

Name of the Department : **Department of Studies in Earth Science**

Program: **M.Sc., GEOLOGY**, Code: **MSGEL**

I Semester	Code	Course	Hard Core/ Soft Core	LTP	Credit Value	Paper Code
		Crystallography & Mineralogy	Hard Core	202	4	
		Geomorphology, Structural Geology & Surveying	Hard Core	301	4	
		Ore Geology	Hard Core	301	4	
		Marine Geoscience	Soft Core	200	2	
		Environmental Geology	Soft Core	200	2	
		Climatology	Soft Core	200	2	
II Semester	Code	Course	Hard Core/ Soft Core	LTP	Credit Value	Paper Code
		Fuel Resources & Sequence Stratigraphy	Hard Core	400	4	
		Paleontology	Hard Core	301	4	
		Igneous, Sedimentary and Metamorphic Petrology	Hard Core	301	4	
		Minor Project (FW & Technical Report)	Hard Core	004	4	
		Analytical Techniques in Geology	Soft Core	200	2	
		Soil & Water Conservation	Soft Core	200	2	
		Basics of Earth Science	Open Elective	400	4	
III Semester	Code	Course	Hard Core/ Soft Core	LTP	Credit Value	Paper Code
		Remote Sensing & GIS	Hard Core	202	4	
		Geochemistry & Petrogenesis	Hard Core	301	4	
		Indian Stratigraphy	Hard Core	310	4	
		Gemmology	Soft Core	200	2	
		Mineral Economics	Soft Core	200	2	
		Engineering Geology	Soft Core	200	2	
		Industrial Mineral Resources	Open Elective	400	4	
IV Semester	Code	Course	Hard Core/ Soft Core	LTP	Credit Value	Paper Code
		Exploration Geology & Mining Methods	Hard Core	301	4	
		Hydrogeology	Hard Core	301	4	
		Major Project (Dissertation)	Hard Core	006	6	
		Precambrian Crustal Evolution	Soft Core	200	2	
		Crystal Growth & Materials Science	Soft Core	200	2	

M.Sc., DEGREE COURSE IN GEOLOGY
(Two year – Four Semester Scheme)

SYLLABUS
(With New Regulations - CBCCEPS)

SEMESTER I

HARD CORE

CRYSTALLOGRAPHY AND MINERALOGY [LTP / CREDITS = 202/4]

Unit 1: *Crystallography*: Form theory of Crystals, Projections, Derivation of 32 point groups. Zone and Zone Laws, Atomic and ionic radii, Bond length and measurements of Radius, Radius ratio and co-ordination polyhedra, Coordination Number, Pauling's Rules, Spheres in Closest packing, Packing Index. Voids in closest packing, Classification & Co-ordination of voids, Derivative Structures. Crystal Defects / Crystal Imperfections,

Unit 2: *Mineralogy*: Structure, Chemistry, Paragenesis, optical and physical properties of Olivine, Garnet, Al_2SiO_5 group, Epidote, Pyroxene, Amphibole, Mica, Feldspar and Silica group of Minerals.

Practical:1 *Crystallography*: Determination of Grades of symmetry in Crystals and their projections. Determination of Axial Ratios and angle between the faces by using Stereonet.

Practical:2 *Mineralogy*: Identification of rock forming minerals. Determination of mineral formula based on mineral analysis. Plotting mineral compositions in a trilinear diagrams

GEOMORPHOLOGY, GEOTECTONICS & SURVEYING [LTP / CREDITS = 301/4]

Unit 1: *Geomorphology*: Principles of Geomorphology, Relief orders of Earth. Exogenetic and endogenetic processes. Land forms formed through fluvial, glacial, Aeolian, coastal and karst geomorphic process. Principles of terrain classification – landscape and parametric divisions. Role of geomorphology in selecting sites Irrigation in arid and semi arid regions- advantages and reclamation processes, Interpretation of drainage patterns.

Unit 2: *Rock Deformation*: Earth forces, Static and dynamic conditions, Mechanical characters of the rock. Kinds of Rock deformation: Mechanics of deformation. Relationship between Stress and Strain in rock compressive strength, tensile strength, Shear strength in rock; Mechanics of Plastic deformation, Stress and strain ellipsoids. Behavior of minerals and rocks under deformation conditions. Stress strain relationship of elastic, plastic and viscous materials. Experimental studies of rock deformation, evidences of formal deformation. Uses of Mohr representation various stress conditions. Mohr's circle and Envelop. Modulus of Elasticity.

Unit 3: *Folds and Folding*: Single fold, fold system classification of folds. The distribution of strain in folds, mechanism of development of folds, types of folds. Fault and faulting: faulting terminology, Breccias and Mylonite. Slickensides's and drag structures, classification: Genetic and Geometrical, types of faults. Recognition of fault in the field, uses of faults. Joints: classification and types of joints, joint sets and system, joint surfaces, relation of joints to other structures origin of joints. Unconformities, Plutons, Cleavage and Schistosity, Foliation: axial plane of foliations, origin of axial plane foliation, preferred orientation of layer silicates. Transposed foliation-Development of transposed foliation, Recognition of transposition. Lineation: slickenside striae, mineral lineations, pebbles, boulders, mullion and boudins, Origin of lineation.

Practical: 1 construction of geological cross-section, structural contour maps, Tracing of outcrops, Interpretation of underground structure from borehole data, solution to fault problems, use of stereographic projection in structural calculation, construction of rose diagram for structural data.

Chain survey, Compass survey, Plane table survey, Dumpy level survey, GPS survey, Total Station Survey.

Reference:

1. Geomorphology by William D. Thornbury.
2. Modern Physical Geography by Arthur N. Strahler & Alan H. Strahler.
3. Applied Geomorphology by Hails.
4. Billings, M.P.(1978) Structural Geology – Prentice – Hall of India Private Ltd. New Delhi.
5. Suppe, J.(1985) – Principles of structural geology – Prentice – Hall.
6. Price, N.J. and Cosgrove, J.W. (1990) Analysis of Geological Structure. Camb. Univ. Press.
7. Hobbs, B.E. Means D and Millions, P.F. (1976) an outline of structural geology. Press.
8. Ramsay, J.G. (1967) – Folding and fracturing of rocks. Mc.Graw Hills New York.
9. Badgley P.C. – Structural Geology for the exploration geologist.
10. Whitten, T- Structural Geology.
11. Ramsay, J.G. Structural Analysis of Metamorphic Tectonites.
12. Surveying and Levelling – Late T.P. Kanetkar and S.V. Kulkarni.
13. Surveying – Punmia.

ORE GEOLOGY [LTP / CREDITS = 301/4]

Unit 1: Ore – bearing fluids: magma, hydrothermal fluids, meteoric waters, seawaters, connate waters, metamorphic fluids. Depositional textures: exsolution, replacement, colloidal – colloform and open-space filling textures. Wall rock alteration: reaction between wall rocks and fluids, alteration assemblages and types of alteration. Paragenesis and zoning in mineral deposits. Classification of ore deposits. Deposits related to ultramafic-mafic rocks (layered intrusions, anorthosites, kimberlites, carbonates, komatiites). Deposits related to intermediate to felsic rocks (Iron deposits, porphyry Mo, pegmatites, granitic Tin and U, skarn deposits with typical examples).

Unit 2: Deposits related to weathering – Nickel laterite deposits, Deposits related to clastic sedimentation: placer deposits – Witwatersrand gold and U deposits. Chemical sedimentation: phosphate deposits, evaporates, manganese nodules, Ore deposits related to subaerial (Epithermal gold – Au) and submarine volcanism (Kuroko Cu–Zn, Japan, BIFs). Ore deposits related to metamorphism, metallogenic provinces, Epochs and plate Tectonic – classification of ore deposits.

Unit 3: Metallic deposits of India: Iron, Manganese, Copper, Chromium, Gold, Lead, Zinc and Bauxite deposits, Non-metallic deposits (Industrial minerals) – Minerals used as fertilizers, refractories, abrasives, pigments, ceramic and glass-making materials.

Practical: Optical methods in minerals: Determination of pleochroic scheme and optic sign in minerals. Birefringence. Identification of ore minerals based on optical properties: chromite, ilmenite, Ti-magnetite, hematite, pyrite, sphalerite, galena, chalcopyrite, covellite, Bornite, pyrrhotite, Arsenopyrite, Pyrolusite.

