and their determination.

Engineering properties of rocks, Rocks as construction material. Rock Quality Designation (RQD).

UNIT-II

Impact of civil engineering projects on environment, nature's equilibrium, reservoir induced seismicity; alternatives for environment protection. Mass movement: landslide and causes of slopes instability.

UNIT - III

Origin and types of surface and subsurface water. Hydrological properties of rocks: porosity, permeability, specific yield, specific retention, hydraulic conductivity, transmissivity and storage coefficient.Geological formations as aquifers.

UNIT - IV

Well hydraulics: steady and radial flow. Pumping test analysis, Groundwater exploration: Geologicaland Geophysical methods(Remote Sensing, electric resistivity and seismic refraction).

UNIT - V

Artificial recharge of groundwater. Consumptive and conjunctive uses of water. Chemical properties of groundwater in relation to domestic, industrial and irrigation purposes. Water contamination and pollution. Groundwater provinces of India.

Course Code : MGLC 3.12
Course Title : Engineering Geology and Hydrogeology
Credit: 2

Study of properties of common rocks with reference to their utility in engineering projects. Study of maps and models of important engineering structures such as dam sites and tunnels. Interpretation of geological maps for landslide problems.

Delineation of hydrological boundaries of water table contour maps. Preparation of hydrogeomorphic maps using toposheets, aerial photos and satellite imagery. Analysis of rainfall data, estimation of average annual rainfall. Determination of porosity, hydraulic conductivity, etc. from mechanical analysis data of aquifer material.

Determination of aquifer parameters using Theis and Jacobs method.

Computation of Index properties of soil

Computation of Index properties of rock

Computation of RQD

Books Recommended

Alley, W.M. 1993: Regional groundwater quality. VNR, New York. ISBN 0442009372,Wiley.

Davies, S.N. and Dewiest, R.J.M. 1966:.Hydrogeology. John Wiley. ISBN-10: 0894646389, Krieger Pub Co.

Todd, D.K. 1980: Groundwater hydrology. John Wiley.

Todd, D.K. Larry W.Mays: Groundwater hydrology 3rd Edition. John Wiley. ISBN-10: 9788126530038 Wiley India Pvt Ltd.

Van Te Chow, David R. Maidment, Larry W. Mays: Applied Hydrology. ISBN-10 9780070702424 McGraw Hill Education.

Fetter, C.W. 1990: Applied hydrogeology. Merrill ISBN-10: 0130882399 Pearson.

Freeze, R.A. and Cherry, J.A., 1979: Groundwater. Prentice Hall. ISBN 0133653129 Prentice Hall

Karanth, K.R. 1987: Groundwater assessment - Development and management. ISBN-10: 007517120 Tata-McGraw Hill.

Raghunath, N.M. 1982: Groundwater. Wiley Eastern. ISBN-10: 812219046 Newagepublishers.

Bhagu R. Chahar: Groundwater hydrology ISBN-10: 9339204638 McGraw Hill Education

A.R. Mahendra. Goundwater Technology Handbook: A field guide to extraction and usage of groundwater.ISBN-10: 1482812657 Partridge Publishing.

Krynine, D.H. and Judd, W.R. 1998: Principles of engineering geology. CBS Publishers.
Sharma, P.V. 1997: Environmental and engineering geophysics. Cambridge University Press.
Subramaniam. V. 2000: Water. Kingston Publications.
F.G. Bell,Basic Environmental and Engineering Geology, Whittles Publishing (2007) ISBN 10: 1420044702 ISBN 13: 9781420044706.
Gangopadhyay, Subinoy, Engineering Geology. Oxford University PressISBN 10: 0198086350 ISBN 13: 9780198086352.
Parbin Singh, Engineering and General Geology. ISBN 10: 9350142678 ISBN13:9789350142677.

Course Code : MGLC 3.21
Course Title : Economic Geology and Ore Geology
Credit: 4

UNIT- I
Chemical composition, origin, occurrences and distribution in India – Bauxite, Lead, Tin, Tungsten, Magnesium and Mercury.

UNIT- II
Chemical composition, origin, occurrences and distribution in India – Diamond, Corundum, Talc, Clay, Ochre and Carbonate.

