

NILAMBER-PITAMBER UNIVERSITY

Medininagar, Palamu – 822101



SYLLABUS

FOR

MASTER IN SCIENCE

GEOLOGY

AS PER C.B.C.S.

(Implemented from Session 2017-19)

M.Sc. Programme in Geology

Table : Course Structure for M.Sc. Programme in Geology

Semester	Course	Credit	Hrs./Week
I	FC (Compulsory) – (FC-I)	5	5 (L) + 1 (T)
	Core Course – 1 (CC-1)	5	5 (L) + 1 (T)
	Core Course – 2 (CC-2)	5	5 (L) + 1 (T)
	Core Course (P) – 3 [CC (P)-3]	5	10
II	Elective Course (SE) (EC-1)	5	5 (L) + 1 (T)
	CC – 4	5	5 (L) + 1 (T)
	CC – 5	5	5 (L) + 1 (T)
	CC (P) – 6	5	10
III	CC – 7	5	5 (L) + 1 (T)
	CC – 8	5	5 (L) + 1 (T)
	Elective (GE/DC) (EC – 2)	5	5 (L) + 1 (T)
	EC (P) – 3	5	10
IV	CC – 9	5	5 (L) + 1 (T)
	Elective (GE/DC) (EC – 4)	5	5 (L) + 1 (T)
	EC (P) – 5	5	5 (L) + 1 (T)
	Project	5	10

GEOLOGY

M.Sc. Semester – I

FC 1 – GEOL Compulsory (FC-1)

Geotectonics and Structural Geology

Full Marks: 70+30 Total Lectures-70 Hrs. Credit-5 Time- 3 Hrs.

(Ten questions are to be set out of which five are to be answered)

- Unit 1:** Study of seismic waves – structure and composition of the earth – Radioactivity – Basic concept of palaeomagnetism, Major tectonic features of the earth-shield areas, mobile belts, rift valleys, mid oceanic ridges, continental shelves and slopes, submarine canyons.
- Unit 2:** Plate Tectonics: Concept, geological and tectonic environment of plate boundaries, Sea Floor Spreading, Island arcs, hydrothermal vents; Orogeny and orogenic cycles – Epeirogeny and evolution of plateaus. Structural and tectonic features of India. Tectonic framework of India. Structure and origin of the Himalaya. Quaternary tectonics.
- Unit 3:** Mechanical principles of rock deformation; concept of stress, strain and the resulting ellipsoids; Factors controlling behaviour of rock material. Folds, Recognition, mechanics and causes of folding – Recognition of top and bottom of beds; Faults, recognition criteria and mechanics of faulting; Joints quantitative and qualitative classification of joints; Unconformities – types, recognition, significant, distinction from faults and their use in dating structural events.
- Unit 4:** Cleavage, Schistosity and Lineation – their description origin and relation to major structures. Petrofabric analysis – Field and laboratory techniques – Petrofabric diagrams and their interpretation. Classification and characteristics of tectonites, diapirs and related structural features.

Unit 5 : Toposheets: Definition, scale – definition, scale, reading various components of a toposheet geological map – definition, various components of a geological map including scale, legend, structures, etc. Geological Field work instruments, Use of clinometers compass, Brunton compass, strike and dip measurements; sampling and oriented sample and its significance; Geological mapping of igneous, sedimentary and metamorphic terrains, GPS and its applications in Geology.

Suggested Books :

1. Condie, Kent, C. (1982): Plate Tectonics and Crustal Evolution, Pergamon Press Inc.
2. Gass I.G. (1982): Understanding the Earth, Artemis Press (Pvt.) Ltd., UK
3. Ghosh, S.K. (1993): Structural Geology: Fundamental and Modern Development, Pergamon Press
4. Hobbs, B.E., Means, W.D. and Williams, P.F. (1976): An outline of Structural Geology, John Wiley and Sons, New York
5. Naqvi, S.M. (2005): Geology and Evolution of the Indian Plate (From Hadean to Holocene – 4Ga to 4Ka), GSI, Bangalore
6. Ramsay, J.G. (1967): Folding and fracturing of rocks, McGraw Hill
7. Windley B. (1973): The Evolving Continents, John Wiley and Sons, New York
8. N.J. Price and J.W. Cosgrove (1990): Analysis of Geological Structures, Cambridge University Press
9. Ragan, Donal M.: Structural Geology, Cambridge University Press
10. Whitten, E.H. Timothy (1966): Structural Geology of Rocks, Chicago: Rand McNally
11. George H. Davis (2011): Structural Geology of Rocks and Regions, John Wiley and Sons
12. Fossen H (2010): Structural Geology, Cambridge University Press

GEOLOGY

M.Sc. Semester – I

Core Course - 1 GEOL (CC-1)

Stratigraphy and Palaeobiology

Full Marks: 70+30 Total Lectures-70 Hrs. Credit-5 Time- 3 Hrs.

(Ten questions are to be set out of which five are to be answered)

- Unit 1:** Principles of Stratigraphy; Concept of Lithofacies and Biofacies; Stratigraphic Correlation; concepts of Magnetostratigraphy and Sequence stratigraphy; Precambrian stratigraphy of Dharwar and Singhbhum-Chotanagpur craton; Proterozoic stratigraphy-tectonic framework, geological history and evolution of Vindhyan Super Group, Cuddapahs and their equivalents.
- Unit 2:** Palaeozoic stratigraphy: Palaeozoic formations of India with special reference to type localities, history of sedimentation, fossil content; Concept, classification, lithology, life and age of Gondwana supergroup, Mesozoic formations of India with special reference to type localities, history of sedimentation, fossil content, tertiary formations of Northeastern India, Siwalik Group; Stratigraphic boundary, problems, pre-cambrian – Cambrian (PC/C), Permian-Triassic (P/Tr) and Cretaceous-Tertiary (K/T) boundaries.
- Unit 3:** Study of Ichno fossils; Taphonomy and preservation; Morphology, classification, biostratigraphy and evolutionary trends of Trilobites, Brachiopods, Bivalves, Cephalopoda, Gastropods and Echinoids.
- Unit 4:** Vertebrate and its classification. Evolutionary trends in Equidae, Proboscidae and Man; Siwalik mammals and their causes of extinction.
- Unit 5 :** Micropalaeontology: foraminifera, Diatomism, morphology and biostratigraphy; Gondwana flora and their significance; Palynology, types of Gondwana palynomorphs and its importance; Microfossils and their significance in oil exploration.

Suggested Books :

1. A. Sahni, (1996): Cretaceous Stratigraphy and Palaeoenvironments, GSI, Bangalore
2. Boggs, S. (2001): Principles of Sedimentology and Stratigraphy, Prentice Hall
3. Danbar, C.O. and Rodgers, J. (1957): Principles of Stratigraphy, John Wiley and Sons
4. Doyle, P. and Bennett, M.R. (1996): Unlocking the Stratigraphic Record, John Wiley and Sons
5. Krishnan, M.S. (1982): Geology of India and Burma, C.B.S. Publ. and Distributors, Delhi
6. M. Mamakrishnan & R. Vaidyanadhan (2008): Geology of India – (Vol 1 & 2), GSI, Bangalore
7. T.M. Mahadevan (2002), Geology of Bihar and Jharkhand, GSI, Bangalore
8. Naqvi, S.M. (2005): Geology and Evolution of the Indian Plate (From Hadean to Holocene – 4Ga to 4Ka), GSI, Bangalore
9. Pascoe, E.H. (1968): A Manual of the Geology of India and Burma (Vol. I-IV), Govt. of India Press, Delhi
10. Pomeroy, C. (1982): The Cenozoic Era? Tertiary and Quaternary, Ellis Harwood Ltd., Halsted Press
11. Schoch, Robert, M. (1989): Stratigraphy: Principles and Methods, Van Nostrand Reinhold, New York
12. Boardman, R.S. Cheetham, A.M. and Rowell, A.J. (1988): Fossil Invertebrates, Blackwell.
13. Clarkson, E.N.K. (1998): Invertebrate Paleontology and Evolution, Allen and Unwin, London
14. Horowitz, A.S. and Potter, E.D. (1971): Introductory Petrography of Fossils, Springer Verlag.
15. Mayr, E. (1971): Population, Species and Evolution, Harvard
16. Prothero, D.R. (2004): Bringing Fossil to Life – An Introduction to Paleontology (2nd Ed.), McGraw Hill
17. Raup, D.M. and Stanley, S.M. (1985): Principles of Paleontology, CBS Publ.
18. Romer A.S. (1959): The Vertebrate Story, Univ. of Chicago Press
19. Smith, A.B. (1994): Systematics and Fossil Record – Documenting Evolutionary Patterns, Blackwell.
20. Strenn, C.W. and Carroll R.L. (1989): Principles of Invertebrate Paleontology, McGraw Hill Book Co.
21. Alfred Traverse (1988): Paleopalynology, Unwin Hyman, USA
22. Arnold (2002): Quaternary Environmental Micropaleontology (Ed. Simon K. Haslett), Oxford University Press, New York
23. Bigot, G., Graham and Trotter (1985): Elements of Micropaleontology, London.