Reference:

1. The geology of ore deposits - John M. Guilbert and Charles F. Park, Jr. W.H. Freeman and Co., New York. 1986.
2. Interpretation of ore textures - Bastin, E.S.
3. Economic Mineral deposits by Jenson and Bateman, A.M.
4. Ore microscopy - Cameron, E.N.
5. Textures of the ore minerals - Edwards, A.B.
6. Ore deposits - Park, Jr. C.F.
7. Geology of Mineral deposits - Smirnov, U.J.
8. The ore minerals and their intergrowths - Ramhor, Dr. Paul.

9. Ore Petrology - Stanton, R.L.
10. India's mineral resources – Sinha and Krishnaswamy, S.
11. Metallic and Industrial minerals - Lamey Carl, A.
12. Introduction to India's economic minerals - Sharma, N.L. & Ram . K.S.
13. A treatise on industrial minerals of India-Sinha, R.L.
14. Mineral deposits of India, Mukerjee 1999: Allied publications.

SOFT CORE

MARINE GEOSCIENCES[LTP / CREDITS = 200/2]

Unit-1:Introduction Marine Geology. Continental margins and ocean floors. Plate boundaries and movements. Sea-floor spreading and subduction zones. Classification of sub marine topography. Physiographic features of the ocean floor. Oceanographic exploration instruments. Seamounts. Submarine canyons. Mid-ocean ridges. Oceanic trenches. Physico-chemical characteristic of sea water. Depth-wise distribution of temperature, salinity and density of sea water. Marine life and marine environment.

Unit-2: Ocean water Circulation. Factors and Mechanisms. Ocean Waves- their causes and distribution. Ocean Tides- their causes and effects. Oceanic Currents - their types, patterns of distribution and their significance. Tsunamis. Ocean sediment deposits- sources.-their Types and distribution. Marine natural resources. Types of marine mineral resources and their distribution. Marine energy resources. Marine Placer deposits. Manganese nodules and the methods of exploitation.

Reference:

1. Maohotra,A K, Ocean Science and Technology
2. Tchernia,P, Descriptive regional oceanography
3. K.Siddhartha, Oceanography- A brief Introduction
4. Willam A Anikouchine and Richard W Stenberg, The world Ocean- An Introduction to oceanography
5. Cuchlaine A M King, Oceanography for Geographers
6. H V.Thurman, Introduction to oceanography
7. Willam A Anikouchine and Richard W Stenberg, The world Ocean- An Introduction to oceanography
8. Cuchlaine A M King, Oceanography for Geographers
9. H V.Thurman, Introduction to oceanography.
10. Marine Geology,James P. Kennett,Prentice-Hall, 1982 - Science - 813 pages
11. Marine Geology,H. Kuenen,Read Books, 01-Mar-2007 - Science - 592 pages

ENVIRONMENTAL GEOLOGY[LTP / CREDITS = 200/2]

Unit 1:Introduction to Environmental Geology. Man and environment. Earth's system, Interactions among lithosphere, hydrosphere, atmosphere and biosphere. Geological process affecting the environment. Environmental hazards created by man's activities such as mining and industrial activities. Disasters Management,Environmental Risk Assessment, Environment hazard, Risk safety. Impact of climate on various earths systems, Flood hazard zonation mapping and risk analysis and relief aspects. Public perception of risk, risk communication. Environmental Impact Assessment. Causes of Environmental degradation. Environmental law and ethics.

Unit 2: Land pollution: Water, land and soil pollution. Causes and effects of urban and industrialization. Land use planning and terrain evaluation for environmental management.. Solid Wastes and their methods of Management. Sewage sources and their treatment methods. **Marine pollution:** Causative factors – land based sources – marine based sources – types of pollution – oil spills – process of oil spill process and its effects on marine and continental environment. Global warming causes and its effects.

Reference:

1. Environmental Geology – Peter TP Flawn
2. Environmental geosciences – Arthur H Strahler & Alan Strauler

3. Geology in Environmental planning- A.D. Howard & I.Ramson
4. Focus on Environmental Geology –R Turk
5. Environmental Science –S C Santra
6. Environmental geology by Waldia K.S

CLIMATOLOGY[LTP / CREDITS = 200/2]

Unit-1: Definition of Climate and weather. Climatology, its meaning, aims and methods. Climatology as distinguished from meteorology. The Climatic elements. Order of treatment of climatic elements. Earth's Atmosphere- Structure and properties of Atmospheric layers. Solar Climate and Physical Climate. Continental and Marine Climate. Temperature as a climatic element. Atmospheric Moisture, humidity, precipitation, and cloudiness. Types of clouds and Fogs. Major circulation of air as local winds. Atmospheric distribution of pressure. Climatic factors on Evaporation and Condensation. Factors influencing global climate. Dust content in air and principles of atmospheric visibility. Climatic zones and their subdivisions. Classification of climates,- Koppen's and Thornthwaite's scheme of climatic Classifications. Characteristics of various climatic zones.

Unit-2: Changes of Climate- Natural factors- Geological and secular changes, periodic variations and Role of Anthropogenic activities in climatic changes with case studies. Climate Observations, stations and networks. Climate data management. Instruments and climatic measurements. Thermometers, barometers, hygrometers, rain and snow gauges, Sunshine recorders. Weather maps and charts. Extreme climatic events- Cyclones, Jet Streams, Western Disturbances, Ozone Depletion, Storms, Hurricanes and Tornadoes. Droughts. Elements of Weather forecast and methods. Global Climate Models. General Weather Systems of India. Monsoon systems. Green house effect,

References:

1. Climatology: An Atmospheric Science, 2/e, Pearson Education India, 1993 - 423 p.
2. Encyclopedia of World Climatology, John E. Oliver, Springer Science & Business Media, 2008, 854 p.
3. Climatology, Majid Husain, Anmol Publications, 1994 - 376 p.
4. Advances in Meteorology, Climatology and Atmospheric Physics, Costas Helmis, Panagiotis T. Nastos, Springer Science & Business Media, 2012, 1278 p.
5. Remote Sensing Applications in Meteorology and Climatology, Robin A. Vaughan, Springer Science & Business Media, 2012, 480 p.
6. Applied Climatology: An Introduction, John F. Griffiths, Oxford University Press, Incorporated, 1976, 136 p.
7. Principles of climatology: a manual in earth science, Hans Hermann Neuberger, John Cahir, Holt, Rinehart and Winston, 1969, 178 p.
8. Climatology, an introduction, John E. Oliver, John J. Hidore, Merrill, 1984, 381 p.
9. Global Physical Climatology, Dennis L. Hartmann, Academic Press, 1994, 411 p.
10. Weather, radar and Flood forecasting, Collings. V. K (1987) John Wiley and sons.
11. General Climatology, Crithfield. H. J, (1996) Prentice Hall, New Jersey.
12. Climatology by Miller, Austin A Publication: London Methuen and company 1961 . xii, 320p.
13. General climatology by Flohn, H [ed.] Publication: Amsterdam Elsevier Publishing
14. company 1969 . xi, 266p.
15. Climatology by Miller, A. Austin Publication: London Methuen And Co 1938 . x, 304pp
16. Climatology by Haurwitz, Bernhard Publication: New York Mc Graw-Hill 1944 . xi, 409p.
17. Methods in climatology by Conrad, Victor Publication: Cambridge Harvard University
18. Press 1946 . xx, 228p.
19. Climatology by Kendrew, W G Publication: Oxford The Clarendon Press 1957 . xv, 400p.
20. Climatology by Blair, Thomas A Publication: New York Prentice-Hall 1942 . xvi, 484p.

FOUNDATION COURSE IN GEOLOGY[LTP / CREDITS = 400/4]

Unit 1: Mineralogy and Petrology. Basics of mineralogy. Physical properties of minerals. Classification of minerals based on chemical composition and structure. Rock forming minerals. Ore minerals. Oxides, carbonates, phosphates, sulphates, sulphides, and hydrocarbon. Silicates- quartz, feldspar, olivine, garnet, pyroxene, amphibole. Definition and basics of Petrology. Classification of Rocks. Igneous, sedimentary and metamorphic rocks. Forms, Structures and textures of Igneous Rocks. Lithification and diagenesis. Structures of sedimentary rocks. Classification of sedimentary rocks based on grain size, and mode of formation. Agents and structures of metamorphic rocks. Grades and facies of metamorphism. Petrographic properties of all THREE kinds of rocks.