UNIT- III
Chemical composition, origin, occurrences and distribution in India – Rare Metals (Monazite, Antimony, Bismuth, Cadmium, and Platinum) andRare Earth Element (REE).

UNIT-IV
Modern concept of ore genesis. Mode of occurrence of ore bodies - morphology and relationship of host rocks. Textures, paragenesis and zoning of ores and their significance. Concept of ore bearing fluids, their origin and migration; wall rock alteration. Chemical composition of ores - bulk chemistry, trace elements, REE and isotopes. Organic matter in ores and their significance.

UNIT- V
Orthomagmatic ores of mafic-ultramafic association - diamonds in kimberlite, REE in carbonatites. Ores of silicic igneous rocks - Kiruna type, pegmatites. Stratiform and stratabound ore deposits, placers and palaeoplacers. Metamorphism of ores and metamorphogenic ores. Ores related to weathering and weathered surfaces.

Course Code : MGLC 3.22
Course Title : Economic Geology andOre Geology
Credit: 2
Preparation of maps showing distribution of important metallic and industrial minerals in India and the world.Megascopic identification of Indian metallic ores in handspecimen, megascopic study of structures and fabric of different ores and their associations, microscopic properties of ore forming minerals.

Books Recommended:

Craig, J.M. and Vaughan, D.J. 1981: Ore petrography and mineralogy. John Wiley.ISBN 0-471-55175-9.

Evans, A.M. 1993: Ore geology and industrial minerals. Blackwell.ISBN 9780632029532.

Sawkins, F.J. 1984: Metal deposits in relation to plate tectonics. Springer Verlag.ISBN 9783642967856.

Stanton, R.L. 1972: Ore petrology. McGraw Hill.ISBN. 0070608431.

Torling, D.H. 1981: Economic geology and geotectonics. Blackwell.ISBN-10: 0470271450.

Barnes, H.L. 1979: Geochemistry of hydrothermal ore deposits. John Wiley. ISBN 0471 050563.

Klemm, D.D. and Schneider, H.J. 1977: Time and strata bound ore deposits. Springer Verlag.ISBN 978364266806-7.

Guilbert, J.M. and Park, C.F. (Jr) 1986: The geology of ore deposits. Freeman.ISBN 10: 0716714566.

Mookherjee, A. 2000: Ore genesis - A holistic approach. Allied Publishers. ISBN 10: 8170235766.

Alan M. Bateman; Mead L. Jensen,Economic Mineral Deposits published by Wiley & Sons, Incorporated, John ISBN 10: 0471090433 ISBN 13: 9780471090434.

Anthony M. Evans, Ore Geology and Industrial Minerals: An Introduction (Geoscience Texts)Wiley (1993)ISBN 10: 0632029536 ISBN 13: 9780632029532.

Guilbert J.M. The Geology Of Ore Deposits (Pb 2015*)*.Cbs (2015)ISBN 10: 8123925662 ISBN 13: 9788123925660.

Laurence R. Introduction to Ore-Forming Processes.Wiley-Blackwell. ISBN:9780632063789.

Sarkar S.C. Gupta A Crustal Evolution and Metallogeny in India. Cambridge University Press; 1 editionISBN-13: 9781107007154 ISBN-10: 1107007151.

Course No. : GLD 3.11 (a)
Course Title : Fuel Geology &Geochemistry
Credit: 4

UNIT-I

Coal: definition,rank, grade and types. Chemical characterization: proximate and ultimate analysis. Macroscopic ingredients and microscopic constituents: concept of macerals and microlithotypes. Fundamentals of coal-bed methane exploration and production. Methods of coal prospecting and estimation of coal reserves.

UNIT- II

Nature of crude oil: composition and physical properties of oil. Transformation and maturation of organic matter into kerogen. Migration: primary and secondary migration. Trapping mechanism for oil and gas.

UNIT- III

Source rock and Cap rock. Reservoir rock types: sandstone, carbonate and fractured reservoir. Major oil bearing basins of India. Geology of the following oilfields of India: Digboiand Bombay High. Atomic fuels: mode of occurrence and association of atomic minerals in nature.

UNIT- IV

Origin and abundance of elements in the solar system and in the earth, and its constituents. Atomic structures and properties of elements in the periodic table. Special properties of transition and rare earth elements. Geochemical classification of elements.

