

MAHARSHI DAYANAND SARASWATI UNIVERSITY, AJMER



पाठ्यक्रम
SYLLABUS

SCHEME OF EXAMINATION AND COURSES OF STUDY

FACULTY OF SCIENCE

M.Sc. Geology (Earth Science)

M.Sc. (Semester I & II)

(w.e.f. 2015-16)

M.Sc. (Semester III & IV)

(w.e.f. 2016-17)

महर्षि दयानन्द सरस्वती विश्वविद्यालय, अजमेर

NOTICE

1. Change in Statutes/Ordinances/Rules/Regulations Syllabus and Books may, from time to time, be made by amendment or remaking and candidates shall, in so far as the University determines otherwise comply with any change that applies to years he has not completed at the time of change. The decision taken by the Academic Council shall be final.

1. समय-समय पर संशोधन वा पुनः निर्माण कर परिणियमों/ अध्यादेशों/नियमों / विनियमों / पाठ्यक्रमों व पुस्तकों में परिवर्तन किया जा सकता है, तथा किसी भी परिवर्तन को छात्र को मानना होगा कि विश्वविद्यालय ने अन्यथा प्रकार से उनको छूट नहीं दे और छात्र ने उस परिवर्तन के पूर्व वर्ष पाठ्यक्रम को पूरा न किया हो, विश्वा परिषद द्वारा लिये गये निर्णय अंतिम होंगे।

M.Sc. GEOLOGY (EARTH SCIENCE)

Scheme of examination and courses of study :

1. Candidates for admission of the master of science M. Sc Geology (Earth science) degree shall be required have pass B.S c. degree with geology as one subject. Students without geology shall be admitted but their marks shall be reduced by 5% in B.Sc.
2. Admission will be given on the basis of merit. The merit will be drawn on aggregate marks received in the qualifying examination by the candidate.
3. The duration of the course is for two academic years (four semesters). The course work of the M.Sc. degree in geology (earth science) shall be in accordance with the scheme of examination and syllabus prescribed.
4. The minimum attendance required by a candidate will be as per university rules.
5. A candidate for a pass at each of the part I and part II examination shall be required to obtain:
 - a. At least 36% marks in aggregate of the papers prescribed for the examination and
 - b. At least 36% marks in practical(s).
6. Wherever prescribed at the examination, provided that a candidate fails to secure at least 25% marks in each individual theory paper at the examination he/she shall be deemed to have failed at the examination notwithstanding having obtained the minimum percentage of marks required in the aggregate for the examination.
7. No division shall be awarded for the first three semester examinations. Division shall be awarded at the end of the fourth semester examination and combined marks obtained after four semester examination taken together as noted below :

First division	60% of aggregate of above marks taken together.
Second division	48% of aggregate of above marks taken together.

All the rest will be declared to have passed the examination.
8. There will be four theory papers in each semester of 50 marks each.
9. An education tour may be organized both for M.Sc. sem I & II and M.Sc. III & IV to important places of geological interest within or outside the state under the supervision of faculty member/s of the department. The expenses will be borne by the participating student however, the college/ university will provide train/ bus travel, concession as per necessity and rules. Travelling expenses of the teacher/s will be borne by the employers as per rules of TA and DA.

**Program of study and examination scheme
M.Sc. PREVIOUS GEOLOGY (EARTH SCIENCE)**

SEMESTER - I		Max. Marks	Hours of instruction per week
Paper I	Geodynamics	50	5 Hours
Paper II	Structural geology	50	5 hours
Paper III	Geomorphology	50	5 hours
Paper IV	Mineralogy and geochemistry	50	5 hours
Practical I	Structural geology	50	5 hours
Practical II	Mineralogy and geomorphology	50	5 hours
SEMESTER - II			
Paper I	Igneous and metamorphic petrology	50	5 hours
Paper II	Sedimentology	50	5 hours
Paper III	Stratigraphy of India	50	5 hours
Paper IV	Palaeobiology	50	5 hours
Practical I	Petrology	50	5 hours
Practical II	Palaeobiology and Stratigraphy of India	50	5 hours

M.Sc. FINAL GEOLOGY (EARTH SCIENCE)

SEMESTER - III			
Paper I	Photogeology and remote sensing	50	5 hours
Paper II	Engineering geology	50	5 hours
Paper III	Ore geology	50	5 hours
Paper IV	Mineral exploration	50	5 hours
Practical I	Photogeology and engineering geology	50	5 hours
Practical II	Ore geology and exploration	50	5 hours
SEMESTER - IV			
Paper I	Fuel geology	50	5 hours
Paper II	Mining and mineral dressing	50	5 hours
Paper III	Hydrogeology	50	5 hours
Paper IV	(Optional -I) Environmental geology	50	5 hours
Paper IV	(Optional -II) Advanced remote sensing And GIS	50	5 hours
Paper IV	(Optional -III) Computer application In geology	50	5 hours
Practical I	Mining and fuel geology	50	5 hours
Practical II	Hydrogeology+ optional paper 50	50	5 hours

M.D.S.U. Syllabus / M Sc Geology / 05.