Unit 2: Structural Geology and Geodynamics. Mechanical characters of the rock. Rock deformation. Kinds of rock deformation. Relationship between stress and strain in rocks compressive strength, tensile strength, residual stresses in rock. Mechanics of plastic deformation, stress and strain ellipsoids. Folds - Origin, characteristics, geometrical classification. Faults- Description and classification of all types of Faults. Unconformities: Definition and different types of unconformities. Salt Domes and Plutons. Joints-characteristic features & classification of joints. Geodynamics. Earths interior-Characteristics features crust, upper mantle and core. Continents and ocean basins. Plate Tectonics: Concept and its development, parts of a plate, spreading centres, mid-oceanic ridges, consuming margins, subduction zones, island arc volcanism at spreading centres: accretion, Mantle convection. Sea floor spreading and its impact.

Unit 3. Stratigraphy and Palaeontology. Stratigraphic principles. Nature of Geological Record. Branches of Stratigraphy, Correlation – Physical and Biological Criteria. Standard Stratigraphic scale. Introduction to Palaeontology - Classification of life. Fossils: Definition, fossilization, types of fossils, Casts and Molds. Tracks and Trails. Uses of fossils. Morphology and Geological distribution of - Foraminifera, Brachiopods, Mollusca-Lamellibranchs, Gastropods, Cephalopods, Echinoids & Trilobites. Plant fossils - Morphology and distribution of Lepidodendron, Siggillaria, Calamites, Glossopteris, Ptillophyllum.

Unit-4: Economic Geology- Introduction - Definition and importance of Economic Geology. Ore minerals, Gangue minerals, Tenor and Grade of Ore. Ore Genesis - Principles and Ore formation Processes: Magmatic concentration, contact metasomatism, hydrothermal processes: cavity filling and replacement, weathering: Residual and Mechanic concentrations, sedimentation: Oxidation and supergene enrichment and metamorphism. Occurrence and distribution of following mineral deposits. of India a) Metallic Deposits: Gold, Copper, Iron, Manganese and Aluminium. b) Non-metallic Deposits: Mica, Abrasives, Refractories and Ceramics, Fossil Fuels - Coal and Petroleum.

II SEMESTER

HARD CORE

FUEL RESOURCES & SEQUENCE STRATIGRAPHY [LTP/CREDITS= 400/4]

Unit 1: Definition and origin of coal. Stratigraphy of coal measures. Fundamentals of coal petrology, peat, lignite, bituminous and anthracite coal. Microscopic constituents of coal. Indian coal deposits.

Unit 2: Origin, migration and entrapment of hydrocarbons. Characters and source and reservoir rocks. Structural, stratigraphic and mixed traps. Geographical and geological distributions of onshore and offshore petroliferous basins of India.

Unit 3: Mineralogy and geochemistry of radioactive minerals. Instrumental techniques of detection and measurement of radioactivity. Radioactive methods of prospecting and assaying of mineral deposits. Distribution of radioactive minerals in India. Nuclear waste disposal=geological constraints.

Unit 4: Introduction to Stratigraphy, branches of Stratigraphy. Terms and concepts of Sequence Stratigraphy and its relationship with other branches of Stratigraphy. Sedimentary basin analysis through sequence Stratigraphy. Out crop and subsurface procedures. Global sea

level changes/ eustatic sea level. Applications of sequence stratigraphy in petroleum exploration with case studies

Reference Books:

1. Nuclear geology and Atomic mineral Resources – S.N. Virnave. Published by Bharati Bhawan 1995.
2. Mineral Resources of India – D.K. Banerjee. Published by the world press.
3. Radioactive minerals – R. Dhanaraju –2005 published by Geological Society of India.
4. Economic Mineral deposits – A.M. Bateman
5. Geology of Mineral deposits – Smirnov U.G.
6. Indian Mineral Resources – Krishna Swamy.S.
7. Introduction to India Economic Mineral deposits – Sharma, N.L. & Ram, K.S.
8. Basic Petroleum Geology – P.K.Link
9. Petroleum Stratigraphy – R.L.Breuner
10. World Oil Energy Economics – H.A.Kerklelin
11. Jaharia Coal Field – D.Chandra
12. Petroleum Formation and Occurrence – B.P. Tissot
13. Petroleum Geology – Levorsen
14. Sequence stratigraphy- BHP petroleum (America) Inc – Michael Yeaman, Lavy Holcomb, Gill Tailor 1990
15. Sequence stratigraphy – BP Exporation. Stockley Park UK Bridge London, Publ. Blackwell science
16. Sea Level Changes- An Integrated Approach Spl. Pbln.42, Barbara H.Lidz, Editor of Spl. Publ. Oklahoma USA 1998
17. Sequence in Layered Rocks- Blatt Middleton & Humay
18. Sedimentary Petrology- Pettijhon

PALAEONTOLOGY [LTP / CREDITS = 211/4]

UNIT: 1 Micro-Paleontology: Origin and Evolution of Life: Introduction of Microfossils; Classification of Microfossils; Separation of various Microfossils: Morphology, stratigraphic significance and applications of – Foramanifera, Ostracoda, Palynofossils, Acritarchs, Bryozoa, Chitinozoa, conodont, Scoleconodonds. Diatom, Radiolarians, Dinoflagellates and Nanoplanktons. Application of microfossils in fossil fuel exploration, paeoclimatic interpretation and maturation of sediments, Oxygen and Carbon Isotope studies on Fossils.

Unit: 2 Invertebrates: morphology, classification, paleo-ecology and evolutionary trends of porifera. Mollusca: Pelecypoda, Classification on the basis of dentition and dental formula, dental system with example. Class Cephalopoda suture pattern. Arthropoda: Class Trilobita, Echinodermata, Trace fossils – marine & terrestrial, Hemicardata: Class Graptozoa

Unit: 3 Vertebrates &Paleobotony: Vertebrates: Evolution, classification and geological significance of – Fishes; Amphibian, Reptails, Mammals: Elephant, Horses and Man. Paleobotony: Techniques of spores and pollens analysis, Morphology, General classification of algae and stromatolies and their stratigraphic importance. Paleozoic, Mesozoic and Cenozoic plants – Bryophytes, pterdophytes, Gymnosperms and Angiosperms their stratigraphic significance.

Practical: Identification, Diagnosis and Geological distribution of the following Groups: Invertebrate – Brachipods – 5 genera, Cephalopoda: 5 genera, Pelecypoda: 5 Genera, Trilobita: 5 genera, Graptozoa: 2 Genera, Plant Fossils: 6 genera, Microfossils – Foraminifera: 8 genera, Ostracoda: 3 genera, Palynofossils: 6 genera. Problems on biostratigraphy & Palaeo-ecology.

References:

1. Clarkson, E.N.K., 1998, *Invertebrate Paleontology and Evolution*, IV edition, publ., Blackwell
2. Stearn, C.W. & Carroll R. L. 1989, *Paleontology-the record of Life*, Publ. John Wiley.
3. Smith, A.B, 1994, *Systematics and the Fossils Record-Documenting Evolutionary Patterns.*, publ., Blackwell

4. Prothero. D.R., 1998, *Bringing Fossils to Life- An Introduction to Palaeontology.*, publ., Mc Graw Hill
5. D. J. Jones, 1956. *Microfossils*
6. F.T.Banner and A.R.Lord., *Aspects of Micropaleontology*
7. M.P.Glaessner, *Principles of Micropaleontology*
8. M.D.Brasier, 1955, *Microfossils*, publ.George allan and Wiley & Sons
9. Romer.A, *Vertebrate Paleontology*
10. Colbert, *Introduction to Vertebrate Paleontology*
11. Sukla., A.C & Misra S.P, 1975, *Study of Paleobotany* Vikar Publ. House
12. Sripad.N.Agashe, *Palaeobotany*
13. Maohotra, A K, Ocean Science and Technology
14. Tchernia,P, Descriptive regional oceanography
15. K.Siddhartha, Oceanography- A brief introduction
16. William A Anikouchine and Richard W Stenbegr; the world Ocean- An Introduction to oceanography
17. Cuchlaine A M King, oceanography for Geographers
18. H.V. Thurman, Introduction to Oceanography

IGNEOUS, SEDIMENTARY AND METAMORPHIC PETROLOGY [LTP / Credits = 301/4]

Unit 1: Igneous Petrology: IUGS and Chemical classification of Igneous rocks, Classification, texture and its petrogenetic significance, origin of Granite, Syenite, gabbro, and Layered Igneous complex, Kimberlite, Anorthosite, Carbonatite and Peridotite. Mineralogy, classification, textural peculiarities and origin of Pegmatite, Dolerite, Lamprophyre, Basalt, Rhyolite, Trachyte and Andesite. Add a note on their economic importance and Indian occurrence.

