FACULTY OF SCIENCE
DEPARTMENT OF EARTH SCIENCES
M.Sc. Geology
(Choice Based Credit System) (2017-2018)
REGULATIONS AND SYLLABUS

REGULATIONS

Eligibility

Candidates for admission to the M.Sc., Geology degree programme shall be required to have passed in B.Sc., Geology course.

Master Programme

A Master's programme consists of a set of Core courses and optional courses

Core courses are basic courses required for each programme. The number and distribution of credits for core courses will be decided by the respective faculties.

Optional courses suggested by the respective departments and they may be distributed in all the four semesters.

A course is divided into five units to enable the students to achieve modular and progressive learning.

Semesters

An Academic year is divided into two semesters, Odd semester and Even semester. The normal semester periods are:

Odd semester: July to November (90 working days)

Even semester: December to April (90 working days)

Credit

The term credit is used to describe the quantum of syllabus for various programmes in terms of hours of study. It indicates differential weightage given according to the contents and duration of the courses in the curriculum design.

Courses

A course carrying one credit for lectures, will have instruction of one hour per week during the semester, if four hours of lecture is necessary in each week for that course then 4 credits will be the weightage. Thus normally, in each of the courses, credits will be assigned on the basis of the lecture tutorials/laboratory work and other form of learning in a 15 week schedule:

i) One credit for each lecture hour per week.
ii) One credit for every two or three hours of laboratory or practical work per week as per the requirement of department concerned.

Grading System

The term Grading System indicates a 10 point scale of evaluation of the performance of students in terms of marks, grade points, letter grade and class.

Duration

The duration for completion of a Two year Master's Programme in any subject is Four semesters.

Structure and Programme

The Foursemester Master's Programme will consist of:

i) Core courses and Common courses which are compulsory for all students.

ii) Optional courses which students can choose amongst the courses offered by the Departments of Science faculty, Department itself and by the Departments of other faculties. (Arts, Education and Indian Language)

Attendance

Every teaching faculty handling a course shall be responsible for the maintenance of attendance register for candidates who have registered for the course.

Each student should earn 80% attendance in the courses of the particular semester failing which he or she will not be permitted to sit for the End-semester examination.

Examinations

The internal assessment for each theory course carries 25% marks and practical course 40% of marks which is based on two internal assessment tests with assessment tools such as seminar and assignment. The pattern of question paper will be decided by the respective faculty. The tests are compulsory.

For internal assessment evaluation, the break-up marks shall be as follows:

THEORY	MARKS	PRACTICAL	MARKS
Test-I	10	Test at the end of semester	30
Test-II	10		
Assignment	5	Record and reports	10
Total	25	Total	40

There will be one end Semester Examination (75% marks) of 3 hours duration for each Theory course and an end semester examination (60%) to each Practical courses. The pattern of question paper will be decided by the respective faculty.

Evaluation

The performance of a student in each course is evaluated in terms of Percentage of Marks (PM) with a provision for conversion to Grade Point (GP). The sum total performance in each semester will be rated by GPA while the continuous performance in Core, Allied and Optional courses will be marked by (CGPA).

Marks and Grading

The student cannot repeat the internal assessment test I and internal assessment test II. However, if for any compulsive reason, the student could not attend the test, the prerogative of arranging a special test lies with the teacher in consultation with the Head of the Department.

A student has to secure 50% minimum in the End Semester Examination.

The student who has not secured minimum of 50% of marks (Internal assessment mark plus End semester examination) in a course shall be deemed to have failed in that course.

A candidate who has secured a minimum of 50% marks in all the courses prescribed in the programme to pass the Masters Programme.

Grading

A ten point rating scale is used for the evaluation of the performance of the student to provide letter grade for each course and overall grade for the Master's Programme.

Marks	Grade Point	Letter Grade	Class
90 +	10	S	Exemplary
85-89	9.0	D^{++}	Distinction
80-84	8.5	D^{+}	,,
75-79	8.0	D	,,
70-74	7.5	A^{++}	First Class
65-69	7.0	A^{+}	,,
60-64	6.5	A	,,
55-59	6.0	B	Second Class
50-54	5.5	C	,,
49 or Less		F	Fail

Grade cards will be issued to the students, after the declaration of results. The grade card will contain the list of courses registered during the semester, the grades scored and the Grade Point Average for the semester.

GPA is the sum of the products of the number of credits of courses with the grade point scored in that programme, taken over all the courses for the semester divided by the sum of the number of credits for all courses taken in that semester. CGPA is similarly

calculated considering the Core, Allied and Optional courses taken from first semester to tenth semester.

The results of the final semester will be withheld until the student obtains passing grade in all the courses of all earlier semesters.

DEGREE WILL BE AWARDED AS FOLLOWS:

Those who complete successfully all the FOUR – Semester Examinations will be issued M.Sc., degree in Geology.

For First class with Distinction the student must earn 90 credits Pass in all the courses in the first attempt and obtain a CGPA of 8.00 or above in Core and Optional courses from first to fourth Semester.

For the First class the student must earn 90 credits, Pass in all the courses and obtain a CGPA of 6.50 or above in Core, Allied and Optional courses from first to ten semesters.

RANKING OF CANDIDTES

The candidates who are Eligible to get the M.Sc degree in first class with distinction will be ranked on the basis of CGPA scored in Core and Optional courses of study from first semester to fourth semester.

The candidates passing with First class will be ranked next to those with distinction on the basis of CGPA scored in Core and Optional courses of study from first semester to fourth semester.

Candidates who obtain First class with distinction shall be deemed to have passed the examinations provided he / she passes all the courses prescribed for the programme at the First Appearance.

TRANSITORY REGULATIONS

Wherever there had been change of syllabi, examinations based on the existing syllabi will be conducted for three times consecutively after implementation of the new syllabi in order to enable the students to clear the arrears. Beyond that the students will have to take up their examinations in equivalent programmes, as per the new syllabi, on the recommendations of the Head of the Department concerned.

The University shall have powers to revise or change or amend the regulations, the scheme of examinations, the programmes of study and the syllabi from time to time.

M.Sc., GEOLOGY
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF EXAMINATIONS 2017-2018 ONWARDS

Semester-I

Code	Theory & Practical			
		L	P	C
GEOC 101	Geomorphology &Structural Geology	4	0	4
GEOC 102	Advanced crystallography, Mineralogy and Mineral optics	4	0	4
GEOC 103	Indian Stratigraphy and Marine Geology	4	0	4
ENGE 116	Soft Skill (English)	4	0	4
GEOP 104	Practical –I, Structural geology, Crystallography and filed reports.	0	10	4
	Total	16	10	20

Geological Mapping training - Two week's duration

Semester- II

Code	Theory & Practical			
		L	P	C
GEOC 201	Geophysical Exploration	4	0	4
GEOC 202	Remote sensing & GIS	4	0	4
GEOC 203	Hydrogeology and Engineering Geology	4	0	4
GEOP 204	Practical – II Mineralogy, Mineral optics	0	10	4
GEOP 205	Practical – III Remote sensing,Digital image processing and GIS	0	10	4
GEOP 206	Practical – IV Geophysics, Hydrogeology and Engineering Geology, Survey	0	10	4
Option-1	Optional – I Statistics Applications	4	0	4
	Total	16	30	28

Industrial/ institutional training -Three weeks duration during Annual holidays

Semester- III

Code	Theory & Practical			
		L	P	C
GEOC 301	Economic Geology and Mining Geology	4	0	4
GEOC 302	Geological and Geochemical Exploration	4	0	4
GEOC 303	Advanced Petrology	4	0	4
GEOP 305	Practical – V- Economic Geology and Geochemical exploration, Industrial/ Institutional Training report	0	10	4
Option-2	Optional – II Environmental Geology and Disaster Management (internal)	4	0	4
	Total	16	10	20

Short Field visits to nearby geological interested places during week end & holidays

Semester-IV

Code	Theory & Practical			
		L	P	C
GEOC 401	Coal and Petroleum Geology	4	0	4
GEOC 402	Atmospheric Sciences and Meteorology	4	0	4
GEOP 403	Practical-VI Petrology and Petrochemistry		10	4
GEOP 404	Dissertation and Viva-Voce		6	2
GEOO 405.1 405.2	Optional III Isotope Geology and Nuclear Geology (internal) (OR) Instrumentation Techniques in geosciences (Internal)	4	0	4
GEOO 406.1 406.2	Optional – IV Medical Geology (OR) Application of Software in Geoscience	4	0	4
	Total	16	16	22

L= Lecture: P = Practical C = Credit – (Core = 70 + Soft skill = 4 + optional = 16)
Total credits : = 90
End semester Theory: 25 (IA) + 75 (E) = 100
Internal Test (2) = 15; Assignment =5; Seminars = 5; Total = 25
Practical: 40(IA) + 60 (E) = 100
Practical: I & III,IV Test (1) = 30: Record = 10; Total = 40
Practical II, & V, Report= 15: Test (1) = 15 Record = 10 Total=40
Dissertation report-60 and Viva Voce-40
IA = Internal Assessment, E = End Semester written Examination

GEOC101 GEOMORPHOLOGY AND STRUCTURAL GEOLOGY

Objective: To gain knowledge in different aspects of geomorphology viz. theoretical geomorphology (geomorphic concepts, theories of landscape development, plate tectonics, morphometry etc.), geological geomorphology (rocks, earth's movement, structural geomorphology), weathering, transportation and deposition by different agents. This also focuses structural relationship of rocktypes and understanding the structural movement in rocks.