SEMESTER : FIRST. PAPER TITLE FIRST: Geodynamics

Duration: 3Hrs

MM 50

- UNIT -1** Earth's surface features. Seismology: waves, intensity and isoseismic lines. earthquake belts, earthquake zones of India, seismograph, causes of earthquake. Internal structure of the earth. Crust: Composition, seismic, gravity and magnetic characters. Crustal types: shields. Platforms, mountain chains, rift valleys, mid-oceanic ridges, trenches, island arcs and ocean basins.
- UNIT-2** Volcanism :types and causes of volcanic eruptions. World distribution of volcanoes. Migration of volcanoes. Palaeo- magnetism.
- UNIT-3** Isostasy : Development of the concept, isostatic anomalies, isostatic models, evidences.
- Geosynclines: classification and evolution of geosynclines, causes of subsidence and upliftment.**
- UNIT-4** Continental drift: Development of the concept, Taylor's and Wegner's theories of continental drift. Evidences of continental drift and polar wandering: Sea floor spreading. Morphological features of ocean floor.
- UNIT-5** Concept of plate tectonics: types of plate boundaries. Features of convergent and divergent boundaries. Ophiolite suites, Arch-trench system, volcanic mountain chains. Triple junction and their stability, causes of plate motion. Origin of Himalayas.

References:

- Holms, Doris and Arthur: Holme's Principles of Physical Geology. Wiley
- Wyllie, Peter J: The dynamic Earth. Wiley
- Wyllie, Peter J: The way the Earth works. Wiley
- Hodgson, J H: Earthquake and Earth's structures. Prentice Hall.
- Martin H P Bott : The interior of the Earth. Edward Arnold.
- Condie K C : Plate tectonics and crustal evolution.
- Strahler: Earth sciences.
- Gutenberg Beno: Internal constitution of the Earth. Dover.

SEMESTER : FIRST

PAPER TITLE SECOND: STRUCTURAL GEOLOGY

Duration: 3 Hrs

MM 50

- UNIT -1** Rock failure: Mechanical principals of rock deformation, factors controlling behavior of material. Concept of stress and strain analysis in two and three dimensions. Progressive deformation. Moh's circles. Symmetry concepts in deformation. Unconformities: types, significance and recognition.
- UNIT -2** Geometry of fold surface: Single and multi-layered. Classification of folds. Types of folds. Effects of folds on outcrops. Super-imposed folding.
- UNIT -3** Geometry of faults. Classification and types of faults. Slips, separation, recognition of faults, causes of faulting.
- UNIT -4** Origin, kinds and their relation to other structure of fracture and joints, lineation, foliation, rock cleavages and schistosity.
- UNIT -5** Mechanics of folding and faulting. Tectonic fabrics. Magma tectonics : Emplacement of plutons, origin of Ring Dykes and Cone Sheets.

Reference:-

Bayly B: Mechanics in structural Geology. Springer Verlag

Davis G H: Structural Geology of Rocks and regions. John Wiley

Ghosh S K: Structural Geology fundamental of modern developments

Hubert M K: Structural Geology Hafner Publ.

Moore E and Twiss R J: Tectonics Freeman Pergamon Press

Price N J and Cosgrove J W: Analysis of Geological Structure Cambridge university.

Hobbs, Means and Williams: An Outline of Structural Geology.

Badgeley P C: Structural Geology for Exploration Geologist.

Fairhurst: Rocks Mechanics Pergmon Press

Whitten E. H. T: Structural folded Rocks.

SEMESTER: FIRST PAPER TITLE THIRD: GEOMORPHOLOGY

Duration: 3 Hrs

MM 50

UNIT -1 Concept of geomorphology-principles and significance. Cycle of erosion: Davis's and Plank's cycle of erosion. Soil forming processes: soil types soil profile and classification of soils. Landslides, soil creep and solifluction.

UNIT -2 Fluvial agency: Types of rivers, Valley development-Base level and its varieties, graded streams, Cross profile of valleys. Drainage patterns and their significance. Erosion landforms and depositional landforms of streams.

UNIT -3 Glaciers: Types of glaciers, regimes of glaciers, nourishment of glaciers, wastage of glaciers. Major features resulting from glacial erosion and glacial deposition. Glacio-fluvial features. Piedmonts and piedmont problems. Aeolian agency. Topographic effects of wind erosion. Landforms of Aeolian deposition. Arid cycle of erosion.

UNIT -4 Karst topography: Important areas of Karst. Conditions essential for development of Karst, features characteristic of karst region. Origin of limestone caverns. Karst geomorphic cycle.

Marine erosion: Topographic features resulting from marine erosion and marine deposition. Classification of coasts.

UNIT -5 Morphometric analysis of terrains and its significance. Morphometric analysis of drainage basin and its significance. Statistical correlation methods for interpretation. The organization of drainage system

Major geomorphic divisions of India: their characteristics and mevolution.

