M.Sc. (Honours) in Geology
Under the Framework of Honours School System
2019-20
PREAMBLE

The Centre of Advanced Study in Geology was established in the Panjab University in 1958. The Centre was soon recognized for its contribution by the University Grant Commission (UGC), which raised its status to that of the Centre of Advanced Study (CAS) in Palaeontology and Himalayan Geology in the year 1963. The Centre has continued to get funding under SAP-CAS Programme of the UGC. The Centre has also received funding from the Department of Science and Technology, Government of India under COSSIST (1984-1989) and FIST (2002-2007) for improving the infrastructure in research and teaching.

Now the Centre has been renewed as Centre of Advanced Study under Special Assistance Programme of the UGC for a period of 5 years (1-4-2012 to 31-3-2017) in Phase-VII with the financial assistance of Rs. 148 Lacs in the following thrust areas: Palaeontology - Stratigraphy; Petrology; Hydrogeology & Environmental Geology.

The centre has received national and international honours and distinctions for seminal scientific contributions. The centre is endowed with well-equipped student-faculty interfaced laboratories, such as Scanning Electron Microscopy, Optical Microscopy, Sample Preparation Laboratory, and comfortable academic working environs. Besides, an internationally famous museum, a pride of the centre, is the mainstay for school children and lay public, where all and sundry are served hands-on activity for observing and understanding various aspects of earth sciences.

The Centre strives to maintain high standards of teaching by making its students not only aware of various geological problems, but also to study Geology as a quantitative science. The core subjects are taught at undergraduate levels, while interdisciplinary and modern courses are covered in the postgraduate level. The curriculum pertaining to B.Sc. (Honours) (3 Year course & 6 Semesters) in the subject of Geology under Honours School Framework has been upgraded as per provision of the UGC module for CHOICE BASED CREDIT SYSTEM and demand of the academic environment.
## COURSE STRUCTURE

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<td>CM2 GEO-CM2: Neotectonics and Earthquakes</td>
<td>CM5 GEO-CM5: Sedimentology</td>
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<td>CM3 GEO-CM3: Isotope Geochemistry</td>
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<td>SECM2 Geological Field Report &amp; Viva Voce</td>
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### Pattern of End-Semester question paper

The theory question paper for the end-semester examination will have nine questions, with 20 marks reserved for first question, which is compulsory. Further, the latter would comprise of 10 short answer questions, without any choice, covering the whole syllabus. The remaining 4 questions of subjective type carrying 15 marks each, are to be attempted from the 4 Units. Each unit would comprise of two questions.

### Pattern of Mid-Term question paper

The question paper for the mid-term examination will have two questions, each being comprised of four parts with equal marks. Five parts have to be attempted, selecting at least two parts from each question.
M.Sc. (Hons.) Course in
Geology
I YEAR
Semester I and II
## Paper I: MICROPALAEONTOLOGY - (Course No. GEO-CM1)

**Total Marks: [100 (Mid-Semester Test M.M. 20, End-Semester Exam. M.M. 80)]**

**Total Lectures: 60**

**Credits: 4**

*Objective: Microfossils are one of the most significant proxy indicators for studying biostratigraphy, paleoclimate and are also extensively used in paleoenvironmental and climate change studies. This course addresses instrumental techniques and advanced applications of microfossils for petroleum and palaeoclimatic interpretations.*

### UNIT 1: Amoeboid Protists and Calcareous Nannofossils

Foraminifera: Detailed morphology, classification of foraminifera including planktic and benthic Foraminifera. Benthic foraminifera as indicators of environmental change. Geological applications of foraminifera, ecology and geological history.

Calcareous nannofossils: Outline of morphology. Application in biostratigraphy; Calcareous nannofossils and paleoclimate.
UNIT 2: Crustaceans, Pelagic Sea Snails and Algae

Ostracoda: Outline of morphology and classification. Ecology and environmental applications of Ostracoda including ancient and modern continental environments.
Pteropods and Calcareous Algae: Brief Introduction of each group and their applications.

UNIT 3: Siliceous Microfossils

Radiolaria: Outline of morphology. Classification and its applications.
Palynology: Outline of morphology and classification of pollens and spores and charophyta.
Environmental application of pollen and spores.

UNIT 4: Phosphatic and Organic Walled Microfossils

Brief Study of the phosphatic microfossils like Conodonts: Outline of morphology, classification, ecology, geological history, distribution and its applications.
Study of organic walled microfossils Dianoflagellates like morphology, ecology and classification.
Techniques in micropaleontology, principles and applications of SEM, EDX, and Cathodoluminescence.