UNIT – I PRINCIPLES AND PROCESS OF GEOMORPHOLOGY

Basic principles and Concept of Geomorphology, erosion cycles. Historical and process Geomorphology. Processes – weathering, pedogenesis, mass movement, erosion, transportation and deposition, Influence of climate on processes. Geomorphic processes and landforms – fluvial, glacial, eolian, coastal and karst. Earth's gravity and magnetic fields and its thermal structure: Concept of Geoid and, spheroid; Isostasy. Theories of palaeomagnetism. Ice ages and their periodicity.

UNIT – II INDIAN GEOMORPHOLOGY AND APPLICATIONS OF GEOMORPHOLOGY

Indian plate tectonics: configuration of Indian plate, mobile belts in peninsular India. Evolution of Himalaya and Himalayan tectonics. Applications of geomorphology in mineral prospecting, civil engineering, hydrology, structure, lithology and environmental studies. Geomorphology of India.

Unit – III: STRUCTURAL PROPERTIES OF ROCKS:

Mechanical properties of rocks- - elastic, plastic and rupture. Theory of stress and strain. Behaviour of minerals and rocks under stress. Mohr circle. Various states of stress and their representation by Mohr circles.

Unit – IV: FEATURES OF ROCKS:Geometry and analyses of brittle-ductile and ductile shear zones. Sheath folds. Geometry and mechanics of development of folds, boudins, foliations and lineations. Interference patterns of superposed fold.Geometry and mechanics of Fault; Fault-related folding. Gravity induced structures. Recognition of fold and fault in the field, determination of top and bottom of beds, introduction to map reading

Unit – V: STRUCTURAL ANALYSIS:

Structural analysis: Principles and elements of structural analysis of simple and complex structures – Microscopic to macroscopic scale. Petrofabric analysis: Field technique-laboratory technique and interpretation. Stereographic projection – equal area projection and structural analysis. Tectonites, their classification and geological significance.

BOOKS FOR STUDY

01. Billings, M.P, (1974), Structural Geology, Prentice Hall of India.
02. Davies, F. (1999). Dynamic Earth, Cambridge University Press.
03. Dayal, P. (1990). A Text Book of Geomorphology, Shukla Book Depot, Patna.
04. Duff.P.Mcl.D. (1992), Holmes, Principles of Physical Geology, Edited by 4th Ed. Chapman and Hall, London.
05. Fairbridge, R.W. (1968), Encyclopedia of Geomorphology, Reinhold Book Corporation.
06. Hobbs, Means and William, (1976), an outline of Structural Geology, Wiley International Edition.
07. Jeanm Goguel, (1962).Tectonites, W.H.Freeman & Co.,
08. King, L.C. (1967), Morphology of the Earth, 2nd Ed. Oliver & Boyd, London.
09. Leopold, L.S. et.al. (1964), Fluvial processes in Geomorphology, Eurasia Publishing House, New Delhi.
10. Park, R.C. Blackies, (1988). Geological Structures and moving plates, Chapman and Hall, New York.
11. Phillips Edward, F.C. (1994). The use of Stereographic projection in Structural Geology, Arnold Publishers.
12. Ramsay, J.G., Huber, M.I., (1987), Vol.2, The Techniques of modern Structural Geology, Folds and Fractures.
13. Robert R. Compton, (1962), John Wiley & Sons, Manual of field geology, INC, Newyork, London.
14. Sharma, H.S. (1990), Indian Geomorphology, concept Publ. Co., New Delhi.
15. Thornbury, W.S. (1969), Principles of Geomorphology, Wiley Eastern, New Delhi.

16. Windley. B.F., John Wiley & sons, (1978). The Evolving continents, Allen Cox, 1973. Plate Tectonics, Freeman and company.

GEOC 102 ADVANCED CRYSTALLOGRAPHY, MINERALOGY & MINERAL OPTICS

Objectives:To know about the nature, forms, habit, symmetry elements, measurement of interfacial angles and twins in crystals. The classification of crystals into system and classes along with X- diffraction pattern and their interpretation. To learn about the physical and optical properties of rock forming minerals. It deals about the structure, physical and chemical properties of ortho, ring, sheet, chain and framework silicates.

UNIT-I: CRYSTAL SYMMETRIES AND PROJECTIONS:

Crystalline and amorphous states of matter, symmetry elements, translation, rotation, reflection, inversion, screw and glide-point groups. Crystal Projections: Spherical, Stereographic and Gnomonic-Zones. Zone symbols and Weiss Zone law equation, Law of anharmonic ratio-Napier's rule-Equations to Normal-Calculation of interfacial angles, axial ratios, Miller indices.

UNIT-II: X-RAY DIFFRACTION METHODS &NOTATIONS:

Crystal classes-Derivation of 32 crystal classes based on Schoenflies notation, Hermann Mauguin system. Bravies lattices and their derivation. An outline on space groups.

X-ray diffraction method: basic principle, powder method: Bragg's law and its application. Calculation of cell dimensions. Method of identification of minerals from X-ray diffractogram.

UNIT-III: OPTICAL & CHEMICAL MINERALOGY:

Optical classification of minerals: Optical properties: Refractive indices, Pleochroism, Birefringence. Optic sign, Uniaxial and biaxial interference figures. Optic axes, Optic axial angle measurements-Optic orientation-Optical anomalies. Atomic structure, Chemical bonds. Structural classification of silicate minerals. Transformation of minerals – polymorphism, polytypism, and polysomatism. Solid solution and exsolution. Isomorphism, Atomic substitution, Pseudo-morphism-Flourescence in minerals. Metamict state. Bonding of common oxides, sulphides and silicate minerals.

UNIT-IV: SILICATE STRUCTURES AND STUDY OF IMPORTANT SILICATE GROUPOF MINERALS:

Brief account of silicate structure and distinguishing features and geochemical significances of the following group of minerals. Frame work silicates: Feldspar, Feldspathoid, Zeolite and Scapolite. Chain silicates: Pyroxene and Amphibole. Sheet silicates: Mica, Chlorite and clay minerals.

UNIT-V: SILICATE AND NON SILICATE MINERALOGY:

Description of chemical, optical and physical properties, distinguishing features, paragenesis of the following important group of minerals: Ortho and ring silicates: Olivine, Garnet, Alumino silicates and Epidote. Study of following individual minerals: Zircon, Staurolite, Beryl, Cordierite and Tourmaline. Non-silicate- Spinel group, Carbonates and Phosphates.

BOOKS FOR STUDY:

01. Azaroff, L.V. & W.H.Berger, (1959). The powder method, Mc Graw Hill Book Co., American mineralogist special volumes on Mineralogy.

02. Babu, S.K. and D.K.Sinha, (1987), Practical Manual of Crystal Optics, CBS Publishers & Distributors.
03. Berger, W.H. (1956). Elements of Crystallography, John Wiley and sons.
04. Berry Mason, L.G. (1961). Mineralogy, John Wiley & Sons
05. Dana, E.S. (1935). A Text Book of Mineralogy, John Wiley & Sons
06. Deer, W.A, Howie, R.A and Zussman, J, Longmans, (1966), An Introduction to Rock Forming minerals,
07. Deer, W.A., Howie, R.A., Zussman, J., (1962), Longmans,. Rock forming minerals (Vols1-5).
08. Ernest, E. Walhstrom, (1960). Optical Crystallography, John Wiley & Sons
09. Kerr, B. F. (1959),Optical Mineralogy, 5th Ed. Mc Graw Hill, New York, Evans, 1966.An introduction to Crystal chemistry, R.C., Cambridge University Press,
10. Mitra, S. (!986) Fundamentals of Optical, Spectroscopic and X-ray Mineralogy, S.R.Technico Book House, Ashok Raj Path, Patna.
11. Ralph, B.Grim, (1953), Clay mineralogy, Mc Graw Hill Book Co.,

GEOC 103 INDIAN STRATIGRAPHY ANDMARINE GEOLOGY

Objectives:To learn about the geological time scale, principles of stratigraphy and the description of strata and their relationship to tectonics, climate, fossils along with their distribution in different parts of India from Precambrian to recent and geological boundary problems and applications of stratigraphy.To gain knowledge of marine environments, morphology, processes, classification, and marine resources. To integrate modern and classical concepts of geology in an understanding of the history of the oceans and microfossils. Also aims in dealing the current sea level changes, its impact and coastal management.

UNIT-I: PRINCIPLES OF STRATIGRAPHY AND PRECAMBRIAN OF INDIA

Principles of stratigraphy, Geological time-scale. Nomenclature and the modern stratigraphic code. Lithostratigraphic, chronostratigraphic and biostratigraphic subdivisions.Concept of sequence stratigraphy. Methods of startigraphic correlation including Shaw's Graphic correlation. Stratigraphic correlation of fossiliferous and unfossiliferous strata. Dharwar-Stratigraphy and their economic importance-Cuddapah Basin structure and tectonics, Stratigraphy and economic importance; Vindhyan system, its fossils, age and economic importance.

UNIT-II: PALEOZOIC & MESOZOIC ROCKS OF INDIA

Cambrian to carboniferous system, their distributions, geological succession and fossils. saline series-Gondwana group-classification, geological succession, distribution, structure, sedimentation, fossils, palaeogeography and economic importance. Triassic and Jurassic system of extra peninsular region and Kutch, their stratigraphy, classification and faunal characteristics. Cretaceous system, Trichinopoly and Pondicherry, its stratigraphy, distribution and faunal characteristics, Palaeogeography of Cretaceous Period.

UNIT-III: CENOZOIC, QUATERNARY GEOLOGY & IGNEOUS PROVINCES OF INDIA

Deccan traps and their distribution, structural features-inter-trappean and infra-trappean beds, Lameta beds, age and economic importance. Tertiary group; Cretaceous-Tertiary transition in India. Siwaliks - their distribution, constitution, sedimentation, climate and fossil assemblages and correlation. Quarternary geology; Pleistocene-Holocene system-division and distribution-Glacial and interglacial periods - igneous epochs in India.

