

THE COURSE STRUCTURE OF M.Sc. (GEOLOGY) UNDER CHOICE BASE CREDIT SYSTEM

FIRST SEMESTER

Paper I (GEOLF 01) –FOUNDATION - Basics of Geology -5 Credits (Teaching 5 hours per week and minimum 60 teaching hours). Time -3 hours; F. M. -70

Instructions-In all NINE questions of equal value will be set out of which an examinee shall have to answer FIVE questions. Q.N. 1 will be compulsory consisting of SEVEN very short answer type questions, each of TWO marks covering the entire syllabus.

Knowledge of Dip, Strike, Contour, Scale, Geological maps, Topographic map, Clinometer compass, Brunton Compass, Pattern of dipping strata- rule of V's. GPS. Continental drift-evidences, causes, mechanism, and present status. Sea floor spreading- mid oceanic ridges, magnetic and gravity anomalies, deep sea trenches, island and volcanic arc. Plate tectonics – types of plate boundaries, causes of plate motion, relation of plate tectonics with seismicity, volcanism and diastrophism. Mobile belts. Palaeomagnetism. Tectonics of Precambrian orogenic belts of India. Structure and tectonics of Himalaya.

Concept of stress and strain. Two dimensional stress and strain analysis. Types of strain ellipses and ellipsoid, their properties and geological significance. Mechanism of deformation-intercrystalline and intracrystalline slip. Classification, causes and mechanism of folding and buckling. Geometry of superposed folding. Classification, causes and mechanism of faulting. Shear zones and their types. Minor structures (planar and linear) - their origin and significance. Concept of petrofabrics and symmetry, interpretation of fabric data on microscopic and mesoscopic scale.

Paper II (GEOLC 02) CORE 1- Crystallography, Optical Mineralogy, Systematic Mineralogy, Geomorphology, 5 Credits (Teaching 5 hours per week and minimum 60 teaching hours)- Time -3 hours; F. M. -70

Instructions-In all NINE questions of equal value will be set out of which an examinee shall have to answer FIVE questions. Q.N. 1 will be compulsory consisting of SEVEN very short answer type questions, each of TWO marks covering the entire syllabus.

Crystallography

Crystallography- introduction. International system of crystallographic notation- Miller system and Hermann- Mauguin system. Derivation of 32 classes. Symmetry elements & common forms of normal classes of all the systems. Point group, lattice and space group. Twinning and twinning

laws, crystal imperfection. X-ray crystallography and Bragg's law. X-ray investigations of crystals by oscillation, powder and rotation methods.

Optical Mineralogy

General principles of mineral optics. Isotropism and anisotropism. Important optical properties of mineral – R.I and relief, colour and pleochroism, interference colours, birefringence, extinction, optic axial angle. Optical properties of minerals in relation to crystallography. Dispersion and optic anomalies. Behavior of Uniaxial and Biaxial minerals under convergent polarized light. Uses of accessory plates.

Systematic Mineralogy

Elementary idea of crystal chemistry, co-ordination number and bonding, ionic substitution, isomorphism, polymorphism, pseudomorphism and solid solution. Structure and classification of silicates. Atomic structure, mineral chemistry, P-T stability, properties, paragenesis and occurrence of the following mineral groups: Olivine, Garnet, Pyroxene, Amphibole, Mica, Clay, Quartz, Zeolite, Feldspar and Feldspathoid.

Geomorphology .

Concept of geomorphic cycle and its interpretation. Land forms in relation to lithology and structure. Morphometric analysis. Fluvial land forms, drainage pattern and its significance. Aeolian processes and land forms. Glacial processes and land forms. Coastal geomorphology. Karst topography. Study of geomorphic feature of Chotanagpur plateau. Application of geomorphology in mineral prospecting, civil engineering and environmental studies.

Paper III (GEOLC 03) CORE 2- Sedimentology, Palaeobiology-5 Credits (Teaching 5 hours per week and minimum 60 teaching hours).

Time -3 hours; F. M. -70

Instructions-In all NINE questions of equal value will be set out of which an examinee shall have to answer FIVE questions. Q.N. 1 will be compulsory consisting of SEVEN very short answer type questions, each of TWO marks covering the entire syllabus.

Sedimentology

Classification of sandstone and Limestone. Provenance – concept of mineral stability and maturity of sediments, light & heavy minerals and their significance. Texture – clastic and non-clastic texture, concept of grain size and grade, graphical representation of grain size and statistical parameters. Mechanical analysis of sediments. Sedimentary environment – factors & classification. Study of palaeocurrent features, sedimentary primary structures and their significance. Concept of sedimentary facies. Sequence stratigraphy.