UNIT- V

Radiogenic isotopes. Radioactive decay schemes of U-Pb, Sm-Nd, Rb-Sr, K-Ar, and growth of daughter isotopes. Radiometric dating of single minerals and whole rocks. Stable isotopes: nature, abundance and fractionation.

Course No. : GLD 3.12 (a)
Course Title : Fuel Geology & Geochemistry
Credit: 2

Megascopic characterization of banded coals. Proximate analysis of coal. Completion of outcrops in the given maps and calculation of coal reserves. Identification of macerals in coal.

Interpretation of organic geochemical data for characterizing source rocks. Preparation of structural contour maps. Study of geological maps and sections of important oilfields of India. Estimation of oil reserves.

Calculation of mineral formulae from the concentration of various oxides in minerals. Calculation of normative minerals from rock composition. Presentation of analytical data. Estimation of pressure and temperature from important models of geothermometry and geobarometry.

Books Recommended

Taylor, G.H., Teichmuller, M., Davis, A., Diessel, C.F.K., Littke, R. and Robert, P. 1998: Organic petrology. GebruderBorntraeger, Stuttgart. ISBN 3443010369.

Chandra, D., Singh, R.M. and Singh, M.P. 2000: Textbook of coal (Indian context). Tara Book Agency, Varanasi.ISBN 0-306-30349-3.

Singh, M.P. (Ed) 1998: Coal and organic petrology. Hindustan Publishing Co., New Delhi.ISBN 10: 8170750520 ISBN 13: 9788170750529.

Stach, E., Mackowsky, M.T.H., Taylor, G.H., Chandra, D. and Teichmuller, M.R. 1982: Statch's text book of coal petrology. GebruderBorntraeger, Stuttgart.ISBN 10: 3443390684 / ISBN 13: 9783443390686.

Hobson, G.D. and Tiratsoo, E.N. 1982: Introduction to petroleum geology. Gulf Publishers, Houston.ISBN 10: 0872013995; ISBN 13: 9780872013995.

Tissot, B.P. and Welte, D.H. 1984: Petroleum formation and occurrence. Springer Verlag.ISBN 0-38713281-3: ISBN 10: 3642878156 / ISBN 13: 9783642878152.

Geology of Petroleum – A.I. Leverson, 2006. CBS Publishers & Distributors, 260pISBN 10: 8123909314 ISBN 13: 9788123909318.

Deshpande B.G: The World of Petroleum; Publisher: New Age International Publisher (1992); ISBN 10: 8122403700 / ISBN 13: 9788122403701.

Chandra.D&Singh B.M: Petroleum (Indian Context) Tara Book Agency (Kamachha, Varanasi).
Selley, R.C. 1998: Elements of petroleum geology. Academic Press.ISBN: 9780123860323. Hardcover ISBN: 9780123860316.
Durrance, E.M. 1986: Radioactivity in geology - Principles and application. Ellis Hoorwool.ISBN-10: 0853127611; ISBN-13: 978-0853127611.
Dahlkamp, F.J. 1993: Uranium ore deposits. Springer Verlag.ISBN 978-3-540-78557-6: ISBN 978-3-662-02892-6.
Boyle, R.W. 1982: Geochemical prospecting for thorium and uranium deposits. Elsevier.SBN 9780444420701, 9780444597632.
Mason, B. and Moore, C.B. 1991: Introduction to geochemistry. Wiley Eastern.ISBN 10: 0471575216 / ISBN 13: 9780471575214.
Krauskopf, K.B. 1967: Introduction to geochemistry. McGraw Hill.ISBN 10: 007035443X
Faure, G. 1986: Principles of isotope geology. John Wiley.SBN-10: 0471864129; ISBN-13: 978-0471864127.
Hoefs, J.M. 1980: Stable isotope geology. John Wiley. ISBN 9783540707080: ISBN 9783662022900.
Marshal, C.P. and Fairbridge, R.W. 1999: Encyclopaedia of geochemistry. Kluwer Academic.ISBN: 0412755009 9780412755002.
Govett, G.J.S. (Ed) 1983: Handbook of Exploration Geochemistry. Elsevier.ISBN 0444419322, 9780444419323.
Nordstrorm, D.K. and Munoz, J.L. 1986: Geochemical thermodynamics. Blackwell.ISBN 10: 0865423199 / ISBN 13: 9780865423190.
Henderson, P. 1987: Inorganic geochemistry. Pergammon Press.ASIN: B001THLQXI.
Rastogi, R.P. and Mishra R.R. 1993: An introduction to chemical thermodynamics. Vikash Publishing House.ISBN-10: 0706999355: ISBN-13: 978-0706999358.
Spear, F.S. 1993: Mineralogical phase equilibria and P-T-t Paths. Mineralogical Society of America.ISBN 0-939950-34-0.

