UNIVERSITY DEPARTMENTS

ANNA UNIVERSITY:: CHENNAI 600 025

REGULATIONS-2013

CURRICULUM I TO II SEMESTERS (FULL TIME)

M.Phil (GEOLOGY)

SEMESTER I

SL. NO.	CODE NO	COURSE TITLE	L	T	P	C
THEORY						
1.	GY8101	Earth Systems Science	4	0	0	4
2.	GY8102	Research Methodology	4	0	0	4
3.		Elective I	4	0	0	4
4.		Elective II	4	0	0	4
		TOTAL	**16**	**0**	**0**	**16**

SEMESTER II

SL. NO.	CODE NO	COURSE TITLE	L	T	P	C
1.	GY8211	Project	0	0	32	16
2.	GY8212	Seminar	0	0	2	1
		TOTAL	**0**	**0**	**34**	**17**

TOTAL CREDITS: 33

ELECTIVES

SL. NO.	CODE NO	COURSE TITLE	L	T	P	C
THEORY						
1.	GY8001	Advanced Petrology	4	0	0	4
2.	GY8002	Advanced Techniques in Sedimentology	4	0	0	4
3.	GY8003	Advances in Image Processing for Resources Mapping	4	0	0	4
4.	GY8004	Applied Engineering and Environmental Geology	4	0	0	4
5.	GY8005	Applied Geomorphology	4	0	0	4
6.	GY8006	Applied Hydrogeology	4	0	0	4
7.	GY8007	Applied Micropaleontology	4	0	0	4
8.	GY8008	Economic Geology and Ore Geology	4	0	0	4
9.	GY8009	Geological Remote Sensing	4	0	0	4
10.	GY8010	GIS for Geological Studies	4	0	0	4
11.	GY8011	Groundwater Geochemistry	4	0	0	4
12.	GY8012	Groundwater Modeling	4	0	0	4
13.	GY8013	Hyperspectral Remote Sensing	4	0	0	4
14.	GY8014	Integrated Approach for Watershed Management	4	0	0	4
15.	GY8015	Marine Resources and Offshore Geophysics	4	0	0	4
16.	GY8016	Optimization Techniques in Remote Sensing	4	0	0	4

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GY8101 **EARTH SYSTEMS SCIENCE** **L T P C**
4 0 0 4

OBJECTIVES
To prepare the students to understand the the concepts of Earth system

OUTCOME:
Student gains confidence in addressing the interaction between the various spheres of the earth system

UNIT I PETROLOGY **12**
Petrogenesis of Granites, anorthosites and carbonatites – Roll of fluid inclusion studies in petrogenesis of Igneous rocks – Ortho and para amphibolites – Tectano-metamorphic evolution of southern Granulite Terrain (SGT), Eastern Ghats Mobile Belt (EGMB)– Dharwar Craton (DC).

UNIT II SEDIMENTOLOGY **12**
Basins analysis – Sedimentation Process of fluvial, marine Aeolian, environments – Sedimentary texture, structure and its interpretations to depositional environments. – Sedimentological techniques

UNIT III HYDROGEOLOGY **12**
Heterogeneity and anisotrophy - compressibility and effective stress of water- groundwater flow - hydrodynamic dispersion & diffusion coefficient - water quality - transport processes- behavior of contaminants - dispersivity- sources of contamination - geochemical testing and contaminant studies

UNIT IV APPLIED GEOMORPHOLOGY **12**
Geomorphology in tropics – Types and tools – Processes of weathering and soil formation, nature and formation of slopes, mass movements, planation surfaces, geomorphic cycle,. River basin and drainage network, karst forms, semiarid and arid environments. Glacial and coastal forms and processes. Sea level change, natural hazards and environmental management

UNIT V REMOTE SENSING AND GIS **12**
Principles of Remote sensing, Photogrammetry – Image interpretation, Lithological, structural and geomorphic mapping. Principles of GIS, standard GIS packages - database concepts – Assigning rank and weights, buffering and overlay analysis - applications to geologic studies.