Palaeobiology

Methods and techniques in Palaeontology. Mass extinction. Morphology and geological records of Brachiopoda, Lamellibranchia, Cephalopoda, Trilobita, Foraminifera, Chitinozoa, Acritarch and Plant fossils. Evidence of life in Precambrian time. Applications of micropaleontology in petroleum exploration. Evolution of Horse and man.

Books recommended:

- Principles of Geomorphology—W.D.Thornbury
- Geomorphology-Bloom
- Applied Geomorphology – J.R. Helis
- Holme’s Principles of Physical Geology—P. McL D. Duff
- Structural Geology -- M.P. Billings
- Folding and fracturing of rocks—J.G.Ramsay
- Techniques of Modern Structural Geology (vol. 1 & 2)—Ramsay & Huber
- An outline of structural Geology-Hobbes, Means and Williams
- Structural geology: fundamentals of modern developments – S.K. Ghosh ?
- Structural Geology of Rocks & Regions—Davis & Reynolds
- Dynamic Himalaya -- K. S. Valdiya
- Plate Rectonics and Crustal Evolution – Kent. C. Condie
- Geomorphology and global tectonics- M. A. Summerfield
 - Invertebrate palaeontology and evolution – E.N.K. Clarkson
 - Principles of Palaeontology—David M. Raup & Steven M. Stanley
 - Principles of Invertebrate palaeontology – Shrock and Twenhofel
 - Sedimentary Rocks—F.J. Pettijohn
 - A Practical Approach to Sedimentology – R.C.Lindholm
 - Principles of Basin Analysis – A.D.Maill
 - Geology of India – Vaidyanadhan and Ramakrishnan
 - Introduction to Sedimentology- S.M.Sengupta
 - Applied Sedimentology – R.C.Selley
 - Sedimentary Petrology: An Introduction – M.E. Tucker
 - Carbonate Sedimentology – M.E. Tucker
 - Principles of physical sedimentation-Allen, J R L
 - Depositional sedimentary environments – H.E. Reineck and I.B. Singh

Paper IV (GEOLP 04) Practical -5 Credits (Teaching 10 hours per week and minimum 120 teaching hours). F. M. - 70

1. Calculation of axial ratio of common crystal forms of tetragonal, orthorhombic and monoclinic systems.
2. Identification of common rock forming minerals under petrological microscope.
3. Determination of pleochroic scheme of important rock forming minerals.
4. Determination of optic sign of important rock forming minerals.
5. Geological cross-section of maps and their interpretation.

6. Structural problems such as bore hole, dip & strike, rake & plunge, Pie & Beta diagrams.
7. Identification of important invertebrates, vertebrates, microfossils and plant fossils
8. Grain-size analysis on log probability graph paper.
9. Megascopic and microscopic study of important sedimentary rocks.

SECOND SEMESTER

Paper VA (GEOLS 05 A) Skill Enhancement Course-5 Credits (Teaching 5 hours per week and minimum 60 teaching hours). **Time – 3 hours, F. M. – 35; (Sessional = 15 marks).**

In all NINE questions of equal value (Seven marks each) will be set, out of which an examinee shall have to answer FIVE questions.

Theoretical knowledge of thin section preparation, separation of microfossils from its matrix, maceration techniques, heavy liquid separation of microfossils, preparation of minerals and fossils for SEM, sample preparation for XRF and XRD and interpretation of data by clay minerals, REE and TE. Isotopic study . Fission track method and thermochronology, Computation of stratigraphic thickness from traverse and construction of stratigraphic column. Theoretical idea of determination of carbonate minerals and plagioclase feldspar in sediments. Idea of Gemstone-its quality, colour, chatoyancy, asterism, hardness, luster, specific gravity. Gem testing. Man made stones. Organic gems, gem cuttings.

Paper VB (GEOLS 05 B) – Practical based on the topics of skill enhancement course. , F. M. – 35; (Sessional = 15 marks).

Paper VI (GEOLC 06) CORE 3- Photogeology, Igneous Petrology, Metamorphic Petrology-5 Credits (Teaching 5 hours per week and minimum 60 teaching hours).

Time -3 hours; F. M. -70

Instructions-In all NINE questions of equal value will be set out of which an examinee shall have to answer FIVE questions. Q.N. 1 will be compulsory consisting of SEVEN very short answer type questions, each of TWO marks covering the entire syllabus.