UNIT-IV: MARINE ENVIRONMENT AND PROCESS

Origin of ocean water- Physical and chemical properties of sea water- Morphology of oceans: Continental margins, continental shelf, Continental slope, rise, submarine canyon, ocean floor, Abyssal hills, sea mounts and trenches. Ocean circulation: Causes and characters, surface currents, deep water circulation. Ocean waves and tides. Shore and Shoreline processes - sediment types, character, movement and distribution. Satellite applications in marine process. Sea level processes and Sea level changes. Sea Surface temperature.

UNIT-V: MARINE ENVIRONMENT & PRODUCTS:

Life in the ocean; major environmental domains, modes of marine life. Marine resources: heavy minerals, petroleum hydrocarbons, gas hydrates, Mn-nodules, Phosphorite, L.St. Evaporites (Salt and gypsum). Marine pollution, Coastal zone management and conservation Oceanic sediments: Factors controlling the deposition and distribution of oceanic sediments; geochronology of oceanic sediments. Tectonic evolution of the ocean basins, Evolution of east and west coast of India.

BOOKS FOR STUDY:

01. Arkall, W.S. (1956), Jurassic Geology of the World, Oliver and Boyd Ltd., Edinburg.
02. Bowen, D.C. (1978), Quaternary Geology, Pergamon press.
03. Detrich, G. (1963), General Oceanography, Interscience, London.
04. Gignox, M.(1960), Stratigraphic Geology, Paris.
05. Grabau, A.W., (1957), Principles of Stratigraphy, John Wiley and Sons, Newyork.
06. James, (1982), Deltas, Process of deposition and models for exploration, M.Colman,2nd Ed. International Human Resources Development Corporation, Boston.
07. Krishnan, M.S. (1982), Geology of India and Burma, 6th Edition, CBS Publishers and distributors.
08. Palivaal, B.S. (1998), The Indian Precambrian, Scientific Publishers, Jodhpur.
09. Ravindra Kumar, (1985), Fundamentals of Historical Geology and Stratigraphy of India, Wiley Eastern Ltd, New Delhi.
10. Read, H.H, and Watson, (1972),Earth's History,1, 2, Vols.,London
11. Wadia, D.Tata (1975), Geology of India, McGraw Hill Pub. Co., 4th Ed.
12. Weller, J.M. (1960), Stratigraphic principles and practice, Harper & Bros, Publishers, New York.
13. Keith Stowe, (1979), Ocean science, John Wiley and Sons, Newyork.
14. Kennett, J.P. (1982), Marine Geology, Prentice Hall, Inc. New Jersey.
15. King, (1967), An Introduction to oceanography, Mc Graw Hill Book Co., New York.
19. Kuenen, Ph.H. (1950), John. John Wiley & Sons, Marine Geology.
20. Shepard, F.P. (1960), Submarine Geology, John Hopkins press.

GEOP 104 – PRACTICAL -I STRUCTURAL GEOLOGY CRYSTALLOGRAPHY AND FIELD REPORTS

OBJECTIVE: Aim to do exercises on Structural, Geology Crystallography,

STRUCTURAL GEOLOGY:

Calculation of True dip and apparent dip.

Determination of Throw/Heave/ Stratigraphic separation.

Estimation of Thickness of beds,

Elementary structural analysis with use of stereographic methods

Interpretation of geological and contour maps.

CRYSTALLOGRAPHY,

Identification of crystal models
Goniometric measurement of interfacial angles.

SECOND SEMESTER

GEOC 201 GEOPHYSICAL EXPLORATION

Objective: To know the different sampling methods for collecting water, rock, ores. Sample preparation for different analysis of minerals, ores and rocks. To familiarize the different search for ore minerals, economic minerals, geological mapping. To gain knowledge in the different geophysical prospecting methods.

UNIT I PRINCIPLES OF GEOPHYSICS AND ELECTRICAL METHODS

Scope and historical development of Geophysics- geophysical exploration methods-limitations- problem of ambiguity in geophysical interpretation-Out line of field theories.

Electrical methods: Self potential method, Instruments, Field procedure- Resistivity method-Instruments, Field procedure, Interpretation, Electrical Resistivity Tomography-Electromagnetic methods- Magneto-Telluric method-Induced Polarization Methods-Applications of electrical methods

UNIT –II GRAVITY, MAGNETIC FIELDS AND METHODS

Basic theory-Geoid-Gravitational field of Earth-Measurement of gravity- types of gravimeter- Field Procedure-Reduction of gravity data-Interpretation of gravity anomalies-Applications

Earth's Magnetism- Secular and transient variations and their concepts-Palaeomagnetism-Instruments-Field procedure- Corrections and reduction of data-Magnetic anomaly maps-Removal of regional effects-Interpretation-Applications-Principles of airborne magnetic survey

UNIT- III SEISMOLOGY AND SEISMIC METHODS

Elements of earthquake seismology; seismic waves, seismic sources, faulting source, double couple hypothesis, electrodynamics, focal mechanism and fault plane solutions; seismic gaps; Generalized Snell's Law; Ray theory; reflection, refraction, diffraction; Seismic methods, seismic energy sources; detectors; recording and telemetry devices

UNIT- IV SEISMIC REFLECTION AND REFRACTION METHODS

Principles of reflection and refraction methods-Instruments and equipments-Operational methods-weathering and elevation corrections- Interpretation of a refraction seismic data by graphical and analytical techniques- seismic reflection data processing, velocity analysis, F-K filtering, stacking-Applications

UNIT- V RADIOACTIVITY METHODS AND WELL LOGGING

Principles of Radioactivity-Instruments-Field procedure- Interpretation-Applications

Well logging principles and concepts. Open hole, cased hole and production logging; Electrical logs; lateral, latero, induction, S.P porosity logs sonic, density, neutron natural gamma logging while drilling.

BOOKS FOR STUDY:

1. Mathew N.O, Sadiku, 2007.Elements of Electromagnetics,., Fourth edition, Oxford University Press.
2. B.D. Gupta, 2001. Mathematical physics., Sangam Books Limited.
3. S.S. Sastry, 2005.Introductory Methods of Numerical Analysis, , PHI Learning Pvt Ltd. Delhi.
4. Brooks, A.R. (1972), Geobotany and Biogeochemistry in mineral exploration, Harper and Row.
5. Dobrin, M.B. (1960), Introduction to Geophysical prospecting, , Mc Graw Hill Book Co., New Delhi.
6. D.A. Cox, (1995), The elements of Earth , Oxford University Press, New York
7. Govett, G.J.S. (Ed) (1983). Handbook of Exploration Geochemistry, Elsevier.
8. Hawkes, H.E. and Webb, (1965), Geochemistry in Mineral Exploration, Harper and Row Publishers.
9. Mason and Moore, (1985), Principles of Geochemistry, Wiley Eastern Ltd. New Delhi.
10. Mc Kinstry, H.E. (1960). Mining Geology, Asia publishing house, Course in Mining Geology.
11. Parasnis, D.S. (1975). Principles of Applied Geophysics, Chapman and Hall. Pacal, 2nd Ed. 1977,
12. Ramachandran Rao, M.B. (1975), Outlines of Geophysical prospecting (A Manual for Geologists) Prasa Ranga, University of Mysore,
13. Rose, A.W.Hawks, H.E. and Webb, J.A. (1979), Geochemistry in Mineral Exploration, Academic press.
14. Sharma, P.V. (1986), Geophysical methods in Geology, Elsevier.
15. Stanislane, M. (1984), Introduction to Applied Geophysics, Reidel Publishers.
16. Telford.W.M, Sheriff, R.E., Gelot, L.P, (2001), Applied Geophysics (Second Edition) Cambridge University press.London.

GEOC202 REMOTE SENSING AND GIS

Objective: To know the basic knowledge of the EMR spectrum, resolutions, data acquisition system and image processing of satellite images. It also deals in detail about the application of soil and aerial photography. To know about the application of Remote sensing in the interpretation of physiography, lithology and structues. To know the concepts of GIS & its application in Geology. Especially in hydrogeochemistry, engineering geology and environmental geology. To become familiar with different GIS softwares. This deals in detail about the concepts of GIS, the spatial data analysis and data management

UNIT – I:PRINCIPLES OF REMOTE SENSING AND THERMAL REMOTE SENSING

Remote sensing concept,definition and types, an overview of Indian space mission. Electromagnetic spectrum, energy sources and radiation principles. Energy interaction in the atmosphere, energy interactions with earth's surface, Atmospheric windows, Types of sensors and platforms. Resolution and scanning mechanism. Basic principles of Thermal Remote Sensing. Black body radiation, thermal inertia.

UNIT – IIMICROWAVE REMOTE SENSING

Passive microwave Remote Sensing: Basics, Physics of Radar waves, Spectral Characteristics. Active microwave Remote sensing: SLR spectroscopy and RADAR geometry. SAR interferometry principles

UNIT – III IMAGE PROCESSING

Image processing: Digital data-concepts of image processing. Image rectification and restoration. Geometric correction, Radiometric correction. Image enhancement and filtering. ImageClassification. Hyperspectral imaging: Concepts and techniques.