Unit 2: Sedimentary Petrology: Aim, Scope and importance – Historical development-Relationship with other branches of geology. **Properties of Sedimentary rocks:** textures of sedimentary rocks, Sedimentary facies and environment. Diagenesis of sediments. **Classification and description of sedimentary rocks:** Gravels, Conglomerates, Sands and Sandstones, Argillite, Non-evaporates and Evaporates, Heavy mineral studies, Grain size parameter Modes and Mechanism controls of sedimentation, Stock's law, Primary Sedimentary structures, Tectonics and sedimentation. **Applications of sedimentary rocks:** in Petroleum Geology.

Unit 3: Metamorphic Petrology: Introduction. Definition. Limits and agents of Metamorphism. Structure and Texture of Metamorphic rocks- Types of metamorphism based on principal process (Orogenic, Hydrothermal, Burial, regional, fault zone, Prograde-Retrograde, progressive Retrograde). Regional and Contact Metamorphism of Pelitic and impure Calcareous rocks. Major metamorphic rocks. Metamorphism of mafic rocks. Protoliths and types- Zones of Metamorphism, Metamorphic reactions- Kinetics of metamorphism- Mineral assemblages equilibrium/Reaction Texture and geo-thermo barometry. Metamorphic Reactions. Characteristics of different grades and facies of metamorphism, Metasomatism and granitization, Migmatites. Plate tectonics and Metamorphic Zones. Paired metamorphic belts.

Practicals: Mega & Microscopy Of Igneous Rocks - Identification and classification of Igneous rocks in hand specimens and thin Sections. Identification of microstructures and textures in igneous rocks. Significance of micro-textures in understanding magmatic and tectonic process.

Sedimentary petrology Practical: identification of Sedimentary rocks in hand specimens and thin sections. Identification of Structures in Sedimentary rocks. Grain size analysis - sieving, analysis of roundness and sphericity by visual method

Metamorphic Petrology Practicals: Megascopic and Microscopic identification of different types of metamorphic rocks and significance of structure and micro textures in understanding metamorphic and tectonic process.

Reference:

1. Petrology of Igneous and Metamorphic rocks by **Hyndman**
2. Principles of of Igneous and Metamorphic rocks by **Anthony R. Philpotts**.
3. Igneous petrology by **Anthony Hall**
4. Petrology of Igneous and Metamorphic rocks by **Best**.
5. Sedimentary Petrology – Pettijohn
6. Petrography – An introduction to the study of rocks in thin sections – H Kowell, Williams and Turner.
7. Manual of sedimenraty petrology – Krumbein and Pettijohn.
8. Principles of sedimentation – Twenhofel.
9. Sequence in layered rocks – Shrock, R.R
10. Procedures in sedimentary petrology – R.E. Carvar
11. Origin of sedimenrary rocks – Blatt, Middleton and Hurray.
12. Microscope sedimenraty petrology – A.V.Carrozi.
13. Sand and Sand Stones – Pettijohn, Potter and Siever.
14. Petrology of Sedimentary rocks – R.L.Folk.
15. Hand book of subsurface geology – C.A. Moore
16. Marine geology and Oceanography of the Aretic seas- Yvonne Herman.
17. Petrography – An introduction to the study of rocks in thin sections – H Kowell,,Williams and Turner.
18. Migmatites - Ashworth.
19. Metamorphism - A. Methuen & Co.
20. Migmatites and the origin of granitic rocks - Mehnert K.R. Elsevier & Co.
21. Metamorphism and Metamorphic rocks - Miyashiro, A. George, Allen and Unwin.
22. Petrogenesis of metamorphic rocks- Winkler, H.G.F. Springer, verly.

SOFT CORE**FIELD WORK AND TECHNICAL REPORT(Minor project)**

[LTP / CREDITS = 004/4]

ANALYTICAL TECHNIQUES IN GEOLOGY [LTP / CREDITS = 110/2]

Unit:1 Introduction to instrumental methods of chemical analysis, Spectroscopy photometry and spectrophotometer, Infrared spectroscopy – FTIR. Atomic Absorption spectroscopy (AAS), and Inductively coupled Plasma (ICP-MS) analysis technique, Thermal analysis techniques – DTA, TGA, DSC etc., Electron Microscopy – SEM, TEM, AFM;, X-Ray powder diffraction techniques (XRD), X-ray Fluorescence (XRF) technique, Electro probe micro analysis technique, (EDAX, WDS).

Unit 2 Tutorial: Assignments/Seminar/Test/Discussion

Reference:

1. Silicate analysis by Potts
2. Petrographic techniques by Hutchinson

SOIL & WATER CONSERVATION [LTP / CREDITS = 200/2]

Unit-1: Definition of Soil. Soil genesis and morphology. Factors of Soil Formation. Processes of Soil Formation. The Soil profile-Nature of Soil Profile.. Concept of Pedon and Landforms. Components and Composition of Soils. Physical Properties of Soils. Soil Structure. Chemical Properties of Soils. Soil pH. Soil Mineralogy. Ion-exchange Capacity of Soils. Soil Salinity. Acid Soils. Alkaline soils. Engineering properties of soils. Soil Moisture . Role of Nutrients in Soils . Soil Microbiology & Organic Matter. Soil testing and surveys. Soil Classification systems & Soil Taxonomy. Soil related problems. Soil pollution . Soil erosion- causes and effects. Soil loss measurements. Universal Soil Loss Equation and its application. Soil surface management and soil stabilization practices. Sediment traps. Soil conservation practices-Tillage methods. Biological soil conservation.

Mechanical conservation works including terracing methods. Irrigation and Engineering Practices.

Unit-2: Definition of water conservation. Water Conservation Practices. Water Resources in Watersheds and River Basins. Water Use and Consumption. Water management. Improving Drainage and reclaiming salt-affected soils. Technological options for drainage. Choice of method. Design principles. The effect of scale. Methods of Irrigation -modern techniques. In-situ conservation of soil water. Runoff management- Decreasing runoff amount(contour farming, strip cropping, contour barriers, vegetative hedges). Water Erosion Control practices. Reducing runoff velocity(slope management, waterways, diversion channels, engineering structures, etc). Flood control- Inundation methods and Flood diversion. Water storage- Small earth dams, Weirs, Sand dams. Losses of stored water- seepage/ evapotranspiration and its controlling methods.

References:

1. Principles of Soil Conservation and Management- Humberto Blanco-Canqui, Rattan Lal, Springer, 16-Sep-2008 - 617 pages
2. Soil and Water Conservation Policies and Programs: Successes and Failures, Ted L. Napier, Silvana M. Napier, Jiri Tvrdoň, CRC Press, 24-Nov-1999 - Technology & Engineering - 656 pages
3. Advances in Soil and Water Conservation, Francis J. Pierce, CRC Press, 01-Feb-1998 - Technology & Engineering - 300 pages
4. Soil and water conservation engineering, Richard K. Frevert, Glenn Orville Schwab, Wiley, 1966 - Nature - 683 pages
5. Soil And Water Conservation Handbook: Policies, Practices, Conditions, and Terms, Paul W. Unger, Haworth Food & Agricultural Products Press, 23-Oct-2006 - Political Science - 248 pages
6. Soil Erosion and Conservation, R. P. C. Morgan, John Wiley & Sons, 05-Feb-2009 - Science - 320 pages
7. Soil Erosion: Processes, Prediction, Measurement, and Control, Terrence J. Toy, George R. Foster, Kenneth G. Renard, John Wiley & Sons, 27-May-2002 - Science - 338 pages
8. Soil Erosion by Water: Some Measures for Its Control on Cultivated Lands, Food and Agriculture Organization of the United Nations, Food & Agriculture Org., 01-Jan-1965 - Nature - 284 pages
9. Water Conservation, Management and Analysis, Madireddi V. Subba Rao, Readworthy, 2011 - Water - 144 pages
10. Soil and Water Conservation Policies and Programs: Successes and Failures, Ted L. Napier, Silvana M. Napier, Jiri Tvrdoň, CRC Press, 24-Nov-1999 - Technology & Engineering - 656 pages
11. A Practical Approach to Water Conservation for Commercial and Industrial Facilities, Mohan Seneviratne, Elsevier, 11-Jul-2007 - Technology & Engineering - 400 pages
12. Soil and Water Conservation in Semi-arid Areas, Issue 57, Norman Hudson, Food & Agriculture Org., 01-Jan-1987 - Arid regions - 172 pages

OPEN ELECTIVE

BASICS OF EARTH SCIENCE [LTP / CREDITS = 400/4]

Unit 1: Physical Geology -Introduction to geology. Origin of the Earth. Age of the earth. Interior of the Earth. Geomorphic processes and cycles, Geological action of wind, water, glaciers. Volcanoes and earthquakes. Morphology of Oceans, Principles of Isostasy and uniformitarianism.