TOTAL : 60 PERIODS

REFERENCES:

1. Best M.G., Igneous and Metamorphic Petrology, 2nd ed. Blackwell. UK, 2002.
2. Donald R. Prothero, Frederic Schwab., Sedimentary Geology: An Introduction to Sedimentary Rocks and Stratigraphy W H Freeman, USA, 2003.
3. Fetter, C. W., Applied Hydrogeology, (3rd edition), New York, Macmillan, 1994
4. Lillesand. TM.,Kiefer, R.W and Chipman, K.W. Remote sensing and image imterpretation Fifth Edition. Wiley. 2007.
5. Pelletier J D. Quantitative Modelling of Earth Surface Processes, Cambridge University Press, Cambridge, 2008.

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GY8102 RESEARCH METHODOLOGY L T P C
4 0 0 4

OBJECTIVES:

- To prepare the students on research concepts, literature analysis, research problems and development of skill to write research papers and thesis. To develop the technical skills in geological research, analytical techniques and instrumentation.

OUTCOME:

- Student gains confidence in addressing the research objectives.

UNIT I INTRODUCTION 12

Research concepts, identification of research topic of current interest to solve natural and societal issues, thrust areas of research, method of defining the research objectives and achieving research objectives.

UNIT II LITERATURE REVIEW 12

Methods of collection of literature; primary and secondary sources, reviews, monographs, journals, literature collection methods; e- journals, research gate, web search engines. Impact factor, citation indices.

UNIT III METHODS OF WRITING OF RESEARCH ARTICLES AND THESIS 12

The objectives and research results v/s design of title of research article; consolidation of research results, interpretation and preparation of abstract, art of writing the contents of research article under different headings, Preparation of tables, figures, and references in the article. Method of writing the thesis, Method of presentation of research articles and posters in conferences.

UNIT IV GEOLOGICAL RESEARCH ANALYTICAL METHODS 12

AAS, ICPMS, XRF, XRD, Instruments– sample preparation methods, procedures for Major and Minor element analysis, Chromatography, dating instruments. EPMA, Mass spectrophotometer; data interpretation and statistics.

UNIT V PETROLOGICAL AND GEOPHYSICAL INSTRUMENTATION 12

Petrological microscopes; scanning electron microscopes; Transmission electron microscopes; Thin section preparation analysis, resistivity meter, magnetic susceptibility meter, logging instruments.

TOTAL : 60 PERIODS

REFERENCES:

1. Cooray, P.G., A guide to scientific writing, Institute of fundamental studies, Srilanka, 1990.
2. Apha, Standard Methods for Examination of water and Wastewater, American Public Health Association, Washington, DC., 1985.
3. Cooray, P.G., A guide to scientific writing, Institute of fundamental studies, Srilanka, 1990.
4. Griffiths, I.C., Scientific method in analysis of sediments, McGraw Hill book., New York, 1988.
5. Ramesh, R., and Anbu, Chemical methods for environmental analysis, MacMillan India ltd., Chennai, 1996.

GY8001 ADVANCED PETROLOGY L T P C
4 0 0 4

OBJECTIVE

- This course is an introduction to the igneous processes, physical and chemical characteristics of magma, and various rock types. It describes occurrence and geological setting of igneous rocks, metamorphic agents and formation of metamorphic rocks.

OUTCOME

- Student will be able to understand the Igneous and metamorphic processes and evolution of earth resources and rock types.

UNIT I IGNEOUS PETROLOGY 12

Silicate melt equlibria & phase diagrams for magmatic crystallization; magmatic differentiation mechanisms; graphical tests for differentiation; cooling behavior of magmas; nucleation & crystal growth in magmas; classes & regimes based on composition, geodynamic set-up, source & depth of origin; Magmatic evolution at oceanic ridges, oceanic islands, active continental margins & islands arcs & continental rifts; layered basic complexes; Alpine-type peridotites & ophiolites; Kimberlites, nepheline syenites & alkaline complexes; granite – granodiorite plutonic association; pegmatites; precambrian massif anorthosites, Mantle petrology & origin of primary basic magmas**.**

UNIT II FUNDAMENTAL CONCEPTS IN THERMODYNAMICS 12

Free energy, entropy, enthalpy & laws of thermodynamics, Introduction to experimental petrology.