Photogeology

Elementary idea of Photogeology. Aerial photography, types of aerial cameras and flight planning. Human eye and stereoscopic vision, depth perception. Stereoscopes- their types, construction and function. Geometric characteristics of aerial photographs. Photogrammetry- calculation of height of an object using relief displacement and stereoscopic parallax. Interpretation of geographical, geomorphological, structural and lithological features from aerial photographs. Application of photogeology in geological mapping and mineral exploration.

Igneous Petrology

Magmas their nature, composition and genesis. Crystallisation of congruent, incongruent and solid solution series. Study of the following three component systems of petrological interest:

Diopside – Albite –Anorthite; Diopside – Forsterite – Silica; Diopside – Forsterite – Anorthite. Diversity in igneous rocks – Differentiation, assimilation and magmatic mixing. Modern classification of igneous rocks. Study of ultramafic rocks, basalt, alkaline rocks and granitic rocks. Large Igneous Province.

Metamorphic Petrology

Metamorphism- role of temperature, pressure and fluids in metamorphism. Types of metamorphism. Metamorphic zones, grades and facies. Mineral assemblages and important reactions in different facies. Metamorphic belts. ACF & AKF diagrams and their significance. Regional and thermal metamorphism of pelitic and calcareous rocks. Petrogenesis of charnockite and eclogite.

Paper VII (GEOLC 07) CORE 4- Indian Stratigraphy, Geochemistry, Isotope Geology, Marine Geology, Mathematical Geology -5 Credits (Teaching 5 hours per week and minimum 60 teaching hours). Time -3 hours; F. M. -70

Instructions-In all NINE questions of equal value will be set out of which an examinee shall have to answer FIVE questions. Q.N. 1 will be compulsory consisting of SEVEN very short answer type questions, each of TWO marks covering the entire syllabus.

Indian Stratigraphy

Principles of Stratigraphy, stratigraphic classification, correlation and code of stratigraphic nomenclature. Lithology, classification, fossil content and economic importance of the following stratigraphic units of India: Precambrian of Singhbhum and Dharwar, Cuddapah Supergroup, Vindhyan Supergroup, Gondwana Supergroup, Siwalik Group, Tertiary of Assam. Pc-C, K/T, P/T boundary problems of India, Magnetostratigraphy - General principles, magnetic polarity time scales, application of magnetostratigraphy.

Geochemistry

Origin and cosmic abundance of elements. Geochemical classification of elements. Geochemical cycle. Primary geochemical differentiation of the earth. Principles of ionic substitution in minerals. Laws of thermodynamics and its geological applications. Geochemical evolution of the earth. Introduction to modern techniques of mineral characterization.

Isotope Geology

Radioactivity – stable and unstable isotopes. Nature abundance and fractionation of stable isotopes. Radioactive decay schemes. Application of radioactivity in geology. Age of the earth: Ar^{40} - K^{40} method, U^{238} Th^{232} method, U^{235} , $Pb^{206/207}$ method C^{14} method. Concordant & Discordant age pattern.

Marine Geology

Morphological and tectonic domains of ocean floor. Relief of the ocean floor. Coral reefs – types, structures and origin. Ocean deposits – transportation and deposition of marine sediments. Marine mineral resources and their controlling factors.

Mathematical geology

Linear equations, mathematical models in geology. Application of statistics in geology- Kurtosis, Skewness, and standard deviation. Collection, tabulation and presentation of geological data for statistical purposes. Graphical representation of data, histogram, frequency, curve, bar diagram, measures of central tendency.

Books recommended:

- Igneous Petrology-M G Best
- Igneous Petrology-A R McBirney
- Igneous Petrology-M K Bose
- Petrology and Genesis of Igneous Rocks—Alok K. Gupta
- Metamorphic Petrology-F J Turner
- An Introduction to Metamorphic Petrology-B W Yardley
- Geology of India and Burma – M.S.Krishnan
- Fundamentals of Historical Geology & Stratigraphy of India—Ravindra Kumar
- Geology of India (Vol 1&2)—R. Vaidyanadhan & M. Ramakrishnan
- Precambrian Geology of India – S.M. Naqvi and J.J.W.Rogers
- Principles and Applications of Photogeology- S.N. Pandey
- Remote Sensing and Image Interpretation- Lillesand and Kieffer
- Remote sensing geology- R P Gupta
- Image interpretation in geology—S.A. Drury
- Fundamentals of Remote Sensing – George Joseph
- Fundamentals of Remote Sensing & GIS—S.K.Sinha
- Remote Sensing and its applications—L.R.A. Narayan