UNIT – IV:INTRODUCTION TO GIS AND DATA SOURCES

Geographic Information System:Definition and basic concepts. Data types and models. Spatial/Geometrical data-Raster data, Vector data, Attribute data, spaghettic and topology model. Advantages and disadvantages of raster and vector data formats. Data sources: map scanning and digitizing, topology building, editing, cleaning, linking of spatial and non-spatial data. Data processing: Updating, correction and map projection. Advanced data models. Grid model, TIN model and Network model

UNIT-V SPATIAL ANALYSIS AND APPLICATION

Logic, general arithmetic, statistical and geometric operations. Query and report generation from attribute data. Overlay, buffer zones, raster and vector overlay methods. Spatial interpolation. Web GIS: overview advantages and limitations.

Application of Remote Sensing and GIS: in landform and land use mapping, structural mapping, hydrogeological studies, Natural hazard management and mineral exploration.

BOOKS FOR STUDY:

01. Curran, P, (1985), Principles of Remote sensing, Longman, London.
02. Drury, S.A, (1987), Image interpretation in Geology, Allen and Unwin. Drury, S.A. 1990, A guide to Remote Sensing, Oxford Science Publication.
03. Gupta, R.P, (1991), Remote sensing geology, Springer - Verlag, Heidelberg.
04. Lillesand, T.M and keifer, R.W, (1987), Remote sensing & Image interpretation, 3rd Ed., John Wiley and sons.
05. Miller, F.H. and Kikhail, E.M. (1980), Photogrammetry, Harper and Row publishers, New York.

06. Miller, V.C. (1961), Photogeology, Mc Graw Hill, New York.
07. Pandey, S.N. (1987), Principles of applications of photogeology, Wiley Eastern Ltd., New Delhi.
08. Paul R.Wolf and Bon A. Dewitt, (1974), Elements of Photogrammetry, Mc Graw Hill, New York, Tokyo.
09. Ray.R.G, (1969), Aerial photographs in geological interpretation, USGS proc., Pap.373. Rampal; Handbook of aerial photography and image interpretation for resource management, John Wiley & sons, New York.
10. Sabbins, F.F, (1985), Remote sensing principles and application, Freeman, Sanfrancisco.
11. Schanda, E, (1976), Remote sensing for Environmental sciences, Springer-Verlag.
12. Verstappan, T.H, (1977), Remote sensing in Geomorphology, Elsevier scientific publishing co., Amsterdam.

GEOC 203: HYDROGEOLOGY AND ENGINEERING GEOLOGY

OBJECTIVE: To know and understand about the distribution and abundance and threat to water resources, relationship of water to rock properties, techniques to find ground water resource its exploration and exploitation. Isotopic signatures in hydrological cycle. To know about the engineering properties and rocks and geological features.

UNIT -I: ORIGIN, OCCURRENCE AND DISTRIBUTION OF WATER

Origin of water: meteoric, juvenile, magmatic and sea waters, Hydrologic cycle - precipitation, runoff, infiltration and evapotranspiration, Hydrographs. Subsurface movement and vertical distribution of groundwater, Springs, Classification of aquifers, Concepts of drainage basin and groundwater basin. Hydrological properties of rocks - specific yield, specific retention, porosity, hydraulic conductivity, transmissibility, storage coefficient, water table fluctuations -causative factors, water table contour maps, Water bearing characteristics of different geological formations, Hydro-stratigraphic units, Groundwater provinces of India.

UNIT -II: WELL HYDRAULICS AND WELL DESIGN

Theory of groundwater flow, Darcy's law and its applications, methods of determination of permeability in laboratory and in field. Types of wells, drilling methods, construction, design, development and maintenance of wells.Specific capacity and its determination. Unconfined, confined, steady, unsteady and radial flow conditions, Pumps tests - methods, data analysis and interpretation for hydrogeologic boundaries, Evaluation of aquifer parameters using Thiem, Theis, Jacob and Walton methods

UNIT -III: GROUNDWATER CHEMISTRY AND MANAGEMENT

Groundwater quality - Physical and chemical properties of water, Quality criteria for different uses, Graphical representation of water quality data, Groundwater quality in different provinces of India - Problems of arsenic and fluoride, Saline water intrusion in coastal aquifers and its prevention. Groundwater development in urban areas and rain water harvesting, Artificial recharge methods, Groundwater problems in arid regions and remediation. Groundwater balance and methods of estimation. Groundwater legislation.

UNIT -IV: MAJOR ISOTOPES IN GROUNDWATER

Stable isotopes in water cycle: Relation between $^{18}O/^{16}O$ and $^{2}H/^{1}H$ in natural waters,. Isotope effects in precipitation: The latitude / annual temperature effect, Seasonal effect, Oceanic and continental precipitation. Altitude effect, Amount effect, Inter-annual variations, Small-scale variations, Palaeoclimate reconstruction. Tritium in the atmosphere, Atmospheric CO_2 concentrations, Stable carbon isotopes in atmospheric CO_2, .

Radiocarbon in atmospheric CO_2. Water Sampling and storage for isotope analysis. Laboratory treatment of water samples : $^{18}O/^{16}O$ analysis , $^{2}H/^{1}H$ analysis, ^{3}H analysis of water , ^{14}C analysis of dissolved inorganic carbon , $^{13}C/^{12}C$ analysis of dissolved inorganic carbon.

UNIT- V: CONCEPTS IN ENGINEERING GEOLOGY:-

Role of geology in Engineering projects: Engineering properties of rocks. Choice of rocks as constructional, road metals and their distribution in India, Nature and properties of building stones. Seismic zones and designing structures. Soil mechanics. Stability of slopes. Geological considerations in the construction of tunnels, dams, bridges roads and reservoirs. Dams classification and parts of dams. Systematic dam site investigation. Geological, geomorphologic and geophysical investigations for foundation studies. Water fitness of reservoirs and, failure of dams. Important river valley projects of India. Tunnels: types, systematic investigations of sites and problems in the construction of tunnels.

BOOKS FOR STUDY:

01. Davie and De Weist, (1965), Hydrology, John Wiley and Sons.
02. Gautam Mahajan, (1995), Groundwater Surveys and Investigations, Ashes Publishing House, New Delhi.
03. Geohydrology, Rogar, J.M.Deweist, (1965), John Wiley and sons.
04. Howrman Bower, (1965), Ground water Hydrology, Mc Graw Hill Book Co.
05. Karanth, K.R. (1986), Hydrology, S.R.Technico Book house, Ashok Raj path, patna-6.
06. Karanth, K.R. (1998), Groundwater Management, S.R.Technico Book house, Ashok Raj path, patna-6.
07. Krynine, D.P. and Judd, W.R. (1957), Principles of Engineering and Geotechniques, Mc Graw Hill Book co.
08. Legget, H.F. (1962). Geology and Engineering, Mc Graw Hill Book co.
09. Ragunath, H.M. (1983). Ground water, John wiley & sons,
10. Rogar, J.M. Deweist, (1965), Geohydrology John wiley and sons,
11. Subramanya, K. (1994). Engineering Hydrology, Tata Mc Graw Hill.
12. Todd, D.K. (1980).Groundwater Hydrology, John Wiley and Sons, 2nd Ed.
13. Tolman, C.P. (1998), Ground water, Mc Graw Hill Book Co.
14. Zaruba, Q. and Menci, V. (1976). Engineering Geology, Elsevier Scientific Publishing Co.,

GEOP- 204: PRACTICAL –II. Mineralogy and Mineral Optics

Objective: to understand the optcial properties of minerals in thin section and megascopic properties of minerals in hand specimen

Megascopic study of important rock forming group of minerals.
Microscopic study of important rock forming group of minerals.
Calculation of molecular and structural formulae of feldspars, Pyroxenes, Amphiboles, Olivines, Garnets, Epidote.
Determination of optical properties of minerals by classical methods.
Determination of plagioclase orientation in thin section and its Anorthite content from extinction angle measurements.
Birefringence of minerals-using Berek compensator.
Pleochroic scheme,
2V by Mallards method,
Optic signs of uniaxial and biaxial minerals.
Determination of cell dimensions and identification of minerals from X-Ray diffractogram.

Stereographic projections of crystals of Isometric, Tetragonal, Hexagonal, Orthorhombic, Monoclinic and Triclinic system.Calculation of axial ratios, miller indices of faces application of Weiss zone law, Tangent relationships, Napier's rule, law of anharmonic ratio and equation to normal.

GEOP205 PREACTICAL –III. REMOTE SENSING, DIGITAL IMAGE PROCESSING AND GIS.

Objectives: To interpret the geological features, lithology, drainage patterns, engineering structures by using aerial photographs, Satellite products and Preparation of different thematic maps through Remote sensing. To know the application of different GIS softwares in hydrogeology, engineering geology and environmental geology. To interpret the geostatistical interpretation of Geological data.

PHOTOGEOLOGY:

a. Stereo test.
b. Tracing details from stereogram and stereo pairs after basic interpretation.
c. Determination of photo scale
d. Identification of landforms
e. Preparation of land use map
f. Identification and interpretation of drainage patterns
g. Demarcation of groundwater potential zones
h. Identification of geological, geomorphological and structural features
i. Preparation of geological maps
j. Study and preparation of topographic profiles from topographic maps.
k. Interpretations of Aerial photographs-Tone, Texture

REMOTE SENSING:

a. Satellite imageries-visual and stereoscopic methods, Drainage Pattern
b. Preparation and interpretation of Coastal and Fluvial landforms
c. Preparation of Lineaments map
d. Preparation of land use map
e. Demarcation of Groundwater Potential zones

DIGITAL IMAGE PROCESSING

a. Starting ERDAS imagine, and exploring the viewer interface
b. Identifying image statistics, Histogram, contrast enhancement
c. Band ratios, filters, georeferencing/ rectification & principal component analysis
d. Unsupervised classification/supervised classification and mosaicing
e. View images and Map composer

GEOGRAPHIC INFORMATION SYSTEM:

Digital Mapping

a. Registration
b. Digitized coverage
c. Edited coverage
d. Labelling and Annotation
e. Projection and Transformation
f. Generation of Grid map
g. Scaling/ Area determination

GEOLOGICAL MODELLING

a. Exercise on data input to geological modeling software,
b. Model Exercise with Modflow and PHREEQC.