Reference:-

Holms, Doris and Arthur: Holme's Principles of Physical Geology. Wiley

Thornbury, W D : Geomorphology.Wiley.

Small, RJ: Study of Landforms.Cambridge.

VonEngelen, O D:Geomorphology- Systematic and regional.MacMillan.

Savinder Singh: Geomorphology.

Mathew Fontain Maury: The Physical Geography of Sea.Harvard Univ. Press.

David Lang; The Earth system. Brown Publishers.

Hallis J R: Applied Geomorphology.

SEMESTER: FIRST

PAPER TITLE FOURTH: MINERALOGY AND GEOCHEMISTRY

Duration: 3 Hrs

MM 50

UNIT -1 Crystallography: Basic concepts of Crystallography, Crystal symmetry and

symmetry elements.Crystal projections- Spherical , Gnomonic and Stereographic projections. Classification of crystals into crystal systems and crystal classes, Derivation of 32 crystal classes. Twinning. X-Ray crystallography- Bragg's equation- Powder and single crystal methods.

UNIT -2 Atomic structure, mineralogical properties and mode of occurrence of the following:-

Sulphides (AX,A2X andAX2Types), Oxides (XO ,X2O,XO2,X2O3 and XY2O4 types),Sulphates (anhydrous and hydrous), Carbonates (Calcit, Dolomite and Aragonite groups). Classification silicate structures. Isomorphism. Polymorphism and pseudo morphism. Ex solution.

Atomoc structure, chemistry, physical and optical properties of the following rock forming mineral groups:

Epidote, Chlorite and allumino-silicates.

Precious and semi precious stones.

UNIT -3 Atomic structure, chemistry, physical and optical properties of the following rock forming mineral groups:

Garnet ,Olivine, Pyroxene, Amphibole, Mica, Feldspar, Feldspathoid and Quartz.

UNIT -4 Principles of Optics. Double refraction. Optical classification of minerals. Determination of refractive index. Uniaxial and Biaxial indicatrix. Determination interference colours and interference figures. Optic sign and its determination.

UNIT -5 Geochemical classification of elements. Radioactive decay scheme of U-Pb, Rb-Sr, K-Ar and Sm-Nd. Laws of Thermodynamics. Concept of Geochemical cycle. Principles of ionic substitution in minerals. Composition of the Earth.

Reference:-

Gribble, C D:Rutley's Elements of Mineralogy.

Phillips, W R and Griffin D T Optical Mineralogy.CBS

Klein,C.and Hauribut,C S: Mannual of Mineralogy. John Wiley.

Maaon : Principles of Geochemistry.

Hoefs,J: Stable Isotope Geochemistry. Springer Verlag.

Anderson: Geochemistry.

Dana: Textbook of Mineralogy.

PRACTICAL PRACTCASLS BASED ON THEORY PAPERS

Practical-1 Structural geology an Geomorphology 4Hrs Duration 50MM

Practical-2 Crystallography, Mineralogy 4Hrs Duration 50MM

SEMESTER: SECOND

PAPER TITLE FIRST: IGNEOUS AND METAMORPHIC PETROLOGY

Duration: Hrs

MM 50

UNIT -1 Origin of magma. Factors affecting magma composition. Evolution of magma by differentiation and assimilation .Phase equilibria of monary (Silica), Binary(Mixed and eutectic Ab-An, Leu-Si) and Ternary(Ab-An-Di, Fo-Fa-Sil) Silicate systems. Magmatism in relation to plate tectonics.

UNIT -2 Forms ,structures and textures of igneous rocks and iterpretation of crystallization history. Layered igneous structures.Classification of igneous rocks including IUGS system. Reaction principle and reaction series. Petrographic provinces.

UNIT -3 Origin of Granite: Magmatic and granitisation processes. Petrogenesis.

Petrography and Indian occurrences of Basic and Ultrabasic plutonic association; Granite -Granodiorite association; Tholeiite and alkali olivine basalt; Basalt-Dacite-Rhyolite association; Nepheline syenites, Ophiolites, Cumulates, Anorthosites and Pegmatites

- UNIT -4 Agents of metamorphism, kinds of metamorphism, types of metamorphism. Structures and textures of metamorphic rocks. Metamorphic differentiation. Concept of metamorphic zones in contact aureole.
- UNIT -5 Metamorphic grades, facies and facies series, facies classification. Metasomatism and their types. Types and origin of migmatites. Metamorphism of carbonates, pelites and mafic rocks. Charnockites, Khondalites, Eclogites. Paired metamorphic belts.