UNIT III APPLIED SEDIMENTOLOGY 12

Sedimentary basin analysis; Diagenesis & lithification of Carbonate, sandstone & shale sedimentary facies, sedimentary environmental models; Deposition environmental analysis, provenance, sedimentological techniques.

UNIT IV METAMORPHIC PETROLOGY 12

Kinetics of metamorphism; Facies concept; Granulite facies with reference to the formation of Charnockites, facies series, Anatexis; Migmatites Metamorphism in relation to magma genesis & orogeny.

UNIT V FLUID INCLUSION STUDIES 12

Introduction, Methodology, Instruments & data interpretation techniques, Fluid inclusion studies on sedimentary environments deposits, Geological thermometry & Barometry, Fluid inclusions and its application to the study of metamorphic rocks.

TOTAL: 60 PERIODS

REFERENCES:

1. Barker A.J. Introduction to Metamorphic Textures and Microstructures. 1st ed., Blackie, Glasgow; 2nd ed., Stanley Thornes, Cheltenham, 1998.
2. Best M.G., Igneous and Metamorphic Petrology, 2nd ed. Blackwell. UK, 2002.
3. Hall, Anthony, Igneous Petrology. Longman, UK1996.
4. Mason R., Petrology of the Metamorphic Rocks, 2nd ed. Unwin Hyman, London, 1990.
5. Tony Philpotts Principles of Igneous and Metamorphic Petrology, Cambridge University Press, UK, 2006

GY8002 ADVANCED TECHNIQUES IN SEDIMENTOLOGY L T P C
4 0 0 4

UNIT I TEXTURAL ANALYSIS OF SAND AND CLAY 12

Particle size analysis, distribution; sieving techniques; relationship of particles size to mineralogical composition; sphericity and roundness; authigenic minerals; size analysis of silt and clay; settling analysis; pipette analysis; separation of clay minerals.

UNIT II GRAPHIC REPRESENTATION OF PARTICLE SIZE DISTRIBUTION 12

Histogram, cumulative – frequency diagram, frequency distributions; of computation of statistical parameters of the particle size distribution; Interpretation of data; study of depositional environment' cluster analysis; factor analysis; fence diagrams.

UNIT III HEAVY MINERAL ANAYSIS AND PROVENANCE 12

Separation of heavy minerals – gravity method, Magnetic susceptibility method; Heavy mineral composition; identification; SEM analysis of heavy minerals; interpretation of provenance.

UNIT IV CARBONATE STAINING AND PEELS TECHNIQUES 12

Identification of carbonates; staining techniques; slab preparation; etching; preparation of peel; carbonate sedimentation and environment. Diagenesis and its significance in depositional environment

UNIT V FACIES ANALYSIS AND INSTRUMENTAL DATA INTERPRETATION TECHNIQUES 12

Depositional environment and facies; XRD studies – clay minerals, carbonate minerals; DTA techniques; Clay minerals; SEM analysis techniques and interpretational procedures; paleocurrent analysis.

TOTAL : 60 PERIODS

REFERENCES:

1. Friedman G.M., and sanders. J.E., Principles of sedimentology, John Wiley and sons, New York, 1978.
2. Selley R.C., Appied sedimentology. Academic Press. New York, 1988
3. Griffiths, 1 C., Scientific method in analysis of sediments, McGraw – Hill book., co., New York 1967.

GY8003 ADVANCES IN IMAGE PROCESSING FOR RESOURCES MAPPING L T P C

4 0 0 4

UNIT I PATTERN RECOGNITION 12

Fundamentals of Pattern Recognition, Mathematical formulation of pattern recognition problems and decision functions, statistical approach, Bayes classifier,probability density function estimation, clustering algorithms (supervised and unsupervised), fuzzy recognition systems, feature selection methods.

UNIT II ARTIFICIAL NEURAL NETWORKS 12

Fundamentals of artificial neural networks (ANNs),Theory and practical implementation of networks, ANNs for pattern recognition, neural net architectures, supervised and unsupervised learning, nonlinear system modeling, applications to image processing.