SUGGESTED READING


Paper II: NEOTECTONICS AND EARTHQUAKES - (Course No. GEO-CM2)

Total Marks: [100 (Mid-Semester Test M.M. 20, End-Semester Exam. M.M. 80)]

Total Lectures: 60 Credits: 4

Objective: This course intends to impart concepts of plate geometry and associated tectonic processes. The objective of the course is to introduce the concept of neotectonics and its affects on landscape evolution. The geology of faults, earthquake occurrence and the problem of earthquake prediction are discussed.
UNIT 1: Plate Tectonics

Plate Tectonics: accreting plate boundary, subduction, transform faults, thrust and fold hotspots and mantle plumes; palaeomagnetism and motion of plates, driving mechanism, geodynamics and heat transfer. Dynamic evolution of continental and oceanic crust.

UNIT 2: Orogenic Belts

Tectonics of Precambrian orogenic belts of India. Formation of mountain roots. Anatomy of orogenic belts. Introduction to the Himalayan tectonics; longitudinal, transverse and out of sequence faults; Rate of deformation in the Himalaya – Quaternary, Holocene and GPS based rates; Tectonic deformation and seismicity in the Himalaya, Indo-Gangetic Plains & Peninsular India. Tectonic geomorphology of mountains (landscape response to isostatic and tectonic uplift, terraces, mountain front: escarpments, fault segmentation, mountain front sinuosity, scarp morphological changes with time).

UNIT 3: Neotectonics

Introduction to neotectonics and active tectonics; Mountain building process; Thrust and fold belts; Active faults: concepts, methods and case studies; Geomorphic markers of tectonic deformation; Active tectonics and alluvial rivers; Tectonics and erosion; Tectonic-climate interaction; Landscape response to active tectonics; GPS geodesy and its applications to lithospheric deformation, Rate of deformation and seismicity; Introduction to paleoseismology; Seismic hazard zonation at regional and local scale.

UNIT 4: Faults and Earthquakes


SUGGESTED READING

Objective: The prime aim of this course is to provide detailed insights into the principles, methodology and applications of important radiogenic-stable- and cosmogenic-isotope dating techniques. This forms the basis to trace the source(s) of magmas and to date various tectonothermal events.

UNIT 1: Nuclear Systematics

Introduction, nuclear stability, atomic mass and binding energy; radioactive decay mechanisms; the law of radioactive decay; review of mineral structure; principles of mass spectrometry; Rb-Sr method: principles, isotopic evolution of Sr, Rb-Sr isochron and limitations.

UNIT 2: Radiogenic Isotope Geochronometers-I

K-Ar method: principles, methods and applications; Concept of closure temperatures and cooling ages; Ar-Ar method: principles, method and advantages: Sm-Nd Method: decay scheme, evolution of Nd with time, Nd model ages and application of Nd to petrogenesis;

UNIT 3: Radiogenic Isotope Geochronometers-II

U-Th-Pb Method: decay schemes, isochron; U-Pb zircon dating, methodology and application; Lu-Hf method: decay scheme, isochron and application; Zircon as evolutionary tracer.

UNIT 4: Radiogenic, Cosmogenic and Stable Isotopes

Common Pb-Pb method and its applications; Principles and application of Re-Os, K-Ca, Fission Track and Radiocarbon methods of dating; stable isotopes and their fractionation; ratio Mass Spectrometry; principles of oxygen, carbon and sulphur isotope geochemistry.

SUGGESTED READING


Practical I: MICROPALAEONTOLOGY - (Course No. GEO-CM1P)

Total Marks: [50 (Continuous Assessment M.M. 10, End-Semester Exam. M.M. 40)]

Total Lectures: 60 Credits: 2

1. Palaeoenvironments of assorted specimens.
2. Detailed study of palaeoecology and functional morphology of various microfossils.
3. SEM: Sample preparation and Au sputtering, imaging and microphotography.
4. Techniques in micropalaeontology (separation of micro fossils from matrix).
5. Morphotaxonomical study of common planktonic, larger and smaller foraminiferial taxa.
M.Sc. (Hons.) Geology

6. Study of important planktic foraminifera useful in biostratigraphy.
7. Identification of benthic foraminifera characteristic of various deep sea environment.
8. Morphological study of common calcareous nanofossils, ostracods, radiolarians, diatoms, conodonts, pollens and charophyta.
9. Detailed palaeoenvironmental and biostratigraphical studies of ostacoda and charophytes.