- Introduction to geochemistry- B Mason and C B Moore
- Introduction to geochemistry- K B Krauskopf
- Principles of Geochemistry – Brian Mason
- Principles of isotope geology – G Faure
- Marine geology-- Kennett, Jp
- Oceanography for Geographers – Sharma and Vatal
- The sea floor-Seibold, E and Berger, W H
- Nuclear Geology and Atomic Mineral Resources – S.N.Virnav
- Mathematical Modelling – J.N. Kapur
- Introduction of Linear Algebra in Geology – J. Ferguson

Paper VIII (GEOLP 08) Practical 5 Credits (Teaching 10 hours per week and minimum 120 teaching hours). F.M. – 70 (Sessional -30)

1. Visual interpretation of aerial photographs and satellite images.
2. Determination of scale of the photographs and images.
3. Height measurement using parallax bar.
4. Megascopic and microscopic studies of some important igneous & metamorphic rocks.
5. Calculation of CIPW Norms & Niggli values of igneous rocks.
6. Construction of ACF & AKF diagrams.
7. Identification and plotting of important stratigraphic rocks.
8. Classification of lithostratigraphic units
9. Geological field work OR Internship for maximum two weeks from any reputed organization/ Institution etc. Students opting a field work will have to submit a field report under supervision of teachers of the department. Students opting for internship will have to choose a recognized / suitable organization / institution on their own cost and risk and submit a certificate from the organization /institution and present a report of work done.

THIRD SEMESTER

GENERIC ELECTIVE (GE) - -5 Credits (Teaching 5 hours per week and minimum 60 teaching hours). Department of Geology offers TWO Generic Electives. One has to select any ONE.

Paper IX A (GEOLG-A- 09A) –Remote Sensing and GIS

Time – 3 hours, F. M. – 35; (Sessional = 15 marks).

In all NINE questions of equal value (Seven marks each) will be set, out of which an examinee shall have to answer FIVE questions.

Remote sensing and GIS

Principles of remote sensing. General idea of electromagnetic spectrum. Spectral signature of common natural objects. Radiation laws. Interaction of EMR with the Earth's surface and with the atmosphere. Platform and Sensors. Multi spectral scanners. Resolution of sensor- spatial, spectral, radiometric and temporal. Microwave remote sensing. Digital image processing techniques. Application of remote sensing in geology, mineral exploration, groundwater & hydrocarbon exploration. Remote sensing applications in planning of large engineering structures & urban development. Principles of Geographic Information System (GIS), data structures, data acquisition & retrieval, overlay operation and application of GIS. Global Position system. Important Indian and International satellite programs.

Paper IX B (GEOLG-A- 09B) – Remote Sensing and GIS. Practical – F.M. – 35 (Sessional – 15). It will based on GE of paper IX A.

Paper IX C (GEOLG-C-09)- Organic –walled Microfossils/Palynology

Time – 3 hours, F. M. – 35; (Sessional = 15 marks).

In all NINE questions of equal value (Seven marks each) will be set, out of which an examinee shall have to answer FIVE questions.

Brief idea of palynology, spore and pollen-their morphology and characteristics . Separation of palynomorphs from matrixes/sedimentary rocks, identification under microscope. Geological history of spore and pollen and their environmental significance. Utility in oil exploration programe, thermal Alteration Index of spore and pollen. Acritarchs, Chitinozoa, Melanosclerites –their morphology, geological history, classification, palaeoenvironmental importance.

Paper IX D (GEOLG-C- 09) – Organic –walled Microfossils/Palynology. Practical – F.M. – 35 (Sessional – 15). It will based on GE of paper IX C.

Paper X (GEOLC 10) CORE 5- Remote Sensing and GIS, Ore Geology, Ore formation and control, Mining and Exploration Geology -5 Credits (Teaching 5 hours per week and minimum 60 teaching hours). Time -3 hours; F. M. -70

Instructions-In all NINE questions of equal value will be set out of which an examinee shall have to answer FIVE questions. Q.N. 1 will be compulsory consisting of SEVEN very short answer type questions, each of TWO marks covering the entire syllabus.

Remote sensing and GIS

Principles of remote sensing. General idea of electromagnetic spectrum. Spectral signature of common natural objects. Radiation laws. Interaction of EMR with the Earth's surface and with the atmosphere. Platform and Sensors. Multi spectral scanners. Resolution of sensor- spatial, spectral, radiometric and temporal. Microwave remote sensing. Digital image processing techniques. Application of remote sensing in geology, mineral exploration, groundwater & hydrocarbon exploration. Remote sensing applications in planning of large engineering structures & urban development. Principles of Geographic Information System (GIS), data structures, data acquisition & retrieval, overlay operation and application of GIS. Global Position system. Important Indian and International satellite programs.