Course No. : GLD 3.11 (b)
Course Title : Sedimentary Environment and Sedimentary Basins
Credit: 4

UNIT- I

Modern laboratory techniques in sedimentological studies. Detailed study of volcanoclastics, chemical precipitates. Clay deposits: mineralogy,physical properties, chemistry and genesis. Processes of dolomitization and phosphatization. Origin of various types of cements.

UNIT- II

Use of trace fossils, stromatolites, thrombolites, and related structures in palaeoenvironmental analysis. Methods of palaeocurrent determination and basin analysis. Tectonics and evolution of the sedimentary basins. Sedimentary cycles, rhythms and cyclothems.

UNIT- III

Analysis of sedimentary facies and preparation of facies maps. Lithofacies, biofacies, dynamics and primary structures associated with the following environments: Deserts, Alluvial Fans, River Plains, Glaciers, Deltas and Estuaries.

UNIT- IV

Lithofacies, biofacies, dynamics and primary structures associated with the following environments: Clastic Shorelines, Clastic Shelves, Marine Evaporite Basins, Carbonate Platforms, Deep Sea and Ocean Bottom, Deep Sea Trench and Rise.

UNIT-V

Sedimentation pattern and depositional environment of selected, undeformed and deformed sedimentary basins of India representing Precambrain, Phanerozoic and Contemporary basins.

Course No. : GLD 3.21 (b)
Course Title : Sedimentary Environment and Sedimentary Basins
Credit: 2

Prepare facies maps based on borehole data and interpret them.
Correlation stratigraphic columns based on lithological, heavy mineral assemblage and palaeontological data.
Interpret geophysical logs.

Books Recommended

Reading, J.G. 1986: Sedimentary Environment &Facies. Blackwell.ISBN-10: 0632015721; ISBN-13: 978-0632015726.
Reineck, H.E. and Singh, I.B. 1975: Depositional Sedimentary Environment. Springer Verlag. ISBN 3540073779.
Carver, R.E. 1971: Procedures of Sedimentary Petrology. John Wiley.ISBN: 047113855X 9780471138556.
Tucker, M. 1988: Techniques in Sedimentology. Blackwell.ISBN: 0632013613 9780632013616 0632013729 9780632013722.
Friedman, G.M. and Sanders, J.E. 1978: Principles of Sedimentology. John Wiley.ISBN-10: 0471752452.
Guy Plint, A. 1995: Sedimentary Facies Analysis. Spl. Publ. IAS No.22. Blackwell.ISBN-13: 9780865428980.
Miall, A.D. 1996: The Geology of Fluvial Deposits. Springer Verlag. ISBN. 3540591869; 9783540591863.
Miall, A.D. 1997: The Geology of Stratigraphic Sequences. Springer Verlag. ISBN 9783642050275.

Course No. : GLD 3.11(c)
Course Title : Advanced Hydrogeology
Credit: 4

UNIT - I

Groundwater and the hydrologic cycle. Precipitation: types and causes. Factors affecting evaporation and transpiration. Runoff characteristics: the hydrograph; hydrographic analyses. Water balance studies. Distribution of water in the earth’s crust. Origin of springs (including thermal). Geologic structures favouring groundwater occurrence.

UNIT - II

Forces and laws of groundwater movement. Factors affecting groundwater movement and occurrence: geomorphology, lithology, and structure. Movement of groundwater: Darcy's law of fluid flow. Water table contour maps and flow net analysis. Well hydraulics: confined, unconfined, steady, unsteady and radial flow. Pumping tests and analysis of test data; evaluation of formation characteristics; Thiem's equilibrium method; Theis' method.