Practical II: NEOTECTONICS AND EARTHQUAKES - (Course No. GEO-CM2P)

Total Marks: [50 (Continuous Assessment M.M. 10, End-Semester Exam. M.M. 40)]

Total Lectures: 60 Credits: 2

1. Focal mechanism solutions.
2. Plate tectonics problems two-piece jigsaw puzzle.
3. Problems related to faults and scarps.
5. Techniques for estimation of earthquake magnitude.

Practical III: ISOTOPE GEOCHEMISTRY - (Course No. GEO-CM3P)

Total Marks: [50 (Continuous Assessment M.M. 10, End-Semester Exam. M.M. 40)]

Total Lectures: 60 Credits: 2

1. Calculation of atomic weight of elements.
2. Calculation and plotting of binding energy and neutron/proton ratios of various isotopes.
3. Problems related to radioactive decay of nuclides.
4. Determination of K-Ar, Rb-Sr and Sm-Nd ages.
5. Initial ratios and plotting of isochrons using Rb-Sr and Sm-Nd isotope data.

Skill Enhancement Course: GEOLOGICAL FIELD WORK - (Course No. GEO-SECM1)

Total Marks: 50 Credits: 2

Geological field Work: The duration of field work would be eight days (two credits). The field work would consist of independent geological mapping, study of regional geology including the study of rocks/minerals/fossils of geologically important areas. It is mandatory for the student to maintain a systematic field diary and collect good geological samples. The marks for field work will be awarded by teachers who conducted the field work.

A candidate, who does not attend the field work or fails to get pass marks in it, will have to do the field work by joining the field tour of the same class (M.Sc. Hons. I Year) in a subsequent year as per University rules. There will not be any grace marks for this paper.
II Semester Examination

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Total Credits & Marks: 20 500

Paper I: VERTEBRATE DIVERSITY AND EVOLUTION - (Course No. GEO-CM4)

Total Marks: [100 (Mid-Semester Test M.M. 20, End-Semester Exam. M.M. 80)]

Total Lectures: 60 Credits: 4

Objective: This course covers the evolution of vertebrates from basal fishes to hominids. The main objective of the course is to impart knowledge on diversity, evolution, and interrelationships among vertebrates. It is also aimed at providing insights into current debates on vertebrate palaeobiology and geological and biological processes responsible for vertebrate evolution.

UNIT 1: Early vertebrates: Fish and Early Tetrapods

Vertebrate body plan; ancestry of vertebrates, early body plans with external armor; major steps in vertebrate evolution, Devonian diversity of fishes; evolution of jaws, teeth, internal skeleton, evolution of limbs and lungs and invasion of land. Palaeozoic fish revolution.
UNIT 2: Reptiles, Birds, Dinosaurs and Early Mammals

Development of amniote egg and dominance of land by reptiles; late Palaeozoic environments; vertebrate response to Permo-Triassic mass extinction; rise and fall of mammal-like reptiles; emergence of dinosaurs, conquering of land, air and sea by reptiles; origin of mammals and diversification of monotremes, marsupials and placentals; ancestry of birds nested in feathered dinosaurs; Cretaceous-Palaeogene boundary mass extinction.

UNIT 3: The Rise of Mammals

Palaeogene hyperthermal events and emergence of modern mammalian orders; expansion of grasslands and co-evolution of grazing mammals, evolution of horses and proboscideans; back to water - whale evolution representing transition from terrestrial to aquatic life; Early Palaeogene vertebrate fauna of India. Shrinking forests and expanding grasslands; Siwalik Fauna; emergence of hominids; Pleistocene megafaunal extinctions.

UNIT 4: Vertebrate Palaeobiogeography and Phylogenetics

Evolution of vertebrates during India’s journey from Gondwanaland to Asia - Gondwana vertebrates; Vertebrate fauna of Deccan Volcanic Province and other Cretaceous formations. Vicariance, dispersals and geodispersals; Role of plate tectonics in disjunct distribution of mammals; molecular versus morphology based phylogenies for mammalian origin and dispersals.

SUGGESTED READING


Paper II: SEDIMENTOLOGY - (Course No. GEO-CM5)

Total Marks: [100 (Mid-Semester Test M.M. 20, End-Semester Exam. M.M. 80)]

Total Lectures: 60 Credits: 4

Objective: Major objective of the course is to teach students the concepts, fundamentals and applications of Sedimentary Geology discipline of Earth Sciences in the light of recent advances in this discipline as well as its role and significance in geosciences. Also, a full unit of this course will cover significance of sedimentary rocks to science and society because sedimentary rocks serve analogue of ancient civilization as well as are indispensible storehouse of basic necessities of modern civilization.