GEOLOGY

M.Sc. Semester – I

Core Course - 2 GEOL (CC-2)

Crystallography and Descriptive Mineralogy

Full Marks: 70+30 Total Lectures-70 Hrs. Credit-5 Time- 3 Hrs.

(Ten questions are to be set out of which five are to be answered)

Unit 1: External symmetry of crystals: Symmetry elements, methods of projection, Hermaun Muguin notation, Internal symmetry of crystals; Derivation of 230 space groups, diffraction of crystals by X-rays, Braggs' Law.

Unit 2: Principles of optical mineralogy: polarized light, behaviour of isotropic and anisotropic minerals in polarized light, refractive index, pleochroism double refraction, birefringence, sign of elongation, interference figures, 2V, dispersion in minerals, Optic sign-determination of uniaxial and biaxial minerals.

Descriptive Mineralogy

Unit 3: Principles of crystal chemistry; Chemical bonds, ionic radii, coordination principle, radius ratio; Principles of ionic substitution in minerals, Isomorphism, Exsolution polymorphism, pseudomorphism, Introduction to XRF, XRD and Electron Probe Microanalysis.

Unit 4: Structural classification of silicate minerals: description of chemistry, optical and physical properties and paragenesis of the following mineral groups; Olivine group, Garnet Group, Epidote group, pyroxene group, Amphibole group.

Unit 5 : Description of chemistry, optical and physical properties and paragenesis of the following mineral groups: Mica group, Chlorite group and clay minerals, Quartz group, Feldspar group, Feldspathoids and Zeolites

Suggested Books :

1. Dexter Perkins, 2003 – Mineralogy, Pearson Education Private Ltd.
2. Carmelo Giacovazzo, 2002 – fundamentals of crystallography, Oxford University Press
3. Boris Konstantinovich Vainshtein, 1994 – Modern Crystallography: Fundamentals of crystals, symmetry and methods of structural crystallography, Springer.
4. William D. Nesse, 2009 – Introduction to Mineralogy, Oxford University Press
5. Dana, E.S. – 1955 – Text Book of Mineralogy, Wiley
6. Wade, F.A. and Mattox, R.E. – 1960 – Elements of crystallography and Mineralogy, harmer and brods
7. Philips, P.C. – 1971 – An Introduction to Crystallography, John Wiley
8. Winchell, A.N. – 1968 – Elements of optical mineralogy, Parts I & II, Wiley Eastern
9. Berry, L.G. and Mason B., Dietrich, 1983 – Mineralogy – concept, descriptions, determinations, Freeman
10. Buerger, M.J. – 1956 – Elementary Crystallography, Wiley
11. Heinrich, E.W. – 1965 – Microscopic identification of Minerals McGraw Hill
12. Naidu, P.R.J.C.S. – 1971 – Johansen's Optical Mineralogy, Wiley
13. Deer, W.A. Howie, R.A. & Zussman, J. – 1992 – Rock Forming Mineralogy Vols. 1 to 5, Longmans.
14. Hammond, C. 1990 – Introduction to Crystallography, Oxford University Press
15. Klein, C., 2002 – Manual of Mineral Science, 22nd Edition, New York, John Wiley and Sons.

GEOLOGY

M.Sc. Semester – I

Core Course (P) - 3 GEOL [CC (P)-3]

Full Marks: 100

Time- 6 Hrs.

Completion of outcrops in given maps; Structural problems by Stereographic Net; Plotting of Geological Sections; Mineral formulae, calculation of important rock forming mineral groups; Microscopic identification of important rock forming minerals; Determination of Optic sign of Uniaxial and Biaxial Minerals; Determination of pleochroic scheme; Determination of an content in plagioclase feldspars; Study of rocks in hand specimens from known Indian stratigraphic horizons and type localities; Megascopic study of invertebrate fossils; Study of molar tooth of important vertebrate fossils, study of morphological characters of selected microfossils; Megascopic study of plant fossils; study of morphological characters of selected palynomorphs.

GEOLOGY

M.Sc. Semester – II

Elective Course (SE) (EC-1)

Select one Elective from the following Elective Groups:

- Group A : Fossil Fuel Geology**
- Group B : Sedimentology**
- Group C : Hydrogeology**
- Group D : Ore Geology**
- Group E : Environmental Geology**

Elective Course (SE) GEOL (EC-1)

Group A : Fossil Fuel Geology

Full Marks: 70+30 Total Lectures-70 Hrs. Credit-5 Time- 3 Hrs.

(Ten questions are to be set out of which five are to be answered)

Unit 1: Definition and origin of coal, sedimentology of coal bearing strata; Mode of occurrence and structures of coal; Coal forming epochs in the geological past.

Unit 2: Physical and chemical characterization of coal; Proximate and Ultimate analysis of coal, Rank, grade and types of coal, Types of coking and non-coking coals; Classification of coal.

Unit 3: Macroscopic and microscopic examination of coal, concepts of macerals and microlithotypes, origin and classification of macerals, concept of coal rank, application of coal petrology.

Unit 4: Basics of coal bed methane, coal as its reservoir – its exploration and production; Application of microscopic methods for C.B.M. prospecting; Gas Hydrates, Shale gas.

Unit 5 : Microscopic techniques for evaluation of rank, Palaeoenvironmental study and characterization of coal for carbonization, gasification and hydrogenation processes.

Suggested Books :

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

Elective Course (SE) GEOL (EC-1)

Group B : Sedimentology

Full Marks: 70+30 Total Lectures-70 Hrs. Credit-5 Time- 3 Hrs.

(Ten questions are to be set out of which five are to be answered)

Unit 1: Sedimentary textures – shape, size, fabric and surface textures, methods of textural analysis, textural parameters and their significance. Framework, matrix and cement of terrigenous sediments.

Unit 2: Sedimentary structures: Classification, genesis and significance primary structures, palaeocurrent analysis, biogenic and chemical sedimentary structures, Use of structures and textures in basis studies.

Unit 3: Origin of sediments and sedimentary rocks, Lithification and diagenesis.

Unit 4: Petrogenesis of sandstones, Graywacke and grawacke problem; plate-tectonics and sandstones composition; Argillaceous rocks, their classification and genesis.

Unit 5 : Carbonates; Minerlogy, chemistry, texture and classification of limestones; Diagenesis of limestone in various diagenetic realms, change in mineralogy, fabric, chemistry and petrophysical characteristics; study of evaporates such as gypsum, anhydrite and halite.

Suggested Books :

1. Blatt, H. Middleton, G.V. and Murray, R.C. (1980): Origin of Sedimentary Rocks, Prentice Hall Inc.
2. Collins, J.D. and Thompson, D.B. (1982): Sedimentary Structures, George Allen and Unwin, London
3. Lindholm, R.C. (1987): A Practical Approach to Sedimentology, Allen and Unwin, London

4. Pettijohn; F.J. (1975): Sedimentary Rocks (3rd Ed.), Harper and Row Publ. New Delhi
5. Reading, H.G. (1997): Sedimentary Environments and Facies, Blackwell Scientific Publication
6. Reineck, H.E. and Singh, I.B. (1973): Depositional Sedimentary Environments, Springer-Verlag
7. Selley, R.C. (2000): Applied Sedimentology, Academic Press
8. Tucker, M.E. (1981): Sedimentary Petrology: An Introduction, Wiley and Sons, New York
9. Tucker, M.E. (1990): Carbonate Sdimentology, Blackwell Scientific Publication.

Elective Course (SE) GEOL (EC-1)

Group C : Hydrogeology

Full Marks: 70+30 Total Lectures-70 Hrs. Credit-5 Time- 3 Hrs.

(Ten questions are to be set out of which five are to be answered)

- Unit 1:** Hydrologic Cycle, Distribution of water in earth crust, Groundwater in hydrologic cycle; Groundwater, origin types, importance, Aquifer, their types and characteristics, Hydrologic properties of aquifer materials, porosity, permeability, specific yield, specific retention, hydraulic conductivity, transmissivity, storage coefficient.
- Unit 2:** Forces and laws of groundwater movement; Darcy law and its application in hydrogeology; Confined, unconfined, steady, unsteady and radial flows of groundwater, Methods of pumping test and evaluation of aquifer parameters, Springs: Types, origin and movement of water, water table map and its significance.
- Unit 3:** Hydrographic analysis, water budget studies, water resources inventory of the basin; Consumptive and conjunctive use of surface and groundwater; Causative factors for water table fluctuation, Wells; types, drilling methods, construction, design and development of wells.
- Unit 4:** Physical and chemical characteristics of groundwater, Interpretation of chemical analysis, Relationship of quality to use groundwater, pollution, sources of surface and subsurface pollution, Control of groundwater pollution.
- Unit 5 :** Chemical characteristics of groundwater in relation to various uses – domestic, industrial and irrigation; Water contaminants and pollutants, natural (geogenic) and anthropogenic contaminants; Saline water intrusion in coastal and other aquifers and its prevention; Groundwater contamination and problems of arsenic and fluoride in Indian subcontinent with special reference to Jharkhand.

