THIRUVALLUVAR UNIVERSITY

MASTER OF SCIENCE

M.Sc. GEOLOGY DEGREE

COURSE UNDER CBCS

**(With effect from 2020-2021)**

**The Course of Study and the Scheme of Examination**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| ***Sl.******No.*** | ***Study Components*** | ***Ins. hrs./ week*** | ***Credit*** | ***Title of the Paper*** | ***Maximum Marks*** |
| ***Course Title*** |
| **SEMESTER I** |  | ***CIA*** | ***Uni. Exam*** | ***Total Marks*** |
|  | Core-Theory | Paper-1 | 5 | 4 | Applied Geomorphology | 25 | 75 | 100 |
|  | Core-Theory | Paper-2 | 5 | 4 | Structural Geology and Geotectonics | 25 | 75 | 100 |
|  | Core-Theory | Paper-3 | 5 | 4 | Mineralogy | 25 | 75 | 100 |
|  | Core-Theory | Paper-4 | 5 | 4 | Palaeontology | 25 | 75 | 100 |
|  | Core-Practical | Paper1- | 4 | - | Practical –I Structural Geology, Mineralogy andPalaeontology | - | - | - |
| Internal Elective for same major students (Choose any one) |
|  | **Core Elective** | **Paper-1** | 3 | 3 | 1. OreGeology
2. FuelGeology
3. MarineGeology
 | 25 | 75 | 100 |
| External Elective for other major students (Inter/multidisciplinary papers) |
|  | **Open** **Elective** | **Paper-1** | 3 | 3 | 1. Meteorology and ClimateChange
2. Geohazards
3. Water ResourcesManagement
 | 25 | 75 | 100 |
|  |  |  | **30** | **22** |  | **150** | **450** | **600** |
|  |
| **SEMESTER II** |  | ***CIA*** | ***Uni.******Exam*** | ***Total Marks*** |
|  | Core-Theory | Paper-5 | 4 | 4 | Igneous and Metamorphic Petrology | 25 | 75 | 100 |
|  | Core-Theory | Paper-6 | 4 | 4 | Sedimentology | 25 | 75 | 100 |
|  | Core-Theory | Paper-7 | 4 | 4 | Stratigraphic Principles and IndianStratigraphy | 25 | 75 | 100 |
|  | Core-Theory | Paper-8 | 4 | 4 | Exploration Geology | 25 | 75 | 100 |
|  | Core-Practical | Paper-1 | - | 3 | Practical –I Structural Geology,Mineralogy and Palaeontology | 25 | 75 | 100 |
|  | Core-Practical | Paper-2 | 4 | 3 | Petrology and Sedimentology | 25 | 75 | 100 |
| Internal Elective for same major students (Choose any one) |
|  | **Core****Elective** | **Paper-2** | 4 | 3 | 1. Palaeobotany
2. Sequence Stratigraphy
3. Petroleum Exploration
 | 25 | 75 | 100 |
| External Elective for other major students (Inter/multidisciplinary papers) |
|  | **Open** **Elective** | **Paper-2** | 4 | 3 | 1. Earth SystemScience
2. Gemology
3. SoilGeology
 | 25 | 75 | 100 |
|  | **\*Field Study** |  | - | 2 | Geological Mapping/ Field Training | 100 | - | 100 |
|  | **Compulsory Paper** | 2 | 2 | Human Rights | 25 | 75 | 100 |
|  |  |  | **30** | **32** |  | **325** | **675** | **1000** |
|  |
| **SEMESTER III** |  | ***CIA*** | ***Uni.******Exam*** | ***Total Marks*** |
|  | Core-Theory | Paper-9 | 4 | 3 | Remote Sensing and Digital Image Processing  | 25 | 75 | 100 |
|  | Core-Theory | Paper-10 | 5 | 3 |  Economic Geology | 25 | 75 | 100 |
|  | Core-Theory | Paper-11 | 5 | 3 | Hydrogeology  | 25 | 75 | 100 |
|  | Core-Practical | Paper-3 | 5 | - |  Economic Geology and Mining Geology | - | - | - |
|  | Core-Practical | Paper-4 | 5 | - | Hydrogeology, Remote Sensing and GIS | - | - | - |
| Internal Elective for same major students (Choose any one) |
|  | **Core Elective** | **Paper-3** | 3 | 3 | 1. Field Geology
2. Analytical Techniques

and Instrumentation1. Micropaleontology
 | 25 | 75 | 100 |
| External Elective for other major students (Inter/multi-disciplinary papers) |
|  | **Open** **Elective** | **Paper-3** | 3 | 3 | 1. Rainwater Harvesting and Artificial Groundwater Recharge
2. Environmental Geology
3. Water Quality Analysis
 | 25 | 75 | 100 |
|  | \*\*MOOC Courses |  | **-** | - | Massive Open Online Courses (MOOC) | - | - | 100 |
|  |  |  | **30** | **15** |  | **125** | **375** | **600** |
|  |
| **SEMESTER IV** |  | ***CIA*** | ***Uni.******Exam*** | ***Total Marks*** |
|  | Core-Theory | Paper-12 | 5 | 4 | Geographic Information System (GIS) and Applications | 25 | 75 | 100 |
|  | Core-Theory | Project | 11 | 5 | Project with viva voce Examination- Compulsory | 100 (75Project+ 25 Viva) | 100 |
|  | Core-Practical | Paper-3 | 4 | 3 | Economic Geology and Mining Geology | 25 | 75 | 100 |
|  | Core-Practical | Paper-4 | 4 | 3 | Hydrogeology, Remote Sensing and GIS | 25 | 75 | 100 |
| Internal Elective for same major students (Choose any one) |
|  | **Core** **Elective** | **Paper-4** | 3 | 3 | 1. Industrial Minerals and Mineral Economics
2. Mining and Engineering Geology
3. Applied Geology and Geostatistics
 | 25 | 75 | 100 |
| External Elective for other major students (Inter/multi-disciplinary papers) |
|  | **Open** **Elective** | **Paper -4** | 3 | 3 | 1. Geoheritage, Geoparks and Geotourism
2. Introduction to Geospatial Technology
3. Disaster Management
 | 25 | 75 | 100 |
|  |  |  | **30** | **21** |  | **150** | **450** | **600** |
|  |  |  | **120** | **90** |  |  |  | **2800** |

**\* Field Study**

There will be field study which is compulsory in the first semester of all PG courses with 2 credits. This field study should be related to the subject concerned with social impact. Field and Topic should be registered by the students in the first semester of their study along with the name of a mentor before the end of the month of August. The report with problem identification and proposed solution should be written in not less than 25 pages in a standard format and it should be submitted at the end of second semester. The period for undergoing the field study is 30 hours beyond the instructional hours of the respective programme. Students shall consult their mentors within campus and experts outside the campus for selecting the field and topic of the field study. The following members may be nominated for confirming the topic and evaluating the field study report.

1. Head of the respective department
2. Mentor
3. One faculty from other department

\*\***MOOC Courses**

Inclusion of the Massive Open Online Courses (MOOCs) with zero credit available on SWAYAM, NPTEL and other such portals approved by the University Authorities.