Unit 2: Structural Geology - Rock deformation. Earth forces. Folds and Foldings, Fault and Faulting, Joints, Cleavage, Unconformities, Concepts of plate tectonics, sea floor spreading and geosynclines.

Unit 3: Stratigraphy- Introduction, Definition of Stratigraphy, Branches of Stratigraphy and its relation with other branches of Geology, Principles of Stratigraphy- Law of Uniformitarianism, Law of order of superposition, Law of Faunal Succession. Geological

Record and its nature Eon, Era, Period. Geological Time Scale. Classification of Standard Stratigraphic scale. Nomenclature and units-Litho, Bio and Chrono stratigraphic units, Correlation- Lithostratigraphic and Biostratigraphic

Unit 4: Paleontology -Introduction, Definition of Paleontology, Classification of Plants, Invertebrate and Vertebrate fossils. Fossils-Toponymy (Burial Law), Types of Fossilization, Mode of preservation- Mummification, Carbonization, Silification, Casts, Moulds, Tracks and Trails. Applications of Fossils. General morphological characters and Geological age of the following Invertebrate and Plant Fossils: Brachiopoda, Cephalopoda, Pelecypoda and Trilobita. Plant fossils: Glossoptritis, Gangamopteris, Ptillophylum, Calamites and Lepidodendron

References:

1. Physical Geology by Arthur Holmes
2. Structural Geology by Billings
3. General Geology By P.K. Mukerjee
4. Physical Geology By Strahler
5. Stratigraphic Principles and Practice-Weller
6. Stratigraphy-Kumberlein and Sloss
7. Paleontology of the Invertebrates-Tasch Publ.Jhon Wiley and Sons
8. Paleontology- Henry Wood
9. Fossils Plants- Arnold
10. The Elements of Paleontology Black,R.M Pub. Cambridge university press

SEMESTER III

HARD CORE

REMOTE SENSING AND GIS [LTP / CREDITS = 202/4]

Unit 1: Remote Sensing: Fundamental concepts of Remote Sensing. Electromagnetic Spectrum. Principles of Aerial Photography, Photogrammetry and Remote Sensing. Energy Interactions with the matter and atmosphere. Black Body radiation. Sensors, Scanners and their capabilities, Platforms- Types of Platforms. Satellite Remote Sensing. Resolution and Types of Resolution. Method of Image Interpretation. Digital Image Processing. Indian Remote Sensing Satellites. Remote Sensing in Visible, Infrared Rays, Micro Wave and Thermal regions. Application of Remote sensing in Geological mapping, Mineral Exploration, Soil and water resources studies. Role of Remote Sensing in Flood hazard evaluation and disaster management.

Unit 2: GIS: Definition of Geographic Information System. The nature of geospatial information and data representation. Cartography. Maps and spatial information. Cartographic symbology. GIS and its subsystems. Components of a GIS. Databases used in GIS. Data Structures: Relational, hierarchical and network. RDBMS. Data models used in GIS. Spatial data models. Vector data Model. Raster data Model. DEM. TIN. Vector and raster - advantages and disadvantages. Attribute data models. Topological relationships of spatial data. Data Sources.GPS. Data input techniques. Digitization of maps and imageries; Coordinate transformation; Attribute data generation . Spatial data layers . Data retrieval and querying. Spatial analysis -Spatial overlay operations, buffering, trend surface mapping. Network analysis and proximity analysis; 3D models. GIS Modeling for decision support. Applications of GIS in earth's resources evaluation and management.

Practical: Remote Sensing: Visual and Digital interpretation of Reading of Topo maps.Visualization and Interpretation of Satellite Imageries.Interpretation and Demarcation of lithological Units.Interpretation Drainage patterns and water bodies.Interpretation and Measurement of Lineaments Interpretation of Geological Structures, Interpretation of land use/land cover.Interpretation of vegetation Interpretation of Mining and Mineralized zones

GIS: Methods of digitizing geospatial data(toposheet/ satellite image). Methods of creating x,y,z data as database and preparing contour maps. Georeferencing co-ordinates in scanned topo sheets or maps and computing the geometrical properties of digitized zones.

Methods of using DEM files, analysing hydrological components, basins, slopes, aspects and other features. Carrying out different kinds of spatial analysis including, buffering, Proximity, split, clip and neighbourhood analysis. Application of GIS model for various spatial analysis.

Reference:

1. Text book of Remote sensing and geographical Information system, 1st & 2nd Ed. By M. Anjireddy, BS Publications, Hyderabad
2. Remote sensing principles and Interpretations, 3rd edition, Floyd. F. Sabins
3. Applications of Remote sensing and GIS by H T Basavarajappa, Et. Al
4. Cartography: Visualization of Geospatial data – Menno-Jan Kraak and Ferjan Ormeling
5. Principles and application of Photogeology – Shiv N Pandey
6. Aerial photographic interpretation, Principles and applications - D.R.Leuder.
7. Photogeology - Miller, J.C.
8. Mannual of colour aerial photography -Ed. Smith, J.T.Jr.
9. Manual of photogrammetry - Ed: Morrie M.Thompson.
10. Manual of Remote sensing - Ed: Robert G Reeves.
11. Theory of pattern recognition and modern forecasting - V.Karpin and Wright Pattern.
12. Remote sensing in Geology - Parry S. Siegal & Alan. R.Gillespie
13. Manual of photographic interpretation - Ed: Colwell, R.N.
14. Principles of Remote Sensing – Patel Singh; SP publication
15. Digital Remote Sensing – Pritivish Nag M Kudrat ; Concept publication
16. Principles of GIS for land and resources assessment, Burrough, P.A., 1986, Oxford.
17. Introductory cartography, Campbell, 1984, Prentice Hall
18. Map data processing, Freeman and Pieroni, 1980, Academic Press.
19. An introduction to Geographical information systems: Ian Heywood et. al.
20. Geographical information systems and digital image processing – Muralikrishna 1999. Allied Publication
21. Fundamentals of remote sensing and Geoinformatics , by Anjireddy, Hyderabad ed. 1 and 2.
22. Geographic Information Systems: An Introduction, 3rd Ed, Bernhardsen, John Wiley & Sons, 01-Jan-2007 - 444 pages
23. Geographic information systems and science, Paul Longley, Wiley, 13-Jul-2001 - Education - 454 pages
24. Geographic Information Systems for Geoscientists: Modelling with GIS, Graeme F. Bonham-Carter, Elsevier, 18-May-2014 - Science - 416 pages
25. Geographic Information Systems and Science, Paul Longley, John Wiley & Sons, 22-Mar-2005 - Science - 517 pages
26. Handbook on Geographic Information Systems and Digital Mapping, United Nations. Statistical Division, United Nations Publications, 2000 - Census - 197 pages
27. Introductory Readings In Geographic Information Systems, D J Peuquet, D F Marble, CRC Press, 16-Dec-2003 - Technology & Engineering - 371 pages
28. Geographic Information Systems (GIS) and Mapping: Practices and Standards, Issue 1126, Arnold Ivan Johnson, C. Bernt Pettersson, ASTM International, 01-Jan-1992 - Travel - 346 pages
29. Introduction to Geographic Information Systems, Kang-tsung Chang, McGraw-Hill Education, 16-Jan-2015 - Science - 448 pages
30. Fundamentals of Geographical Information Systems, Michael N. DeMers, Wiley, 2009 - Science - 443 pages
31. Textbook of Remote Sensing and Geographical Information Systems, Kali Charan Sahu, Atlantic Publishers & Dist, 01-Dec-2007 - 512 pages
32. Geographic Information System, B. Gurugnanam, New India Publishing, 09-Jun-2009 - Geographic information systems - 206 pages
33. Fundamentals of Geographical Information Systems, Michael N. DeMers, Wiley, 2009 - Science - 443 pages

GEOCHEMISTRY AND PETROGENESIS

Unit 1: Geochemistry: Basic concepts and scope of geochemistry, Age, origin and composition of the universe with special reference to solar system, Geochemical classification of elements, primary differentiation of the earth, Meteorites- classification, composition and origin, Geochemical cycle, geochemical fractionation of trace and REE elements in magmatic process and its importance.