Suggested Books :

1. C.F. Tolman (1937): Groundwater, McGraw Hill, New York and London
2. D.K. Todd (1995): Groundwater Hydrology, John Wiley and Sons
3. F.G. Driscoll (1988): Groundwater and Wells, UOP, Johnson Div. St. Paul, Min, USA
4. H.M. Raghunath (1990): Groundwater in Hydrosphere (Groundwater Hydrology), CBS Publ.
5. K.R. Karanth (1989): Hydrogeology, Tata McGraw Hill Publ.
6. S.N. Davies and R.J.N. De Wiest (1966): Hydrogeology, John Wiley and Sons, New York
7. Patra, H.P., Adhikari, Shyamal Kumar, Kumar, Subrata (2016): Groundwater Prospecting and Management, Springer
8. Jakeman, A.J., Barreteau, O., Hunt, R.J., Rinaudo, J.D., Ross, A. (2016): Integrated Groundwater Management Concepts, Approaches and Challenges, Springer
9. Ramanathan, A., Johnstons, S., Mukherjee, A. Nath, B. (Eds.) 2015: Safe and Sustainable Use of Arsenic-Contaminated Aquifers in the Gangetic Plain A Multidisciplinary Approach, Springer
10. C.W. Fetter Jr. (2016): Applied Hydrogeology (4th Edition); Pearson Education Ltd.
11. Kevin M. Hiscock (2009): Hydrogeology: Principles and Practice, Wiley-Blackwell
12. Singhal, B.B.S. Gupta R.P. (2010): Applied Hydrogeology of Fractured Rocks, Springer.

Elective Course (SE) GEOL (EC-1)

Group D : Ore Geology

Full Marks: 70+30 Total Lectures-70 Hrs. Credit-5 Time- 3 Hrs.

(Ten questions are to be set out of which five are to be answered)

Unit 1: Ore deposits and or minerals, Classification of ore deposits, Magmatic processes of mineralization, Prophyry, skarn and hydrothermal mineralization.

Unit 2: Structure and texture of ores, Paragenesis, controls of ore localization, spatial and temporal distribution of ore deposits.

Unit 3: Plate tectonics and ore genesis, Ore bearing fluids, movement of ore bearing fluids, Fluid inclusion studies of ores, Geothermometry.

Unit 4: Mineralization associated with ultramafic, mafic and acidic rocks, Wall rock alteration, Magma related mineralization through geological time.

Unit 5 : Mineralization associated with sedimentary rocks, Submarine volcanism, weathering and metamorphic processes, Stratiform and stratabound ores.

Suggested Books :

1. Edward, R. and Stkinson, K. (1986): Ore Deposit Geology, Chapman and Hall, London
2. Craig, J.M. and Vaughan, D.J. (1981): Ore Petrography and Mineralogy, John Wiley
3. Evans, A.M. (2012): Ore Geology and Industrial Minerals, 3rd Edition (Reprint), Blackwell
4. Sawkins, F.J. (1984): Metal Deposits in relation to plate tectonics, Springer Verlag
5. Stanton, R.L. (1972): Ore Petrology, McGraw Hill
6. Torling, D.H. (1981): Economci Geology and Geotectonics, Blackwell Sci. Publ.
7. Barnes, H.L. (1979): Geochemistry of Hydrothermal Ore Deposits, John Wiley

8. Klemm, D.D. and Schneider, H.J. (1977): Time and Strata Bound Ore Deposits, Springer Verlag.
9. Guilbert, J.M. and Part, Jr. C.F. (1986): The Geology of Ore Deposits, Freeman
10. Mookerjee, A. (2000): Ore Genesis – A Holistic Approach, Allied Publishers.
11. Wolf, K.H. (1981): Handbook of Strata Bound and Straiform Ore Deposits, Elsevier
12. Jensen, M.L. and Bateman, A.M. (1981): Economic Mineral Deposits, John Wiley and Sons, New York
13. McKinstry, H.E. (1972): Mining Geology, Prentice Hall Inc.
14. Arogyaswamy, R.N.P. (1995): Courses in Mining Geology, Oxford and IBH Publishing Co. New Delhi
15. Thomas, L.J. (1978): An Introduction to Mining, Methuen, Brisbane
16. Clark, G.B. (1967): Elements of Mining, Asia Publishing House
17. Sinha, R.K. & Sharma, N.L. (1993): An Introduction to Mineral Economics, Wiley Eastern
18. Chatterjee, K.K. (1993): An Introduction to Mineral Economics, Wiley Eastern.

Elective Course (SE) GEOL (EC-1)

Group E : Environmental Geology

Full Marks: 70+30 Total Lectures-70 Hrs. Credit-5 Time- 3 Hrs.

(Ten questions are to be set out of which five are to be answered)

Unit 1: Basics of Environment: Type of Environment, Man and Environment; components of Environmental geology, concepts and principles of Environmental geology; time scale of global changes in ecosystem and climate.

Unit 2: Atmosphere, structure and composition of atmosphere, Global warming, Green house effect; CO₂ increase and global warming in the present and past atmospheres

Unit 3: Environmental pollution: Sources of Air pollution, emission of major industrial air pollutants, effects of air pollution on atmospheric processes, oxides of carbon as pollutants, green house effect, global warming, chloro fluoro carbons (CFC's), depletion of ozone layer, effects of ozone depletion, smog, acid rain.

Unit 4: Components of Hydrosphere, solubility of gases in water, Impact of oceanic and atmospheric circulation on climate and rain fall.

Unit 5 : Water pollution: Types of water pollution, groundwater pollution and its effects, sources of water pollution; organic and inorganic contamination of groundwater and its remedial measures.

Suggested Books :

1. Abhijit Dutta, Environmental Issues and Challenges
2. B.K. Sharma, Environmental Pollution
3. Bell, F.G. (1999): Geological Hazards, Routledge, London
4. Bryant, E. (1985): Natural Hazards, Cambridge Univ. Press
5. Keller, E.A. (1978): Environmental Geology
6. Rekha Ghosh and D.S. Chatterjee, Environmental Geology

7. Valdiya, K.S. (1987): Environmental Geology – Indian Context
8. Patwardhan, A.M. (1999): The Dynamic Earth System
9. Smith, K. (1992): Environmental Hazards
10. Subramaniam, V. (2001): Textbook of Environmental Hazards
11. Strahler and Strahler: Environmental Geology

GEOLOGY

M.Sc. Semester – II

Core Course - 4 GEOL (CC-4)

Geochemistry and Igneous Petrology

Full Marks: 70+30 Total Lectures-70 Hrs. Credit-5 Time- 3 Hrs.

(Ten questions are to be set out of which five are to be answered)

- Unit 1:** Origin and abundance of elements in the Solar System and in the Earth, cosmic abundance of elements, Geochemical classification of elements; Radiogenic Isotopes, Radioactive decay scheme of U-Pb, Sm-Nd, Rb-Sr, K-Ar and growth of daughter isotopes; Radiometric dating; Stable Isotopes, nature, abundance and fractionations.
- Unit 2:** Laws of thermodynamics and its application in Petrology: Geochemistry and principles of evolution of hydrosphere, biosphere and atmosphere, Geochemical cycle and principles of geochemical prospecting.
- Unit 3:** Nature and evolution of magma: plate tectonics and generation of magmas; Plume magmatism and hot spots; Large igneous provinces and mafic dyke swarms; Partial melting, batch and fractional melting; Crystal fractionation and contamination: IUGS classification of the igneous rocks and CIPW norms.
- Unit 4:** Phase equilibrium – binary system (Ab-An, Ab-Or, Dj-An, Fo-Si) and their relations to magma genesis and crystallization in the light of modern experimental works; Ternary systems (Di-Ab-An, Di-Fo-Si, Di-Fo-An, Fo-An-Si) and their relations to magma genesis and crystallization.
- Unit 5 :** Petrogenetic significance of igneous textures: Petrology and petrogenesis of major igneous rock types with Indian examples of

ultramafic, komatite, basalt, anorthosite, granite, alkaline rocks, ophiolite, carbonatite, lamprophyre.