Ore Geology

Ore genesis and its major theories. Process of formation of mineral deposits- magmatic concentration, hydrothermal processes, oxidation and supergene sulphide enrichment, residual and mechanical concentration. Texture of ore, wall rock alteration. Ore microscope and qualitative optical properties. Paragenesis and paragenetic sequence and zoning. Fluid inclusion- nature, location, composition and application.

Ore formation and control

Nature and morphology of principal types of ore deposits. classification of ore deposits. Metallogenic provinces and epochs. Control of mineral (ore) localization including brief idea of plate tectonic controls. Ore-deposits environment- diamond deposits in kimberlite and lamproites, pegmatite environment, Cu-Ni-Fe deposit with basic and ultrabasic rocks, Greisen deposits. Skarn environment. strata-bound deposits, stratiform sulphide, oxide and sedimentary environment.

Mining and Exploration Geology

Concepts of mining geology. Important mining methods, sampling methods. Mining hazards – mine inundation, mine fire, rock burst and subsidence. Mineral beneficiation. Detailed geophysical methods of Exploration- gravity, magnetic, seismic and electrical methods. Geochemical exploration methods, Geological and geobotanical exploration methods.

Paper XI (GEOLC 11) CORE 6-

Indian mineral resources and mineral economics, Hydrogeology, Engineering Geology, Environmental Geology -5 Credits (Teaching 5 hours per week and minimum 60 teaching hours). **Time -3 hours; F. M. -70**

Instructions-In all NINE questions of equal value will be set out of which an examinee shall have to answer FIVE questions. Q.N. 1 will be compulsory consisting of SEVEN very short answer type questions, each of TWO marks covering the entire syllabus.

Indian mineral resources and mineral economics

Brief knowledge of mode of occurrence, origin, reserve, and geology of the following Indian mineral deposits- Bauxite of Eastern Ghat, Iron and Copper ores of Singhbhum, Copper ores of Khetri, Pb-Zn of Zawar, Uranium deposits of Jaduguda and Mica deposits of Koderma. Mineral Economics- Reserve and resource, UNFC classification, strategic, essential and critical minerals, National Mineral Policy of India. Conservation and substitution of minerals.

Hydrogeology

Groundwater- origin, types, importance, occurrence and movements. Aquifers and their types. Hydrological cycle. Hydrologic properties of rocks- porosity, permeability, specific yield, specific retention, hydraulic conductivity, transmissivity and storage coefficient. Water table contour maps, hydrograph. Theory of groundwater flow, Darcy's law and its applications. Groundwater quality, estimation and treatment for various uses. Water contaminants and pollutants. Water table and its fluctuation. Artificial recharge to groundwater. Groundwater provinces of India.

Engineering Geology

Engineering properties of rocks, rock discontinuities (defects) and their hazardous effects. Important rock mass classification (RMR). Geological consideration for river valley projects – dams and reservoirs, tunnels - their types. Site selection, problems and their remedies. Movements with special emphasis on landslide. Causes of hill slope instability. Earthquake and seismicity. Seismic zones of India. Aseismic design of building. Problems of groundwater in engineering projects.

Environmental Geology

Concept of ecology, environment and environmental geology. Impact of urbanization, mining and other industrial activities on the environment. Impact of large dams on environment. Natural hazards-flood, earth quake and volcanoes; their impacts and mitigation.

Books recommended:

- Principles and Applications of Photogeology- S.N. Pandey
- Remote Sensing and Image Interpretation- Lillesand and Kieffer
- Remote sensing geology- R P Gupta
- Image interpretation in geology—S.A. Drury
- Fundamentals of Remote Sensing – George Joseph
- Fundamentals of Remote Sensing & GIS—S.K.Sinha
- Remote Sensing and its applications—L.R.A. Narayan
- Ore Genesis- A Holistic Approach – Ashoke Mookherjee
- The Nature of Ore Deposits (Vol-1 & 2)– Richard Beck
- Ore Geology and Industrial Minerals- An Introduction – Anthony
- Ore Geology – R.L. Stanton ?
- Economic Mineral Deposits – Jensen and Bateman
- Ore Microscopy and Ore Petrography – James and David
- Courses in Mining Geology – R.N.P. Arogyaswamy
- The Geology of Ore Deposits – Gilbert and Park
- Mining Geology – H.E. McKinstry
- Geophysical Practice in Mineral Exploration & Mapping – T.S.Ramakrishna
- Field Geology – F.H.Lahee
- Geobotany and Biogeochemistry in Mineral Exploration -- Brooks
- Mineral Deposits of India – R.N.Umathy
- Mineral Resources of India – D.K.Banerjee
- Economic Geology – Umeshwar Prasad
- Mineral Economics – K.K.Chatterjee
- Indian Mineral Wealth—Brown and Dey
- Geology of Ore Deposits – Gilbert and Park
- Economic Mineral Deposits of India – S.K.Borroh
- Microfossils- Brasier
- Introduction to marine micropaleontology-Haq, B. U. and Boersma, A