Unit 2: Geochronology: Radioactive decay schemes, Radioactive dating, Radiogenic isotope systematics: U-Pb, Rb- Sr, K- Ar systematics. Stable isotopes: Carbon, Oxygen, Sulphur and Hydrogen.

Unit 3: Petrogenesis: Genesis- properties- emplacement- crystallisation and differentiation of magmas. Bowen's reaction series. Mechanism of magma diversification (differentiation)- partial melting, crystal fractionation, Thermogravitational diffusion, liquid immiscibility, vapour transport, vapour phase alterations magma mixing, exsolution phenomena, assimilation. Phase equilibria studies- Basic concepts -phase and component, phase rule, unary system with examples of P-T diagrams of water and Al_2SiO_5 / Silica, ternary system and binary system -Diop-An and Fo-Fa.

Practicals: P-T calculations and construction of P-T diagrams. Petrochemical calculations- Niggli verte and Niggli base, CIPW norm calculation, Trilinear plots, construction of Variation/ Discriminant diagrams using major, trace and REE geochemistry data and interpretation. Isotopic age determination of rocks/minerals.

References:

1. Geochemistry- William.M.White-Wiley black well publications
2. Introduction to carbon capture and sequestration- Berend Smit, Jeffrey.A. Reimer, CurtisM. Oldenburg and Ian.C.Bourg.
3. Rare earth element Geochemistry by Henderson
4. Geochemistry by Rankama and Sahama
5. Petrologic Phase equilibria – W.G.Ernst
6. The Interpretation of Geological Phase diagrams - Ernest G Ehlers
7. Petrogenesis – Wilson
8. Solutions, Minerals and Equilibria – Garrels and Christ, 1966
9. Simulating the Earth- J.R. Holloway and B.J. Wood, 1988
10. Basic analytical Petrography – Ragland, 1989
11. Principles of Igneous and Metamorphic Petrology by Antony R Philpotts, 1979.1.
12. Geochemical Thermodynamics by Darrell Kirk Nordstrom and James L. Munoz
13. Chemical Thermodynamics for earth scientists by Philip Fletcher, 1993
14. Chemical Fundamentals of Geology by Robin Gill.
15. Elementary Thermodynamics by B.J. Wood and D.G. Fraser, 1976
16. Equilibrium Thermodynamics by Roger Powell
17. Principles of Geochemistry – Brian Mason
18. Geochemistry by Anderson
19. Chemical Thermodynamics by Bruce H Mahan

INDIAN STRATIGRAPHY [LTP / CREDITS = 310/4]

Unit 1: Precambrian Era – Introduction, Physical features, Physiographic features and Tectonic features of India. Brief studies on – *Dharwar Craton, Baster Craton, Singhbhum Craton, Bundelkhand Craton and Aravalli Craton*. A brief account on – *Eastern Ghats Mobile Belt, Pandyan Mobile Belt and Satpura Mobile Belt*. Precambrian of Himalaya. Proterozoic Sedimentary Basins - *Bijawar and Sonari, Gwalior, Abujhmar, Papaghni sub-basin, Vindhyan, Chhattisgarh, Khariar, Ampani, Indravati, Sabri, Pranhita-Godavari, Cuddapah, Kaladgi and Bhima*.

Unit 2: Paleozoic Era: Introduction, Tethyan Basin, Paleozoic Life, Trace fossils and Stromatolites. Precambrian/Cambrian boundary, pC/C boundary in Himalayan basins. *Cambrian* – Jammu and Kashmir, Himachal Pradesh, Tal Basins and Uttaranchal. *Ordovician and Silurian* - Jammu and Kashmir, Himachal Pradesh and Uttaranchal. *Devonian* - Jammu and Kashmir, Himachal Pradesh and Uttaranchal. *Carboniferous* - Jammu and Kashmir,

Eastern Karakoram, Himachal Pradesh and Uttaranchal. *Permian* - Jammu and Kashmir, Himachal Pradesh, Uttaranchal, Bhutan Arunachal Pradesh and Peninsular India-Cauvery Basin. *Gondwana Supergroup* – Introduction, Characteristics, Stratigraphy and Structure, Classification and Age, Life in Gondwana, Coastal Gondwana Basins, Gondwana in Extra-Peninsular India, Environmental of deposition and Economic Significance.

Unit 3: Mesozoic Era – Introduction, Life of Mesozoic Era, *Triassic* - Jammu and Kashmir, Himachal Pradesh, Uttaranchal, Sikkim, Rajasthan and Kutch. Permo-Triassic Boundary. *Jurassic* – Kutch, Rajasthan, Jammu and Kashmir, Himachal Pradesh, Uttaranchal, Jharkhand and Bhutan. *Cretaceous* – Gujarat, Rajasthan, Jammu and Kashmir, Himachal Pradesh, Uttaranchal, East Coast, Trichinopoly, Narmada Basin, Lameta Formation, Jharkhand, Assam/Meghalaya, Andaman and Nicobar Islands. Cretaceous/Tertiary Boundary. *Deccan Volcanic Province* – Introduction, Regional Stratigraphy, Subprovinces, Volcano-Plutonic Complexes, Petrology and Petrogenesis, Inter-Trappean beds, Distribution and its age.

Unit 4: Cenozoic Era – Introduction, Distribution, Climate, Correlation, Fauna and Flora, Classification and Stratigraphy. *Paleogene* – Introduction, Fauna and Flora, Stratigraphy and Distribution. *Neogene* – Introduction, Fauna and Flora, Stratigraphy and Distribution. *Quaternary* – Introduction, Distribution, Quaternary climatic changes, Quaternary Sea level changes. Siwalik – Stratigraphy and Sedimentation, Distribution and Fauna of Siwalik. Geology of Offshore Basins. Morphology and Evaluation.

References:

1. Geology of India Vol.1 & 2. M.Ramakrishnan and R Vaidyanathan
2. Geology of India – Wadia, D.N., Mc Millan and Co.
3. Geology of India and Burma – Krishnan M.S. Higginbotham, Madras.
4. A hand book of the Geology of the Mysore State – B. Rama Rao, Bangalore press.
5. Precambrian Stratigraphy and Geochronology of the Peninsular India – Sarkar, S.N. Dhanbad Publishers.
6. Review papers on the Stratigraphy of India –Rec.Geol.Surv.India Vol.101, Part 2.1972Cretaceous Tertiary formations –Geol.Soc. India, seminar Vol. 1958.
7. Paleozoic of Himalayas. HPC publ.
8. Reconnaissance Rb-Sr dating of the Precambrian of Southern Peninsular India-Crawford, A.R., J.G.S.I 1972. 117-126.

SOFT CORE

GEMMOLOGY [LTP / CREDITS = 200/2]

Unit 1: Introduction to Gemology, classification of gemstones, detailed study of different physical and optical properties of minerals with special reference of to gem minerals. Physical- optical effects in gemstones. Colour and Cause of colour in gems, Colour enhancement in gems.

Unit 2: Cutting and polishing of gemstones. A detailed study of important precious and semi-precious gem minerals, their characters and occurrences, World occurrences in general and Indian occurrences in particular (i)Precious varieties 1. Diamond 2. Gem corundum 3. Topaz 4. Emerald (ii) Semi-precious varieties Garnets, Quartz, Lapis lazuli, Turquoise and Organic gems.