Suggested Books :

1. Krauskopf, K.B. (1967): Introduction to Geochemistry, McGraw Hill
2. Mason, B. and Moore, C.B. (1991): Introduction to Geochemistry, Wiley Eastern
3. Rollinson, H.R. (1993): Using geochemical data: Evaluation, Presentation, Interpretation, Longman U.K.
4. Bose, M.K. (1997): Igneous Petrology, World Press, Kolkata
5. Best, Myron G. (2002): Igneous and Metamorphic Petrology, Blackwell Science
6. Cox, K.G. Bell, J.D. and Pankhurst, R.J. (1993): The Interpretation of Igneous Rocks, Chapman and Hall, London
7. Faure, G. (2001): Origin of Igneous Rocks, Springer
8. Hall, A. (1997): Igneous Petrology, Longman
9. LeMaitre R.W. (2002): Igneous Rocks: A Classification and Glossary of Terms, Cambridge University Press
10. Mc Birney (1994): Igneous Petrology, CBS Publ., Delhi
11. Phillpotts, A.R. (1994): Principles of Igneous and Metamorphic Petrology, Prentice Hall of India
12. Sood, M.K. (1982): Modern Igneous Petrology, Wiley, Interscience Publ. New York
13. Srivastava, Rajesh K. and Chandra, R. (1995): Magmatism in Relation to Diverse Tectonic Setting, A.A. Balkema, Rotterdam
14. Wilson, M. (1993): Igneous Petrogenesis, Chapman and Half, London
15. Winter, J.D. (2001): An Introduction to Igneous and Metamorphic Petrology, Prentice Hall, New Jersey
16. Hoefs, J. (1980): Stable Isotope Geochemistry, Springer – Verlag
17. Krauskopf, K.B. (1967): Introduction to Geochemistry, McGraw Hill,

18. Mason, B. and Moore, C.B. (1991): Introduction to Geochemistry, Wiley Eastern
19. Rollinson, H.R. (1993): Using Geochemical Data, Evaluation, Presentation, Interpretation, Longman, UK

GEOLOGY

M.Sc. Semester – II

Core Course - 5 GEOL (CC-5)

Sedimentary and Metamorphic Petrology

Full Marks: 70+30 Total Lectures-70 Hrs. Credit-5 Time- 3 Hrs.

(Ten questions are to be set out of which five are to be answered)

Unit 1: Surface processes and rock weathering; Processes of transport and generation of sedimentary rocks, Sedimentary texture; Textural elements of classic and non-clastic rocks, Structures, important erosional, depositional and post depositional sedimentary structures and their significance, Provenance : Source of sediments, compositional maturity, significance of light and heavy minerals in provenance study.

Unit 2: Sedimentary environment and facies, Facies modeling for marine, non-marine and mixed sediments, Tectonics and sedimentation, Classification and definition of sedimentary basins, Sedimentary basins of India, Cyclic sediments, Seismic and sequence stratigraphy, Purpose and scope of basin analysis. Stratum contours and isopach maps.

Unit 3: Concept of zones and grades; Metamorphic facies and facies series, Fabric in metamorphism, classification of metamorphic rocks, mineralogical phase rule, A detailed description of each of low pressure, medium to high pressure and very high pressure with special reference to mineralogical assemblages metamorphic differentiation; ACF, AKF and AFM diagrams in metamorphic petrology.

Unit 4: Regional metamorphism and Ocean Floor metamorphism; regional and thermal metamorphism of pelitic rocks, regional and thermal metamorphism of basic and ultrabasic rocks; Regional and thermal metamorphism of impure, silicious carbonate rocks, Metamorphism of granitoides, charnockites, and migmatites.

Unit 5 : Metamorphism in space and time; plate tectonics and metamorphic processes; paired metamorphic belts, Archaean and Proterozoic terrains, Polymetamorphism.

Suggested Books :

1. Blatt, H. Middleton, G.V. and Murray, R.C. (1980): Origin of Sedimentary Rocks, Prentice Hall Inc.
2. Collins, J.D. and Thompson, D.B. (1982): Sedimentary Structure, George Allen and Unwin, London
3. Lindholm, R.C. (1987): A Practical Approach to Sedimentology, Allen and Unwin, London
4. Miall, A.D. (2000): Principles of Basin Analysis, Springer-Verlag
5. Pettijohn, F.J. (1975): Sedimentary Rocks (3rd Ed.) Harper and Row Publ. New Delhi
6. Reading, H.G. (1997): Sedimentary Environments and facies, Blackwell Scientific Publication
7. Reineck, H.E. and Singh, I.B. (1973): Depositional Sedimentary Environments, Springer-Verlag
8. Selley, R.C. (2000): Applied Sedimentology, Academic Press
9. Tucker, M.E. (1981): Sedimentary Petrology: An Introduction, John Wiley and Sons, New York
10. Bucher, K. and Martin, F. (2002): Petrogenesis of Metamorphic Rocks (7th Rev. Ed.), Springer-Verlag
11. Philpotts, A.R. (1994): Principles of Igneous and Metamorphic Petrology, Prentice Hall
12. Spry, A. (1976): Metamorphic Textures, Pergamon Press
13. Winter, J.D. (2005): An Introduction to Igneous and Metamorphic Petrology, Prentice Hall

14. Yardley, B.W.D., Mackenzie, W.S. and Guilford, C. (1995): Atlas of Metamorphic Rocks and their textures, Longman Scientific and Technical, England
15. Yardley, B.W. (1989): An Introduction to Metamorphic Petrology, Longman, NY
16. Best, M.G. (2004): Igneous and Metamorphic Petrology, CBS Publ.
17. Winkler H.G.F. (1979): Petrogenesis of Metamorphic rocks, Springer Verlag
18. Turner E.J. (1980): Metamorphic Petrology, McGraw Hill, New York

GEOLOGY

M.Sc. Semester – II

Core Course (P) - 6 GEOL [CC (P)-6]

Full Marks: 100

Time- 6 Hrs.

(A - 60 Marks)

- (i) Megascopic and Microscopic studies of Igneous, Sedimentary and Metamorphic rocks
- (ii) Megascopic studies of Sedimentary Structures
- (iii) Graphic representation of Modal analysis in QAP and APF diagrams
- (iv) Graphic representation of chemical analysis in ACF, AKF and AFM diagrams
- (v) Calculation of C.I.P.W. Norm and Niggli Values

(B - 40 Marks)

- (vi) Geological Mapping of two weeks duration in a geologically complex area and Field Work Report based on it.

GEOLOGY

M.Sc. Semester – III

Core Course - 7 GEOL (CC-7)

Geomorphology and Remote Sensing in Geology

Full Marks: 70+30 Total Lectures-70 Hrs. Credit-5 Time- 3 Hrs.

(Ten questions are to be set out of which five are to be answered)

Unit 1: Fundamental concepts – significance of structure, process and time; A brief account of concepts of evolution of landforms; Characteristic features of landforms, characteristics and types of fluvial landforms, Fluvial cycles, concept of peneplains, stream rejuvenation, causes and effects; Aeolian landforms, Arid cycle of erosion; Glacial landforms, periodicity of glaciations and its causes; Karst topography, Relationship of geologic structure to topography, Volcanic landforms.

Unit 2: Geomorphology of the coasts, classification of shorelines and their evolution, Evidences of eustatic changes and their causes, Influence of lithology on relief, development of landforms of flat lying, tilted, folded, dome and faulted structures; Development of drainage systems, Drainage patterns, drainage analysis in geological interpretation, Geomorphic features of India; Application of geomorphology in groundwater, mineral and oil exploration and engineering projects.

Remote Sensing in Geology

Unit 3: Electromagnetic spectrum and its properties, Atmospheric windows; Interaction of electromagnetic radiation with matter, spectral signatures; Basic ideas of thermal infra red and microwave remote sensing; Photogrammetry-recent advancements and applications; Remote sensing satellite programmes and their characteristics.

Unit 4: Basic principles of image interpretation and digital image techniques; Principles and applications of GIS; Image characters and their relations

with ground objects based on tone, texture and pattern; Interpretation of topographic and tectonic features; Identification of Igneous, Sedimentary and Metamorphic rock types in images.

Unit 5 : Principles of terrain analysis; Morphometric analysis; Geomorphological mapping based on genesis of landforms; Terrain evaluation for strategic purposes.