UNIT 1: Sediments and Sedimentary Rocks

Sediments ranging from detrital to chemical including volcaniclastic and extraterrestrial sediments; Sediment generating surface processes and products, processes of sediment transport, syn- and post-depositional sedimentary processes; Maturity and stability of sediments; Genesis and composition of elastic and non-elastic sedimentary rocks.
UNIT 2: Sedimentary tools, techniques and methodology

Bedforms and Sedimentary structures; Grain size analysis; Palaeocurrent analysis; Heavy mineral studies; REE and trace element studies; Staining methods; Insoluble residue studies; Sedimentary logs; Clay mineralogy studies; Cathodoluminescence; XRD and SEM studies.

UNIT 3: Sedimentary Environments and Tectonics

Sedimentary Environments: classification including continental, marine and transitional environments; Sedimentary Facies; Sedimentary Basins: basic concepts and terminology; Plate tectonics and Sedimentation: sedimentation in divergent margins, convergent margins, transform tectonic regimes.

UNIT 4: Significance for Science and Society

Hydrocarbon energy industry: coal, oil shale and petroleum; Building and Heritage stone; Minerals, Mining and Ore industry; Provenance, Climate and Environment proxy tool.

SUGGESTED READING


Paper III: CHEMICAL PETROLOGY AND CRUSTAL EVOLUTION - (Course No. GEO-CM3)

Total Marks: [100 (Mid-Semester Test M.M. 20, End-Semester Exam. M.M. 80)]

Total Lectures: 60 Credits: 4

Objective: This course introduces chemical applications of trace elements in igneous rocks in order to interpret and understand the processes of magma crystallisation and its evolution, and to infer various tectonomagmatic settings of basaltic and granitoid rocks. This will form the basis to understand crust-mantle evolution with special emphasis on early Earth’s crustal evolution and supercontinents dynamics.
UNIT 1: Igneous Processes
Magma series; Minor elements in magmatic crystallisation; Distribution coefficients; Models for solid-melt processes; Geochemical criteria for discriminating between tectonic environments; Application of trace elements in igneous rocks.

UNIT 2: Mantle Dynamics
Petrology of the mantle; Basalt generation from mantle; primary magmas; Heterogeneous mantle; Crust-mantle evolution: Secular changes in the crust and mantle; evolution of the lithosphere.

UNIT 3: Continental Crust
Continental crust: shields and platforms, orogens; heat flow in the continents; exhumation and cratonisation; rheology, origin and composition of crust; Isotopic record of juvenile crust; continental growth.

UNIT 4: Early Earth and Supercontinents
Archaean crust: greenstone belts and granite-gneiss terrains; Earth’s oldest rocks; TTGs: petrography, classification, geochemistry and petrogenesis; Global changes at the end of the Archean; supercontinents and supercontinent cycle: assembly and dispersal of Kenorland, Columbia, Rodinia, Gondwana and Pangea.

SUGGESTED READING

Practical I: VERTEBRATE DIVERSITY AND EVOLUTION - (Course No. GEO-CM4P)
Total Marks: [50 (Continuous Assessment M.M. 10, End-Semester Exam. M.M. 40)]

Total Lectures: 60

1. Vertebrate skeletal anatomy: anatomical features of Fish, Amphibians, Reptiles, Birds and Mammals.
2. Study of early fishes, tetrapods and mammals.
3. Dental morphology and evolution of mammals.
4. Primate cranial and postcranial anatomy.
5. Vertebrate fossil preparation techniques including histology.

Practical II: SEDIMENTOLOGY - (Course No. GEO-CM5P)
Total Marks: [50 (Continuous Assessment M.M. 10, End-Semester Exam. M.M. 40)]

Total Lectures: 60

1. Megascopic and microscopic studies of various clastic and non-clastic sediments and their rocks.
2. Selective Heavy mineral thin-section studies.
3. Exercises on sedimentary logs and facies.
4. Case study (in groups) of a sedimentary rock used in societal applications.
Practical III: CHEMICAL PETROLOGY AND CRUSTAL EVOLUTION - (Course No. GEO-CM6P)

Total Marks: [50 (Continuous Assessment M.M. 10, End-Semester Exam. M.M. 40)]

Total Lectures: 60

Credits: 2

1. CIPW normative calculations.
2. Interpretation of tectonic discrimination diagrams.
3. Interpretation of trace element diagrams.
4. Petrographic studies of TTGs.
5. Distribution of oldest rocks.