References:

1. Gems and Gem industry in India-GSI Memoir 45- R.V Karanth.
2. Gem and Gem Minerals – EH Kvan and CB Slawson
3. Encyclopedia of Minerals and Gem stones - Edited by Michael O' Don Oghal.
4. Precious stones - by Max-Bauer Vol. I and II. Publisher Dover publications Ink. New york.
5. Gems and precious stones- Simon and Schusters, Publ.Fire side book publishers.
6. Gems and precious stones- Cally Hall, the apple press publishers
7. Gemmological instruments-Peter.G.read, Butterworth publ.
8. Gem stone enhancement-Kurt Nassau, Butterworth publ.

9. Rutley's Elements of Mineralogy- by H.H. Read, CBS publication
10. Dana's Manual of Mineralogy
11. GEMS by R.Webster - Batter work and co. ltd., London
12. Gemstones - Herbert Smith - Published by Methuen co. Ltd., London
13. Introduction to Rock forming minerals-Deer, Howie and Zussman.
14. Physical Geology-P.K.Mukherjee
15. Geology of India-R.Vaidyanathan and M.Ramakrishnan
16. Geology of Karantaka-B.P.Radhakrishna
17. Mineral Resources of Karnataka-B.P Radhakrishna

MINERAL ECONOMICS [LTP / CREDITS = 110/2]

Unit 1: Introduction and concepts of mineral economics. Peculiarities in mineral deposits. Concepts in mineral exploration and mineral resource estimation. Classification of Indian mineral resources. Role of mineral industry in national economy. Strategic, critical and essential minerals. India's status in mineral production. Changing patterns of mineral consumption. National Mineral Policy. Mineral Concession Rules. Mineral legislation in India. Mineral production, processing, coproducts and byproducts. Mineral inventory. Consumption and substitution of minerals. Demand Analysis and market survey. Mineral conservation and environment. Mineral information system. Marine mineral resources and Law of Sea.

Tutorial: Assignments/Seminar/Test/Discussion

Reference:

1. Mineral Economics by Truscot, John Wiley and Sons, Inc, 1987.
2. An introduction to mineral Economics – K.K.Chatterjee. publisher : - Wiley Eastern. 1993.
3. Mineral Economics : - R.K. Ssinha and N.L.Sharma. Oxford and IBH publication

ENGINEERING GEOLOGY [LTP / CREDITS = 200/2]

Unit:1 Engineering properties of rocks. Rocks as construction material, Geological considerations in selecting sites for tunnels, bridges, Dams and reservoirs, highways, Reservoir sedimentation: Causes – effects- basin, channel and geological factors, climatic influence, monitoring- desilting methods.

Unit:2 Geological investigation of landslides – hazards – hazards zonation mapping – stability analysis mitigation measures. Coastal Erosion: Causes of Coastal Erosion Near shore dynamics, erosion mechanisms- longshore drift, Effects of coastal erosion – Controlling methods – barriers groins, sea walls, Jetties and stone revetments. Geology of soils and elements of soil and soil mechanics.

Reference:

1. Plate tectonics and crustal evolution – Condie,K.C.
2. Manual of Field geology – Compton.
3. Soil their Orgin, constitution and classification – Robinson G.W
4. Soils – Tambane and others
5. Nature and Properties of Soil- Harry O Buckmen Nylc C. Brady
6. Fundamentals of Soil Science – Miling, Truck and Forth. H.D(1984) John willey
7. Introduction to Physical Geology – Strahler, A.N – 1965 – Willey
8. Climatology – Stringer (1982) Surjeet Publication Soil Atlas of Karnataka, NBSSLUP Publication.

OPEN ELECTIVE

INDUSTRIAL MINERAL RESOURCES [LTP / CREDITS = 400/4]

Unit 1: Definition of a Mineral. Classification of Minerals – Rock forming minerals & Ore forming Minerals, Silicate and Non-Silicate minerals. Physical, Chemical and optical properties of Minerals.

Unit 2: Description of Industrial Minerals: Gold, Silver, Coal, Copper, Diamond, Asbestos, Barite, Calcite, Diatomite, Feldspar, Gypsum, Kaolin, Mica, Silica, Talc, Zeolite,

Unit 3: Minerals Used in Paint, Fertilizers, Pesticides, Abrasives, Refractories, Ceramics, Glass, Pharmaceuticals, Petrochemical and Nuclear Energy

Unit 4: Gem Minerals: (i) Precious varieties 1. Diamond 2. Gem corundum 3. Topaz 4. Emerald (ii) Semi-precious varieties Garnets, Quartz, Lapis lazuli, Turquoise and Organic gems. Minerals Used in Civil work: Sandstones, Marbles, Granites, Sand and Gravel

References:

1. Industrial Minerals and Their Uses: a hand book and formulary. Ed. By Peter A Ciullo, Noyes Publications, 1996,
2. India's Mineral Resources by S. Krishnaswamy, Revised by R.K.Sinha, Oxford & IBH Publishing Co.PVT. LTD.

IV SEMESTER

HARD CORE

EXPLORATION GEOLOGY & MINING METHODS [LTP/CREDITS = 301/4]

Unit 1: Geological Exploration- Mode of occurrence of commercial-grade deposits of Fe, Mn, An-Ag-(W), Cu,Pb-Zn,Ti,Ni,Mo,Sn,Al,Pt - group. U-Th. Geological criteria for mineral prospecting. Indications of ore. Geological prospecting methods. Small and large scale geological mapping. Methods of geological exploration - exploratory grids, location and documentation of exploratory workings (pits, trenches underground workings), drilling, core logging. Sampling techniques and evaluation of grade.

Mining terminology, methods of open cast, underground and alluvial mining.

Definition and scope of mineral processing, comminution, crushers and classifiers. Froth flotation techniques of separation.

Unit 2: Geochemical Exploration: Geochemical cycle, mobility of elements and geochemical anomaly. Mode of occurrence of trace elements. Primary dispersion patterns of deep seated origin, syngenetic and epigenetic. Geochemical rock surveys. Weathering and its products. Mobility of elements in the surficial environment and surficial dispersion patterns and forms. Anomalies in residual and transported over burden. Anomalies in waters and drainage sediments.

Uptake of mineral matter by plants. Biogeochemical anomalies and survey techniques. Vapour geochemistry.

Unit 3: Geophysical exploration: Geophysical anomalies, Electrical prospecting: Resistivity method, important electrode arrangements, instruments, interpretation and application of electrical methods in ground water investigation.

Magnetic prospecting: Magnetic properties of rocks and minerals, Earth's magnetic field, instrument and measurements, interpretation of magnetic anomalies.

Gravity prospecting: Earth's gravity field, regional and local gravity anomalies, instruments, interpretation of gravity anomalies.

Seismic prospecting: Elastic properties of rocks and minerals, refraction and reflection technique time-distance relation for horizontal interfaces, seismic instruments and records.

Radio metric methods: Radioactivity of rocks and minerals, instruments and measurements of radiation, Well logging: Different techniques of logging..

Practical: Geological Exploration- Delineation of ore deposit based on exploration data. Classification of ore reserves. Economic evaluation of ore deposit. Preparation of technical report.

Geochemical Exploration: Geochemical methods in mineral exploration and choice of materials and methods. Interpretation of Geochemical maps for locating ore mineralization. Preparation of geochemical anomaly maps.

Geophysical exploration: Resistivity methods: Curve matching techniques and s-line method.

REFERENCE BOOKS

1. Introduction to geophysical prospecting - Milton B Dobrin
2. Exploration geophysics – Jakaosku J J
3. Outlines of geophysical prospecting - A manual for geologists – M B Ramachandra Rao
4. Geophysical Methods in Geology – P V Sharama
5. Exploration Geophysics for geologist and Engineers – Bhimasanakaran and Gaur
6. Principles of Applied Geophysics – D S Paransis
7. Introduction to Geophysics – C H Howel
8. Geochemistry in mineral exploration Rose, A.W Hawkes. H.E & Webb J.S. 1979. Academic press.
9. Principles of geochemical prospecting. Ginzburg. I.I. Petgamon Press, N.Y. London.
10. Biochemical methods of Prospecting - Malyuga, D.P.
11. Principles of Mining Geology, Arokiaswamy.
12. Geological prospecting and exploration – Kreiter, V.M.
13. Rock geochemistry in Mineral Exploration. G.J.S.Govett. Elsevier Publication. 1983.