Suggested Books :

1. Richard J. Huggett (2007); Fundamentals of Geomorphology, Routledge
2. Keith A. Sverdrup, Alison Duxbury, Alyn C. Duxbury (2006); Fundamentals of Oceanography; McGraw Hill Higher Education
3. Thornbury, W.D. (1969): Principles of geomorphology, Wiley
4. Worcester, P.G. (1948): A text book of geomorphology
5. B.W. Sparles (1981): Geomorphology, Longman Group Ltd.
6. George Allen & Coates (1980): Coastal Geomorphology
7. Pitty, A.F. (1972): Introduction to geomorphology, Methuen
8. Bloom, A.L. (1979): geomorphology, Prentice Hall
9. Arthur L. Bloom (2004): geomorphology : A systematic analysis of late Cenozoic landforms, Waveland Pr. Inc.
10. Miller, V.C. (1961): Photogeology, McGraw Hill
11. Sabbins, F.F. (1985): Remote Sensing – Principles and Applications, Freeman
12. Lillesand, T.M. and Keifer, R.W. (1987): Remote Sensing and Image Interpretation; John Wiley
13. S.N. Pandey (1987): Principles and Applications of Photogeology, Wiley Eastern, New Delhi
14. Gupta R.P. (1990): Remote Sensing Geology; Springer Verlag
15. Compton R.R. (1962): Manual of Field Geology
16. Angela L. Coe (2010): Geological Field Techniques, Blackwell
17. Oya, M. (2001): Applied Geomorphology for Mitigation of Natural Hazards, Springer

GEOLOGY

M.Sc. Semester – III

Core Course - 8 GEOL (CC-8)

Economic Geology

Full Marks: 70+30 Total Lectures-70 Hrs. Credit-5 Time- 3 Hrs.

(Ten questions are to be set out of which five are to be answered)

Unit 1: Concepts of Ore Genesis; Distribution of Ore deposits-Global perspective; Mode of occurrences and morphology of ore bodies, controls of ore localization; classification of ore deposits; processes of ore formation-magmatic, sedimentary, metamorphic associations and weathering processes; ore deposits and plate tectonics.

Unit 2: Occurrence and distribution in Indian of metalliferous deposits – base metals, iron, manganese, aluminum, chromium, gold; Indian deposits of non-metals deposits viz. Mica, asbestos, barites, gypsum, graphite, apatite etc. Gemstones, refractory minerals, abrasives and minerals used in glass, fertilizer, paint, ceramic and cement industries, Building stones, Phosphorite deposits, Atomic minerals; Atomic fuel resources in India-distribution and prospects. Rare earth minerals.

Unit 3: Coal: Origin, structure, mode of occurrence and types of coal, physical and chemical properties of coal, Macroscopic and microscopic constituents of coal, macerals and microlithotypes; classification, rank and grade of coal; Important coalfields of India with special reference of Jharkhand

Unit 4: Petroleum: Origin and migration of petroleum, Properties of source and reservoir rocks, Petroleum traps, petroliferous basins of India; Fundamentals of coal bed methane (CBM), Prospects of CBM in India.

Unit 5 : Geological criteria for mineral prospecting; Basic principles of Geochemical exploration; Principles and application of surface

geophysical exploration techniques; Brief outline of various well logging techniques, Strategic, critical and essential minerals. India's status in mineral production vis a vis world scenario; National Mineral Policy.

Suggested Books :

1. Arogyaswami, R.P.N. (1996): Courses in mining geology, Oxford and IBH Publ.
2. Bagchi, T.C., Sengupta, D.K. Rao, S.V.L.N. (1979): Elements of Prospecting and Exploration, Kalyani Publ.
3. Banerjee, P.K. and Ghose, S. (1997): Elements of Prospecting for Non-fuel mineral deposits, Allied Publ.
4. Chaussier, Jean – Bernard and Morer, J. (1987): Mineral Prospecting Manual, North Oxford Academic
5. Clark, G.B. (1967): Elements of Mining (3rd Edn.), John Wiley
6. Dobrin, M.B.; Savit, C.H. (1988): Introduction of Geophysical Prospecting, McGraw Hill
7. Keary, P., Brooks, M. and Hill, I. (2002): An introduction to geophysical exploration (3rd Ed.), Blackwell
8. Rider, M.H. (1986): Whittles Publishing, Caithness, The Geological Interpretation of Well Logs, (Rev. Ed.)
9. Robert, D. (1985): Encyclopedia of Well Logging
10. T.S. Ramakrishna (2006): Geophysical Practice in Mineral Exploration and Mapping GSI, Bangalore
11. Mookherjee, A. (2000): Ore Genesis-A Holistic Approach, Allied Publisher
12. Dhanraju, R. (2005): Radioactive Minerals, Geol. Soc. India, Bangalore
13. Craig, J.M. and Vaughan D.J. (1981): Ore Petrography and Mineralogy, John Wiley
14. Evans (1973): Ore Geology and Industrial Minerals

15. Cogen B. and Dey A.K. (1975): Mineral and Nuclear Fuels of India, Oxford Pub.
16. Bagchi, T.C., Sengupta D.K., Rao, S.V.L.N. (1979): Elements of Prospecting and Exploration, Kalyani Publ.
17. Banerjee, P.K. and Ghosh, S. (1997): Elements of Prospecting for Non-fuel Mineral deposits, Allied Publ.
18. Chaussier, Jean – Bernard and Morer, J. (1987): Mineral Prospecting Manual, North Oxford Academic.

GEOLOGY

M.Sc. Semester – III

Elective Course (GE/DC) (EC-2)

Select one Elective from the following Elective Groups:

Elective Course (GE/DC) GEOL (EC-2)

Group A : Fossil Fuel Geology

Full Marks: 70+30 Total Lectures-70 Hrs. Credit-5 Time- 3 Hrs.

(Ten questions are to be set out of which five are to be answered)

Unit 1: Elementary idea about coal preparation, Washing and beneficiation of coal, Blending of coal; coal carbonization, coal gasification, coal liquefaction and coal combustion; Briquetting of coal.

Unit 2: Assessment of coal reserves; Geological, Geobotanical and Geophysical survey for coal; Gondwana palynology and its application for coal exploration.

Unit 3: Mining of coal-underground mining and open cast mining; Coal mining hazards and its mitigation; Trace elements in coal; Coal as environment pollutant; conservation of coal

Unit 4: Unit geological and geographical distribution of coal deposits of Jharkhand.

Unit 5 : Geological and geographical distribution of coal and Lignite deposits in India except Jharkhand.

Suggested Books :

1. Chandra, D, Singh, R.M. Singh, M.P. (2000): Textbook of Coal (Indian context), Tara Book Agency, Varanasi
2. Scott, A.C. (1987)Coal and Coal-bearing strata: Recent Advances, Blackwell Scientific Publications

3. Singh, M.P. (1998): Coal and Organic Petrology, Hundustan Publishing Corporation, New Delhi
4. G.H., Teichmuller, M. Davis, A. Diessel, C.F.K., Litfke, R. and Robert P. (1998): Organic Petrology, Gebruder Borntraeger, Stuttgart
5. Thomas, Larry (2002): Coal Geology, John Wiley and Sons Ltd., England
6. Van Krevelen Stach; E. Mackowsky, M.Th., Taylor, G.H., Chandra, D., Teichmuller, M. and Teichmuller R. (1982): Stach Textbook of Coal Petrology, Gebruder Borntraeger, Stuttgart.
7. Taylor, D.W. (1993): Coal: Typology-Physics-Chemistry-Constitution, Elsevier Science, Netherlands.

Elective Course (GE/DC) GEOL (EC-2)

Group B : Sedimentology

Full Marks: 70+30 Total Lectures-70 Hrs. Credit-5 Time- 3 Hrs.

(Ten questions are to be set out of which five are to be answered)

Unit 1: Concept of basin analysis; Tectonic classification and evolution of sedimentary basins; Plate tectonics in relation to type and evolution of basins.

Unit 2: Sedimentary facies and facies models with Indian analogues; Paleocurrent analysis and its applications.

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

Unit 4: Sedimentary basins of India, Plate tectonics in relation to type and evolution of basins.

Unit 5 : Concept of sequence stratigraphy, regional unconformities, systems tracts and parasequences.

Suggested Books :

1. Blatt, H. Middleton, G.V. and Murray, R.C. (1980): Origin of Sedimentary Rocks, Prentice Hall Inc.
2. Collins, J.D. and Thompson, D.B. (1982): Sedimentary Structures, George Allen and Unwin, London
3. Lindholm, R.C. (1987): A Practical Approach to Sedimentology, Allen and Unwin, London
4. Pettijohn; F.J. (1975): Sedimentary Rocks (3rd Ed.), Harper and Row Publ. New Delhi
5. Reading, H.G. (1997): Sedimentary Environments and Facies, Blackwell Scientific Publication

6. Reineck, H.E. and Singh, I.B. (1973): Depositional Sedimentary Environments, Springer-Verlag
7. Selley, R.C. (2000): Applied Sedimentology, Academic Press
8. Tucker, M.E. (1981): Sedimentary Petrology: An Introduction, Wiley and Sons, New York
9. Tucker, M.E. (1990): Carbonate Sedimentology, Blackwell Scientific Publication.