Reference:-

- Best M.; Igneous and metamorphic petrology. CBS.
- Bose, MK: Igneous petrology. World Press.
- Bucher, K and Frey, M. Petrogenesis of metamorphic rocks. Springer Verlag.
- Kretz, R: Metamorphic crystallization. John Wiley.
- McBerner, AR: Igneous petrology. Jones and Bartlett.
- Phillipots, A. Igneous and metamorphic petrology. Prentice Hall.
- Turner, FJ: Metamorphic Petrology. McGraw Hills. Yardley.
- BW: An introduction to metamorphic petrology. Longman.
- Winkler, HGF: Petrogenesis of metamorphic rocks. Springer Verlag.
- Miyashiro, A: Metamorphism and metamorphic rocks.. George Allen & Unwin.
- Wyllie PJ: Ultramafic rocks. PJ Heffer.
- Huand, VJ Petrology.

SEMESTER : SECOND PAPER TITLE SECOND: SEDIMENTOLOGY**Duration: Hrs****MM 50**

- UNIT -1 Processes of sedimentation. Fluid flow. Origin of sediments. Mode of transport of sediments. Stoke's law. Classification of common sediments (rudites, arenites, argillites). Classification of sedimentary rocks.
- UNIT -2 Origin, classification and significance of primary, secondary and organic sedimentary structures. Palaeocurrent significance in quality assessment. Classification of sandstones and limestones. Dolomites.
- UNIT 3 Textures of sedimentary rocks and their genetic significance. Granulometric analysis of clastic particles, statistical measure and interpretation of nature of sediments, Diagenesis.
- UNIT -4 Elements and types of depositional environments: Continental (Fluvial, Lacustrine, Aeolian, and Glacial), Transitional and Marine environments. Evaporates and Volcanoclastic sediments. Sedimentary facies.
- UNIT -5 Provenance and mineral stability. Concept and types of sedimentary provenance. Heavy minerals: Their separation and utility in the provenance analysis. Tectonic framework of sedimentation (Kay's classification of tectonic elements). Cyclothem.

Reference:-

- Allen, P: Earth surface processes. Blackwell.
- Davis, RA: Depositional systems. Prentice Hall.
- Einsel, G: Sedimentary basins. Springer Verlag.

Miall, AD: Principles of sedimentary basin analysis. Springer Verlag.

Nichols, G: Sedimentology and stratigraphy. Blackwell.

Reading, HG: Sedimentary environments. Blackwell.

Pettijohn, FJ: Sedimentary rocks.

Pettijohn, Potter & Seiver: Sand and sandstones.

SEMESTER : SECOND PAPER TITLE THIRD: STRATIGRAPHY OF INDIA.**Duration: 3 Hrs****MM 50**

- UNIT -1 Criteria for the stratigraphic classification and correlation. Litho-, Bio- and chronostratigraphic units. Magnetostratigraphy. Sequence stratigraphy. Geological timescale. Orogenic cycles in Indian stratigraphy. Tectonic framework of India. Geological column of the Indian stratigraphy.
- UNIT -2 Ice ages in Indian stratigraphy. Precambria Permo-Carboniferous and Pleistocene ice ages, their evidences. Archaean (Azoic) History of India: Distribution and stratigraphy of the Archaean of South India, Madhya Pradesh, Rajasthan, Jharkhand and Orissa.
- UNIT -3 Precambrian (Proterozoic) History of India: Distribution and stratigraphy of the Cuddapah and Vindhyan Supergroups. Palaeozoic history: distribution and stratigraphy of Salt Range and Spiti. Origin and age of Saline formations. Precambrian-Cambrian boundary problem. Pecambrian and Palaeozoic stratigraphy of Rajasthan.
- UNIT -4 Mesozoic history: Distribution and stratigraphy of Triassic of Spiti, Jurassic of Cutch (Kutchh) and Cretaceous of South India. Bagh beds, Lameta Beds. Deccan Trps. Permo-Triassic Boundary.
- UNIT -5 Palaeoclimate, classification, distribution and stratigraphy of the Gondwana Supergroup. Cenozoic history: Tertiary of Assam and Rajasthan, its economic importance. Siwaliks and its vertebrate fossil record. K-T boundary.

Reference:-

- Boggs Sam, JR: Principles of sedimentary and stratigraphy. Prentice Hall.
- Krishnan, MS: Geology of India and Burma. Higginbothams Madras.
- Ravindra Kumar : Historical geology and Stratigraphy of India. John Wiley.
- Wadia, DN: Geology of India. McMillan.
- Doyel and Brennet MR: Unlocking the Stratigraphy: Concepts and Application. Prentice Hall.

SEMESTER : SECOND PAPER TITLE FOURTH: PALAEOBIOLOGY**Duration: Hrs****MM 50**

- UNIT -1 Modes of fossilization, technique of collection and preparation of fossils. Elements of palaeoecology, uses of fossils. Classification, evolution and geological history of following: Trilobites, Graptolites, Echinoides and Corals.
- UNIT -2 Classification, evolution and geological history of following: Brachiopoda, Gasteropoda, Lamellibranchia and Cephalopoda.
- UNIT -3 Succession of vertebrate life through the geological time. Evolutionary history of Man, Elephant and Horse.
- UNIT -4 Micropalaeontology : Classification and separation of micro fossils. Application of microfossils in fossil fuel exploration. Morphology, classification palaeoecology and geological history of following : Foraminifers and Ostracodes.