UNIT III DIGITAL ELEVATION MODELS 12

Overview of digital surface models, DEM specification, Digital models representation. orientations, Epipolar images, Introduction to image matching and techinques. Generation of DEM. improving the DEM. DEM for geomorphological mapping.

UNIT IV IMAGE FUSION 12

Overview of image fusion, need for image fusion, applications, pixel level, feature level and decision level fusion. fusion Strategies -IHS. PCA, Brovey. Multiplicative and Wavelet fusion. Wavelet fusion –multi resolution analysis, continuous wavelet transforn1. discrete wavelet transform. wavelet packets. image compression. image denoising, edge localization. segmentation, texture features. scale recursive filtering and multi resolution data fusion. Case studies.

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UNIT V APPLICATION OF ANN, PATTERN RECOGNITION, 12

W~\velet transforms, OEM and SAR data anai)'sis to urban mapping. Land use and land cover mapping. extraction of linear features. forestry and agriculture. geological mapping and mineral exploration.

TOTAL : 60 PERIODS

REFERENCES:

1. Jain A.K.. 1989. Fundamentals of Digital lmage processing. Prentice-Hall.
2. Schowengerdt R.A., 1997. Remote Sensing -Models and Methods for Image Processing. Academic Press, London.
3. IEEE transactions on Geoscience and Remote Sensing. vol no. 37 no.3, 1999.
4. Digital Photogrammetry, Yves Egels and Michel Kasser, 304 pages
5. Taylor & Francis,2001. 5. Satellite Altimetry and Ealih Sciences. A Hand Book of Techniques and Applications, Lee-Leung Fu, Academic Press, 2000.

GY8004 APPLIED ENGINEERING AND ENVIRONMENTAL GEOLOGY L T P C

4 0 0 4

UNIT I ENGINEERING PROPERTIES OF ROCKS AND SOILS 12

Classification – rock strength – methods of determination – field and laboratory tests

UNIT II DAMS AND TUNNELS 12

Geological investigation for dams and reservoirs – Indian examples – coastal protection and beach engineering – design and construction of tunnels

UNIT III FOUNDATION GEOLOGY 12

Determination of bed rock depth – identification of fractures and zones of weakness – shear and cohesive and frictional strength – failure criteria – RQD – RMR – pore water pressure – bore hole logging – panel diagram – types of foundations

UNIT IV ENVIRONMENTAL HAZARDS 12

Biotic and symbiotic degradation – causes in tanneries – degradation of soil and groundwater – nature and man made hazards

UNIT V ENVIRONMENTAL IMPACT ASSESMENT 12

Environmental indicators – water treatment – geological hazards and pollution – sediments – water – mining – mineral industries.

TOTAL : 60 PERIODS

REFERENCES:

1. Krynine and Judd. Principals of Engg. Geology and Geotechnology, Macgraw Hill New York , 1962.
2. Montgomary , C.W.Environmental Geology . W.C.Brown Publ. Londan , 1989.
3. Waltham , A.C. Foundations of Engineering Geology , Blackie Academic , London , 1994.

GY8005 APPLIED GEOMORPHOLOGY L T P C

4 0 0 4

UNIT I INTRODUCTION 12

Aims, scope and methods, cycles of erosion, Planation surfaces, dating of planation surfaces with case studies.

UNIT II SOILS 12

Geographic coverage, mass wasting processes, soil pedogenesis, taxonomic classification of soils, soil micromorphology, climate inferences, dating of palaeosoils with case studies.

UNIT III PALAEOFLOODS 12

Palaeofloods and sediments, associated sedimentological pattern, calculation of flood sediments, flow and budget, historical data and their interpretation, future flood modeling and prediction, A case study.

UNIT IV COASTAL GEOMORPHOILOGY AND TECTONICS 12

Coastal landforms and geographic coverage, Isostasy and eustatic sea level changes, causes. Quaternary sea level changes with case studies.

UNIT V APPLICATION OF GEOMORPHIC STUDIES 12

Historical data, historical records of weather dependent natural phenomena, verification of climation reconstruction, causes and mitigation of natural hazards such as floods, landslides, drought and earthquakes, with case studies.