**SEMESTER III**

**PAPER -9**

**REMOTE SENSING AND DIGITAL IMAGE PROCESSING**

**Unit I**

Passive Microwave Remote Sensing**:** Basic physics of RADAR waves, spectral characteristics of RADAR waves, microwave radiometers. Active Microwave RemoteSensing**:** RADAR- definition and development, Radar Systems – geometric characteristics, SLR stereoscopy and RADAR grammetry. SAR interferometry- principle, LIDAR Remote Sensing:AltimetricLiDAR: Physics of laser, spectral characteristics of laser, laser interaction with objects, Airborne Altimetric LiDAR principle.

**Unit II**

Hyper-spectral Remote Sensing: Hyper-spectral Imaging: Hyper spectral concepts, data collection systems, calibration techniques, data processing techniques; preprocessing, N-dimensional scatter-plots, Spectral mixture analysis, Spectral Matching, Mixture tuned matched filtering, Classification techniques. Hyper-spectral Remote Sensing: Developments and future missions in India.

**Unit III**

Digital Image Processing: Introduction- Data Formats – Band sequential and Band interleaved characteristics -Compression – Data products; Image display system – Image data encoding and decoding. Image Rectification and Restoration: Geometric correction- Skew corrections – Resampling interpolation methods – Panoramic distortion. Radiometric correction -Sun elevation - Atmospheric correction.Geometric Restoration – Striping – Random error – Earth-Sun distance correction – Atmospheric correction.

**Unit IV**

Image Enhancement: Contrast Manipulation – Gray-Level Thresholding–Density Slicing - Contrast Stretching – Linear & Non-linear - Convolution spatial filtering – Sobel and Laplatian, High and low pass filtering – Histogram equalization. Edge Enhancement – Band ratioing.

**Unit V**

Information Extraction: Principal Component Analysis- Ratio Images- Multispectral Classification – Supervised Classification- Minimum distance classifier, parallelepiped classifier, Gaussian maximum likelihood classifier -Unsupervised classification. Classification accuracy assessment.Image Analysis: Pattern recognition – Shape analysis- Textural and contextual analysis.

**Reference Books:**

1. Fawaz T Ulaby, Richard K Moore and Adrian K Fung, Microwave Remote Sensing active and passive, Vol. 1, 2 and 3 Addison – Wesley Publication company. 1981, 1982, and 1986.
2. Robert M HaralickadSimmonet, Image processing for remote sensing 1983.
3. Travett J W (1986). Imaging Radar for Resources surveys, Chapman and Hall, London.
4. Lillisand,T.M&R.W.Kiefer.(2008). Remote sensing and Image Interpretation, John Wiley and Sons Inc.
5. Gupta R.P (2014). Remote Sensing Geology, Springer.
6. Sabins F F (2007). Remote Sensing: Principles and Interpretation, W H Freeman And Company.
7. Curran,P.B. (1985).Principles of Remote Sensing. ELBS. London.
8. John R Jensen (2017). Introductory Digital Image Processing: A Remote Sensing Perspective, Pearson.
9. Robert A. Schowengerdt (1997). Remote sensing Models and methods for image processing, Academic Press

**PAPER -10**

**ECONOMIC GEOLOGY**

**Unit I**

Scope of economic geology. Mode of occurrence and morphology of ore bodies and relationship with host rocks - Structures of ore and gangue minerals. Modernconcepts of ore genesis.Fluid inclusions-Wall rock alteration.Geothermometry- geobarometry.

**Unit II**

Paragenesis and zoning in mineral deposits-Metallogenetic Epochs and Provinces.Structural, physico-chemical and stratigraphic controls of ore localization.Study of ore forming processes- Orthomagmatic processes- Sedimentary processes- Metamorphic processes- Hydrothermal processes.Ore deposits in relation to plate tectonics.

**Unit III**

Mineralogy, mode of occurrence, uses and distribution in India of the following metalliferous deposits – Iron, Manganese, Aluminium, Copper, Gold, lead, Zinc, Chromium, Molybdenum, Rare Earth Group of metals.

**Unit IV**

The study of non- metallic mineral deposits with reference to geology, mode of occurrence, origin, uses and distribution in India of Mica, Asbestos, Barytes, Gypsum, Limestone, Garnet, Corundum, Calcite, Quartz, Feldspar, Clays, Kyanite, Sillimanite, Graphite, Talc, Fluorite, Beryl and Gem minerals.

**Unit V**

Introduction to ore microscopy, techniques, methods, textures and microstructures of ores, interpretation of ore texture and optical properties of common sulphide, oxide ore minerals; Industrial application of ore microscopy.

**Text/Reference Books:**

1. Anthony Evans, (1993) Ore Geology and Industrial Mineral, John Wiley & sons, USA,
2. Bateman Allan .M. (1962) Economic Mineral Deposits, Asian Publishing House, 2nd Edition.
3. Coggin, B. and Dey, A.K. (1955) India’s Mineral Wealth, oup.
4. Craig, J.M. & Vaughan, D.J., (1981): ore Petrography and Mineralogy. John Wiley
5. Cuilbert, J.M. and Park,Jr. C.F.(1986): The Geology of Ore Deposits, Freidman.
6. Debb.S. (1980) Industrial Minerals and Rocks of India, Allied,Publishers.
7. Edwards, R. and Atkinson, K. (1986) Ore deposit geology, Ist Edition, Chapman and Hall. New Delhi,.
8. Evans, A.M. (1993): Ore Geology and Industrial Minerals, Blackwell.
9. Gokhale, K.V.G.K. and Rao , T.C (1978)- Ore deposits of India, their distribution and processing, Thompson press,.
10. James R. Craig and David J.Vaughan (1994): Ore Microscopy and Petrography.
11. Jansen M.L. & Bateman A.M.: (1981), Economic Mineral Deposits, John Wiley & Sons, Singapore.
12. Klemm, D.D. and Schnieder, H.J. (1977): Time and Strata Bound Ore Deposits, Springer-Verlag.
13. Krishnaswamy ,S. - India’s Mineral Resources, oxford and IBH.
14. Lindgren W. (1933)Mineral Deposits, McGraw Hill,.
15. Mookherjee, A. (2000): Ore Genesis-A Holistic Approach, Allied Publisher.
16. Park, C.F. and Macdiarmid, R.A (1970) Ore deposits, Freeman,
17. R.M. Umathay, (2006)Mineral Deposits of India, Dattsons, New Delhi, India,
18. Ramdhor, P. (1969): The Ore Minerals and their Intergrowths, Pergamon Press.
19. Robb, L. (2005)Introduction to ore-forming processes, Blackwell publishing, U.K.,.
20. Stanton, R.L. (1972): Ore Petrology, McGraw Hill.
21. Wolf, K.H. (1976-1981): Hand Book of Stratabound and Stratiform Ore Deposits, Elsevier Publications.
22. Meher,D.N. Wadia, (1994), Mineral of India, National Book Trust, New Delhi.
23. Sinha.R.K and Sharma.N.L.(1970), Mineral Economics, Oxford IBH Publishing Co., New Delhi.