Skill Enhancement Course: GEOLOGICAL FIELD REPORT & VIVA VOCE - (Course No. GEO-SECM2)

Total Marks: 50 (Field Report M.M. 25 and Viva Voce M.M. 25)

Credits: 2

Field Report & Viva-Voce: The student will prepare a well illustrated field report based on the field work conducted in the previous semester. A board of examiners will evaluate the field report and conduct the viva-voce and would consist of the Chairman or his nominee, the faculty members who conducted the field work and three other faculty members appointed by the Board of Control. Only the latter would evaluate the field report and submit the marks independently to the Chairman, and similarly, they would also award the marks of viva-voce independently. In both the cases, i.e. marks of field report and voce-voce, an average value of three, will be considered as the final marks.

A candidate, who does not submit the field report and/or does not attend the viva-voce examination or fails to get pass marks in it, will have to resubmit the report or attend the viva-voce examination as the case may be of the same class (M.Sc. Hons. I Year) in a subsequent year as per University rules. There will not be any grace marks for this paper.
Outlines of Tests, Syllabi and Courses of Reading for M.Sc. (Honours School) II Year in Geology (Semester System) 
Examination 2019-20

III Semester Examination

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**Practical**

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**Field Work**

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**Total Marks for M.Sc. (Hons. School) III Semester (Geology)**

| 500 |

*Continuous Assessment: Seminar (10 marks) and Sessional (5 marks).

**Pattern of End-Semester question paper**

The theory question paper for the end-semester examination will consist of seven questions. Each question paper will be of 80 marks, with 20 marks reserved for first question, which would be compulsory. Further, the latter would comprise of 10 short answer questions, without any choice, covering the entire syllabus. The remaining 4 questions carrying 15 marks each, shall be attempted by the students from the 2 Units, selecting two questions from each unit. Each unit would comprise of three questions.

**Pattern of Mid-Term question paper**

The question paper for the mid-term examination will have two questions, each being comprised of four parts with equal marks. Five parts have to be attempted, selecting at least two parts from each question.
Syllabi and Courses of Reading

Paper I: REMOTE SENSING-GIS & GEOMORPHOLOGY – CLIMATOLOGY (Course Nos. 901 & 902)

Total Marks: 100 (Mid-Semester Test M.M. 20, End-Semester Exam. M.M. 80)

Course No. 901: REMOTE SENSING-GIS

Objectives: This course aims to understand the basic principles and applications of remote sensing in various branches of geosciences, besides evolving decision support system using GIS.

UNIT I
Concept and principles of remote sensing; general idea about electromagnetic spectrum; aerial photography and satellites remote sensing; remote sensing sensors; remote sensing platforms and types of remote sensing; advantage of remote sensing; aerial photography, types of aerial photographs; aerial photo interpretation-tone; texture, pattern, shape, size, drainage etc. and identification of geological rock types; stereoscopes: pocket and mirror stereoscope; different satellite exploration programmes and their characteristics: LANDSAT, SPOT, IRS, etc; image interpretation techniques; applications of remote sensing data for geological and environmental studies; introduction of Geographic Information System; components of GIS; vector and raster modes; idea about various GIS softwares being used in Geology; applications and advantages of Geographic Information System.

Essential Reading

Further Readings

Course No. 902: GEOMORPHOLOGY-CLIMATOLOGY

Objectives: The main aim of this course is to understand the techniques and methodology used in geomorphic analyses, and to comprehend the applications of geomorphology in geology. The fundamental principles of climatology are highlighted based on Earth’s radiation balance and global insolation.

UNIT II
Concepts in geomorphology; geomorphic processes and landforms: fluvial glacial, eolian, coastal and karst. Structural landforms; geomorphic models of landscape evolution: ideas of Penck and Davis; morphometric analysis; pedology: classification and origin of soils; Application of geomorphology in hydrology, economic geology, engineering and environmental studies.
Fundamental principles of Climatology; earth’s radiation balance; distribution and variation in global insolation; heat and air temperature; air pressure and wind belts; atmospheric circulation; humidity; cloud formation and precipitation; water balance; air masses: distribution, classification and sources; monsoon, jet streams; tropical cyclones; ENSO; classification of climates: Koppen’s and Thornthwaite’s classification; climatic change.

**Essential Reading**


**Further Reading**


S. Chand Company Ltd., New Delhi.


**Paper II: PETROLEUM GEOLOGY & ORE GEOLOGY – (Course Nos. 903 & 904)**

**Total Marks: 100 (Mid-Semester Test M.M. 20, End-Semester Exam. M.M. 80)**

**Course No. 903: PETROLEUM GEOLOGY**

**Objectives:** This course intends to impart basic conceptual aspects of petroleum and gas, and its reservoirs through sedimentological dynamics and geophysical exploration.