TOTAL : 60 PERIODS

REFERENCES:

1. Bradley, R.S., Quaternary Palaeoclimatology, Allen and Unwin Boston, 1984.
2. Craig, R.G. and Crafts, J.L. (eds). Applied Geomorphology, Allen and Unwin Boston, 1983.
3. Goudie, A.S ., (eds) . Geomorphological techniques, Allen and Unwin Boston, 1983.
4. Plummer, C.C. and McGeary, D. Physical Geology, Wm.C. Brown Publ., 1991.
5. Ritter, S., Applied Geomorphology, John Wiley, New York, 1993.

GY8006 APPLIED HYDROGEOLOGY L T P C

4 0 0 4

UNIT I PHYSICAL PROPERTIES 12

Heterogeneity and anisotropy of hydraulic conductivity- compressibility and effective stress of water- hydrodynamic dispersion & diffusion coefficient

UNIT II GROUNDWATER RESOURCES EVALUATION 12

Evaluation and exploitation of groundwater resources- measurement of parameters-aquifer yield- recharge and discharge of groundwater-management of resources

UNIT III GROUNDWATER IN GEOLOGICAL PROCESSES 12

Geotechnical problems- hill slope hydrogeology- landslide-tunnels-sea wate intrusion-over pumping- land subsidence-groundwater and petroleum- groundwater and geothermal energy

UNIT IV CHEMICAL PROPERTIES OF GROUNDWATER 12

Chemical equilibrium-dissolution and solubility-oxidation and reduction process- environmental isotopes-chemical evolution of groundwater –hydro geochemistry of fractured hard-rock aquifers,

UNIT V CONTAMINANT HYDROGEOLOGY 12

Water quality- transport processes- behavior of contaminants-dispersivity- sources of contamination - Writing aquifer testing and characterization report - writing a report on installation of piezometers, geochemical testing and contaminant studies

TOTAL : 60 PERIODS

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REFERENCES:

1. Appelo,A.A.J and Postma,D., Geochemistry, Groundwater and Pollution., A.A.Balkema, New York, 1991
2. Bear, J. Hydraulics of Groundwater, McGraw Hill, 1979
3. Domenico P.A. and F.W. Schwartz, Physical and chemical hydrogeology. John Wiley 1990.
4. Fetter, C.W., Contaminant hydrogeology, Macmillan, London,1993
5. Freeze,R.A and Cherry, J.A., Groundwater, Prentice-hall, London, 1979.

GY8007 APPLIED MICROPALAEONTOLOGY L T P C
4 0 0 4

UNIT I INTRODUCTION 12

Scope, use and its application in oil industries and paleoecological studies; Methodology – separation of microfossils form matrix, mounting techniques and identification.

UNIT II FORAMINIFERA & OSTROCODA 12

General review of systematic, ecology and evolution of Foraminifera and Ostracoda and radiolarian, calcareous nanno planktons, dinoflagellate, diatoms.

UNIT III BIOSTRATIGRAPHY 12

Biostratigraphy,distribution of different microfossil groups in present day ecosystems and application of their pattern in older assemblages and biostratigraphic zonation.

UNIT IV EXPLORATION MICROPALAEONTOLOGY 12

Application of different microfossil groups in exploration for oil and other minerals, Biofacies in delineation of basin boundaries- case studies.

UNIT V PALYNOLOGY 12

Introduction, classification, affinity of spore and pollen, diatoms, dinoflagellate, age determination, Palynology in lignite, coal & oil exploration.

TOTAL : 60 PERIODS

REFERENCES:

1. Bignot, G., Elements of micropaleontology, Graham and Trotman. International Student edition. Bordas Dunod Paris, 1982.
2. Tshudy, R.H., and Scott, R.A., Aspects of palynology, Wiley Inter Science, New York, 1989.
3. Howard Armstrong, Martin D. Brasier ., Microfossils., 2005 2nd edition., Blackwell Publisher,London
4. Robert Wynn Jones Micropaleontology in Petroleum Exploration ,2001., Oxford University Press,London
5. Ronald E. Martin .,Environmental Micropaleontology : The Application of Microfossils to Environmental Geology .,2000 ., Plenum Publishing Corporation,London

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GY8008 ECONOMIC GEOLOGY AND ORE GEOLOGY L T P C
4 0 0 4

UNIT I INTRODUCTION 12

Objective and scope. Ore formation during earth processes- Hydrothermal, sedimentary ores and ores formed during weathering. Ore microscopy usage in mineral technology. Construction of Eh-Ph diagrams and their applications to formation of Fe and Mn ores. Formation of gold, diamond and platinum.