**PAPER -11**

**HYDROGEOLOGY**

**Unit I**

Hydrogeology: Hydrologic cycle and its components, Origin and age ofgroundwater, Occurrence of groundwater, Global distribution of fresh water. Vertical distribution of groundwater.Aquifers: Types of aquifers. Springs: Types of springs. Hydrologic properties of rocks: Porosity, Permeability, Specific yield, Specific retention, Hydraulic conductivity, Transmissivity and Storage coefficient.

**Unit II**

Groundwater movements: Sub surface movement, Base flow, Effluent flow andinfluent flow. Darcy’s law, Reynold’s number, Laminar flow and turbulence flow. Water level fluctuation: Water table and Piezometric surface and its fluctuations.Pumping test: objective, layout of the test and its measurement.

**Unit III**

Water well technology: Well types, drilling methods, construction of well, designof well, development and maintenance of wells. Artificial recharge ofgroundwater: Concept and methods. Saline water intrusion in aquifers: Salinewater intrusion, Ghyben–Herzberg’s relationship between fresh and saline water, Prevention and control of salt water intrusion in the coastal aquifers.

**Unit IV**

Groundwater quality: Chemical composition of groundwater, major cationsandanions, trace elements and their sources. Water quality measurements: physical, chemical and biological parameters. Graphical representation of hydrochemicaldata: Piper’s facies analysis. Groundwater contaminations and Pollutions:Problems related to arsenic and fluoride contamination, radio isotopes in hydrogeological studies. Trace element and health hazards, Impact of urbanization. Hydrogeochemical provinces of India.

**Unit V**

Groundwater exploration techniques: Surface investigation of groundwater-Geologic method, electrical resistivity method, seismic method, gravity and magnetic method. Subsurface investigation of groundwater: test drilling, water level measurements. Application of Geophysical logging in Groundwater exploration.Groundwater provinces of India.

**Text / Reference Books:**

1. Alley, W.M., (1993), Regional Groundwater Quality-VNR, New York
2. Davies, S.N. and De Wiest, D.R., (1966), Hydrogeology-John Wiley& sons, Inc, New York,463p.
3. Fetter, C.W., (1990), Applied Hydrogeology-McGraw Hill, Publisher, New Delhi.
4. Freeze, R.A. and John,A., (1979), Groundwater, Cherry, Prentice Hall,Inc,604p.
5. Handa.O.P (1984), Groundwater Drilling, Oxford & I.B.H. Publishing Co.
6. Hem J.D.,(1970), Study and interpretation of the chemical characteristics of
7. Hiscock,K.,(2005), Hydrogeology, Principles and Practice, Blackwell Publishing,389p.
8. Karanth, K.R., (1987), Groundwater Assessment, Development and Management-Tata McGraw Hill New Delhi 720p.
9. Kazmann, (1973), Modern Hydrology, Harper and sons Publishers, New Delhi.
10. Manning,J.C.,(2007),Applied Principles of Hydrology, CBS Publishers and Distributers ,New Delhi.
11. Raghunath, H.M., (2007), Groundwater 3rdedition,New Age International Publishers,520p.
12. Reddy and Rami,J.P.,(2008), A Textbook of Hydrology, University Science Press, Bangalore.
13. Schwartz,F.W and Zhang,H.,(2003), Fundamentals of groundwater, John Wiley& sons, Inc, New York,583p.
14. Shaw,E.M., (1994), Hydrology in Practice,3rd edition, Chapman and Hall,London,569p.
15. Subramaniam, V., (2000), Water-Kingston Publ. London.
16. Todd, D.K., (1980), Groundwater Hydrology-John Wiley & sons publishers, New York,535p.
17. Tolman.C. (1972), Groundwater, McGraw Hill Book Company.
18. Walton.W.C. (1970). Groundwater Resource Evaluation, McGraw Hill Book Company.

**PRACTICAL-III**

**ECONOMIC GEOLOGY AND MINING GEOLOGY**

**Economic Geology**

Study of Industrial and ore minerals with special emphasis on physical, chemical characteristics, mode of occurrences and uses.

**Mining Geology**

Problems relating to evaluation of Ore reserves.

**PRACTICAL – IV**

**HYDROGEOLOGY, REMOTE SENSING AND GIS**

**Hydrogeology**

Estimation of chemical dissolved constituents: major, minor and traces ingroundwater using standard laboratory techniques.

Diagrammatic representation ofhydrochemical data: bar, circular radial, multivariate schoeller diagram, fourcoordinatediagrams, stiffs diagram, horizontal and vertical scale diagram. Plotting on maps-Piper, U.S. Salinity Laboratory diagram, Wilcox’s, Doneen’s, Gibb’s and Durov’s plots.

Groundwater exploration techniques: geophysical and geological methods of ground water exploration.

Pumping test: time draw down and time recovery tests and evaluation of aquifer parameters.

**Remote sensing and GIS**

**Aerial Photography**:Stereovision Test, Pocket &Mirror Steoscope-3D Observation,Identification photo/image Recognition elements. Interpretation of drainage pattern, landforms, rock types and structures.

**Satellite remotesensing**:Demarcation of marginal information, Interpretation of satellite datafor geomorphology, structure, lithology and land use land cover. Exposureto Digital Image Processing techniques,spectral plot for different features.

**GIS:**Geo-Referencing, Digitization, Preparation of Vector and Raster Image, Buffer analysis andOverlay analysis.

**CORE ELECTIVE**

**PAPER - 3**

**(to choose one out of 3)**

**A. FIELD GEOLOGY**

**UNIT I**

Definition and scope of Field Geology – Prior planning – Basic equipment required for field work – Types of field investigations. Field work objectives and types of data collected. Introduction to topographic maps: parts, symbols, and other information. Basic concepts: relief, contours, slope, gradients, profiles and sections. Interpretation of topographic maps. Base map preparation and map scale.

**UNIT II**

Rock outcrops and their surficial expressions. Basic concepts: strike, dip, apparent dip and rock trends. Introduction to the outcrop features used in mapping: foliations, lineations, bedding, and lithological contacts. Geological mapping: Techniques of mapping: Traverse methods: Compass and Contact traverse, Exposure mapping, Variable lithology mapping, Line maps. Preparation of field note based data sheet.

**UNIT III**

Field Equipments: Clinometer compass: different parts and their functions. Measuring attitude of linear structures – determination of bearings – advantages and limitations.Brunton Compass: different parts and their functions - measuring attitude and trends – determination of bearings – adjustments – magnetic declination in topographic sheets - advantages and limitations. Brief account on the utility of Prismatic Compass and Plane Table in mapping open cast mines and quarries.

**UNIT IV**

Brief account of the following: Use of Aerial Photographs in geological mapping,Structural mapping, Stratigraphic mapping methods. Outline of mapping methodology for – igneous terrain, sedimentary terrain and metamorphic terrain. Methods of mapping in areas with sparse outcrops. Outcrop structural features common to all rock types. Outline of use and applications of GPS in field geology. Sample location techniques in digital base maps.

**UNIT V**

Field geological report: Parts and preparation. Geological and topographic map symbols. Brief introduction of field indicators used in geological mapping: geomorphological, weathering, mineral composition and petrography. Geological materials: types of samples – mineral,ore,fossil,rock. Methods of sampling - care and packing of samples in the field. Outline of preparation of thin sections of geological samples.