**UNIT I**

Introduction, occurrence, indications and composition of petroleum and gas; origin, generation, migration and accumulation of petroleum and gas; characteristics of sandstones and carbonate reservoirs and provenance; Petroleum Traps and mechanisms; Geology of onshore and offshore petroliferous basins of India; global distribution of petroleum and gas; principles of stratigraphic classification and correlation. Hydrodynamic processes of sediment transport and depositional systems; facies maps; concepts and applications of sequence stratigraphy: boundaries, flooding surfaces, system tracts, sea level changes and basin analysis; applications of seismic stratigraphy in petroleum and gas; well logging and geophysical techniques; economics and management of reservoirs; non-conventional energy resources: coal bed methane and gas hydrates.

**Essential Reading**


Course No. 904: ORE GEOLOGY

Objectives: In this course emphasis is laid on modern concepts of ore genesis and metallogeny along with mineral economics.

UNIT II

Modern concepts of ore genesis; global metallogeny as related to crustal evolution in space and time; ore deposits and plate tectonics; fluid inclusions and their significance in ore geology; mineral deposits associated with igneous (ultramafic, mafic, alkaline, felsic, mafic-felsic), sedimentary (clastic, chemical, biochemical), metamorphic (contact and regional) rocks vis-à-vis India and world classic examples; some typical mineral deposits of the world such as: residual, supergene enriched, black smokers, Mn nodules, porphyry deposits.

Resources and reserves, and their classification; strategic, critical and essential minerals; India’s status in mineral production; changing patterns of mineral consumption; importance of minerals in national economy; National Mineral Policy; Mineral Concession Rules; marine mineral resources and Law of Sea.

Essential Reading


Further Reading

Paper III: ISOTOPE GEOLOGY & ENGINEERING GEOLOGY - (Course Nos. 905 & 906)
Total Marks: 100 (Mid-Semester Test M.M. 20, End-Semester Exam. M.M. 80)

Course No. 905: ISOTOPE GEOLOGY

Objectives: The prime aim of this course is to provide detailed insights into the principles, methodology and applications of important radiogenic-stable- and cosmogenic-isotope dating technique.

UNIT I
Introduction and physics of the nucleus; radioactive decay; the law of radioactive decay; review of mineral structure; principles of mass spectrometry; K-Ar method: principles, methods and applications; Ar-Ar method: principles, method and advantages; Rb-Sr method: principles, Rb-Sr isochron and limitations. Sm-Nd Method: decay scheme, evolution of Nd with time, Nd model ages and application of Nd to petrogenesis; U-Th-Pb Method: decay schemes, U-Pb isochron, U-Pb mineral dating and application; principles and application of Fission Track and Radiocarbon methods of dating; stable isotopes and their fractionation; ratio Mass Spectrometry; principles of oxygen, carbon and sulphur isotope geochemistry.

Essential Reading

Further Reading

Course No. 906: ENGINEERING GEOLOGY

Objectives: The main aim of this course is to understand the engineering properties of rocks and application of geology to various engineering projects.

UNIT II
Mechanical properties of rocks and soils; types of foundations; Geological consideration relative to building stones and road materials; Geological investigations for river valley projects; dams and reservoirs; tunnels: types, methods and problems; bridges: types and foundation problems; landslides: classification, causes, prevention and rehabilitation; geotechnical case studies of major projects in India, viz. Bhakra Nangal project, Nagarjunsagar project, Andhra Pradesh & others.

Essential Reading
Further Reading


Practical I: REMOTE SENSING-GIS, GEOMORPHOLOGY- CLIMATOLOGY & ORE GEOLOGY (Course No. 907P)

Total Marks: 75 (Continuous Assessment M.M. 15, End-Semester Exam. M.M. 60)


Geomorphology-Climatology: Morphometric analyses of drainage; morphometric analyses using GIS software; distribution of climatic parameters; wind and rainfall variation.

Ore Geology: Maps of major and important mineral and metallic deposits of world and India; megascopic study of metallic ores – sulphides, oxides and silicates of copper, iron, aluminium, zinc, lead, tin, tungsten, chromium, nickel, manganese and molybdenum.

Practical-II PETROLEUM GEOLOGY, ISOTOPE GEOLOGY & ENGINEERING GEOLOGY (Course No. 908P)

Total Marks: 75 (Continuous Assessment M.M. 15, End-Semester Exam. M.M. 60)

Petroleum Geology: Magascopic and microscopic study of cores and well cuttings. Study of geological maps and sections of important oilfields of India and world. Study of larger benthic foraminifers useful in petroliferous basins in India. Study of sedimentary rocks, their facies and depositional characteristics. Study of sedimentary structures in context of their palaeoenvironments. Exercises on sequence stratigraphic frameworks. Calculation of oil reserves.