UNIT - III

Groundwater in arid, semiarid, coastal and alluvial regions. Groundwater in hard-rock and limestone terrain of India. Groundwater recharge: artificial and natural; factors controlling recharge. Conjunctive use of water resources in basin management. Groundwater legislation. Problems of over-drafting of groundwater. Water logging. Sources of salinity of groundwater. Seawater intrusion in coastal aquifers and remedial measures. Fluctuations of groundwater level: causes and their measurement.

UNIT - IV

Environmental impact of groundwater extraction. Groundwater quality: major chemical constituents, sources, concentrations and effects on usability; physical and chemical criteria. Water pollution and contamination; its treatment; problems of arsenic and fluoride. Wells: their types, construction and design. Types of drilling: cable tool, hydraulic rotary, reverse rotary and DTH.

UNIT-V

Geological and geophysical methods of groundwater exploration: gravity, magnetic, resistivity and seismic refraction methods. Radiation /geophysical logging. Application of remote sensing in groundwater exploration. Stable isotopes in hydrogeological studies.

Course No. : GLD 3.12 (c)
Course Title : Advanced Hydrogeology
Credit: 2

Deciphering of hydro geological boundaries on water table contour maps, analysis of Hydrographs, Determination of permeability in laboratory and in field, determination of aquifer parameters using Theis and Jacob's methods.

Books Recommended

Alley, W.M. 1993: Regional groundwater quality. VNR, New York.*ISBN* 1863202986.
Davies, S.N. and Dewiest, R.J.M. 1966: Hydrogeology. John Wiley. *ISBN* 10: 0471199001.
Fetter, C.W. 1990: Applied hydrogeology. Merrill Publishing.*ISBN* 10: 0675208874.
Freeze, R.A. and Cherry, J.A. 1979: Groundwater. Prentice Hall.
Garg, S.P. 1982: Groundwater and tube wells. Oxford and IBH Publishing Co.
Hudak, P.F. 2000: Principles of hydrogeology. Lewis Publishers.ISBN-10: 0849330157.
Karanth, K.R. 1987: Groundwater assessment- Development and management. Tata-McGraw Hill.ISBN*:* 0074517120, 9780074517123.
Mahajan, G. 1990: Evaluation and development of groundwater. D.K. Publishers.

Mahajan, G. 1995: Groundwater. D.K. Publishers.ISBN-10: 0756631114.
Pitchaiah, P.S. (Ed) 1995: Groundwater. Ashish Publishing House, New Delhi.
Raghunath, N.M. 1982: Groundwater. Wiley Eastern. ISBN 10: 8122419046.
Singhal, B.B.S. 1986: Engineering geosciences. SavitaPrakashan.
Subramaniam, V. 2000: Water. Kingston Publications, London. *ISSN*: 21670447
Todd, D.K. 1980: Groundwater hydrology. John Wiley. *WILEY. John Wiley* & Sons, Inc.*ISBN* 0471059374.
USDI, 1993: Groundwater manual. Scientific Publishers, Jodhpur. *ISBN*: 9789383692828. E-*ISBN*: Scientific Publisher-USDI.
Viessman, W., Knapp, J.W., Lewis, G.L. and Harbaugh, T.E. 1977: Introduction to hydrology. Harper and Row.*ISBN* 10: 0673991652.
Walton, W.C. 1988: Groundwater resource evaluation. McGraw Hill.McGraw Hill Text (January 1970)ISBN-10: 0070680515.

Course No. : GLD 3.21 (a)
Course Title : Geology of Northeast India
Credit: 4

UNIT - I
Stratigraphic succession, lithology, structure, tectonics and mineral resources of Nagaland and Manipur.

UNIT - II
Stratigraphic succession, lithology, structure, tectonics and mineral resources of Assam .

UNIT - III
Stratigraphic succession, lithology, structure, tectonics and mineral resources of Meghalaya.

UNIT - IV
Stratigraphic succession, lithology, structure, tectonics and mineral resources of Arunachal Himalaya.

UNIT - V
Stratigraphic succession, lithology, structure, tectonics and mineral resources of Mizoram and Tripura.

Course No. : GLD 3.22 (a)
Course Title : Geology of Northeast India
Credit: 2

Megascopic studies on rocks and minerals in North East India.
Preparation of maps on minerals, tectonics and geomorphology.