UNIT -5 Concept of palaeobotany and palynology. Plant life through ages. Characteristic features of Lower Gondwana flora. Characteristic features of Upper Gondwana flora.

Reference:-

- Moore, Lalicher and Fisher. Invertebrate fossils.
 Woods, H: Invertebrate palaeontology.
 Clarkson, ENK: Invertebrate palaeontology and evolution. Blackwell.
 Stearn CW and Carrol RL: Palaeontology - The record of life. John Wiley
 Smith, AB: Systematics and fossil record - Documenting evolutionary pattern. Blackwell.
 Prothero, DR: Bringing fossils to life: An introduction to Palaeobiology. McGraw hill.
 Ananthraman and Jain: Textbook of Palaeontology.
 Banner, FT and Lord AR: Aspects of micropalaeontology.
 Roger, AS: Vertebrate palaeontology.
 Jones DJ: Microfossils.
 Glassener, MP: Principles of micro palaeontology.
 Haq, BU and Bøersma: Introduction to marine micropalaeontology.
 Andrew: Palaeontology.

PRACTICAL PRACTICALS BASED ON THEORY PAPERS

- Practical-1 Petrology 4Hrs Duration 50MM
 Practical-2 Paleobiology and stratigraphy of India 4Hrs Duration 50MM

SEMESTER: THIRD**PAPER TITLE FIRST: PHOTO GEOLOGY AND REMOTE SENSING**

Duration: 3 Hrs **MM 50**

- UNIT -1 Introduction to aerial photography. Multispectral photography. Types of aerial photographs. Geometric principles of photographs - relief and tilt displacement, Vertical exaggeration and distortions. Taking measurements from ariel photographs: Scales, distances area and height. Measuring instruments and their use Parallax Bar.
- UNIT -2 Preparation of photogeological maps. Mosaic. Controlling factors of aerial photographs: Scale, flight plan, area, purpose, time and season of photography. Introduction to overlap, side lap, drift, crab. Fiducial marks. Elements of interpretation of ariel photographs. Background knowledge. Factors affecting aerial photographs.
- UNIT -3 Types of electromagnetic radiations (EMRT), energy used in remote sensing. Sensor platforms. Energy interaction with earth surface and atmosphere. Reflectance of minerals, vegetation rocks and water. Scattering. Active and passive sensors imaging.
- UNIT -4 Multi spectral scanners (MSS, SLAR, SAR, LISS cameras. Thermal infrared line scanners (TIRLS)
 Near infrared (NIR), Microwave (Radar). Imagery. Introduction to Image processing. Discrete image processing system
- UNIT -5 Application of photogeology and remote sensing in the study of geomorphology, lithology structural features, mineral exploration and hydrogeology. Preparation of base map by radial triangulation. Concept of

geographic information system.

Reference:-

- Curan, PJ: principles of remote sensing. ELBS (Longman)
 Drury, SA: Image interpretation in Geology. Allen and Unwin.
 Land, DR: Principles and interpretation of Aerial photographs.
 Miller, VC: Photogeology. McGraw.
 Pandey, SN: Principles and applications of Photogeology. New Age.
 Parry S Seigal And Allen, R: Remote sensing in geology.
 Patel, AN and Surendra Singh: Principles of remote sensing. Scientific. Publ.
 Pratt, VK: Digital Image Processing.
 Tripathi and Bajpai ed. Remote sensing in geosciences.
 Wolf: Introduction to Photogrammetry.
 Jensen: Environmental Remote sensing.

SEMESTER: THIRD PAPER TITLE SECOND: ENGINEERING GEOLOGY

Duration: 3 Hrs **MM 50**

- UNIT -1 Importance of geology in civil engineering. Merits and demerits of civil engineering in fold, faults and joints affected areas. Engineering properties of rocks.
- UNIT -2 Testing of engineering properties of rocks used as foundation sites, building stones, aggregates and ballasts.
- UNIT -3 Dam and its parts, types of dams, geological consideration for the selection of a dam site. Reservoir: geological consideration. its capacity. Water tightness and influencing factors. silting and desilting of reservoir.
- UNIT -4 Geological consideration in major engineering projects: construction of tunnels, highways, bridges and canals. Lining of tunnels.
- UNIT -5 Landslides: causes, effects and prevention. Consideration of civil engineering in seismic areas.

Geo-Hazards: mitigation and management.

Reference:-

- Bell, FG: Geological hazards. Route Ledge.
 Blyth, FCH: Geology for Engineers. Arnold Ltd.
 Kesavulu, NC: Textbook of engineering geology. McMillan
 Khurmi, RS: Fundamentals of engineering geology. Dhanpat Rai and Sons.
 Krynine and Judd: Principles of engineering geology and geotechnics. McGraw.
 Parbeen Singh Engineering geology. Katson Publ.
 Rammathan, RM: Engineering geology. Anuradha Agency TN.
 Richey, JE: Elements of engineering geology. Sir Issac, Pitman & sons.
 Sumit, K: Environmental hazards. Routledge.
 Trefethen, NC: T B of geology and engineering geology. McMillan.