**Reference Books:**

1. Compton, R.R. (1985). Geology in the Field, John Wiley & Sons Inc., New Delhi.
2. McClay, K.R. (2003) The Mapping of Geological Structures, 2nd ed., John Wiley & Sons Ltd, New Delhi.
3. Compton, R.R. (1966). Manual of Field Geology. 2nd ed., New York, Wiley.
4. Lahee,F (1987). Field Geology, CBS Publishers,New Delhi.
5. Mathur,S.M. (2001). Guide to Field Geology. Prentice Hall India. New Delhi.
6. Gokhale,N.W. (2001). A Guide to Field Geology. CBS Publishers,New Delhi.
7. Coe,A.L. (ed). (2010). Geological Field Techniques. Open University Press,MiltonKeynes,UK.
8. Barnes,J.W. (2004). Basic Geological Mapping. John Wiley & Sons Inc., New Delhi.
9. Freeman,T. (1999). Procedures in Field Geology. John Wiley & Sons Inc., New Delhi.

**CORE ELECTIVE**

**PAPER - 3**

**B. ANALYTICAL TECHNIQUESAND INSTRUMENTATION**

**Unit I**

Introduction to analytical chemistry: Qualitative and quantitative analysis.Classification of methods.Types of instrumentalanalysis, various instrumental techniques and laboratory safety.

**Unit II**

Laboratory techniques: Laboratory operation and practices. Unitsofmeasurements. Laboratory notes. Errors and evaluation.Determination of accuracy.Statistical evaluation of data.

**Unit III**

Petrological microscope: Principles, parts, operation and application ofPetrological microscope, Ore microscope and Scanning electron microscope. Preparation of thin section.Preparation of rock powder for chemical analysis. Rock digestion through acid treatment, Rock digestion through fusion with alkali salts.

**Unit IV**

Geochemical sampling techniques: Sampling methods and principles, Types ofsampling, sampling interval. Heavy mineral separation methods.Flamephotometer and UV spectrometer: Basic principles, parts, operation andmechanism.

**Unit V**

Instruments used for geochemical analysis: Basic concept and techniques ofAtomic Absorption Spectrometer (AAS), Inductively Coupled Plasma - Atomic Emission Spectrometer (ICP-AES), X-Ray Diffraction (XRD), X-Ray Fluorescence (XRF) and Differential Thermal Analysis (DTA).

**Text / Reference Books:**

1. Dana,E.S.,(1955),Text book of Mineralogy, John Wiley., Deer,
2. W.A., Howie, R.A. and Zussman, J., (1996), The Rock forming Minerals-Longman.,
3. Flint,Y.,(1970), Basic crystallography,Mid Publishers.,
4. Francis Rouessac and AnnickRouessac., (2007), Chemical Analysis (Modern Instrumentation Methods and Techniques) John Wiley & sons, 574p.,
5. Hutchinson, C.S., (1974), Laboratory Handbook of Petrographic Techniques-John Wiley.,
6. Kerr,P.F.,(1959), Optical Mineralogy,McGraw Hill.,
7. Klein, C. and Hurlbut, Jr. C.S., (1993), Manual of Mineralogy-John Wiley.,
8. MadhuArora.,(2008),Analytical chemistry-Himalaya Publishing House, Mumbai., Phillips,
9. Wm, R. and Griffen, D.T., (1996), Optical Mineralogy-CBS Edition.,
10. Putnis, Andrew, (1992), Introduction to Mineral Sciences-Cambridge University Press.,
11. Spear, F.S. (1993), Mineralogical Phase Equilibria and Pressure-Temperature-Time paths-Mineralogical Society of America Publ.

**CORE ELECTIVE**

**PAPER - 3**

**C. MICROPALEONTOLOGY**

**Unit I**

Principles of Micropaleontology: Microfossils - definition, types of microfossils, uses of microfossils in various fields of Geological Sciences and Industry. Definition, scope and relationship of micropaleontology with ocean sciences.Historical developments and recent trends in micropaleontological studies including deep sea drilling (JOIDES, DSDP, ODP, IODP, JGOFS). Modern field and laboratory techniques in the study of microfossils: surface and sub-surface sampling methods, processing and separation of microfossils, preparation of faunal slides and thin sections. Field and Laboratory equipment’s used for micropaleontological studies.

**Unit II**

Calcareous Microfossils I: Dimorphism, test morphology, wall structure, chamber shape and arrangements, aperture openings and ornamentation of foraminifera. Classification and evolution of foraminifera.Ecology, paleoecology and geological distribution of foraminifera.Application of foraminifera in stratigraphy with special reference to Jurassic, Cretaceous and Tertiary periods in India.

**Unit III**

Calcareous Microfossils II: Morphology, hinge types, ornamentation, sculpture, orientation of carapace, classification and geological distribution of Ostracoda. Significance of ostracodes in ecology and paleo-ecological studies.Sample preparation techniques, morphology, ecology, application and geological distribution of calcareous nannofossils.Brief study of pteropods, calpionellids, calcareous algae and bryozoa.

**Unit IV**

Phosphatic, Siliceous and Organic-Walled Microfossils: Extraction methods, outline of morphology, composition and stratigraphic significance of conodonts. Preparation techniques, major morphological groups and application of radiolarians.Sample collection, preparation techniques, morphology and application of diatoms. Maceration techniques, outline of morphology and application of fossil spores and pollen.

**Unit V**

Application of Microfossils: Application of microfossils in biostratigraphy - First Appearance Datum (FAD) and Last Appearance Datum (LAD), units of biostratigraphy and biostratigraphic correlation. Application of Microfossils in understanding patterns causes and types of global events. Micropaleontology in hydrocarbon exploration – sequence stratigraphy, subsidence analysis, thermal history and biosteering.Application of microfossils in interpretation of paleoenvironment and paleoclimate – paleobathymetry, back-tracking technique, paleo-temperature estimation and sea-level change, ocean eutrophication, acidification, environmental monitoring, paleoclimate and paleomonsoon.Applicationof micropaleontology in oceanography, paleogeography and engineering geology.