Books Recommended

Nandy, D.R. 2001: Geodynamics of Northeastern India and the adjoining region. ACB Publications.

Kumar. G. 1997: Geology of Arunachal Pradesh. Geol. Soc. India Publication.

Karunakaran, C. 1972: Geology and Mineral Resources of the states of India. Misc. Publ., GSI, vol. 30.

Dasgupta, A.B. and Biswas, A.K. 2000: Geology of Assam. Geol Soc. India Publication.

Naqvi, S.M. 2005: Geology and evolution of the Indian Plate (4 Ga to 4 Ka). Capital Publishing Co.

Krishnan, M.S. 1982: Geology of India and Burma (6th ed). CBS Publishers and Distributors, Delhi.

Kumar, R. 1985: Fundamental of historical geology and stratigraphy of India (3rd ed) Wiley Eastern.

Wadia, D.N. 1957: Geology of India (3rd ed).

Course No. : GLD 3.21(b)
Course Title : Petroleum Exploration
Credit: 4

UNIT - I

Identification and characterization of petroleum source rocks. Amount, type and maturation of organic matter (kerogen) and its types. Characteristics of reservoir rocks. Porosity and permeability of reservoir rocks. Effects of diagenesis on the reservoir quality.

UNIT – II

Elements of geophysical methods of exploration. Physical properties of rock-density, resistivity and elastic wave velocities. Principles of gravity exploration, concept of gravity anomaly, reduction of data, interpretation of anomaly maps, identification of folds, faults and contacts. Principles of seismic reflection and refraction methods. Bright spots.

UNIT – III

Types of wells: exploration, appraisal and development wells. Drilling rigs and its components. Types of drilling fluid, properties and functions. Elements of well drilling: Cable-tool drilling, rotary drilling. Conventional and sidewall coring. Duties of Wellsite geologists. Mud logs and mud circulation, well kicks and blowouts.

UNIT – IV

Elements of logging: Electric, radioactivity and the sonic logs.Reservoir drive mechanisms-depletion drive, displacement drive and combination drive. Estimation of oil and gas reserve: volumetric and simulation method. Principles of Enhanced oil recovery method.

UNIT-V

Tectonic classification, stratigraphic evolution and hydrocarbon accumulations in the following basins of India- Cambay basin, Bombay Offshore, Cauvery basin, Krishna-Godavari basin, Upper Assam basin, Mahanadi basin, Naga Hills, Tripura and Rajasthan basins.

Course No. : GLD 3.22(b)
Course Title : Petroleum Exploration
Credit: 2

Preparation and interpretation of structure contour map and location of oil and gas.
Interpretation of isopach maps.
Evaluation of organic matter (kerogen) type and maturity of source rocks.
Interpretation of 2D seismic section.
Reserve calculation.

Books Recommended

North, F.K. 1985: Petroleum geology. Allen & Unwin. ISBN: 0045530033 9780045530038 0045530041.
Tissot, B.P. and Welte, D.H. 1984: Petroleum formation and occurrence. Springer Verlag. ISBN 9783642878138.
Selley, R.C. 1998: Elements of petroleum geology. Academic Press. ISBN: 9780123860323.
Deshpande B.G: The World of Petroleum; Publisher: New Age International Publisher (1992); ISBN 10: 8122403700 / ISBN 13: 9788122403701.
Chandra.D& Singh B.M: Petroleum (Indian Context) Tara Book Agency (Kamachha, Varanasi). ISBN 10: 8176462349 / ISBN 13: 9788176462341.
SahayBhagwan: Petroleum Exploration and Exploitation Practices; Allied Publishers Limited. ISBN: 8170231620, 9788170231622.
Laudon Robert C: Principles of Petroleum Development Geology; PTR Prentice Hall; ISBN, 0136494684, 9780136494683.
Hunt John M: Petroleum Geochemistry and Geology(2nd Edition); ISBN 10: 0716710056.