GEOP 206 PREACTICAL –IV. GEOPHYSICS, HYDROGEOLOGY AND ENGINEERING GEOLOGY & SURVEYING

OBJECTIVE: Aimed to do exercises in hydrogeology and engineering geology for better understanding of ground water chemistry and process. Application of geology in civil engineering project. To know the basics of engineering surveys.

GEOPHYSICS:
Interpretation of Gravity data
Interpretation of Magnetic data
Electrical resisitivity field survey and data analysis,(resist software.& IP2win).
Interpretation of Seismic data
Preparation of geophysical anomaly maps

Preparation and Interpretation of Isoresistivity maps
Interpretation of Self Potential, resistivity, Gamma , Neutron, Sonic, Caliper, Dipmeter , and temperature logs in oil wells and water wells

HYDROGEOLOGY:

Calculation of Rainfall by Arithmetric method.

Determination of catchment area by Theissen polygon method and calculation of rainfall

Determination of catchment area by Isohyetal methodand calculation of rainfall

Determination of catchment area by Geometric methodand calculation of rainfall.

Basinwise Groundwater Budgeting.

Calculation of Specific yield and transmissibility from the given data

Interpretation of well inventory data from pump test data

Interpretation of water well logs.

Identification of groundwater zones from resistivity data.

Chemical analysis of major dissolved constituent of groundwater by titrimetric method

Chemical analysis of major dissolved constituent of groundwater by spectrphotometric method

Chemical analysis of major dissolved constituent of groundwater by flame photometric method.

Determination and calculation of Water quality parameters pH, EC, TDS.

Calculation of SAR, TH, NCH, TDS, EC and interpretation for various uses

Graphical representation of chemical data and identification of type of water.

Classification of water for drinking water by using WHO standards..

ENGINEERING GEOLOGY:

Engineering properties of different geological materials.

Selection of suitable places for construction of damsfrom the map.

Selection of suitable places for the construction of tunnels from the map.

Selection of suitable places for the construction of reservoirs from the map.

Identification of probable Flooding area from the map and suggesting remedial measures to control flood.

Construction of retaining walls-Problems and solutions.

SURVEYING.

Chain survey, Compass surveying, Theodolite, Demo: Theodolite and Total station.

SEMESTER III

GEOC 301 ECONOMIC GEOLOGY AND MINING GEOLOGY

OBJECTIVES: To know about the economic mineral processes and the distribution of metallic and non-metallic minerals deposits in India. Ores and their genesis. .Emphasizing to understand the various techniques in mining, mine environment and mineral economics.

UNIT-I: PROCESS OF MINERAL DEPOSITS

Classification of mineral deposits. Process of formation of mineral deposits - Magmatic concentration, sublimation, contact metasomatism, hydrothermal process, sedimentation, evaporation, residual and mechanical concentration, oxidation and supergene enrichment and metamorphism. Controls and localization of mineral deposits. Metallogenic epochs and provinces. Geological thermometry.

UNIT-II: METALLIC AND NON METALLIC MINERALS

Study of following metallic mineral deposits, their origin, occurrence & distribution in India and uses: Gold, Silver, Platinum, Aluminium, Iron, Manganese, Chromium, Vanadium, Molybdenum, Tungsten, Nickel, Cobalt and Titanium, Copper, Lead, Zinc, Magnesium and atomic minerals. Study of important non-metallic industrial minerals including origin, occurrence, distribution in India and uses - asbestos, mica, baryte, talc, ceramic minerals, building stones, cement raw materials, mineral pigments. Refractory materials, abrasive minerals, fertilizer minerals, and gemstones.

Unit–III: ORE PETROLOGY & MINERAL ECONOMICS

Principles of Ore microscopy and Ore microscope. Polishing and mounting of ores. Physical and optical properties of ore minerals. Ore textures and paragenesis. Micro chemical techniques and application of ore microscopy. Mineral economics and its concept. Peculiarities inherent in mineral industry. Strategic, critical and essential minerals. Tenor, grade, cut-off grades and specification of minerals with relevant to domestic examples. National mineral policy 2008 – India's mineral production, export & import and price of major minerals in India and mineral taxation.

UNIT –IV: EXPLORATION AND SURFACE MINING

Methods of investigation of ore bodies: rock sampling techniques. Ore reserve estimation. Introduction to mining. Classification of mining methods. Cycles of mining operation. Surface mining, drilling methods and types of drills. Mine explosives and bench parameters, mine haulage.

UNIT –V: SUB SURFACE MINING AND MINE ENVIRONMENT:

Subsurface mining methods. Basic concepts. Shaft, adit, winze, raise, stope, mine support and ventilation. Outline of underground coal mining methods. Mine machineries, organization and structure of a mine. Role of geologist in mining industry. Mining legislations. Preparation of mine plan, mining scheme. Environmental impact assessment and management plans, mine accidents, miner's diseases.

BOOKS FOR STUDY:

01. Aiyengar, N.K.N. (1964), Minerals of Madras, Dept. of Industries and Commerce, Madras.
02. Alan M. Bateman, (1961), Economic mineral deposits, Asia Publishing House.
03. Arogyaswami, R.N.P. (1970). Course in Mining Geology, Oxford and IBH Publishing house,
04. Deb, S. (1980), Industrial minerals and Rocks of India, Allied Publishers Pvt. Ltd.
05. Gokhale, K.V.G. K. and T.G. Rao, (1972), Ore deposits of India, Thompson press Ltd., Delhi – 6, India.
06. Krishnaswamy, S. (1972). India's mineral Resources, Oxford & IBH Publishing Co.,
07. Lindgren, W. (1933), Mineral deposits, Mc Graw Hill Book Co.
08. Mc Kinstry, H.E. (1960). Mining Geology, Asia publishing house,
09. Sinha, R.K. and Sharma, B.N.L (1973). Mineral Economics, Oxford and IBH Publishing Co.,
10. William, C.Peters, (1989) Exploration and Mining Geology, John Wiley and sons, Second Ed.
11. Young, C.J. (1940). Elements of Mining, Mc Graw Hill Book co.,

GEOC 302 GEOLOGICAL AND GEOCHEMICAL EXPLORATIONS

OBJECTIVE: To develop skill in the exploration of Earth resources using geological, and geochemical tools. To know the different sampling methods and sample preparation for exploration of mineral resources.

UNIT –I: GEOLOGICAL MAPPING:

Reconnaissance Vs detailed mapping, surface mapping. Degree of precision, choice of scales, isolation of outcrops. Sampling, general principles. Methods of sampling: channel, chip, grab, pitting, trenching, digging. Sampling errors and precautions. Topographic expression of ore bodies: Physiographic relations of placer deposits, guides to channels, location of pay streaks. Physiography in relation to oxidation and enrichment. Residual ores, supergene sulphide zones

UNIT –II: GUIDES FOR EXPLORATION:

Mineralogical guides. Rock alteration: nature of alteration, target rings of mineral distribution. Stratigraphic and lithological guides, reasons for favorability, competent Vs

incompetent formations. Examples of favorable formations-applications. Fracture pattern as guides: (Structural guides): Mechanical principle of fracturing, vein patterns. Contacts and folds as guides: Contacts, folds, folds younger than the ore; folds older than ore; dislocated ore bodies.

UNIT–III: INTRODUCTION TO GEOCHEMISTRY OF EARTH AND GEOCHEMICAL PROCESSES IN THE ENVIRONMENT:

Geochemistry, Introduction, definition, aim and scope. Origin and abundance of elements. Distribution of elements in lithosphere. Geochemical cycle- Geochemical classification of elements. Geochemical differentiation of elements in exogenic and endogenic cycle. Redox reactions and Eh-pH diagrams and their applications.

UNIT-IV: CONCEPTS IN GEOCHEMICAL EXPLORATION TECHNIQUES-I:

Geochemical Exploration:Introduction, Principles of geochemical exploration, geochemical environment. Study of geochemical dispersion, mobility, geochemical association. Methods of surveying and sampling: Anomalies, background value, threshold value, path finder elements.

UNIT-V: CONCEPTS IN GEOCHEMICAL EXPLORATION TECHNIQUES-II:

Methods of geochemical exploration: (a) Lithogeochemical prospecting (b) Hydrogeochemical prospecting (c) Biogeochemical prospecting (d) Geobotanical prospecting. Anomalies in Residual overburden. Leached ore outcrops, Gossans and Residual soils transported overburden. Geochemical anomaly map and interpretation of data. Geochemical trace element indicators and their significance. Problems in geological interpretation of geochemical data.

BOOKSFOR STUDY:

01. Jenners, 1987. Geochemical exploration, Universal Books Distributors Co.,
02. Rankama and Sahama, (1950), Geochemistry, University of Chickago Press,
03. Arthur Brownlow 1982, Geochemistry, Prentice Hall,

04. Fyfe, W.S.1964, Geochemistry of solids. Mc Graw Hill Book Co.,
05. Goldschmidt, V.M.1954, Geochemistry, Oxford University press.
06. Henderson, P.Inorganic geochemistry.
07. Kovalevskii, A.L. 1979, Biogeochemical exploration for mineral deposits, Oxonian press.
08. Krauskopf..K.B , 1986, Introduction to geochemistry, , Mc Graw Hill.
09. Mason, B.1971, Principles of Geochemistry, John Wiley & Sons.
10. Mason,B. and Moore.C.B. 1991, Introduction to Geochemistry, Wiley Eastern
11. H.E. Hawkes, J.S. Webb. 1979. Geochemistry in Mineral Exploration,: Academic Press, London

GEOC 303 ADVANCED PETROLOGY

Objective: Understanding the origin, classification and nature of igneous and metamorphic rocks

UNIT-I: Petrography of igneous rocks- -Petrography and petrogenesis of Granites, Pegmatites, Alkaline rocks, Mono-mineralic rocks. Anorthosites and Dunites, Lamprophyres, Carbonatites, Charnockites and Ultra-mafics.