**Text / Reference Books:**

1. Armstrong, H. and Brasier, M.D., (2005). Microfossils. Blackwell Publishing.
2. Bignot, G., (1985). Elements of Micropaleontology. Graham and Trotman.
3. Brasier, M.D., (1980). Principles of Microfossils. George Allen &Unwin.
4. Burger. H.R. (1992)- Exploration Geophysics of the Shallow Subsurface: Prentice Hall.,
5. ParasnisD.S. (1975).Principles of Applied Geophysics, Chapman and Hall.
6. Dobrin M.B.(1981) Introduction to Geophysical prospecting. McGraw Hill International Book Company.
7. Dobrin, M.B. (1976) :-Introduction to Geophysical Prospecting Brooks,
8. Glaessner, M.F., (1945). Principles of Micropaleontology.
9. Gunter Faure. (1998) – Principles and applications of Geochemistry–Pearson
10. Haq B.U. &Boersma A (1998). Introduction to Marine Micropaleontology, Elsevier.
11. Jones, D.J(1969). Introduction to Microfossils. Hafner Publishing Co., New York.
12. Jones, R.W., (1996). Micropaleontology in Petroleum Exploration. Oxford.
13. Kathal, P.K., (1997). Microfossils and their applications. CBS Publishers.
14. Kearey.P and Brooks.M (1984) An Introduction to Geophysical Exploration-ELBS.,
15. Lowire. W. (1997) - Fundamentals of Geophysics. Cambridge Low price Editions.,
16. Martin, R.E. (2000). Environmental Micropaleontology. Springer.
17. Mason.B (1966); Principles of Geochemistry – Willey Toppan.
18. Mathur S.M. (2001) – Guide to Field Geology: Prentice Hall of India
19. McKinstry H.E. (1960) - Mining Geology: Asia Publishing House
20. RamachandraRao M.B.(1975) – Outlines of Geophysical Prospecting – A manual for Geologist: University of Mysore.
21. Robinson. E.S. and Coruh.C. (2002)- Basic Exploration Geophysics– John Wiley.,
22. Sharma,P.V. (1986), Geophysical methods in Geology, Elsevier
23. Stanislane, M. (1984), Introduction to Applied Geophysics, Reidel Publishers

**OPEN ELECTIVE**

**PAPER - 3**

**(to choose one out of 3)**

**A. RAINWATER HARVESTING AND ARTIFICIAL GROUNDWATER RECHARGE**

**Unit I**

Hydrological cycle and its components.Surface water and groundwater.Vertical distribution of groundwater.Over-exploitation of groundwater - Need for artificial recharge and rainwater harvesting - types of wells - drilling technology - design, construction and development of water wells: dug, bore and tube wells.

**Unit II**

Types of pumps - various artificial recharge structures: recharge ponds - recharge pits - percolation ponds - basin spreading - surface and subsurface dykes - recharge wells - recharge bore wells. Rainwater harvesting in urban areas: RWH structures - design - construction.

**Unit III**

Estimation of probable runoff from an area including from rooftops - maintenance and monitoring of RWH structures. Study of benefits - effects on local groundwater environments - remedial measures. Recycling of domestic water - sources of water to recharge in urban areas.Aquifer and its types.

**Unit IV**

Water table and its fluctuations.Water quality parameters. BIS and WHO standards. Watershed management strategy.Salt water intrusion and remedial measures.Interlinking of rivers in India.Indian monsoon pattern.Role of meteorological department.

**Unit V**

Groundwater management strategy, recycling of effluent water, sources of water contamination and remedial measures. Impact of urbanization on water resources.Definition for river basin, sub basin,watershed and micro watershed. Role of public in watershed management practices at village level.

**Text / Reference Books:**

1. Rajora,R.,(1998), Integrated Watershed Management, Rewat Publications, New Delhi. Tideman.E.M.,
2. Lal.S., (2004), Watershed, Development, Management and Technology, Mangal Deep Publications,358p.
3. Paranjape,S.et.al.,(1998), Watershed Based Development: A Source Book, Bharat GyanVigyanSamathi, New Delhi.
4. Suresh,R.,(2002), Soil and Water Conservation Engineering, Standard Publishers and Distributers, Delhi.
5. Kakade,B.K.,(2002), Soil and Water Conservation Structures in Watershed Development Progarmmes ,BAIF Development Research Foundation, Pune.

**OPEN ELECTIVE**

**PAPER - 3**

**B. ENVIRONMENTAL GEOLOGY**

**Unit I**

Environmental Geology

Earth’s place in space.Fundamentalsconceptsof Environmental Geology*:*HumanPopulation Growth - Sustainability - Earth as a System - Hazardous Earth Processes - Scientific Knowledge and Values. Internal Structure of the Earth and Plate Tectonics - Plate Tectonics & Environmental Geology.Minerals and Rocks.Ecology and Geology.

**Unit II**

Natural Hazards

Hazards, Disasters, and Nature Processes - Evaluating Hazards*:* History, Linkages, Disaster Prediction, and Risk Assessment - Fundamentals principles concerning Nature Hazards - Human response to Hazards - Global Climate and Hazards - Population Increase, Land - use Change and Nature Hazards.

**Unit III**

Volcanoes and Earthquakes

Earthquakes:Magnitude and intensity. Plate boundary related Earthquakes -Earthquake processes (Faulting, Tectonic group). Earthquake shaking (seismic waves, seismograph) -Earthquake cycle - Earthquake caused by Human Activity-Effects of Earthquakes – Tsunami - Earthquake risk and Earthquake prediction - Earthquake warning system. Volcanic activity - Volcanic Hazards, Forecasting volcanic activity.Landslides: Human use Landslide - Minimizing the Landslide Hazards- Perception of Landslides.

**Unit IV**

River, Flooding, and Coastal Hazards

Rivers and Flooding: Sediments in River - River velocity, Discharge, Erosion, andSediments deposition- Effects of Land - use Change - Channel Pattern & Floodplain Formation - River Flooding - Urbanization& Flooding- The Nature and Extent of Flood Hazards - Adjustments to Flood Hazards - Perception of Flooding. Coastalprocesses:Erosion - Coastal Hazards & Engineering structure - Human activityand Coastal erosion - Perception of and Adjustment to Coastal Hazards.

**Unit V**

Resources and Pollution

Water Resources: A brief global prospective surface water – Groundwater -Interactions between surface water and Ground water - Desalination - Water Managements - Water and Ecosystem.Water Pollution: Selected Water Pollutions – Oxygen - Demanding Waste - Pathogenic Organisms - Nutrients - Toxic Substances - Synthetic Organic Chemicals – Heavy Metals - Surface Water Pollution and Treatment- Point Source and Non-point Source - Ground water Pollution and Treatment. Mineral resources: Mineral of Human use - Geology of Mineral Resources - Environmental Impact of Mineral Development - Recycling Mineral Resource Energy. Geothermal Energy.

**Text / Reference Books:**

1. Bennett, M. R. B., Doyle, P. (1997)Environmental Geology By. John Wiley & Sons, New York. RekhaGhosh and D. S. Chatterjee. Environmental Geology – Geoecosystems Protection in Mining Areas. Capital Publ. Co., New Delhi.
2. Carla W. Montgomery WCH Wm.C (1989). Environmental Geology, Brown Publishers Dubuque, Iowa
3. Chiras, D.D, (1989)Environmental Science – A framework for decision making, Addison – Wesley Publishing Company. New York.,
4. Davis, N. et.Al., (1976)Environmental Geosciences, John Wiley and Sons, New York.,
5. Detwler, T.R,(1971) Man’s Impact on Environment, McGraw Hill
6. Keith, L. H. (1996)Principles of Environmental Sampling. ACS Professional Reference book, Amer. Chem. Soc., Washington DC.
7. Khoshoo, T. L. (1988)Environmental Concerns and Strategies. AshishPubl.New Delhi.
8. Montgomery, C.W., (1989)Environmental Geology, Brown publications.,
9. Ray, P. K. and Prasad, A. K. (1995)Pollution and Health. Wiley Eastern Publ., New Delhi.,
10. Strahler, A.N., (1973)Environmental Geology, John Wiley and sons, New York.,
11. Subramanian, V. (2002), A Text book in Environmental Science, Narosa Publishing House, New Delhi
12. Valdiya, K. S. (1987)Environmental Geology - Indian Context. McGraw Hill Publ.,

**OPEN ELECTIVE**

**PAPER - 3**

**C. WATER QUALITY ANALYSIS**

**Unit I**

Physical properties of water: Colour,odour,taste,temperature,turbidity and viscosity.Methods of analysis of physical properties.World Health Organization (WHO) and Bureau of Indian Standards (BSI).