Elective Course (GE/DC) GEOL (EC-2)

Group C : Hydrogeology

Full Marks: 70+30 Total Lectures-70 Hrs. Credit-5 Time- 3 Hrs.

(Ten questions are to be set out of which five are to be answered)

Unit 1: Occurrence of groundwater in different rock types; Geologic structures favouring groundwater occurrence; Occurrence of groundwater in various hydrostratigraphic units of India; Groundwater provinces of India.

Unit 2: Components of groundwater basin characterization: Slope, characteristics, lithology and associated geological structures, soil type and thickness, etc.; Geomorphic controls for groundwater accumulation; Drainage pattern, their relationship with lithology and geologic structure; tools.

Unit 3: Groundwater basin characterization and prioritization by Remote Sensing and GIS

Unit 4: Surface and subsurface geological and geophysical methods of groundwater exploration; Identification of groundwater potential zones by various remote sensing techniques, Application of GPR in groundwater exploration, Use of radio isotopes in hydrogeological studies.

Unit 5 : 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.

Suggested Books :

1. C.F. Tolman (1937): Groundwater, McGraw Hill, New York and London
2. D.K. Todd (1995): Groundwater Hydrology, John Wiley and Sons

3. F.G. Driscoll (1988): Groundwater and Wells, UOP, Johnson Div. St. Paou, Min, USA
4. H.M. Raghunath (1990): Groundwater in Hydrosphere (Groundwater Hydrology), CBS Publ.
5. H.S. Nagabhushaniah (2001): Groundwater in Hydrosphere (Groundwater hydrology), CBS Publ.
6. K.R. Karanth (1989): Hydrogeology, Tata McGraw Hill Publ.
7. S.N. Davies and R.J.N. De Wiest (1966): Hydrogeology, John Wiley and Sons, New York
8. Patra, H.P., Adhikari, Shyamal Kumar, Kumar, Subrata (2016): Groundwater Prospecting and Management, Springer
9. Jakeman, A.J., Barreteau, O., Hunt, R.J., Rinaudo, J.D., Ross, A. (2016): Integrated Groundwater Management Concepts, Approaches and Challenges, Springer
10. Ramanathan, A., Johnstons, S., Mukherjee, A. Nath, B. (Eds.) 2015: Safe and Sustainable Use of Arsenic-Contaminated Aquifers in the Gangetic Plain A Multidisciplinary Approach, Springer
11. C.W. Fetter Jr. (2016): Applied Hydrogeology (4th Edition); Pearson Education Ltd.
12. Kevin M. Hiscock (2009): Hydrogeology: Principles and Practice, Wiley-Blackwell
13. Singhal, B.B.S. Gupta R.P. (2010): Applied Hydrogeology of Fractured Rocks, Springer.

Elective Course (GE/DC) GEOL (EC-2)

Group D : Ore Geology

Full Marks: 70+30 Total Lectures-70 Hrs. Credit-5 Time- 3 Hrs.

(Ten questions are to be set out of which five are to be answered)

Unit 1: Non-magmatic processes of mineralization, Occurrence and distribution in India of iron and base metal deposits.

Unit 2: Occurrence and distribution in India of manganese, aluminum, chromium, nickel and gold deposits, Energy and fuel minerals, PGE and associated ores.

Unit 3: Indian deposits of non-metals: mica, asbestos, gypsum, graphite and apatite; Gemstones, refractory minerals, abrasives and minerals used in glass, fertilizer, paint, ceramic and cement industries.

Unit 4: Strategic, critical and essential mineral, India's status in mineral production; National Mineral Policy; Marine mineral resources and Laws of Sea. Mineral concession rules.

Unit 5 : Various methods of sampling; surface and sub-surface explorations, Definition and outline of UNFC classification of mineral reserves and resources, Grade and recovery of ores, Methods of ore reserves estimation.

Suggested Books :

1. Edward, R. and Stkinson, K. (1986): Ore Deposit Geology, Chapman and Hall, London
2. Craig, J.M. and Vaughan, D.J. (1981): Ore Petrography and Mineralogy, John Wiley
3. Evans, A.M. (2012): Ore Geology and Industrial Minerals, 3rd Edition (Reprint), Blackwell

4. Sawkins, F.J. (1984): Metal Deposits in relation to plate tectonics, Springer Verlag
5. Stanton, R.L. (1972): Ore Petrology, McGraw Hill
6. Torling, D.H. (1981): Economic Geology and Geotectonics, Blackwell Sci. Publ.
7. Barnes, H.L. (1979): Geochemistry of Hydrothermal Ore Deposits, John Wiley
8. Klemm, D.D. and Schneider, H.J. (1977): Time and Strata Bound Ore Deposits, Springer Verlag.
9. Guilbert, J.M. and Part, Jr. C.F. (1986): The Geology of Ore Deposits, Freeman
10. Mookherjee, A. (2000): Ore Genesis – A Holistic Approach, Allied Publishers.
11. Wolf, K.H. (1981): Handbook of Strata Bound and Strataform Ore Deposits, Elsevier
12. Jensen, M.L. and Bateman, A.M. (1981): Economic Mineral Deposits, John Wiley and Sons, New York
13. McKinstry, H.E. (1972): Mining Geology, Prentice Hall Inc.
14. Arogyaswamy, R.N.P. (1995): Courses in Mining Geology, Oxford and IBH Publishing Co. New Delhi
15. Thomas, L.J. (1978): An Introduction to Mining, Methuen, Brisbane
16. Clark, G.B. (1967): Elements of Mining, Asia Publishing House
17. Sinha, R.K. & Sharma, N.L. (1993): An Introduction to Mineral Economics, Wiley Eastern
18. Chatterjee, K.K. (1993): An Introduction to Mineral Economics, Wiley Eastern.

Elective Course (GE/DC) GEOL (EC-2)

Group E : Environmental Geology

Full Marks: 70+30 Total Lectures-70 Hrs. Credit-5 Time- 3 Hrs.

(Ten questions are to be set out of which five are to be answered)

Unit 1: Basics of Environment: Type of Environment, Man and Environment; components of Environmental geology, concepts and principles of Environmental geology; time scale of global changes in ecosystem and climate.

Unit 2: Atmosphere, structure and composition of atmosphere, Global warming, Green house effect; CO₂ increase and global warming in the present and past atmospheres

Unit 3: Environmental pollution: Sources of Air pollution, emission of major industrial air pollutants, effects of air pollution on atmospheric processes, oxides of carbon as pollutants, green house effect, global warming, chloro fluoro carbons (CFC's), depletion of ozone layer, effects of ozone depletion, smog, acid rain.

Unit 4: Components of Hydrosphere, solubility of gases in water, Impact of oceanic and atmospheric circulation on climate and rain fall.

Unit 5 : Water pollution: Types of water pollution, groundwater pollution and its effects, sources of water pollution; organic and inorganic contamination of groundwater and its remedial measures.

Suggested Books :

1. Abhijit Dutta, Environmental Issues and Challenges
2. B.K. Sharma, Environmental Pollution
3. Bell, F.G. (1999): Geological Hazards, Routledge, London
4. Bryant, E. (1985): Natural Hazards, Cambridge Univ. Press
5. Keller, E.A. (1978): Environmental Geology
6. Rekha Ghosh and D.S. Chatterjee, Environmental Geology

7. Valdiya, K.S. (1987): Environmental Geology – Indian Context
8. Patwardhan, A.M. (1999): The Dynamic Earth System
9. Smith, K. (1992): Environmental Hazards
10. Subramaniam, V. (2001): Textbook of Environmental Hazards
11. Strahler and Strahler: Environmental Geology

GEOLOGY

M.Sc. Semester – III

GEOL [EC (P)-3]

Full Marks: 100

Credit: 5

Time- 6 Hrs.

Elective Practicals

GEOL EC(P)-3 Group A: Fossil Fuel Geology

- (i) Megascopic studies of varieties of coal
- (ii) Megascopic studies of coal bearing rocks
- (iii) Drawing and labeling of parts of Gondwana fossils from different coalfields
- (iv) Borehole problems and calculation of coal reserves from borehole data
- (v) Study of different coal and oilfield of India
- (vi) Study of crude oil samples from oilfield of India
- (vii) Estimation of oil reserves

Or,

GEOL EC(P)-3 Group B: Sedimentology

- (i) Graphic plot of size data and calculation of statistical parameters
- (ii) Microscopic study of clastic rocks
- (iii) Megascopic study of clastic rocks
- (iv) Mechanical sedimentary structures and their environmental significance

Or,

GEOL EC(P)-3 Group C: Hydrogeology

- (i) Determination of porosity of aquifer materials
- (ii) Study of hydrological properties of soil and rocks

- (iii) Construction of water table and piezometric maps and their interpretation
- (iv) Interpretation of geological cross section for locating water bearing horizons
- (v) Flow net analysis
- (vi) Pumping test for evaluation of aquifer parameters
- (vii) Construction of lithologs

Or,

GEOL EC(P)-3 Group D: Ore Geology

- (i) Study of morphological features of ore bodies
- (ii) Megascopic study of important ores-their texture and structure
- (iii) Megascopic study of important industrial, non metallic minerals, precious and semi precious stones
- (iv) Estimation of grade of ores
- (v) Study of metallogenic provinces of India

Or,

GEOL EC(P)-3 Group E: Environmental Geology

- (i) Analysis of pH and electrical conductivity in water
- (ii) Preparation of oceanic and atmospheric circulation maps
- (iii) Preparation of seismic zonation maps of India and world
- (iv) Demarcation of flood prone areas in the outline map of India
- (v) Preparation of volcanic hazards zonation map
- (vi) Preparation of oceanic and atmospheric circulation maps.

