Name of the Department: Department of Studies in Earth Science

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

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<th>I Semester</th>
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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 2: Mineralogy: Structure, Chemistry, Paragenesis, optical and physical properties of Olivine, Garnet, Al₂SiO₅ group, Epidote, Pyroxene, Amphibole, Mica, Feldspar and Silica group of Minerals.


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


**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:**
3. Applied Geomorphology by Hails.
10. Whitten, T- Structural Geology.

**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, komatitites). 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:**
2. Interpretation of ore textures - Bastin, E.S.
3. Economic Mineral deposits by Jenson and Bateman, A.M.
4. Ore microscopy -Cameraon, E.N.
5. Textures of the ore minerals - Edwards, A.B.
6. Ore deposits - Park, Jr. C.F.
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.

SOFT CORE

MARINE GEOSCIENCES[ LTP / CREDITS = 200/2]


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.

ENVIRONMENTAL GEOLOGY[ LTP / CREDITS = 200/2]


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]


References:
14. Climatology by Miller, A. Austin Publication: London Methuen And Co 1938 . x, 304pp

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


II SEMESTER

HARD CORE

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


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 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:**
4. Economic Mineral deposits – A.M. Bateman
5. Geology of Mineral deposits – Smirnov U.G.
7. Introduction to India Economic Mineral deposits – Sharma, N.L. & Ram, K.S.
8. Basic Petroleum Geology – P.K.Link
11. Jaharia Coal Field – D.Chandra
12. Petroleum Formation and Occurrence – B.P. Tissot
13. Petroleum Geology – Levensen
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 – Foraminifera, Ostracoda, Palynofossils, Acritharchs, Bryozoan, Chitinozoan, conodont, Scolenodons. Diatom, Radiolarians, Dinoflagellates and Nanoplanktons. Application of microfossils in fossil fuel exploration, paleoclimatic 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 Graptolozoa

**Unit: 3 Vertebrates &Paleobotony:** Vertebrates: Evolution, classification and geological signigicance 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, pterodphytes, Gymnosperms and Angiosperms their stratigraphic significance.


**References:**
6. F.T.Banner and A.R.Lord., *Aspects of Micropaleontology*
7. M.P.Glaessner, *Principles of Micropaleontology*
9. Romer.A, *Vertebrate Paleontology*
10. Colbert, *Introduction to Vertebrate Paleontology*
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 Stenbe; 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 Pegmatitie, 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 developmet-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.


**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.


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
3. Igneous petrology by Anthony Hall
4. Petrology of Igneous and Metamorphic rocks by Best.
5. Sedimentary Petrology – Pettijohn
9. Sequence in layered rocks – Shrock, R.R

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


**References:**


**OPEN ELECTIVE**

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


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
8. Paleontology- Henry Wood
9. Fossils Plants- Arnold

SEMESTER III

HARD CORE

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


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 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.
10. Theory of pattern recognition and modern forecasting - V.Karpin and Wright Pattern.
11. Remote sensing in Geology - Parry S. Siegal & Alan. R.Gillespie
12. Remote sensing principles and Interpertations, 3rd edition, Floyd. F. Sabins
13. Applications of Remote sensing and GIS by H T Basavarajappa. Et. Al
17. Introductory cartography, Campbell, 1984, Prentice Hall
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.


References:
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
12. Geochemical Thermodynamics by Darrell Kirk Nordstrom and James L. Munoz
13. Chemical Thermodynamics for earth scientists by Philip Fletcher, 1993
15. Elementary Thermodynamics by B.J. Wood and D.G. Fraser, 1976
16. Equilibrium Thermodynamics by Roger Powell
17. Principles of Geochemistry – Brain Mason
18. Geochemistry by Anderson
19. Chemical Thermodynamics by Bruce H Mahan

INDIAN STRATIGRAPHY [LTP / CREDITS = 310/4]


**References:**
5. Precambrian Stratigraphy and Geochronology of the Peninsular India – Sarkar, S.N. Dhanbad Publishers.

**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:**
2. Gem and Gem Minerals – EH Kvans and CB Slawsan
6. Gems and precious stones- Cally Hall, the apple press publishers
MINERAL ECONOMICS [LTP / CREDITS = 110/2]


Tutorial: Assignments/Seminar/Test/Discussion

Reference:

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.


Reference:
1. Plate tectonics and crustal evolution – Condie,K.C.
3. Soil their Orgin, constitution and classification – Robinson G.W
4. Soils – Tambane and others
OPEN ELECTIVE

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


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


References:

IV SEMESTER

HARD CORE

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


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


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..

**Geochmical 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
7. Introduction to Geophysics – C H Howel
10. Biochemical methods of Prospecting - Malyuga, D.P.
12. Geological prospecting and exploration – Kreiter, V.M.

**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.


**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 volume-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-Hereman Bouver
6. Hydrology-C.W.Fetter
8. Groundwater and wells-Hohnson Publications
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]**


**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]**


DISSEMINATION [ LTP / CREDITS = 006/6]

SOFT CORE

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


Reference:
8. Archaean Geology- C.S. Pichamuthu
9. Early Precambrian supracrustal of southern Karantaka-Memoir 112. Geol.Surv. Ind
10. Geology of Karantaka- B.P Radhakrishna
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