Isotope Geology: Calculation of atomic weight of elements; Calculation and plotting of binding energy and neutron/proton ratios of various isotopes; problems related to radioactive decay of nuclides; determination of K-Ar ages; Rb-Sr and Sm-Nd, ages, initial ratios and plotting of isochrons using Rb-Sr and Sm-Nd isotope data.

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

PROJECT ORIENTED GEOLOGICAL FIELD WORK - (Course No. 909FW)

Total Marks: 50

Each candidate will carry out an independent field study, which should include sampling and recording of field observations/data. The marks for Field Work will be awarded by teacher(s) who conduct the field work.
A candidate who does not attend field work or fails to get pass marks in it will have to do the field work by joining the field tour of the same class M.Sc. (H.S.) 2nd Year in a subsequent year as per university rule.
### IV Semester Examination

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**Total Marks for M.Sc. (Hons. School) IV Semester (Geology)**: 500

* Continuous Assessment: Seminar (10 marks) and Sessional (5 marks).

### Pattern of End-Semester question paper

The theory question paper for the end-semester examination will consist of seven questions. Each question paper will be of 80 marks, with 20 marks reserved for first question, which would be compulsory. Further, the latter would comprise of 10 short answer questions, without any choice, covering the entire syllabus. The remaining 4 questions carrying 15 marks each, shall be attempted by the students from the 2 Units, selecting two questions from each unit. Each unit would comprise of three questions.

### Pattern of Mid-Term question paper

The question paper for the mid-term examination will have two questions, each being comprised of four parts with equal marks. Five parts have to be attempted, selecting at least two parts from each question.
Paper I: PETROLEUM GEOCHEMISTRY & EXPLORATION GEOPHYSICS -
(Course Nos. 1001 & 1002)

Total Marks: 100 (Mid-Semester Test M.M. 20, End-Semester Exam. M.M. 80)

Course No. 1001: PETROLEUM GEOCHEMISTRY

Objectives: This course aims to understand various techniques in petroleum geochemistry with special emphasis on geochemical exploration.

UNIT I

Application of petroleum geochemistry to exploration and reservoir management; source rocks relation with kerogen and related hydrocarbon types; geochemical techniques of source rock evaluation; pyrolyzer and pyrolysis results; hydrogen and oxygen indices in hydrocarbons; vitrinite reflectance, thermal alteration & conodont alteration index and associated hydrocarbons and fixed carbon values analyses; gas chromatography of drill cuttings and evaluation of gases composition; biomarker analysis for reservoir and source rock evaluation; reservoir geochemical processes and application; petroleum geochemical proxies for reservoir management during exploration to production phase; extraction of core samples; recovery of hydrocarbons and polar non-hydrocarbons by soil phase extraction; mass spectrometry and its use in exploration and development of reservoir; linkages between geochemical proxies and petrophysics of reservoir rocks.

Essential Reading


Further Reading


Course No. 1002: EXPLORATION GEOPHYSICS

Objectives: The major objective of this course is to comprehend Geophysical Exploration methods used for mineral, water and oil exploration.

UNIT II

Introduction to geophysics; shape and size of earth; gravitational field of the earth; variation of gravity on the earth surface; principles of gravity methods and instrument used; gravity field surveys; corrections applied to gravity data; The Bouguer anomaly; regional and residual anomalies; gravity anomaly maps and their interpretation; geomagnetic field of the earth; magnetic properties of rocks; principles of magnetic methods; instruments of magnetic surveying; fluxgate magnetometer, proton-precision magnetometer, alkali vapour magnetometer; field surveys and data reductions; aeromagnetic surveys; electrical methods: basic principles and various types of electrode configuration; electrical surveying, self potential and resistively surveying; field procedures; profiling and sounding; seismic methods: principles and instruments used; seismic velocity and interpretation of seismic data; seismic reflection and refraction methods; application in mineral and petroleum exploration; description of borehole environment; brief outline of various well logging techniques: self potential and resistivity logs, radioactive logs, induction logs, caliper logs, sonic logs, borehole video; well logging applications in petroleum, groundwater and mineral exploration.
Paper II: HYDROGEOLOGY & ENVIRONMENTAL GEOLOGY- (Course Nos.1003 & 1004)

Total Marks: 100 (Mid-Semester Test M.M. 20, End-Semester Exam. M.M. 80)

Course No.1003: HYDROGEOLOGY

Objectives: The main emphasis of this course is on the principles of occurrence, movement development and management of groundwater resources.