SEMESTER: THIRD PAPER TITLE THIRD: ORE GEOLOGY

Duration: 3 Hrs **MM 50**

- UNIT -1 Relation of magma to mineral deposits. Geological thermometers. Ore genesis. Control of ore deposits. Paragenesis and zoning in mineral deposits. Classification of processes of mineral deposits. Metallogenic epochs and provinces.
- UNIT -2 Processes of mineral deposits: Magmatic concentration. Sublimation.

12 / M.D.S.U. Syllabus M Sc Geology

Pegmatites. Contact metasomatism. Hydrothermal, metamorphic. Volcanogenic deposits and carbonates.

- UNIT -3 Processes of mineral deposits: Sedimentary, placers, residual, evaporation, oxidation and supergene enrichment. Ore microscopy: Textures and structures of ores. Stratiform and stratabound ore deposits.
- UNIT -4 Origin, mode of occurrence, association, uses and Indian occurrences of metallic mineral deposits: Iron manganese, chromium, nickel, copper, lead, zinc, aluminium, tin, tungsten titanium, beryllium, molybdenum, gold and silver.
- UNIT -5 Origin, mode of occurrence, association, specification and grades for use in industries and Indian occurrences of non-metallic mineral deposits: Mica, asbestos, gypsum, ochre, precious and semi-precious stones. Minerals used in fertilizers and cement industries.

Reference:-

- Bateman: Economic mineral deposits. Wiley.
- Deb, S: Industrial minerals.
- Evans, JM: Ore geology and industrial minerals. Blackwell.
- Halloway: Simulating the earth.
- Krisnaswamy: Mineral resources of India.
- Lamey, CA: Metallic and industrial minerals.
- Mookherjee, A: Ore genesis-A holistic approach. Allied
- Mukerjee: Non fuel mineral deposits of India. Allied.
- Stanton, RL: Ore petrology. McGraw Hills.
- Umeshwer Prasad. Economic geology. CBS.

SEMESTER: THIRD PAPER TITLE THIRD: MINERAL EXPLORATION**Duration: 3 Hrs****MM 50**

- UNIT -1 Geological exploration: Mode of occurrence of commercial grade deposits of ores. Geological criteria (Ore guides) for mineral prospecting. Methods of geological exploration: Geological mapping-Base map and toposheets, reconnaissance and detailed mapping. exploratory grids, pits, trenches, core sampling, well logging in evaluation of deposits.
- UNIT -2 Sampling methods. Assaying by channel sampling and placer sampling, underground sampling. Calculation of ore reserves. Classification of ore reserves.
- UNIT -3 Classification principles and brief idea of geophysical methods. Electric method. instruments used in electric prospecting, application in mineral prospecting. Magnetic methods: Magnetic properties of rocks and minerals, magnetometers.
- UNIT -4 Gravity method: Earth's gravity field, regional and local gravity anomalies, pendulum torsion balance of gravimeters, interpretation of gravity anomalies for mineral deposits. Seismic methods: Elastic properties of rocks, types of elastic waves (P, S & L waves). Refraction and reflectance methods, time distance relation for horizontal interface, seismic instruments- geophones.
- UNIT -5 Geochemical exploration: Geochemical cycle, mobility of elements, path finder elements, mode of occurrence of trace elements, primary dispersion pattern of deep seated origin, syngenetic and epigenetic diffusion. Sampling technique for geochemical exploration.

Reference:-

- Arogyaswamy, RNP: Courses in mining geology. Oxford-IBH.
- Dobrin, MB: Introduction to geophysical prospecting. McGraw Hills.
- Hawks, H and Wobb, JS: Geochemistry in mineral exploration. Harper NY.
- Ginzburg, II: Principles of geochemical prospecting. Pergmon.
- Holson, GD and Tiratsoo, EN: Introduction to petroleum geology. Gulf Publ.
- Howel, CH: Introduction to geophysics.
- Milton and Dobrin: Introduction to geophysical prospecting. McGraw Hills.
- Paransia, DS: Principles of applied geophysics.
- Rao, MBR: Outline of geophysical prospecting.
- Sharma, PV: Geophysical methods in geology. Elsevier.