HYDROGEOLOGY [LTP / CREDITS = 301/4]

Unit 1: Vertical distribution of groundwater: Hydrological properties of rocks – specific yield, specific retention, porosity, hydraulic conductivity, transmissivity, storage coefficient. Classification of aquifers, Concepts of drainage basin. Water table fluctuations – causative factors, Preparation and interpretation of water table contour maps. Hydro-stratigraphic units, Groundwater provinces of India, Occurrence of groundwater in igneous, sedimentary and metamorphic rocks.

Unit 2: Theory of groundwater flow, Darcy's Law and its applications, Determination of permeability in laboratory and in field, Types of wells, Drilling methods, construction, design, development and maintenance of wells, Specific capacity and its determination. Types of groundwater flow- Unconfined, confined, steady, unsteady and radial flow conditions. Aquifer parameter evaluation- Pumps tests – methods, data analysis and interpretation for hydrogeologic boundaries, Evaluation of aquifer parameters using Thiem, Theis, Jacob and Walton methods, Groundwater modeling – numerical approach and electrical resistance capacitance network.

Unit 3: Groundwater Exploration: Geological – lithological and structural mapping, lineament Fracture trace analysis, Hydrogeological – lithological classification with respect of hydrologic properties, Hydrogeomorphic units, Location of springs Interpretation of satellite Data for water resources evaluation. Problems relating to occurrence and distribution of groundwater. Groundwater problems related to foundation work, mining, canals and tunnels, Problems of over exploitation and groundwater mining. Groundwater development in urban and rural area. Artificial recharge methods, Groundwater problems in arid regions and remediation. Groundwater balance and the methods of estimation. Groundwater legislation.

Groundwater Chemistry, Hydrogeochemistry physical, chemical and biological properties of water, Quality criteria for different uses, Water quality parameters. Graphical presentation of water quality data, Problems of arsenic and fluoride in groundwater, Saline water intrusion in coastal and island aquifers and its prevention.

Practical: Rainfall patterns of distribution, methods of preparing isohyetal map and Thiessen polygon maps and interpreting volumes of rainfall. Methods of computing runoff volumes-manning coefficient- flow velocity and discharge calculations, wading method. Analysis water level fluctuation data-Preparation of water level fluctuation data-Preparation of water

table contour maps and interpretation. Analysing pumping test data using Jacob's straight line method. Preparation of Iso-resistivity maps and delineating groundwater potential zones. Interpretation of water quality data using numerical and graphical approaches.

Reference:

1. Groundwater-C.F.Tolman
2. Groundwater Hydrology-D.K.Todd
3. Hydrology-S.N.Davis and R.J.M Dewiest
4. Groundwater studies-R.H.Brown and others
5. Groundwater Hydrology-Herman Bouver
6. Hydrology-C.W.Fetter
7. Hand book of Applied hydrology-Van te Chew
8. Groundwater and wells-Hohnson Publications
9. Applied Hydrology-Chow M.Mays.Mac.Graw Hill Publication
10. Hydrology and wetland conservation-Gulam
11. Groundwater survey and investigation-Guatham Mahajan
12. Hydrology-Raghunath
13. Hydrogeology-Karanth
14. Ecology, Environment and Pollution – A Balasubramanian

DISSERTATION [LTP / CREDITS = 006/6]

SOFT CORE

PRECAMBRIAN CRUSTAL EVOLUTION [LTP / CREDITS = 200/2]

Unit 1: Geological time span. Early earth features. Mountain Building activity. Era- Breaking up of Pangea- the Precambrian- Hadean, Archean, Proterozoic, Structure of the Earth. A magma of Ocean- Composition of early Crust- Solidifying Basalt. The earth hotspot and fluid basalts. Lithosphere and Mantle reactions. Origin of the crust. Lower crust-first continents. early continental crust. growth of crust- Mechanism of continental growth and its growth rate. Growth of Continents. Primary Atmosphere. Secondary Atmosphere. Oxygen in atmosphere-geologic indicators of atmosphere-BIFs of Precambrian. Red beds, sulfates and Detrital uraninite and Pyrites, Decreasing Heat in Precambrian Time. paleosols –Biological indicators. Ocean prevailing theory, outgassing. Life in Archean Proterozoic orogeny. Earth- Moon system. Plate tectonics in the Precambrian.

Unit 2: Precambrian mineral Deposits. Proterozoic life. oldest rocks. Continental foundation. Distribution of Precambrian rocks. Proterozoic tectonics. Proterozoic assembly of laurestia-Proterozoic oxygen rocks. atmosphere- Precambrian assembly of Rodinia- grenville orogeny – Proterozoic rifting. Mid-continent rift- snowball earth. Crustal provinces- Precambrian provinces of North America. Cratons of Americ- hadean Crust. Archean and Proterozoic. Shield areas- Canadian Shield. Archean rocks. Green stone belt of South Africa. Cratons-Origin of Cratons, Rift Valleys, Mobile belts, Archean mineral Resources and Proterozoic Sedimentary Basin in India.

Reference:

1. Archaean Geology- C.S. Pichamuthu
2. Early Precambrian supracrustal of southern Karantaka-Memoir 112. Geol.Surv. Ind
3. Geology of Karantaka- B.P Radhakrishna
4. Geology of India (Volume 1 and 2)- R.Vaidyanathan and M. Ramakrishnan
5. Geology of India and Burma- M.S Krishnan
6. Geology of India- M. Wadia
7. Crustal Evolution and Metalogeny in India- Sanib Chandra Sarkar and Anupendu Gupta

CRYSTAL GROWTH AND MATERIALS SCIENCE [LTP / CREDITS = 200/2]

UNIT 1: CRYSTAL GROWTH: Introduction to crystal growth and growth phenomena. Crystal Growth methods- Melt (Bridgeman, Crystal pulling, Czochralski technique, zone melting) Verneuil process from solution, flux growth. CVT/CVD technique, Sol gel technique, Hydrothermal growth (low temperature, low pressure, High temperature, high pressure). Sintering technique.

UNIT 2: MATERIALS SCIENCE: Nature and Properties of Materials. Structure of Solids. Bonding and structure in Materials, Imperfection in Materials, Linear defects, deformation, Planar defects, Volume defects, Diffusion, Mechanical, Thermal, Magnetic, Electrical & Optical properties of materials, Materials Selection, Material Processing, Synthesis & Design, Characteristics and uses of metals, Polymers, Glass, Ceramics, Composites, semi conductive and biological materials.

DISSERTATION [LTP / CREDITS = 006/6]

SOFT CORE

PRECAMBRIAN CRUSTAL EVOLUTION [LTP / CREDITS = 200/2]

Unit 1: Geological time span. Early earth features. Mountain Building activity. Era- Breaking up of Pangea- the Precambrian- Hadean, Archean, Proterozoic, Structure of the Earth. A magma of Ocean- Composition of early Crust- Solidifying Basalt. The earth hotspot and fluid basalts. Lithosphere and Mantle reactions. Origin of the crust. Lower crust-first continents. early continental crust. growth of crust- Mechanism of continental growth and its growth rate. Growth of Continents. Primary Atmosphere. Secondary Atmosphere. Oxygen in atmosphere-geologic indicators of atmosphere-BIFs of Precambrian. Red beds, sulfates and Detrital uraninite and Pyrites, Decreasing Heat in Precambrian Time. paleosols –Biological indicators. Ocean prevailing theory, outgassing. Life in Archean Proterozoic orogeny. Earth- Moon system. Plate tectonics in the Precambrian.

Unit 2: Precambrian mineral Deposits. Proterozoic life. oldest rocks. Continental foundation. Distribution of Precambrian rocks. Proterozoic tectonics. Proterozoic assembly of laurestia- Proterozoic oxygen rocks. atmosphere- Precambrian assembly of Rodinia- grenville orogeny – Proterozoic rifting. Mid-continent rift- snowball earth. Crustal provinces- Precambrian provinces of North America. Cratons of Americ- hadean Crust. Archean and Proterozoic. Shield areas- Canadian Shield. Archean rocks. Green stone belt of South Africa. Cratons-Origin of Cratons, Rift Valleys, Mobile belts, Archean mineral Resources and Proterozoic Sedimentary Basin in India.

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8. Archaeal Geology- C.S. Pichamuthu
9. Early Precambrian supracrustal of southern Karantaka-Memoir 112. Geol.Surv. Ind
10. Geology of Karantaka- B.P Radhakrishna
11. Geology of India (Volume 1 and 2)- R.Vaidyanathan and M. Ramakrishnan
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