**Unit II**

Chemical properties of water:pH-alkalinity,acidity and their measurements, ionizationpotential, gassolubility, precipitation and dissolution of ions, equivalent weight and its measurements, colloids and coagulation, insoluble components and their measurements.

**Unit III**

Laboratory methods of Analysis: standard solutions-determination of Ph-HardnessDissolved oxygen-BOD-COD,TDS-TSS. Determination of F,Cl,N,P,K,Na,Ca,Mg, Fe, CaCo3,HCO3 & Trace Metals.

**Unit IV**

Utility of standards required for potable, Agricultural and Industrial purposes.Tools used for assessing the quality of water.

 **UNIT V**

Water pollution: Urban, Industrial pollution and remedial measures. Arsenic and Fluoride content in water. Recycling of water, water borne diseases, Reverse Osmosis (RO) system and Desalination of water. (Content – 3 Hrs. Assessment – 2 Hrs.) (5 Hrs.)

**Reference Books:**

1. Davis,N.S.,DeWeist,R.J.M.(1996)Hydrogeology,JohnWiley,New York.
2. Todd,D.K.,(2002) Grond Water 3rd edition,JohnWiley,Singapore.
3. Freeze,R.A.,Cherry,J.A.(1979) Ground water,PrenticeHall,New Jersey.
4. Sawyer,C.N., McCarty,P.L.,(1878) Chemistry for Sanitary Engineers,3rd edition,McGrawHill,New York.
5. APHA(1980) Standard Methods for the Examination of Water and Waste Water,15 th edition, American Water Association and Pollution Control Federation,New York.

**SEMESTER IV**

**PAPER - 12**

**GEOGRAPHIC INFORMATION SYSTEM (GIS) AND APPLICATIONS**

**Unit 1**

Introduction to GIS: Definition, Basic Concepts, history and evolution, Components, applications areas, and overview of GIS. Data structure: Spatial and Non-spatial. Data formats – Advantages and disadvantages of raster and vector data. Polygon structures – Arc Node structures. Digitization: Manual and Automatic.

**Unit II**

Spatial data: introduction, maps and their influence on the character of spatial data. Thematic characteristics.Other sources of spatial data. Map Projection and its types. Attribute data management, introduction, database, creating a data base, GIS data base applications. Spatial -Raster -Vector - data base development, data input and editing.

**Unit III**

Spatial data models - Spaghetti model, Topology model, Grid model, Digital Terrain models, and TIN model. Attributedatamanagement-introduction -datamodels-creatingadatabase- GISdatabaseapplications.

**Unit IV**

Spatial Analysis: Logic, general arithmetic, statistical, geometric operations. Query and report generation from attribute data, geometric data search and retrieval, classification reclassification, integrated geometry and attributes, overlay, buffer zones, raster data overlay, integrated data analysis. Spatial interpolation techniques.Exposure to GIS software’s.Definition and concept of Web GIS - advantages and limitations of Web GIS.

**Unit V**

GIS Applications in Natural Resource management, Mineral resources exploration, Geology, Ground water potential zone, locating sites suitable for ground water recharging, groundwater contamination. Mapping and monitoring of forest cover, land use land cover mapping. Coastal Zone Management.

**Reference Books:**

1. Concepts and Techniques of Geographic Information Systems CP Lo Albert K W Yeung, 2005 Prentice Hall of India.
2. Principles of GIS for Land Resources Assessment by P.A. Burrough, Oxford : Science publications, 1986.
3. Geographic Information Systems – An introduction by Tor Bernhardsen, John Wiley and Sons, Inc, New York, 2002.
4. GIS – A computing Perspective by Micheal F. Worboys, Taylor & Francis, 1995.
5. Geographical Information Systems – Principles and Applications, Volume I edited by David J. Maguire, Michael F Goodchild and David W Rhind, John Wiley Sons. Inc., New York 1991.
6. Geographical Information Systems – Principles and Applications, Volume II edited by David J. Maguire, Michael F Goodchild and David W Rhind, John Wiley Sons. Inc., New York 1991.
7. Amdahl G (2002) Disaster Response: GIS for Public Safety, Published by ESRI, Redlands California.

**PRACTICAL-III**

**ECONOMIC GEOLOGY AND MINING GEOLOGY**

**Economic Geology**

Study of, Industrial and ore minerals with special emphasis on physical, chemical characteristic mode of occurrences and uses

**Mining Geology**

Problems relating to evaluation of Ore reserves.

**PRACTICAL – IV**

**HYDROGEOLOGY, REMOTE SENSING AND GIS**

**Hydrogeology**

Estimation of chemical dissolved constituents*:* major, minor and traces ingroundwater using standard laboratory techniques.

Diagrammatic representation ofhydrochemical data*:* bar, circular radial, multivariate schoeller diagram, fourcoordinatediagram, stiffs diagram, horizontal and vertical scale diagram. Plotting on maps-Piper, U.S. Salinity Laboratory diagram, Wilcox, Doneen, Gibbs and Durov plots.

Groundwater exploration techniques: geophysical and geological methods of ground water exploration.

Pumping test*:* time draw down and time recovery tests and evaluation of aquifer parameters.

**Remote sensing and GIS**

**Aerial Photography**:Stereovision Test, Pocket &Mirror Steoscope-3D Observation,Demarcation of marginal informations, Interpretation of drainage pattern, landforms, rock types and structures.

**Satellite remotesensing:**Identification photo Recognition elements. Interpretation of satellite datafor geomorphology, structure and lithology.Exposure to Digital Image Processing techniques,spectral plot for different features.

**GIS:**Geo-Referencing. Digitization, Preparation of Vector and Raster Image, Buffer analysis, and Overlay analysis.

**core elective**

**PAper - 4**

**(to choose one out of 3)**

1. **Industrial minerals and Mineral economics**

**Unit I**

Introduction: Industrial minerals and rocks. Identification of minerals: Physical properties of minerals. Mineral wealth of Tamil Nadu. Mineral based Industries in India. Geology, Mode of occurrence and origin of the raw materials of the following Industries: Refractory and abrasives.

**Unit II**

Mode of occurrence, origin and distribution of economic minerals of India: Ceramic materials, construction materials-cement raw materials, mineral pigments, asbestos, mica and fullers earth. Mineral fertilizers: Geology, source, uses, production and distribution of potash, nitrates, phosphates, gypsum, lime, sulphur, and minor fertilizer minerals.

**Unit III**

Mode of occurrence, origin and distribution of industrial minerals: Industrial properties of rocks: Building stones, decorative stones: Granite Industry: Granites, black Granites (Dolerites) their mode of occurrence, origin and distribution. Cement Industry: Limestone, gypsum - Origin and distribution in Tamil Nadu. Gem Industries: Gem varieties. Clay mineralogy: Physico-chemical and structural properties of clay minerals.