PRACTICAL**PRACTICALS BASED ON THEORY PAPERS**

- Practical-1 Photogeology and engineering geology. 4Hrs Duration 50MM
- Practical-2 Ore geology and exploration 4Hrs Duration 50MM

SEMESTER: FOURTH PAPER TITLE FIRST: FUEL GEOLOGY**Duration: 3 Hrs****MM 50**

- UNIT -1 Origin of coal: Physico-chemical characterization. Proximate and ultimate analyses. Rank and varieties of coal. Macroscopic ingredients and microscopic constituents (Maceral), Lithotypes and microlitho types).
- UNIT -2 Indian and international classification of coal. Preparation of coal for industrial purpose (Coal washing), Coal carbonization (Coke manufacturing), Coal gasification and hydrogenation. Briquetting of coal.
- UNIT -3 Geological features of coal seams. Geology of the productive coal fields of India. Methods of coal prospecting. Estimation of the coal reserves. Elementary idea about coal mining methods. Coal bed methane.
- UNIT -4 Origin, migration and accumulation (Oil traps) of petroleum and natural gas. Kerogene. Geology of productive oil fields of India. Position of oil and natural gas in India.
- UNIT -5 Atomic minerals: mode of occurrence, association and distribution in India. Methods of prospecting. Productive horizons in India. Nuclear power stations of country and future prospects.

Reference:-

- Dahikamp, FJ: Uranium ore deposits. Springer Verlag.
- Durrane, EM: Radioactivity in geology: Principles and applications. Ellis H.
- Holson, GD and Tiratsoo, EN: Introduction to petroleum geology. Gulf Publ.
- Netleton, LL: Geophysical prospecting for oil.
- North, FK: Petroleum Geology. Allen and Unwin.
- Selley, RC: Elements of petroleum geology. Academic press.
- Singh, MP: Coal and organic petrology. Hindustan Publ.
- Tissot, BP and Welt, DH: Petroleum formation and occurrence. Springer Verlag.
- North, FK: Petroleum geology. Allen and Unwin.

SEMESTER: FOURTH**PAPER TITLE SECOND: MINING AND MINERAL DRESSING**

Duration: 3 Hrs

MM 50

- UNIT -1 Mining terminology, mine supports, subsidence, shaft and shaft sinking. Breaking of rocks. Percussion and rotary drilling methods. Classification of mining methods.
- UNIT -2 Alluvial mining and opencast mining. Underground mining (other than coal mining) : Stopping methods, open stopes, timbered stopes, filled stopes, shrinkage stopes, slicing system and caving. Mine atmosphere : mine ventilation, pumping of mine water.
- UNIT -3 Coal mining methods: Board and pillar method, long wall method. Strip mining. Haulage and winding.
- UNIT -4 Mineral dressing : Physical properties of minerals used in mineral dressing. Crushers : Primary and secondary crushers. Grinding mills, Rod mills, Ball mills, autogenous mills.
- UNIT -5 Industrial screening : Types of screens, gravity separation, Heavy-medium separation, Magnetic separation. Froth floatation technique of separation of sulphide ores.

Reference:-

- Arogyaswamy, RNP: Courses in mining geology. Oxford-IBH.
- Gaudin: Principles of ore dressing. McGraw Hill.
- Lewis: Elements of mining.
- McKinstry, HE: Mining Geology. Prentice Hall.
- Richards and Looke: Text book of ore dressing .McGraw Hill.
- Roberts: Elements of ore dressing.
- Young: Elements of mining geology.

SEMESTER : FOURTH PAPER TITLE SECOND: HYDRUGEOLOGY

Duration: Hrs

MM 50

- UNIT -1 Distribution of water; surface and subsurface. Hydrogeological cycle. Precipitation and its types. Ground water: Origin, importance, occurrences and subsurface reservoirs. Vertical distribution of ground water. Hydrostratigraphic units. Water table contour maps.
- UNIT -2 Geological factors governing the occurrence of ground water. Porosity, permeability, specific yield specific retention, hydraulic conductivity, storage coefficient, aquifers and their classification.
- UNIT -3 Groundwater flow: confined, unconfined, steady, unsteady and radial flow. Forces causing flow. Darcy's law. Water level fluctuations: causative factors and their measurements. Methods of pumping tests and analysis of test data. Ground water Exploration.
- UNIT -4 Ground water quality : Physical characteristics; turbidity, color, taste, odor, temperature and specific conductivity. Chemical characteristics: TDS and suspended solids; pH value, hardness, heavy metals and dissolved gases. Biological characteristics. Water contaminants and pollutants.
- UNIT -5 Salt water intrusion in coastal aquifers, remedial measures. Radio-isotopes in hydrogeological studies. Water harvesting. Wet land management. Consumptive and conjunctive use of surface and ground water. Concept of water shade management. Natural and artificial recharge of ground water. Ground water resources of Rajasthan.

Reference:-

- Davis, SN and De Wiest, RJM: Hydrogeology. John Wiley.
- Felter, CW: Applied hydrogeology. Merrill.
- Freeze, RA and Cherry, JA: Ground water. Prentice Hall.
- Gautam, Mahajan: Ground water survey and investigation.
- Gulistan: Hydrogeology and wet land conservation.
- Karanth, KR: Ground water assessments – development and managements.
- Rasghunath, NM: Ground water. Wiley Eastern.
- Subramaniam, V: Water. Kingston Publ.
- Todd, DK: Ground water hydrology. N Wiley.
- Tollman: Ground water.