UNIT-II:Mineralogical, chemical classification. C.I.P.W, Niggli and Streikeisen–IUGS Classification. Tabular classification Plate tectonics and magmatic evolution. Trace elements in igneous rocks and their significance. Fluid inclusion studies of igneous rocks. Plate tectonics in relation to magma.

UNIT-III: Metamorphic textures, structures and their significance. Grades, zones and facies of metamorphism. Zones, grades and facies concepts of metamorphism: Eskola,Turner-Verhoogen, Winkler's concepts. Graphical representation of facies, A.C.F., A.F.M. and A.K.F. diagrams. Cataclastic metamorphism and its products.

Goldschmidt's mineralogical phase rule and its application - stress and anti-stress minerals. Geothermometry and Geobarometry, Fluid inclusion studies in metamorphic rocks. Petrogenetic aspects of important rock suites of India, such as the Deccan Traps, layered intrusive complexes, anorthosites, carbonatites, charnockites, khondalites and granitoids.

UNIT-IV: Introduction, Aqueous , Eolian ,Glacial, Gravitational processes. Heavy mineral zones and their provenance. Paleocurrents and paleogeography and their significance. Biogenic and chemical sedimentary structures. Tectonics and sedimentation.

UNIT-V: Environmental analysis: Sedimentary environment and facies concept, parameters and classification of environments. Facies model and environmental reconstruction - Alluvial Environments, Shore environment and cyclic sequences. Concept of sedimentary model-Walther's law. Sedimentary basins: Concept and classification: crustal sag, Arc-related and divergent plate boundary basins-basin evolution.

Books Recommended

- Alex S.D. Maltman, (1994). The geological deformation of sediments, Chapman Hall,
- Anthony Hall, (1987), Igneous petrology, ELBS publishers.
- Barkar, S. (1983), Igneous rocks, Daniel, Prentice Hall, Englewood Cliffs, New Jersey
- Barker, A.J.Chapman and Hill, (1989). Introduction to metamorphic textures and microstructures,
- Barth, T.F.W. 919620. Theoretical petrology, John & Wiley and sons.

- Bose, M.K. (1997), Igneous petrology, World Press.
- Edwin Roedder, (1986), Fluid inclusions Publisher Mineralogical Society of America, Printed by Book Crafters, Inc. Chelsea, Michigan.
- Folk, R.L. (1961). Petrology of Sedimentary rocks, Hemphills,
- Galloway. W.C. and D.K.Hobdew, (1996). Terrigenous clastic sedimentary systems, Springer, Verlag, New York.
- Gary Nichols, (1999). Sedimentology and Stratigraphy, Blackwell Science Ltd., London,
- Hess, H.H. and Poldervaart, A. (1967), Basalts, Vols, I and II, Ed., Interscience pub.
- Myron G.Best, (1982), Igneous and Metamorphic petrology, W.H.Freeman and Co., New York.
- Nockolds, S.R, Knox, R.W.O.B, Chinner, G.A. (1979), petrology for students, Cambridge University Press.
- Paul, C.Hess, (1989), Origin of Igneous rocks, Harvard University press, Cambridge, London, England.
- Pettijohn, F.J, (1975). Sedimentary rocks, Harper & Bros. 3rd Ed.
- Phillipotts, A. (1992) Igneous and Metamorphic petrology, Prentice Hall.
- Reineck, H.E., and Singh.J.P. (1980). Depositional sedimentary environments, Springer Verlag, New York.
- Roy Lindholm, (1989), A Practical Approach to Sedimentology, Allen and Unwin, USA.
- Sanders, G.M, (1978). Principles of Sedimentology, Friedman, E.J.John Wiley and sons, New York,
- Turner, F.J. & Verhoogen, J. (1960). Igneous and Metamorphic petrology, Mc Graw Hill Book Co.,
- Twenhofel, W.H. (1950). Principles of sedimentation, Mc Graw Hill Book Co.,
- Wahlstrom, E.E. (1961). Theoretical Igneous petrology, John Wiley & Sons,
- Winkler, H.G.S. (1979). Petrogenesis of Metamorphic rocks, Springer Verlag Vth Ed

GEOO 304– Optional-II - ENVIRONMENTAL GEOLOGY AND DISASTER MANAGEMENT (Internal)

Objective: To know about the application of environmental Geoscience and to understand natural and man made environmental hazards, pollutions, controls and their remedial measures. The Course would focus on types of Environmental hazards & Disasters. The main objective is to study the emerging approaches in Disaster Reduction & Management. The emphasis will be on programmes of National & International organizations for Disaster preparedness, Mitigation and awareness.

UNIT-I: Principles of Environmental Geology: Components of Environment, Atmosphere, hydrosphere, lithosphere, biosphere, their interactions and related problems. Renewable and non-renewable resources- types of alternative renewable energy sources- their advantages. Natural hazards – Endogenic: Tectonism, Volcanoes, Earthquakes, landslides and Exogenic: cumulative atmospheric hazards, cyclones, lighting, hailstorms, drought, cold waves, heat waves and floods. Drought and flood hazards in India.

UNIT-II: Man's influence on earth's energy balance. Pollution-Concept and definition. Acid rain, greenhouse effect, Ozone depletion.Deforestation and erosion, global warming and climatic change concepts. Air pollution: Ambient air quality standard, Influence of nitrous oxide, sulphur dioxide, suspended maters on human health. Pollution-Water pollution-drinking water quality standards, Industrial discharge, municipal sewage discharge, agriculture run off. Types of pollutants: Organic, inorganic and radioactive materials-their fate in the environment.

UNIT-III: Environmental impacts due to mining and mineral processing: Occupational hazards, control measures on noise and air in mines. Impact assessment of anthropogenic activities such as urbanization, river- valley projects, disposal of industrial and radioactive waste, excess withdrawal of ground water, use of fertilizers, dumping of ores, mine waste and fly-ash. Land reclamation and rehabilitation of mined out areas

UNIT-IV: Environment legislation, International environmental agreements, Indian Environmental laws. Environmental Impact Assessment Techniques (EIA). Environmental Management Plan (EMP), concepts and components of environmental auditing. Environmental Gradients, Tolerance and Adaptation. Environmental Education(EE).

UNIT-V: Introduction, Theoretical concepts and developments of disaster management. The role of coordination in disaster management, Different approach to disaster recovery. Planning, Prevention and preparedness. The essential strategic planning for emergency management for natural and manmade hazards. The role of disaster mitigation institution-Meteorology, seismological, volcanology, hydrology, industrial safety inspectorate-institution of urban and regional planners, awareness conservation movement, education and training of disaster.

Books Recommended

- Harsh .K. Gupta (2003), Disaster Management, University Press
- Ignacimuthu.S (1998), Environmental Awareness and Protection, Phoenix Publishing House Pvt. Ltd., New Delhi
- Keller.E.A, (1978), Environmental Geology, A. Charles E.Merrill Pub. Co., A. Bell & Howell Co., London, 4th Ed.
- Lawrence Lundgren, 1986, Environmental Geology, Prentice-Hall.
- Mukesh Dhunna (2009) Disaster Management, Vayu Education of India, New Delhi
- Nadhi Gauba Dhawan & Ambrina Sardar Khan (2014).Disaster Management and Preparedness, CBS Publishers & Distributors Pvt Ltd
- R.B Singh(Ed) (2000) Disaster Management, Rawat Publication, New Delhi.
- S.Mukherjee (2015) Disaster Management for General studies Mains,Visalaya Publications Pvt. Ltd.

- Strahler.A.N and Strahler.A.N, A.H. (1973). Environmental Geosciences, Wiley International Edition,
- Thomas D. Schneid and Larry Collins (2001), Disaster management and preparedness: Occupational safety and health guide series, CRC Press
- Upendra Kumar Sinha, (1986), Ganga-Pollution & Health Hazard Inter-India publication, New Delhi.
- Valdiya, K.S. (1987), Environmental Geology, Indian context, Tata Mc Graw Hill. Bombay.
- Valdiya, K.S., 1987 & 2015, Environmental Geology, Indian context, Tata Mc Graw Hill. Bombay.
- J.P.Sinhal (2010) Disaster Management, University Science Press, Delhi

GEOP 305 PRACTICAL-V- ECONOMIC GEOLOGY AND GEOCHEMICAL EXPLORATION

Objective: the content focuses on identification of economic minerals in hand specimen and polished sections, estimation of ore reserves, geochemical analysis of the samples and geochemical anomaly maps

ECONOMIC GEOLOGY:

a. Megascopic identification of ores and economic minerals,
b. Preparation of polished ore specimens
c. Identification of ore minerals by reflected microscope
d. Interpretation of textures and paragenesis of ore minerals
e. Computation of ore reserves from sampling data
f. Estimation of ore reserves by traditional methods:
   included area method
   extended area method
   triangle method
   polygonal method
   cross section method.
g. Computation of ore reserves from maps

GEOCHEMISTRY:

a. Sample preparation for geochemical analysis.
b. Preparation of A solution and B for silicate analysis
c. Preparation of rock sample for AAS
d. Preparation of Geochemisty anomaly maps
e. Determination of background, threshold values from maps and geochemical interpretations

FOURTH SEMESTER

GEOC 401 COAL AND PETROLEUM GEOLOGY

OBJECTIVE: To gain knowledge about the hydrocarbons, their formation, varieties and distribution. To understand the different sedimentary basins of India and methods of exploration of petroleum.