**Unit IV**

Mineral economics and its concepts.Classification and mineral resources.Peculiarities inherent in mineral Industry.National mineral Policy and conservation of mineral resources. Mines and Mineral legislation in India, Mining laws in various lands, Law of Seabed for marine mineral resources. Mineral taxation.

**Unit V**

Strategic, critical and essential minerals, present and future mineral supplies of World, India’s mineral production, Consumption, export and import details and their role in National economy.Tenor, grade and specification of important minerals with relevant to domestic examples.

**Reference Books:**

1. Aiyengar, N.K.N.1964, Minerals of Madras, Dept. of Industries and Commerce, Madras,
2. Alan M.Bateman , 1961, Economic mineral deposits, Asia Publishing House, Mining Geology, H.E. McKinstry, Asia publishing house, 1960.
3. Coggin Brown, J. &Dey, A.K.1955, India’s Mineral Wealth, Oxford University Press,
4. Deb, S.., 1980, Industrial minerals and Rocks of India, Allied Publishers Pvt. Ltd.
5. Evans, A.M. (1993) Ore Geology and industrial minerals, Blackwell.
6. Gkhale, K.V.G.K. and Rao, T.G.1972, Ore deposits of India, Thompson press Ltd., Delhi – 6, Indias
7. Krishnaswamy, S.1972, Mineral Resources, , Oxford and IBH Publishing Co.,
8. Lindgren, W. 1933, Mineral deposits, McGraw Hill Book Co.,
9. Minerals for Atomic Energy, Robert, D.Nininger,D.vanNostrand Co., 1955.
10. Ralph, B.Grim, 1968, Clay Mineralogy, , McGraw Hill Book, Co.,
11. Sinha, R.K and Sharma , B.N.L., 2019, Mineral Economics, Fourth edition, Oxford and IBH Publishing Co

**core elective**

**PAper - 4**

**B. MINING AND ENGINEERING GEOLOGY**

**MINING GEOLOGY**

**Unit I**

Mining terminology, classification, geological factors considered for the selection of mining method viz.- Alluvial/Surface mining, Quarrying, Open-cast mining, and Underground mining methods; Geological conditions for-Types of openings, their position, shape and size -adits, inclines, shafts, levels, cross-cuts, winzes and raises. Types of drilling methods.Explosive types, composition and its applications. Surface mining *machineries*.

**Unit II**

Alluvial mining: Types of placer mining, Panning, hydraulicking, Mechanical methods. Opencast mining Methods – bench cut, glory hole, strip mining. Factors considered for mechanization and transportation. Underground mining methods - board and pillar, room and pillar, long wall mining. Mine supports, Mine ventilation and Drainage. Mining hazards.Mines and Minerals Act.

**ENGINEERING GEOLOGY**

**Unit III**

Scope of geology in civil engineering and mining industry.Various stages of engineering geological investigations for civil engineering projects.Engineering properties of rocks, rock discontinuities, physical characters of building stones, concrete and other aggregates.Use of remote sensing in engineering geology.

**Unit IV**

Geological considerations for the construction of dams and reservoir sites. Types of dams, dam foundation, rock problems. Geotechnical evaluations of tunnel alignments and transportation routes.Methods of tunneling; Classification of ground for tunneling purposes; various types of support.

**Unit V**

Geological considerations for the construction of roads/ highways and bridges. Mass Movements with special emphasis on landslide and causes of hill slope instability. Engineering consideration of seismicity, influence of geological condition on foundation and design of buildings, seismic resistant structure, earthquake problems in India.

**Text / Reference Books:**

1. Arogyaswamy, R.N.P. (199)4. Course in mining Geology. Oxford IBH – New Delhi.,
2. Chandra, B. Krishna, J and Chandrasekaran, A. (1994). Elements of Earthquake Engineering. South Asian Publishers.
3. Deshmukh, R.T. (1993)High Technology in Drilling and Exploration, Oxford-IBH, New Delhi.,.
4. Gupta, H.K. and Rastogi, B.K. (1976).Elements of mining Technology Dhanbad publishers. Dhanbad.
5. Indian Bureau of Mines (1979) Dams and Earthquakes. Elsevier Scientific Publishing Company.,
6. Mineral exploration. IBM, Nagpur.,Krynine, D.H. & Judd, W.R. (1998) Principles of Engineering Geology, CBS Edition.,
7. Mckinstry, H.E. (1980). Mining Geology, Prentice Hall, N.Y., Parbinsingh 1991.
8. Peters, W.C. (1987)A Text Book of Engineering & General Geology. Kataria&Sons.,.
9. R.W. (1997). Geological methods in Mineral Exploration and Mining, Chapman & Hall, London.
10. Schultz, J.R. & Cleaves, A.B. (1951). Geology in Engineering, John Willey &Sons.,
11. Staheler A.N. and Strahler A.M. (1973). Environmental Geoscience-John Wiley & Sons., Venkatramiah, 1989 Engineering Geology.Wiley

**core elective**

**PAper - 4**

**C. APPLIED GEOLOGY AND GEOSTATISTICS**

**UNIT I**

Mining methods–criterion for selecting mining method.Sea bed mining.Exploitation/Recovery/Mining/Extraction of petroleum.Mining legislation in India. Plans to be prepared and maintained in a mine – EMP, Mining Plan, Mine Closure Plan, Surface Plan, etc. Underground gasification of coal and lignite.Fundamentals of ore dressing - crushing, grinding, sizing, jigging, tabling, floatation.Spiraling, Magnetic and electrostatic separation.Beneficiation of ores by bio-leaching method.

**UNIT II**

Scales of measurement: nominal, ordinal, interval and ratio. Averages: MeanMedian, Mode, Geometric mean and Harmonic mean. Measures of dispersion: Range, Mean deviation, Variance, Standard deviation, and quartile deviation, coefficient of variation (Only the Concepts & numerical problems in the field of geology). Elements of probability: random experiments, sample space, event, disjoint events, definitions of probability, independence of events. Addition theorem, multiplication theorem, Bayes’ theorem.

**UNIT III**

Concept of Random variables, probability distributions; standard probability distributions: Binomial, Poisson, and Normal. Importance of sampling in data collection; sampling techniques: simple random sampling, systematic sampling, stratified sampling and cluster sampling. Parameter and statistic; sampling distributions: normal, t, chi square and F.

**UNIT IV**

Introduction to statistical inference: Estimation, testing of hypothesis (basic principles, importance of statistical inference in decision making with suitable examples in Geology); t-test of mean, t-test for equality of means, Chi square test of independence, analysis of variance: one-way and two-way (numerical problems); Non-parametric tests (name of the tests and their applications only).

**UNIT V**

Geological measurements of sequences of data: Correlation and simple linear regression (concepts, least squares method, simple problems in geology); Moving averages and Kriging, trend analysis, multiple regression, principle component analysis, discriminant analysis, cluster analysis, factor analysis.