GEOLOGY

M.Sc. Semester – IV

Core Course - 9 GEOL (CC-9)

Hydrogeology, Engineering Geology, Environmental Geology,

Mining Geology

Full Marks: 70+30 Total Lectures-70 Hrs. Credit-5 Time- 3 Hrs.

(Ten questions are to be set out of which five are to be answered)

Unit 1: Role of groundwater in the hydrological cycle; Controls of geology on groundwater occurrence and distribution; Classification of aquifers and aquifer systems; Darcy's law; Hydraulic conductivity, transmissivity, storage coefficient and specific capacity; Water table contour maps and flow net analysis, Causative factors of groundwater level fluctuations and environmental influences.

Unit 2: Chemical characteristics of groundwater in relation to various uses – domestic, industrial and irrigation; Groundwater contamination and problems of arsenic, fluoride and nitrates; Management of groundwater resources; Artificial recharge to groundwater and rainwater harvesting; Groundwater exploration; Hydrogeomorphic mapping using various Remote sensing techniques; Groundwater provinces of India.

Unit 3: Engineering properties of rocks and soils; Properties and selection of construction materials, landslides and stability of hill slopes; Geological investigation for engineering projects; Geological investigations and criteria for sites selection of Dam sites, Reservoirs, Tunnels and Bridges; Engineering projects-Case histories from India.

Unit 4: Components of environment, Carbon dioxide in atmosphere, global warming caused by CO₂ increase in the atmosphere, Impact assessment of degradation and contamination of surface water and groundwater quality due to industrialization and mining. Soil quality degradation due

to irrigation, use of fertilizers and pesticides, Introduction to climatic changes, causes of climatic changes, world climate during geological periods, Impact of climate on society, Impact of man on climate.

Unit 5 : Mining of surface and underground mineral deposits involving diamond drilling, shaft sinking, drifting, cross-cutting, winging, stoping, room and pillaring, top-slicing, sub-level caving and block caving types of drilling methods; Mining hazards, mine inundation, mine fire and rock burst.

Suggested Books :

1. Arogyaswami, R.P.N. (1996): Courses in Mining Geology, Oxford and IBH Publ.
2. Clark, G.B. (1967): Elements of Mining (3rd Ed.), John Wiley
3. Dobrin, M.B.; Savit, C.H. (1988): Introduction to Geophysical Prospecting, McGraw Hill
4. Keary, P.; Brooks, M. and Hill, I (2002): An introduction to geophysical exploration (3rd Ed.) Blackwell
5. Rider, M.H. (1986): Whittles Publishing, Caithness, The Geological Interpretation of Well Logs (Rev. Ed.)
6. Robert, D. (1985): Encyclopedia of Well Logging
7. T.S. Ramakrishna (2006): Geophysical Practice in Mineral Exploration and Mapping, GSI, Bangalore
8. D.K. Todd (1995): Groundwater Hydrology, John Wiley and Sons
9. H.M. Raghunath (1990): Groundwater, Wiley Eastern Ltd.
10. K.R. Karanth (1989): Hydrogeology, Tata McGraw Hill Publ.
11. S.N. Davies and R.J.N. De Wiest (1966): Hydrogeology, John Wiley and Sons, New York

- 12.Krynine, D.H. and Judd, W.R. (1998): Principles of Engineering Geology, CBS Publ.
- 13.Schultz, J.R. and Cleaves, A.B. (1951): Geology in Engineering, John Wiley and Sons, New York
- 14.Singh, P. (1994): Engineering and General Geology, S.K. Klataria and Sons, Delhi

GEOLOGY

M.Sc. Semester – IV

Select one Elective from the following Elective Groups:

- Group A : Fossil Fuel Geology**
- Group B : Sedimentology**
- Group C : Hydrogeology**
- Group D : Ore Geology**
- Group E : Environmental Geology**

Elective Course (GE/DC) GEOL (EC-4)

Group A : Fossil Fuel Geology

Full Marks: 70+30 Total Lectures-70 Hrs. Credit-5 Time- 3 Hrs.

(Ten questions are to be set out of which five are to be answered)

- Unit 1:** Origin and Nature of oil and gas; Amount, type and maturation of organic matter, Migration of Petroleum
- Unit 2:** Reservoir rocks – petrology of reservoir rocks, porosity and permeability; Reservoir traps-structural, stratigraphic and combination traps.
- Unit 3:** Identification and characterization of petroleum source rocks; Oil and source rock correlation; Palaeodepositional and palaeoenvironmental models with the help of microfossils and palynology
- Unit 4:** Quantitative evaluation of oil and gas, Geological, Geochemical and Geophysical exploration of petroleum
- Unit 5 :** Petroleum basins of India, important oil fields of India; Brief idea about global occurrences of petroleum; Position of oil and natural gas in India, Future prospects and economic scenario.

Suggested Books :

1. Barker, C. (1996): Thermal Modeling of Petroleum Generation, Elsevier Science, Netherlands
2. Holson, G.D. and Tiratso, E.N. (1985): Introduction of Petroleum Geology, Gulf Publishing, Houston, Texas
3. Hunt, J.M. (1996): Petroleum Geochemistry and Geology (2nd Ed.),Freeman, San Francisco.
4. Jahn, F., Cook, M. and Graham, M. (1998): Hydrocarbon Exploration and production, Eslevier Science
5. Makhous, M. (2000): The Formation of Hydrocarbon Deposits in North African Basins, Geological and Geochemical Conditions, Springer-Verlag
6. North, F.K. (1985): Petroleum Geology, Allen Unwin
7. Selley, R.C. (1998): Elements of Petroleum Geology, Academic Press
8. Tissot, B.P. and Welte, D.H. (1984): Petroleum Formation and Occurrence, Springer-Verlag
9. R.C. Chapman (1973): Petroleum Geology, Elsevier Scientific Pub. Co.

Elective Course (GE/DC) GEOL (EC-4)

Group B : Sedimentology

Full Marks: 70+30 Total Lectures-70 Hrs. Credit-5 Time- 3 Hrs.

(Ten questions are to be set out of which five are to be answered)

Unit 1: Concept of soil; components of soil, soil profile, process of soil formation, pedogenic processes, factors of soil formation.

Unit 2: Classification of soil, mineral and chemical composition of soils, mineral stability during weathering, soil organic matter form and function.

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.

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.

Unit 5 : Causes of soil erosion and degradation, A brief introduction to methods of soil conservation.

Suggested Books :

1. Boul, S.W., Hole, F.D., McCracken, R.J. and South, R.J. (1997): Soil Genesis and Classification, 4th Edition, State University Press
2. Brady, N.C. (2002): Nature and Properties of Soils

3. Govinda Rajan, S.V. and Gopala Rao, K.H.G. (1979): Studies of Soil of India
4. Sposito, Garrison (1989): The Chemistry of Soils, Oxford Univ. Press
5. Terzaghi, K. and Pock, R.G. (1996): Soil Mechanics in Engineering (3rd Ed.), John Wiley
6. Wright; V. Paul (1992): Paleosols: Their recognition and interpretation, Blackwell Scientific Publ.
7. Wright, V. Paul and Tucker, M.E. (1991): Calcretes, Blackwell Scientific Publ.

Elective Course (GE/DC) GEOL (EC-4)

Group C : Hydrogeology

Full Marks: 70+30 Total Lectures-70 Hrs. Credit-5 Time- 3 Hrs.

(Ten questions are to be set out of which five are to be answered)

Unit 1: Watershed – concept, classification, components of watershed; rainfall, temperature, topography, nature of soil and depth, lithology and geological structures, drainage pattern, land use pattern; Valley to basin concept in water management.

Unit 2: Natural and artificial recharge of groundwater, rain water harvesting techniques for rural and urban areas; Physical structure for water resource management in rural areas; Use of remote sensing and GIS in watershed management.