UNIT-I: Geological basis of coal formation. Physical and chemical properties of coal. Varieties and ranks of coal. Development of coal facies. Types of deposition and diagenesis of coal. Coalification and bituminization. Sampling of coal, Coal petrography.

UNIT-II: Coal bed methane and gas hydrates. Prospecting and valuation of coal lands, Carbonization and gasification of coal,. Production of coal: export and import, conservation of coal. Distribution of Gondwana and Tertiary coal fields in India. Lignite deposits in India

UNIT-III: Physical and Chemical properties of Petroleum. Origin, of petroleum and natural gas, source rocks, reservoir rocks and traps. Migration and accumulation of oil and gas. Porosity and permeability of reservoir rock. Types of petroliferous basins, relations between basin type and hydrocarbon richness. Classification of petroliferous basins of India, Detailed study of stratigraphy, structure and petroleum geology of Assam shelf, Cambay, Bombay, Krishna-Godavari and Cauvery Basins.

Unit–IV: Introduction to drilling methods: types of drilling operations, designing of oil well. Down hole equipment: drilling rigs, its components and functions. Drilling fluids, well-heads, casing and cementing operations. Principles of kick control, fishing jobs. Drilling methods and equipment for directional, horizontal and multilateral wells. Types of offshore drilling rigs.

UNIT–V: Duties of a well-site geologist. Geotechnical order. Mud logging. Fundamentals of Petrophysics. Archie's Formula- porosity, permeability, Preparation of composite logs. Principles of formation testing. Well completion, Enhanced oil recovery techniques. Gas hydrates and coal bed methane.

Books Recommended

- Asquith,G. and Gibson, C (1982), Basic Well Log, Analysis for Geologists, Academic Press, London.
- Baker, R. A, (2001), Primer of Oil well Drilling: A Basic Text of Oil and Gas Drilling, Petroleum Extension Service, University of Texas at Austin.
- Biswas, S.K., Dave, A., Garg, P., Pandey, J., Maithani, A. and Thomas, N.J. (Eds.). (1993) Proceedings of 2nd Seminar on Petroliferous Basins of India, Dehra Dun, Dec.18-20, 1991, Vol. 1, 2 & 3 Indian Petroleum Publishers, Dehradun.
- Bjorkee, K.o., (1989). Sedimentology and Petroleum Geology, Springer Books (India),

- Chilinger, G.V. and Vorabutr, P. (1981), Drilling and Drilling Fluids. Elsevier Science, Amsterdam.
- Darling, T. (2005), Well Logging and Formation Evaluation, Elsevier Science, Amsterdam.
- Ganju, P.N. (19550, Memoirs of the GSI Petrology of Indian coals, Vol.83.
- Gupta, P.K. and Nandi, P.K. (1995), Wellsite Geological Techniques and Formation Evaluation: A User's Manual, Vol. I, Oil and Natural Gas Corporation, Dehra Dun.
- Hunt J.M. (1996), Petroleum Geochemistry and Geology, 2nd Edition, W.H. Freeman, San Fransisco.
- Hyne, N.J. (2001), Nontechnical Guide to Petroleum Geology, Exploration, Drilling and Production, 2nd edition, Pennwell Corporation, Tulsa, Oklahoma.
- Levorson, A.L. Vakils, (1972), Geology of Petroleum, Peter and Simon Limited, Bombay,
- Moore, E.S. (1980). Coal, John Wiley & Sons,
- North, F.K. (1985), Petroleum Geology, Allen & Unwin, London.
- Ross C.A, (1984), Geology of Coal, Narosa book distributors.
- Selley, R.C. (19970), Elements of Petroleum Geology, 2nd Edition, Academic Press, London.
- Serra, O. (1984), Fundamentals of Well Log Interpretation, Vol.1 and 2. Elsevier, Amsterdam.

GEOC 402 ATMOSPHERIC SCIENCES AND METEOROLOGY

Objective: To know and understand the atmospheric process and fundamentals and concepts of Meteorology.

UNIT-I: Principles of Meteorology, Thermal Structure of the Atmosphere and its Composition. Radiation: Basic Laws - Rayleigh and Mie scattering, Multiple scattering, Radiation from the Sun, Solar Constant, Effect of Clouds, Surface and Planetary Albedo. Emission and Absorption of Terrestrial Radiation, Radiation windows, Radiative Transfer, Greenhouse effect, Net radiation budget;, Moisture variables, Virtual temperature; Vertical stability of the atmosphere:. Tropical convection.

UNIT-II: Cloud classification, Condensation Nuclei, Growth of Cloud drops and ice-crystals, Precipitation Mechanisms: Precipitation of warm and mixed clouds, Artificial precipitation, Hail suppression, Fog and Cloud –. Basic equations and fundamental forces: Pressure, Gravity, Centripetal and Corolis forces, Continuity equation in Cartesian and Isobaric coordinates

UNIT-III: Low frequency variability, MJO Madden-Julian oscillation), ENSO, QBO (quasi-biennial oscillation) and Sunspot cycles. Basic principles of general circulation modelling; Grid-point and Spectral GCMs; Role of the ocean in climate Modeling; Internal variability of ocean fields (SST, winds, circulation, etc.) and its Relationship with Monsoon.

UNIT-IV: Tropical Meteorology: Trade wind inversion, ITCZ; Monsoon trough tropical cyclones,; Monsoon depressions;; Western disturbances; SW and NE monsoons; Synoptic features associated with onset, Withdrawal, Break active and Weak monsoons and their prediction. Air masses and fronts: Sources, Origin and Classification of Air masses; and Fronts, Extratropical Cyclones and Anticyclones.

UNIT-V: Meteorological Satellites – Polar orbiting and Geostationary Satellites, Visible and Infrared radiometers, Multiscanner radiometers; Identification of Synoptic systems, Fog and Sandstorms, Detection of Cyclones, Estimation of SST, Cloud top Temperatures, Winds and Rainfall: Temperature and Humidity soundings.

Books Recommended

- Bar Charts, (2012). Meteorology (Quick Study: Academic).
- C. Donald Ahrens , (2008), Meteorology Today: An Introduction to Weather, Climate, and the Environment. Study Guide/Workbook .
- C. Donald Ahrens, (2011) Essentials of Meteorology: An Invitation to the Atmosphere.
- Donald Ahrens, C. (2008) Meteorology Today.
- Donald Ahrens. C. (2008) Essentials of Meteorology.
- Frank R. Spellman , (2012). The Handbook of Meteorology.
- Frederick K. Lutgens, dward J. Tarbuck, Dennis Tasa, (2006) The Atmosphere: An Introduction to Meteorology (10th Edition).
- Frederick K. Lutgens, Edward J. Tarbuck, Dennis Tasa , (2009) The Atmosphere: An Introduction to Meteorology (11th Edition).
- Frederick K. Lutgens,, Edward J. Tarbuck, Dennis Tasa, (2012) The Atmosphere: An Introduction to Meteorology (12th Edition).
- James R. Holton, (2004). An Introduction to Dynamic Meteorology (International Geophysics).
- Roland B. Stull, (1988). An Introduction to Boundary Layer Meteorology (Atmospheric Sciences Library).
- Steven A. Ackerman,Meteorology, John A. Knox, (2011) Third Edition.
- Storm Dunlop , (2008). Guide to Weather Forecasting: All the Information You'll Need to Make Your Own Weather Forecast (Firefly Pocket series).
- Storm Dunlop, (2003). The Weather Identification Handbook: The Ultimate Guide for Weather Watchers.
- Sverre Pettersen, (2008) Introduction To Meteorology.
- Roland B. Stull, (1999). Meteorology for Scientists and Engineers.

GEOP 403- Practical VI- PETROLOGY AND PETROCHEMISTRY

OBJECTIVE: Aimed to do exercises in petrology and petrochemistry, for better understanding of rocks.

PETROLOGY:

a. Preparation of thin sections of rocks.
b. Microscopic identification of important igneous (except Acid igneous rocks) Metamorphic and sedimentary rocks.
c. Determination of roundness and sphericity of grains.
d. Granulometric analysis by sieving and determination of transport and depositional condition
e. Separation of heavy minerals, their microscopic characteristics

GEOCHEMISTRY:

a. Calculation of C.I.P.W. Norm, Niggli values
b. Variation diagrams of Harker and Niggli
c. ACF, AKF diagrams

GEOP -404 DISSERTATIONS AND VIVA –VOCE

Each student in the beginning of VI –semester should choose a topic of dissertation in the field related to their Industrial / institutional training and work with a guide, who one among the teacher, in the department. At the end of the semester should submit a dissertation not exceeding 150 pages inclusive of tables and illustrations. Evaluation will be made on the basis of merit of the dissertation and performance in the viva-voce.

GEOO405.1-Optional III - ISOTOPE GEOLOGY AND NUCLEAR GEOLOGY (Internal)

OBJECTIVE: To know the basic principles of Isotopes, Types of isotopes and their applications in the mineral exploration techniques. To become familiar about exploration of Isotopes. To gain knowledge in the isotope Analytical Instruments used in Atomic Mineral Exploration

UNIT – 1: Basic principles of Isotope Geology: Mechanism of radioactive decay and decay series, stable and radioactive isotopes. Stable isotopes, isotope ratios and concentrations, isotope fractionation, Relation between atomic and molecular isotope ratios. Radionuclide and nuclear instability, Nuclear structure, atomic weights, nuclear decay and radiation. Nuclear reactions, natural production - Anthropogenic releases of radionuclides. Distribution of Radioactive elements in Igneous, Sedimentary and Metamorphic rocks, sediment and waters.