**Reference Books:**

1. Davis J. C. Statistics and data analysis in Geology. Wiley.
2. Harbadigh J. M. and Merriam U. F. Computer applications in stratigraphic analysis. Wiley 1968.
3. Miller R. L. and Khan T. S. Statistical analysis in geological analysis. Wiley 1962.
4. Moroney K. J. Facts from figures. Penguin 1952.
5. Krumbein M. B. and Gray Hill H. A. Introduction to statistical methods.
6. Gaudin A. M. Principles of mineral dressing. McGraw Hill.
7. Taggart A. P. Handbook of mineral dressing. Wiley.
8. Paul P., Mishra G. C. and Panda D. K. Modern mining equipments beyond 2000AD as
9. applicable to the limestone mining industry. National Council for Cement and Building, Materials, New Delhi.
10. Bhaskarathondaiman K. Blasting technology. India Cements,Tirunelveli.
11. Biran K. K. and Ramaswamy P. Surface miner – ecofriendly equipment for open cast mines. Mining engineers journal, V. 1(11), 2000.
12. Surana I. S. Mining without drilling and blasting Mining Engineers Journal v 2(9), 2000.

**open elective**

**PAper - 4**

**(to choose one out of 3)**

1. **GEOHERITAGE, GEOPARKS AND GEOTOURISM**

**Unit I**

 Introduction and importance of Geodiversity, Geoheritage, Geoconservation; Geoparks and Geotourism; History of the concept

 **Unit II**

Geological outcrops and society; Threats to geodiversity; Conservation, protection, maintenance of geological sites and related features of National importance; Conservation of geosites as a tool to protect geoheritage.

**Unit III**

Potential geoparks and geosites in India; Rajasthan, Odisha, Karnataka, Andhra Padesh, Madhya Pradesh, Telangana, Tamil Nadu, Kerala, Gujarat, Himachal Pradesh

**Unit IV**

UNESCO geoparks, Geopark networks across the globe; Geotourism and National geological Monuments.

**Unit V**

Guidelines for selection of Geosites; Geoheritage laws, Role of local, state and national governments; Current status of Geoheritage protection in the country; Global geoheritage and protection laws.

**Reference Books:**

1. A Monograph on National geoheritage monuments of India, Indian National Trust for Art and Cultural Heritage, Natural Heritage Division, New Delhi
2. Ranawat, P. S., George, S., 2016 Potential Geoheritage&Geotourism Sites in India International Journal of Scientific and Research Publications, Volume 9, Issue 6, June 2019
3. EzzouraErrami, Margaret Brocx (Ed.) 2009. Geoheritage, Geoparks and GeotourismConservation and Management Series Springer. P 268.

**open elective**

**PAper - 4**

**B. INTRODUCTION TO GEOSPATIAL TECHNOLOGY**

**Unit I**

Remote Sensing: Definition, Electromagnetic spectrum – Energy sources – Electromagnetic spectrum with atmosphere and earth surface features – spectral signatures – atmospheric windows.

**Unit II**

Types of remote sensing based on Energy sources – active and passive, Platforms – aerial and satellite, and Sensors – optical, thermal and microwave. Satellite orbiting mechanisms, types of resolution.A short account of LANDSAT, SPOT and Indian Remote Sensing satellites.Introduction to GPS.

**Unit III**

Geographic Information System: Definition, components of GIS, Data structures: Spatial and Non-spatial, Advantages and Disadvantages of spatial data. Polygon structures: Arc Node structures. Digitization: Manual and Automatic. Data input and output.

**Unit IV**

Spatial Analysis: Logic, general, arithmetic, statistical, geometric operations. Query and report generation from attribute data, geometric data search and retrieval, classification reclassification, integrated geometry and attributes, overlay, buffer zones, raster data overlay, integrated data analysis. Spatial interpolation techniques.Exposure to GIS software’s.Definition and concept of Web GIS.

**Unit V**

Remote Sensing and GIS Applications: Natural Resource management, Urban planning, Agriculture, Geology, Ground water potential zone, locating sites suitable for ground water recharging, groundwater contamination. Mapping and monitoring land use land cover mapping. Coastal Zone Management.

**Text and Reference Books:**

1. Burrough P A (1986). Principles of GIS for Land Resources Assessment, Oxford University Press.
2. ChorPang Lo and Albert K W Yeung (2016).Concepts and Techniques of Geographic Information Systems. Pearson.
3. Curran P.B. (1985).Principles of Remote Sensing.ELBS. London.
4. GupthaR.P. (2003). Remote Sensing Geology.Springer. New Delhi.
5. LillisandT.M&R.W.Kiefer.(2000). Remote Sensing and Image Interpretation.Wiley.
6. Micheal F. Worboys (1995). GIS – A computing Perspective. Taylor & Francis.
7. Miller V.C. (1961). Photogeology.McGraw Hill. New York.
8. Reddy A. (2010).Principles of Remote Sensing and GIS.CBS. Delhi.
9. SabinsF.F. (1974). Remote Sensing Principles and Interpretation. Freeman. New York.
10. Tor Bernhardsen (2002). Geographic Information Systems – An introduction. John Wiley and Sons, Inc, New York.

**open elective**

**PAper - 4**

**C. DISASTER MANAGEMENT**

**Unit I**

Introduction to Disaster: Definition, Nature, Importance of Hazard, Risk, Vulnerability and Disaster- Dimensions & Scope of Disaster Management - India’s Key Hazards – Vulnerabilities - National disaster management framework - Disaster Management Cycle. Types of disaster: natural and manmade.

**Unit II**

Natural Disaster: Natural Disasters - Definition and nature, their types and effects. Floods, drought, cyclone, earthquakes, tsunami, landslides, avalanches, volcanic eruptions, Heat and cold waves, Climatic change: global warming, Sea level rise, ozone depletion.

**Unit III**

Man Made Disasters: Definition, Causes and Impacts: Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, air pollution, water pollution, deforestation and industrial waste water pollution.

**Unit IV**

Disaster Mitigation:Concepts – Need - Mitigation measures – Guiding principles. Types of disaster mitigation: Structural and Non-structural. Preparedness vs. Mitigation. Disaster Mitigation strategies: Government of India Initiative.

**Unit V**

Disaster Management: Pre- disaster stage (preparedness) - Preparing hazard zonation maps, Predictability/ forecasting & warning - Preparing disaster preparedness plan - Land use zoning - Preparedness through Information, education. Emergency Stage - Rescue training for search & operation - Immediate relief - Assessment surveys. Post Disaster stage: Rehabilitation - Social Aspect - Economic Aspect and Environmental Aspect. Indian scenario of hazard preparedness.

**Text and Reference Books:**

* 1. Sharma.S.R, “Disaster management”, A P H Publishers, 2011.
	2. VenuGopalRao.K, “Geoinformatics for Disaster Management”, Manglam Publishers and Distributors, 2010.
	3. Singh.R.B, “Natural Hazards and Disaster Management: Vulnerability and Mitigation”, Rawat Publications, 2006.
	4. Gupta.H.K, “Disaster Management”, University Press, India, 2003.
	5. Gupta.M.C, “Manuals on Natural Disaster management in India”, National Centre for Disaster Management,IIPA, New Delhi, 2001.

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