Paper XII (GEOLP 12) Practical- 5 Credits (Teaching 10 hours per week and minimum 120 teaching hours). F. M. – 70 (Sessional – 30)

1. Megascopic identification of important ores and industrial minerals
2. Ore Microscopic study of important ores
3. Hydrological properties of important rocks.
4. Study of groundwater basins of India.
5. Measurement of electrical resistivity of the given data and its interpretation

6. Study of toposheet
7. 7. Computation of ground water development and radius of influence of given data.

FOURTH SEMESTER

Discipline Specific Elective (DSE) papers: The students may opt any one group of elective papers from the following:

A. Micropalaeontology (MP)

Paper-XIII (GEOL MPE-13) Time -3 hours; F. M. -70

Instructions-In all NINE questions of equal value will be set out of which an examinee shall have to answer FIVE questions. Q.N. 1 will be compulsory consisting of SEVEN very short answer type questions, each of TWO marks covering the entire syllabus.

(a). Introduction to marine micropaleontology, collection, preparation and preservation of microfossils, techniques of separation of microfossils from different types of sedimentary rocks. Biostratigraphy and biochronology, philosophy and methodology behind the establishment of a time scale, biology and evolution, classification of microfossils. (b) calcareous microfossils: (A) Foraminifera-Biology/Palaeobiology of foraminifera-systematic position, cell and its contents, dimorphism, nutrition, movement, reproduction, growth. Test morphology-wall structure, chamber shape and chamber arrangement, aperture and opening, pores, ornamentation; Biostratigraphy and evolution

(B). Ostracoda- growth and reproduction ontogeny, morphology and orientation of carapace, diaphragm, classification and geological distribution, phylogeny and geological distribution.

(C). i. Silicious microfossils- Radiolaria- biology, reproduction, nutrition, skeleton, planktonic adaptation, major morphological groups, evolution and geological history,

ii. marine diatoms- Biology, cell wall, valve structure, reproduction, ecology, major groups, paleoecology, biostratigraphy.

iii. Phosphatic microfossils: Conodonts – Altogether eight (08) questions will be asked and the examinees shall be required to answer any five questions.

Zoological affinities, composition, morphology, paleoecology, conodont stratigraphy.

Paper-XIV(GEOL MPE-14)

Time -3 hours; F. M. -70

Instructions-In all NINE questions of equal value will be set out of which an examinee shall have to answer FIVE questions. Q.N. 1 will be compulsory consisting of SEVEN very short answer type questions, each of TWO marks covering the entire syllabus.

Palaeobotany and Palynology

A. Organic-walled microfossils: palynomorphs: maceration techniques of separation of palynomorphs, preparation of permanent slides, morphology of pollen and spores, application of spore and pollen.

- B. Calcareous algae: Biology, classification, calcification, ecology and paleoecology, biogeography, geological distribution.
- C. Chitinozoa: Biological affinity, classification, morphology, application, Geological history, chitinozoa in Indian stratigraphy.
- D. Acritarchs: Biological affinity, morphology, classification, application, geological history, acritarch in Indian stratigraphy.
- E. Melanoslertes: Biological affinity, morphology, classification, geological history.

Paper-XV(GEOL MPP-15) Practical. F.M. – 70

1. Disintegration of samples, preparation of palynological slides
2. Picking and mounting of microfossils
3. Identification of important genera and species of foraminifera, ostracods, acritarchs, chitinozoa, spores and pollens, melanoslertes.
4. Preparation of range chart by given microfossils against a litholog.
5. field work

Record of laboratory work and viva voce.

Paper-XVI (GEOL MPE-16) Time -3 hours; F. M. -70

Instructions-In all NINE questions of equal value will be set out of which an examinee shall have to answer FIVE questions. Q.N. 1 will be compulsory consisting of SEVEN very short answer type questions, each of TWO marks covering the entire syllabus.