Course No. : GLD 3.21 (c)
Course Title : Marine Geology
Credit: 4

UNIT - I
Ocean morphology, deep ocean floor and various topographic features: ridges, sea mounts, coral reefs, continental shelf, continental slope, trenches and canyons.
UNIT - II
Topography of the ocean floor, Oceanic circulation, waves and currents, pelagic sediments, abyssal plain sediments
UNIT - III
Oceanic sediments and distribution of marine microfossils; stratigraphy and geochronometry of deep-sea deposits.
UNIT - IV
Movements of the sea floor, structure of the ocean basins, Tectonic history and chemistry of oceanic rocks.
UNIT - V
Igneous rocks of the ocean basin, Mineral resources of the oceans, geophysical techniques for the exploration of the sea floor.

Course No. : GLD 3.22 (c)
Course Title : Marine Geology
Credit: 4

Study of Rose diagram.
Study of annual wave period percentage frequencies and plot it on Bar diagram.
Study the pattern of tides and currents.

Books Recommended

Kennett, J.P. 1982: Marine geology. Prentice Hall.ISBN: 0135569362 9780135569368
Seibold, E. and Berger, W.H. 1982: The sea floor. Springer Verlag. ISBN 10: 0387568840.
Pipkin, B.W., Gorsline, D.S., Casey, R.E. and Hammond, D.E. 1972: Laboratory exercises in oceanography. Freeman.ISBN 10: 0716737426.
Introduction to physical Oceanography: John A.Knauss. ISBN-10: 1577664299, Orange grove Books.
The sea floor: An introduction to marine geology: M.J. Keen. ISBN: 9780080125053.
Marine geology: Exploring the new Frontiers of the ocean (the living earth)ISBN-10 0816050775.

4TH SEMESTER

SEMESTER	COURSE CODE	COURSE NAME	CREDIT
IV	MGLC 4.11	Environmental Geology and Climatology	**4**
	MGLC 4.21	Remote Sensing and GIS	**4**
	GLD 4.11	Fieldwork	**4**
	GLD 4.21	Dissertation	**4**
	MGLC 4.12	Environmental geology and Climatology (Practical)	**2**
	MGLC 4.22	Remote Sensing and GIS (Practical)	**2**
	GLD 4.12	Seminar	**2**
	GLD 4.22	Report and Presentation	**2**
		TOTAL	**24**

4TH SEMESTER

Course No. : MGLC 4.11
Course Title : Environmental Geology and Climatology
Credit: 4

UNIT - I

Impact assessment of degradation and contamination of surface water and groundwater quality due to industrialization and urbanization. Water logging problems due to indiscrete construction of canals, reservoirs and dams.

UNIT - II

Soil quality degradation due to irrigation, use of fertilizers and pesticides. Energy crisis: alternative energy resources. Waste management: solid, liquid and radioactive. Geologic aspects of environmental health.

UNIT - III

Earthquakes: causes, magnitude, intensity and distribution. Seismic hazards: Influence of neotectonics in seismic hazards assessment.Volcanism. Deforestation, its causes, impact and remedial measures.

UNIT-IV

Fundamental principles of climatology. Earth's radiation balance; latitudinal and seasonal variation of insolation, temperature, pressure, wind belts, humidity. Vertical and horizontal distribution of temperature. Clouds: formation and classification.

UNIT-V

Factors affecting wind direction and speed, upper level waves and jet streams, the monsoons. Weather disturbances: Properties of air masses, Cyclone: tropical andextratropical. Koppens and Thornthwaite's scheme of classification, Climate change.

Course No. : MGLC 4.12
Course Title : Environmental Geology and Climatology
Credit: 2
Preparation of geohazard maps, wind direction map, temperature distribution, etc.

Books Recommended
Bell, F.G. 1999: Geological hazards. Routledge. *ISBN* 10: 8123908091.
Environmental Geology, James S. Richard. ISBN 9780070164864.
Environmental Geology, Mathew R. Bennett and peter Doyle Wiley. ISBN 9788126560202.
Bryant, E. 1985: Natural hazards. Cambridge University Press.ISBN-10: 0521537436.
Keller, E.A. 1978: Environmental geology. Bell and Howell. ISBN: 130224669.
Patwardhan, A.M. 1999: The dynamic earth system. Prentice Hall.ISBN-10: 9788120346550
Smith, K. 1992: Environmental hazards. Routledge.ISBN-10: 0415224640.
Subramaniam, V. 2001: Textbook in environmental science. Narosa International. ISBN 10: 0849324084 ISBN 13: 9780849324086.
Valdiya, K.S. 1987: Environmental geology - Indian context. Tata McGraw Hill.ISBN-10: 0074519719ISBN-13: 978-0074519714.