UNIT I

Groundwater Exploration and Water Well Construction: Geologic and hydrogeologic methods of exploration; Role of remote sensing in groundwater exploration; Surface geophysical methods — seismic, gravity, geoelectrical and magnetic methods; Types of water wells and methods of construction; Design, development, and maintenance of wells; Sub-surface geophysical methods; Yield characteristics of wells; Pumping tests- methods, data analysis and interpretation.

Groundwater Quality: Physical and chemical properties of water; Quality criteria for different uses; Graphical presentation of groundwater quality data; Groundwater quality in different provinces in India; Groundwater contamination; natural (geogenic) and anthropogenic contaminants; Saline water intrusion; Radio-isotopes in hydrogeological studies.

Groundwater Development and Management: Assessment of Groundwater resources- Dynamic and Static resources; Concept of sustainable development of groundwater resources; Groundwater management — supply side and demand side management; Artificial Recharge of Ground Water- Concept of artificial recharge — recharge methods, relative merits, Applications of Remote Sensing in Artificial Recharge of Ground water; Conjunctive use of surface and groundwater; Groundwater legislation.

Essential Reading


Further Reading

Course No. 1004: ENVIRONMENTAL GEOLOGY

Objectives: The main objective of this course is to understand the role of geological processes on environment, and comprehend the impact of geology on natural resources.

UNIT II
Fundamental concepts of Environmental Geology; natural ecosystems on the Earth and their natural inter relations and inter actions (Atmosphere, Hydrosphere, Lithosphere and Biosphere); natural hazards: landslides, floods, earthquakes, volcanoes, water logging, pollution, their source, types and movement in air, soil, water and rocks, pollution of rivers, takes and groundwater and remedial measures; environmental aspects of natural resource development; water resources, mineral resources, soil resources, fossil fuels; environmental issues related to silting of dams, reservoirs, lakes and remedial measures; watershed management, concept of small dams waste disposal practices and management; environment management: impact assessment of degradation and contamination of surface water and groundwater quality due to industrialization and urbanization; disaster management preparation of EIA.

Essential Reading

Further Reading

Practical I: PETROLEUM GEOCHEMISTRY & EXPLORATION GEOPHYSICS - (Course No. 1005P)
Total Marks: 75 (Continuous Assessment M.M. 15, End-Semester Exam. M.M. 60)

Petroleum Geochemistry: Determine the Hydrogen Index (HI), Oxygen Index (OI) and Production Index (PI) from Rock Eval Data. Determine the kerogen quality and nature of immature source rock by analyzing HI and OI from the given data and after plotting the data on Van Krevlen diagram.

Exploration Geophysics: Interpretation of bore hole logs. Interpretation of seismic and resistivity data. Study of gravity data maps and their interpretation.

Practical-II: Hydrogeology & Environmental Geology (1006P)
Total Marks: 75 (Continuous Assessment M.M. 15, End-Semester Exam. M.M. 60)

Hydrogeology: Water level trend analysis; Groundwater resource estimation- rainfall infiltration and fluctuation methods, Groundwater draft estimation and estimation of Stage of groundwater development. Delineation of aquifer- analysis of drilling cutting, litholog plotting and potential zone demarcation; Pumping test data analysis, hydrochemical maps and facies diagrams.

PROJECT ORIENTED REPORT - (Course No. 1007FW)


Each candidate will submit a project-oriented geological field report based on his/her own field and laboratory work:

It will have three components:
(a) Field observations/data recorded by the candidate,
(b) Laboratory investigation carried out by the candidate, and
(c) Synthesis of (a) and (b).

The marks of laboratory work will be awarded by the teacher(s) who supervised the laboratory investigations. A board of examiners will evaluate the field report, and would consist of the three faculty members appointed by the B.O.C. The latter would evaluate the field report and submit the marks independently to the Chairman. An average value of these marks will be considered as the final marks.

The students will also make a presentation of their project report/work (minimum time: 15 minutes) as a part of defense of their work conducted. The viva-voce examination will be conducted after the presentation. The board of examiners would award the marks of presentation and viva-voce independently. In both the cases, i.e. marks of presentation and viva-voce, an average value will be considered as the final marks.

A candidate who does not submit the field report or fails to get pass marks in it will appear again in viva-voce examination of the same class M.Sc.(H.S.) II Year in a subsequent year as per university rule.