Applied Micropalaeontology

Development in micropaleontology, Ecology and palaeoecology of foraminifera palaeodepth determination, palaeotemperature estimation, palaeochemistry determination, approach to palaeogeography and palaeoclimate. Petroleum exploration- Biostratigraphy, Importance of larger foraminifera in the Tertiary stratigraphy of India. Importance of larger and smaller foraminifera in the oil exploration. Ecology and palaeoecology of ostracoda and their importance in petroleum exploration. Palaeoecology and palaeo-oceanography of radiolarian and its application. Palaeoecology of phosphatic microfossils. Chitinozoa and acritarchs in the important Lower Palaeozoic sections of the Saudi Arabia and European country – their standard biozones of Ordovician and Silurian age.

Dissertation: In lieu of **Paper-XVI (GEOL MPE-16)** the students may opt for dissertation work under the supervision of a faculty member. Students will be selected for opting dissertation on the basis of marks obtained in previous three semesters. Not more than FIVE students will be allowed under the supervision of one teacher.

F.M. - 100

Books recommended:

1. Microfossils- Braiser
2. Introduction of marine micropalaeontology: Haq, B.v and Boresma, A. 1998. Elsevier
3. Elements of micropaleontology. Bignot, g. 1985., Grahm and Trotman

4. Introduction to marine micropalaeontology: Pradeep Kundal 2003.
5. Micropaleontology-Kathal

B. Fuel Geology (FG)

Paper-XIII (GEOL FG E-13) Time -3 hours; F. M. -70

Instructions-In all NINE questions of equal value will be set out of which an examinee shall have to answer FIVE questions. Q.N. 1 will be compulsory consisting of SEVEN very short answer type questions, each of TWO marks covering the entire syllabus.

Coal Geology

Definition and origin of kerogen and coal. Rank, grade and types of coal. Chemical characterization of coal: proximate and ultimate analysis. coal petrography microscopic and macroscopic constituents, concept of macerals and microlithotypes. Application of coal petrography. Beneficiation of coal. Coal carbonization and gasification. Important methods of coal mining. Coal forming epochs in the geological past. Geological and geographical distribution of coal in India. Study of Indian coal basins and detailed geology of important coal fields of India. Estimation of reserves and grading of coal. Coal Production and problems of coal industries in India.

Paper-XIV(GEOL FG E-14)

Time -3 hours; F. M. -70

Instructions-In all NINE questions of equal value will be set out of which an examinee shall have to answer FIVE questions. Q.N. 1 will be compulsory consisting of SEVEN very short answer type questions, each of TWO marks covering the entire syllabus.

Petroleum Geology

Petroleum- its composition and different fractions. Mode occurrences of petroleum in solid, liquid and gaseous states. Surface and sub-surface occurrences. Surface indication of petroleum. Origin of petroleum. Reservoir traps- structural, stratigraphic and combination traps. Migration and accumulation of oil and gas. Oil field water. prospecting for oil and gas. Drilling and logging procedures. Oil bearing basins of India- onshore and offshore. Geological and geographical distribution of petroleum in India. Geology of important productive oil fields of India. Present and future scenario of petroleum in India.

Paper-XV (GEOL FGP-15) Practical. F.M. - 70

1. Macroscopic characterization of banded coals.
2. Completion of outcrop in the given map.
3. Preparation of lithologs using borehole data.
4. Calculation of coal reserves.
5. Microscopic examination of polished coal samples.
6. Proximate analysis of coal.

7. Study of oil basins of India.
8. Study of uranium and thorium bearing geological sections of the country.
9. Macroscopic examination of uranium and thorium bearing minerals and rocks.
10. field work
11. record of laboratory work and viva-voce

Paper-XVI (GEOL FGE-16) Time -3 hours; F. M. -70

Instructions-In all NINE questions of equal value will be set out of which an examinee shall have to answer FIVE questions. Q.N. 1 will be compulsory consisting of SEVEN very short answer type questions, each of TWO marks covering the entire syllabus.

Nuclear and Non-conventional energy resources

concept of atomic energy, mode of occurrence and association of atomic minerals in nature. Methods of exploration for atomic atomic minerals. Productive geological horizons of atomic minerals in India. Nuclear power stations of the country and future prospects. Atomic fuels and environment. Nuclear waste disposal. Geological aspects of Non-conventional energy resources-solar, wind, tidal, water, geothermal and biomass. Basic of coal bed methane. Shale gas and gas hydrates.