UNIT - II : Nuclear devices and techniques: Ionisation chamber, preprational counters, scintillation counters, nuclear fission and fusion techniques. Mass spectrometer and isotopic dilution.

UNIT – III : Isochron method, model/mineral ages, Fission track, 40Ar-39Ar, U-Th disequilibrium, choncordia method, 14C, Be and Al. Interpretation and geological significance of ages. Radimetric dating methods – Lead method, Rb-Sr, K-Ar, C^{14} methods, fission track dating.

UNIT – IV: Oxygen, Hydrogen, Carbon, Nitrogen, Sulphur. Fractionation of stable isotopes in lithosphere, hydrosphere and atmosphere and their applied aspect. Stable isotope geothermometry and geobarometry.

UNIT – V : Isotopes in mineral exploration, petroleum exploration, palaeoclimate evaluation, health and environmental aspects. Distribution of Uranium and Thorium deposits in India. Nuclear power projects and power stations in India. Advantages and Issues on the use of the nuclear power.

Books Recommended

1. Aswathnarayana, U. 1982, Principles of Nuclear Geology,Allied Pub.,
2. Doe, B.R. 1970, Lead Isotopes, , Springer-Verlag.
3. Faure,G. 1986, Principles of Isotope geology, John Wiley & sons.,
4. Faure,G. and Powell,J.L. 1972, Strontium Isotope Geology, Springer-Verlag.

5. Henry Faul, 1993, Nuclear Geology, Academic press.
6. Hoefs,J. 1980, Stable isotope geochemistry, Springer-Verlag.
7. Rankama, T.H. and Sahama,G. 1963. Geochemistry, John wiley & Sons, New York,
8. Robert D. Nininger, D, 1955, Minerals of Atomic energy,. Van Nostrand Co.,.
9. Virnave, S.N.1999, Nuclear Geology and Atomic Mineral Resources, Bharati Bhawan Publishers & Distributors,

GEOO 405.2-Optional III – INSTRUMENTATION TECHNIQUES IN GEOSCIENCE (Internal)

OBJECTIVE: To know the basic principles of techniques and instrumentation to identify the isotopes and radionuclides. To gain knowledge in the isotope Analytical Instruments used in Atomic Mineral Exploration

UNIT – I : Rock sample collection, sediment sample collection, water sample collection, samples for geochemical study. Collection of samples from exposed materials. Samples acquired from drilling operations, bottom of water samples. Sampling apparatus-Scraper or drag bucket type of sampler, coring tube samplers, Snapper or grab bucket samplers, Rod samplers, Chambered weight samplers,

UNIT – II : Sample preparation for thin section of hard rocks and sediments. Preparation of Polished ore section Petrographic study of thin sections. Sample etching, staining and modal count techniques. Techniques of photomicrography. Thin section preparation of heavy minerals.

UNIT - III Separation of minerals-Magnetic seperation-Dielectric seperation of mineral particles. Electrostatic seperation-Seperation; panning- rolling, sieving and hand picking.

UNIT – IV : Determination of major and minor elements. Principles of geological application of cathode luminiscence, atomic absorption spectrophotometry, inductively coupled plasma-atomic emission spectrometry.

UNIT – V : X-ray fluorescence spectrometry, Scanning and Transmission electron microscopy, Micro probe analysis. X-ray diffractometry, thermal ionization and gas source mass spectrometry. Chromatograph.

Books Recommended

- Galen.W.Ewing, 1975, Instrumental methods of chemical analysis, , 4th Ed. International student Ed. Mc Graw Hill, Book Co.,
- Manual of Mineralogy, John Wiley, Klein, C and Hurlbut,Jr. C.S. John Wiley, 1983.
- Phillips, W.M.R. and Griffen, D.T. . 1986, Optical Mineralogy, CBS EdLaboratory Handbook of Hutchinson, C.S. , 1974, Petrographic techniques, John Wiley,
- Putnis, Andrew, 1992, Introduction to Mineral Sciences, , Cambride University press,
- Sharma, B.K.1998, Instrumental methods of chemical analysis, GOEL, Publishing House, Meerus.
- Spear,F.S,1993, Mineralogical phase Equilibria and pressure-Temperature-Time paths. . Mineralogical Society of America Pub
- Deer, W.A., Howie, R.A., and Nuclear structure, atomic weights, Zussman. 1996.The Rock forming minerals, Longman, London.

GEOO406.1-Optional IV MEDICAL GEOLOGY (Internal)

OBJECTIVE: The geochemistry of the environments have a marked influence on their health, giving rise to diseases that affect millions of people This paper aims to expose the students on the interaction of Human beings with the geochemistry of the earth environment.

UNIT-I General characteristics of tropical , subtropical environments, arid zone, seasonally dry tropics and sub-tropics, humid tropics, and sub-tropics zone and mountainous zone. Rock weathering and soil formation, weathering of mineralized terrains, weathering profiles. Weathering and formation of secondary minerals. Chemistry of weathering of ultra-basic rocks.

UNIT-II Medical Geology- Perspectives and Prospects, Public Health and Geological Processes: An Overview of a Fundamental Relationship. Environmental Biology-Natural Distribution and Abundance of Elements, Anthropogenic Sources, Uptake of Elements on Chemical and Biological Perspective and its functions, Geological Impacts on Nutrition.

UNIT-III Pathways and Exposure- Volcanic Emissions and Health, Radon in Air and Water, Arsenic in Groundwater and the Environment. WHO and BIS Standards for drinking water. Fluoride in Natural Waters, soils, sediments, plants. Fluorides and health: Bioavailability of fluoride, Dental fluorosis, Skeletal fluorosis, Dental fluorosis in India, source, nature, cause and extent. Water Hardness and Health Effects, Geochemical basis for tropical endomyocardial fibrosis (EMF), Effect of water hardness on urinary stone formation (urolithiasis), Types of stones: Calcium oxalate, Calcium phosphate, Uric acid, Magnesium ammonium phosphate stones, Cysteine.

UNIT-IV Iodine and health: The iodine cycle in the environment, Iodine in drinking water, Iodine in food, Iodine Deficiency Disorders (IDD), Endemic cretinism, Goitrogens .The nitrogen cycle, Nitrate as fertilizers and environment, Nitrogen loading in rice fields, Nitrates from human and animal wastes, Nitrates and health, Nitrates and Methemoglobinemia, Nitrates and cancer. Bioavailability of Elements in Soil, Selenium Deficiency and Toxicity in the Environment, Soils and Iodine Deficiency, Natural Aerosolic Mineral Dusts and Human Health, Animals and Medical Geology. The Impact of Micronutrient Deficiencies in Agricultural Soils and Crops on the Nutritional Health of Humans.

UNIT-V : Environmental Toxicology, Environmental Epidemiology, Environmental Medicine, Environmental Pathology, Speciation of Trace Elements. Techniques and Tools-GIS in Human Health Studies, Investigating Vector-Borne and Zoonotic Diseases with Remote Sensing and GIS. Mineralogy of Bones, Inorganic and Organic Geochemistry Techniques, Histochemical and Microprobe Analysis in Medical Geology.

Books Recommended

1. C.B. Dissanayake and R.Chandrajith (2009). Introduction to Medical Geology, Springer, London
2. H.Catherine, W.Skinner, Antony R. Berger(2003). Geology and Health: Closing gap, Oxford Univ. press, New York.
3. Iosif F.Volfson (2010). Medical Geology: Current Status and Perspectives, 2010., Russian Geological Society (ROSGEO) Publisher. Moscow.
4. K.S. Valdiya (2004). Geology, environment, Society, University press(India), Hyderabad.

5. Lawrence K. Wang, Jiaping Paul Chen, Yung-Tse Hung, Nazih K. Shammas (2009). Heavy Metals in the Environment , CRS Press, Taylor & Francis Group, Boca Raton, FL

6. M.M. Komatica, (2004) Medical Geology, Vol.2, Effects of geological environment on Human health , Elsevier, U.K.
7. Oile Selinus, B. Elsevier(2003). Essentials of Medical Geology (2005), Acemedica Press., U.K.
8. Oile Selinus, B. Finkleman, R.B., A.Jose (2010) Medical Geology- Regional synthesis(2010), Springer, London.
9. Scott S. Olson, (1999) International Environmental Standards Handbook , CRC Press, London.

10. William N.Rom, (2012). Environmental Policy and Public Health - Air Pollution, Global Climate Change, and Wilderness, by John Wiley & Sons, Inc. Published by Jossey-Bass A Wiley Imprint.

GEOO 406.2-Optional IV APPLICATION OF SOFTWARE IN GEOSCIENCES (Internal)

Objective: to understand applications of the basic softwares used in the interpretation of the geological data

UNIT I: Interpretation and analysis of Geological data using MS- office, IGPET, WATEQ4F

UNIT II: Applications, Principles of data input, processing, interpretation in software like PHREEQC and MODFLOW

UNIT III:ARCGIS, Mapinfo for spatial analysis and integration of complex geological and geophysical data. ERDAS IMAGINE as image-processing tools for analyzing remotely sensed data.

UNIT IV: Overview of geostatistical analysis using statistical package SPSS, Graphical analytical packages like Surfer and RockWorks for both 2-D surfaces.

UNIT – Data Interpretation: Toposheets, Aerial photographs, Satellite imageries. Interpretation of Meteorology data: rainfall, temperature, wind, humidity; Interpretation of borehole logs, litho log, SP log, Resistivity log, Gamma log, neutron log.