Unit 3: Water management, physical structures and their characteristics such as ridge area treatment, gully plug, contour bunding, check dams, gabion structure, percolation tanks etc. traditional methods for water resource management in India.

Unit 4: Basic components of watershed guidelines of India; Participatory approach for programme implementation of watershed, water management and Panchayati Raj Acts.

Unit 5 : Legislations related to water resources; Basic constitutional provisions, Water pollution acts, National Water Policy.

Suggested Books :

1. Isobel W. Heathcote (2009): Integrated Watershed Management: Principles and Practice, Wiley
2. J.V.S. Murty (2008): Watershed Management, New Age Int.
3. K.R. Karanth (1989): Hydrogeology, Tata McGraw Hill Publ.
4. Watershed Guidelines: Govt. of India
5. Rao, K.L.: India's Water Wealth, C.G.W.B. Publication
6. Constitution of India, Jharkhand Panchayati Raj Act

Elective Course (GE/DC) GEOL (EC-4)

Group D : Ore Geology

Full Marks: 70+30 Total Lectures-70 Hrs. Credit-5 Time- 3 Hrs.

(Ten questions are to be set out of which five are to be answered)

- Unit 1:** Geological prospecting of minerals, different types of geophysical methods for exploration-gravity, magnetic, electrical, seismic; Geochemical exploration-nature of sample anomaly, strength of anomaly and controlling factors.
- Unit 2:** Ore dressing and its importance, low grade ores and their beneficiation; Mineral properties and their consideration in ore dressing techniques; Basic ore dressing operations viz. crushing, grinding, sizing, screening and classification; Concentration processes; Magnetic and electrostatic separation, gravity concentration; Forth Floatation, amalgamation and agglomeration.
- Unit 3:** 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, Ore microscopy and its contribution to ore dressing techniques.
- Unit 4:** Surface and underground mining methods, factors in selection of open cast and underground mining methods, room and pillar method, longwall method, environmental aspect of mining activities.
- Unit 5 :** Mineralogy and geochemistry of radioactive minerals, Radioactive methods for prospecting of mineral deposits; Occurrence and distribution of radioactive minerals in India; Radioactive methods in petroleum exploration – well logging techniques

Suggested Books :

1. Edward, R. and Stkinson, K. (1986): Ore Deposit Geology, Chapman and Hall, London
2. Craig, J.M. and Vaughan, D.J. (1981): Ore Petrography and Mineralogy, John Wiley
3. Evans, A.M. (2012): Ore Geology and Industrial Minerals, 3rd Edition (Reprint), Blackwell Publishing and Wiley India Pvt. Ltd.
4. Sawkins, F.J. (1984): Metal Deposits in relation to plate tectonics, Springer Verlag
5. Stanton, R.L. (1972): Ore Petrology, McGraw Hill
6. Torling, D.H. (1981): Economic Geology and Geotectonics, Blackwell Sci. Publ.
7. Barnes, H.L. (1979): Geochemistry of Hydrothermal Ore Deposits, John Wiley
8. Klemm, D.D. and Schneider, H.J. (1977): Time and Strata Bound Ore Deposits, Springer Verlag.
9. Guilbert, J.M. and Part, Jr. C.F. (1986): The Geology of Ore Deposits, Freeman
10. Mookherjee, A. (2000): Ore Genesis – A Holistic Approach, Allied Publishers.
11. Wolf, K.H. (1981): Handbook of Strata Bound and Strataform Ore Deposits, Elsevier
12. Jensen, M.L. and Bateman, A.M. (1981): Economic Mineral Deposits, John Wiley and Sons, New York
13. McKinstry, H.E. (1972): Mining Geology, Prentice Hall Inc.
14. Arogyaswamy, R.N.P. (1995): Courses in Mining Geology, Oxford and IBH Publishing Co. New Delhi
15. Thomas, L.J. (1978): An Introduction to Mining, Methuen, Brisbane
16. Clark, G.B. (1967): Elements of Mining, Asia Publishing House
17. Sinha, R.K. & Sharma, N.L. (1993): An Introduction to Mineral Economics, Wiley Eastern
18. Chatterjee, K.K. (1993): An Introduction to Mineral Economics, Wiley Eastern.

Elective Course (GE/DC) GEOL (EC-4)

Group E : Environmental Geology

Full Marks: 70+30 Total Lectures-70 Hrs. Credit-5 Time- 3 Hrs.

(Ten questions are to be set out of which five are to be answered)

Unit 1: Natural Hazards, its causes, prediction and forecasting, control measures and its proper management; Problems of urbanization, human population and their impact on environment

Unit 2: Distribution, magnitude and intensity of earthquakes; Seismic hazard zones, Neotectonics in seismic hazard assessment; Volcanic hazards, their causes and control.

Unit 3: Landslide, soil creeping, mass movements; coastal erosion, coastal inundations, cyclones; Tsunamis, its causes and control

Unit 4: Floods, causes of floods, flood hazards, management of floods; Water logging, problem of water logging due to indiscrete construction of canals, reservoirs, dams; water logging problem in India.

Unit 5 : Hazards related with mining activities in India, Pollution in the mining areas and mitigation measures; Land degradation in mining areas; Stabilization of overburden in open cast mining areas; Management of underground mining areas.

Suggested Books :

1. Bell, F.G. (1999): Geological Hazards, Routledge, London
2. Bryant, E. (1985): Natural Hazards, Cambridge Univ. Press
3. Keller, E.A. (1978): Environmental Geology
4. Valdiya, K.S. (1987): Environmental Geology – Indian Context
5. Patwardhan, A.M. (1999): The Dynamic Earth System
6. Smith, K. (1992): Environmental Hazards
7. Subramaniam, V. (2001): Textbook of Environmental Hazards
8. Tank, R.W.: Focus on Environmental Hazards
9. Strahler and Strahler: Environmental Geology
10. Truk and Truk : Environmental Geology

GEOLOGY

M.Sc. Semester – IV

GEOL [EC (P)-5]

Full Marks: 100

Credit: 5

Time- 6 Hrs.

Elective Practicals

GEOL EC(P)-5 Group A: Fossil Fuel Geology

- (i) Proximate analysis of coal
- (ii) Preparation of palynomorphs slide
- (iii) Identification of different palynomorphs
- (iv) Preparation of polished particulate mounts of coal (coal pallets)
- (v) Microscopic examination of coal pallets
- (vi) Microscopic study of heavy minerals
- (vii) Megascopic study of cores and their logging
- (viii) Structural problems related to the coal seams
- (ix) Study of Geological maps and sections of important oil fields of India.

Or,

GEOL EC(P)-5 Group B: Sedimentology

- (i) Paleocurrent analysis
- (ii) Study of vertical profile sections of selected sedimentary environments
- (iii) Study of Heavy minerals
- (iv) Graphic representation of trace element data and heavy minerals
- (v) Study of chemical and biogenic sedimentary structures and their sedimentological significance
- (vi) Recognition of marine fossil groups in assorted assemblage and identification of their classes
- (vii) Petrographic study of limestones

Or,

GEOL EC(P)-5 Group C: Hydrogeology

- (i) Determination of temperature, pH, T.D.S., Conductivity, TSS, Alkalinity, Dissolved oxygen, Hardness etc.
- (ii) Determination of Na and K
- (iii) Construction of isochemical maps
- (iv) Graphical representation of hydrochemical data on piper trilinear diagram
- (v) Plotting and interpretation of resistivity data
- (vi) Delineation of watershed on topographical and satellite imageries.

Or,

GEOL EC(P)-5 Group D: Ore Geology

- (i) Preparation of polished section
- (ii) Mineralogical studies of common ore minerals under microscope and establishment of paragenetic sequence
- (iii) Flowchart analysis of ore beneficiation techniques
- (iv) Ore petrographic study of ore minerals and establishment of paragenetic sequences
- (v) Exercises on ore reserve calculation

Or,

GEOL EC(P)-5 Group E: Environmental Geology

- (i) Analysis of alkalinity, acidity etc in water samples.
- (ii) Presentation of natural hazards map
- (iii) Plotting of temperature variations
- (iv) Measurement of Noise level
- (v) Demarcation of landslide prone areas

GEOLOGY
M.Sc. Semester – IV
PROJECT

Full Marks: 100

Credit: 5

Time- 6 Hrs.

The paper will consist of :

- (a) Field work/Lab work related to the project
- (b) Preparation of dissertation based on the work undertaken
- (c) Presentation of project work in the seminar on the assigned topic in the University Department of Geology, N.P. University, Medininagar and open viva-voce there on

NB:- The students will select topics for the project work in consultation with a teacher of the department.

Topics

Project work will be related to the Elective paper.

Each student has to submit two copies of the dissertation work duly forwarded by the Supervisor and Head of the Department concerned. The forwarded copies will be submitted in the University Department of Geology, N.P. University, Medininagar for evaluation.