Dissertation: In lieu of **Paper-XVI (GEOL FGE-16)** the students may opt for dissertation work under the supervision of a faculty member. Students will be selected for opting dissertation on the basis of marks obtained in previous three semesters. Not more than FIVE students will be allowed under the supervision of one teacher. **F. M. - 100**

Books

- . Geology of coal and Indian Coal fields-N L Sharma and K S B Ram
- . Staca's textbook of Coal petrology-E. Stach and other
- . Organic petrology-G S Tayolar and others
- . Coal – Francis
- . Coal –D W vanKrevelen
- . Geology of Petroleum- Levenson
- . Petroleum Geology- F North
- . Coal and coal bed methane-Gayer and Harris
- . Coal resources of India, Memoir GSI
- Mineral and nuclear fuels of the Indian subcontinents and Burma-Brown and Dey

C. Hydrogeology (HG)

. **Paper-XIII (GEOL HGE-13) Time -3 hours; F. M. -70**

Instructions-In all NINE questions of equal value will be set out of which an examinee shall have to answer FIVE questions. Q.N. 1 will be compulsory consisting of SEVEN very short answer type questions, each of TWO marks covering the entire syllabus.

Origin, occurrence and distribution of water

Origin of water: meteoric, juvenile, magmatic and sea waters. Hydrogeological cycle precipitation, runoff, infiltration and evapotranspiration. Hydrographs. Subsurface movement and vertical distribution of groundwater. Springs and their types. Aquifers and their types. Concept of drainage basin and groundwater basin. Hydrological properties of rocks- porosity, permeability, hydraulic conductivity, transmissivity, storage co-efficient. Water table fluctuation – causative factors, concept of barometric and tidal efficiencies. Water table contour maps. Classification of rocks with respect to their water bearing characteristics. Hydrostratigraphic units. Groundwater provinces of India. Hydrogeology of arid zones and wet land of India.

Well Hydraulics and well design

Theory of groundwater flow, Darcy's law and its applications. Types of well, drilling methods, construction design, development and maintenance of wells. Specific capacity and its determination. Unconfined, confined, steady, unsteady and radial flow conditions. Pump test methods. Data analysis and interpretation of hydrogeological data. Evaluation of aquifer parameters using Theis, Jacob and Walton methods.

Paper-XIV(GEOL HGE-14)

Time -3 hours; F. M. -70

Instructions-In all NINE questions of equal value will be set out of which an examinee shall have to answer FIVE questions. Q.N. 1 will be compulsory consisting of SEVEN very short answer type questions, each of TWO marks covering the entire syllabus.

Groundwater chemistry

Groundwater quality-physical chemistry of water. Quality criteria for different uses , graphical representation of water quality data. Groundwater quality in different provinces of india-problems of arsenic and fluoridies. Saline water intrusion in coastal and contamination.

Groundwater exploration

Geological, lithological and structural mapping, fracture analysis. Aquifer characterization.

Location of springs. Surface and sub-surface geophysical methods of groundwater prospecting. Groundwater prospecting using remote sensing techniques.

Paper-XV (GEOL HGP-15) Practical. F.M. - 70

1. Study of hydrological properties of soil and rock samples.
2. Location of groundwater bearing geological formations in an outline map of india.
3. Determination of porosity of soil and rock samples.
4. Determination of hydraulic conductivity of soil and rocks samples.
5. Preparation of water table maps and their interpretations.
6. Interpretation of topographic and aerial photographs and satellites images for groundwater location.
7. Plotting of analytical data of groundwater on Piper –Trilinear and US salinity diagrams for quality assessment

8. pH determination of water samples.
9. Field work
10. Record of laboratory work and viva –voce.

Paper-XVI (GEOL HGE-16)

Time -3 hours; F. M. -70

Instructions-In all NINE questions of equal value will be set out of which an examinee shall have to answer FIVE questions. Q. N. 1 will be compulsory consisting of SEVEN very short answer type questions, each of TWO marks covering the entire syllabus.

.Ground water problems and management:

Ground water problems related to foundation work, mining, canals and tunnels.

Problems of overexploitation of ground water, decline of water table – its causes and remedies, ground water development in urban areas and rain water harvesting, artificial recharge methods, ground water problems in arid regions and remedial measures. ground water balance and methods of estimations. Mine water –its potentiality and utility, Ground water legislation, sustainability criteria and managing renewable and non renewable ground water resources, surface and ground water pollution –nature and anthropogenic causes.

Books Dissertation: In lieu of **Paper-XVI (GEOL HGE-16)** the students may opt for dissertation work under the supervision of a faculty member. Students will be selected for opting dissertation on the basis of marks obtained in previous three semesters. Not more than FIVE students will be allowed under the supervision of one teacher. F. M. - 100

- Groundwater hydrology – D.K. Todd
- Applied Hydrogeology -- C.W.Fetter
- Groundwater – H.M.Raghunath
- Groundwater Assessment – Development and Management – K.R.Karanth