SEMESTER : FOURTH**PAPER TITLE FOURTH: (OPTIONAL-1) ENVIRONMENTAL GEOLOGY.**

Duration: Hrs

MM 50

- UNIT -1 Concept of environmental geology. Classification of environment. Ecological perspectives of environment. Global warming.
- UNIT -2 Impact assessment of degradation and contamination of surface water and ground water quality due to industrialization and urbanization. Soil profiles, soil types and soil quality degradation due to irrigation, use of fertilizers and pesticides.
- UNIT -3 Wet lands: Classification, natural and artificial wet lands, problems of reclamation of wet lands. Water logging problems. Desertification and degradation of land. Anti desertification measures.
- UNIT -4 Causes of floods, flood hazard and management. Impacts of mining activities on environment. Environmental management in mining areas. Effects of earthquakes, seismic hazards and management. Environmental pollution due to industries, energy resources, urbanization.
- UNIT -5 Earth's natural hazardous processes and its impact on environment: Volcanic activity, land slides, coastal hazards. Environmental problems related to dams and reservoirs.

Reference:-

- Bell, FG: Geological hazards. Route Ledge.
- Hsai Yang Fang: Introduction to environmental geotechnology. CRC Press.
- Patwardhan, AM: The dynamic earth system.
- Smith, K: Geological Hazards. Route Ledge.
- Subramaniam, V: Textbook of environmental science. Narosa.
- Graedel, TE and Crutzen, PJ: Atmospheric change. Freeman.
- Valdiya, KS Environmental geology – Indian context. Tata-McGraw.

SEMESTER : FOURTH**PAPER TITLE FOURTH: (OPTIONAL-2) ADVANCED REMOTE SENSING AND GIS**

Duration: 3 Hrs

MM 50

- UNIT -1 Introduction and development of remote sensing techniques ; Ariel remote sensing versus satellite remote sensing. Stereoscopic and pseudoscopic vision. depth perception. Different types of viewing instruments. Vertical exaggeration. Factors affecting vertical exaggeration, determination of vertical exaggeration.
- UNIT -2 Geometric elements of ariel photographs, relief displacement. Image parallax. Parallax measurement- measurement of dip, height and thickness of strata

- 107 M.Sc. Geology
- Stereoscopic plotting instruments. Recognition of various photo interpretation elements. Interpretation of Ariel photographs for geology, geomorphology and structures.
- UNIT -3 Radiation principles. Generation of electromagnetic radiation(EMR) . Electromagnetic spectrum. Interaction of EMR with atmosphere and earth material. Spectral signatures. Space platforms. Remote sensing sensors- Multi spectral scanners (MSS), thermal scanners, passive and active microwave scanners, LISS, WIFS. Visual interpretation of MSS, TM, SPOT and IRS images.
- UNIT -4 Digital image processing(DIP). Sources of image degradation. Image rectification and restoration, image enhancement techniques, multi image manipulation- FCC generation, band rationing, pattern recognition and image classification. Geographic information system (GIS). Components of GIS system, data structure and data model in GIS, functional elements of GIS. Projections.
- UNIT -5 Application of remote sensing and GIS for mineral exploration, ground water exploration, land use/ land cover studies and change detection. Engineering projects and environmental planning.

Reference:-

- Curan, PJ: principles of remote sensing. ELBS(Longman
 Drury,SA: Image interpretation in Geology. Allen and Unwin.
 Parry S Seigal And Allen, R: Remote sensing in geology.
 Patel,AN and Surendra Singh: Principles of remote sensing. Scientific Publ.
 Pratt, VK : Digital Image Processing.
 Tripathi and Bajpai ed. Remote sensing in geosciences.
 Jenson : Environmental Remote sensing.

SEMESTER : FOURTH

PAPER TITLE FOURTH:(OPTIONAL-3) COMPUTER APPLICATIONS IN GEOLOGY

Duration: 3 Hrs

MM 50

- UNIT -1 Introduction to computers. Structure of computer. Hardware and soft ware components. Classification and types of computers. Capabilities and limitations of computers. Computer organization.
- UNIT -2 General working of computer. Input and output devices, magnetic media deices, optical devices, Printers, key board devices, VDU, scanners and digitizers, plotter. Types of softwares.
- UNIT -3 Computer languages. Number system. ASCII. Machine language, high level language . Assembler. Interpreter. Compilers. Flowcharts. Decision tables. Algorithms. MS-DOS, Windows, MS-Office.
- UNIT -4 Basic programming concept. Variable constants, procedures, conditional statements and loops. Visual
- UNIT -5 Computer applications for various geological studies. Preparation of contour maps by surfer. Graphical interpretation. GIS overview.

PRACTICAL PRACTCASLS BASED ON THEORY PAPERS

- Practical-1 Mining and fuel geology 4Hrs Duration 50MM
 Practical-2 Hydrogeology and optional paper. 4Hrs Duration 50MM