Course No. : MGLC 4.21
Course Title : REMOTE SENSING AND GIS
Credit: 4

UNIT-I
Principles of Remote sensing, Electromagnetic energy and spectral response curves, electromagnetic spectrum, sensors and scanners, elements of aerial photo/image interpretation.

UNIT-II
Aerial photography: Types and geometry, stereopair and stereoscopes, photo-mosaics, principles and applications of photogrammetry.

UNIT-III
Satellite remote sensing, Satellite exploration programs and their characteristics: LANDSAT, METEOSAT, SPOT, IRS and KOMPSAT.

UNIT-IV
Digital image processing: Processing, correction, enhancement and classification. Geological interpretation of remotely sensed data for lithology, structure, ground-water potential and hazards.

UNIT-V
GIS: Introduction. Map projection and datum. GIS database:Spatial analysis, vector and raster data, Generation of DEM and interpretation. Applicationsand current trend of GIS.
GPS: Concepts of GPS and its application in earth system sciences.

Course No. : MGLC 4.22
Course Title : REMOTE SENSING AND GIS
Credit: 4

Drainage patterns and analysis. Study of nature of aerial photographs: resolution, mosaic and image parallax. Determination of scale, height, dip, slope, vertical exaggeration and image distortion. Identification of features on single vertical aerial photographs and satellite imagery. Interpretation of cultural details and preparation of land use map using satellite imagery. Exercises on MSS, TM, FCC, IR, Thermal IR, Radar and SPOT images for geological and geomorphological mapping and vegetation, water and mineral resource evaluation. Preparation of false color composites and study of multi-spectral scans and spectral patterns. Image rectification and registration. Exercises on digital image processing. GPS demonstration in the field.

Books Recommended

Drury, S.A. 1987: Image interpretation in geology. Allen and Unwin. ISBN 0 04 550037 1, 0 04 550038 X

Gupta, R.P. 1990: Remote sensing geology. Springer Verlag. ISBN: 978-3-662-55874-4 ISBN: 978-3-662-57254-2

Lillesand, M.T. 2000: Remote sensing and image interpretation. John Wiley. ISBN: 978-1-118-34328-9

Lillesand, T.M. and Kieffer, R.W. 1987: Remote sensing and image interpretation. John Wiley. ISBN: 9781118343289.

Miller, V.C. and Miller, C.F. 1961: Photogeology. McGraw Hill.ISBN-10: 0788141619 ISBN-13: 9780788141614.

Moffitt, F.H. and Mikhail, E.M. 1980: Photogrammetry. Harper and Row.*ISBN*: 070022517X 9780700225170.

Paine, D.P. 1981: Aerial photography and image interpretation for resource management. John Wiley. ISBN: 9780470879382.

Pandey, S.N. 1987: Principles and applications of photogeology. Wiley Eastern, New Delhi.ISBN-10: 0470201266, ISBN-13: 9780470201268.

Ray, R.G. 1969: Aerial photographs in geologic interpretations. USGS Prof. Paper.

Rampal, K.K. 1999: Handbook of aerial photography and interpretation. Concept Publishing Co., New Delhi. *ISBN* 10: 8170225418 / *ISBN* 13: 9788170225416 *Concept Publishing Company*, *New Delhi* (*1999*).

Sabbins, F.F. 1985: Remote sensing - Principles and applications. Freeman.*ISBN* 9781577663539.

Siegal, B.S. and Gillespie, A.R. 1980: Remote sensing in geology. John Wiley. *ISBN*. 0471790524

Nag, P. and Sengupta, S. 2007: Geographical information system: Concepts and business opportunities. Concept Publishing Co., New Delhi.*ISBN* 10: 8170223849/*ISBN* 13: 9788170223849 *Concept Publishing Company*, *New Delhi*(1992).

Course No. : GLD 4.11
Course Title : Field work
Credit: 4

Course No. : GLD 4.21
Course Title : Dissertation
Credit: 4

Course No. : GLD 4.12
Course Title : Seminar
Credit: 2

Course No. : GLD 4.22
Course Title : Report and Presentation
Credit: 2