UNIT II METALLIC AND NON-METALLIC DEPOSITS 12

Geochemical behaviour in magmatic, sedimentary and metamorphic cycles. Occurrence, genesis and distribution of Cu, Mn, Pb, Zn, graphite and gemstones in India. Minerals required in atomic energy, ceramic refractory and cement industries. Mineral wealth of TamilNadu.

UNIT III ORE GENESIS AND RESERVE ESTIMATION 12

Ore formation as a natural ore dressing process in the crust. Ores in felsic rocks. Ore textures, beneficiation methods. Ore microscopy in mineral beneficiation of Cu ores, gold ores. Assay value calculations. Stochastic modeling for economic ores Pb, Zn, Cu.

UNIT IV ORE DRESSING 12

Crushing and grinding, theory of crushing, closed circuit grinding, screens, scrubbers, application of settling tests. Flotation.

UNIT V MINERAL ECONOMICS 12

Concept, scope future and national economy, strategic, critical and essential mineals. National mineral policy, mineral concession rules.

TOTAL : 60 PERIODS

REFERENCES:

1. Bateman, A.M., and Jensen, M.L., Economic mineral deposits, John Wiley & Sons, New York. 1981
2. Gailbert, J.M., Park, C. P. Jr. and Freeman, W. H. The geology of ore deposits, John Wiley and sons, New York. 1986..
3. Krishnaswamy, S. India's mineral resources, Oxford and IBH publishing, New Delhi. 1979
4. Anthony Evans, Ore Geology and Industrial Mineral, Jhon Wiley & sons, USA, 1993
5. R.M. Umathay, Mineral Deposits of India, Dattsons, New Delhi, India, 2006
6. Edwards, R. and Atkinson, K. Ore deposit geology, Ist Edition, Chapman and Hall. New Delhi, 1986.
7. Robb, L. Introduction to ore-forming processes, Blackwell publishing, U.K., 2005.
8. R.M. Umathay, Mineral Deposits of India, Dattsons, New Delhi, India, 2006

GY8009 GEOLOGICAL REMOTE SENSING L T P C
4 0 0 4

UNIT I PRINCIPLES OF REMOTE SENSING 12

Physics of remote sensing – Aerial and space borne platforms their applications – Recent remote sensing satellites – image processing techniques.

UNIT II LITHOLOGICAL STUDIES 12

Lithological mapping from aerial phots and satellite images – interpretation elements for rock type description – digital analysis for lithological discrimination.

UNIT III STRUCTURAL ANALYSIS 12

Identification of major structures – folds and faults –structural analysis from remotely sensed data – digital analysis for structural and neo tectonic interpretation.

UNIT IV GEO EXPLORATION 12

Remote sensing for mineral and groundwater exploration – Application to petroleum, environmental and engineering geology studies.

UNIT V ADVANCES IN REMOTE SENSING 12

Recent remote sensing platforms – Thermal images – stereovision – Airborne sensors.

TOTAL : 60 PERIODS

REFERENCES:

1. Lintz, J.J., and Simonett, D., Remote sensing of environment, Addison Wesley, London, 1976.
2. Lillesand, T., and Kiefer, R.W., Remote sensing and image interpretation, Wiley Eastern, New York, 1975.
3. Reeves, R.G., Manual of Remote sensing. American Soc. of Photgrammetry, 1984.

GY8010 GIS FOR GEOLOGICAL STUDIES L T P C

4 0 0 4

UNIT I INTRODUCTION 12

Development of GIS – Definition – System concepts – coordinate systems in std. GIS packages

UNIT II DATA ENTRY, STORAGE AND MAINTENANCE 12

Type of data – spatial and non spatial data – data structure – vector and raster files – Hardware for GIS – database – Scanner – digitizer – standard GIS packages.

UNIT III GEOLOGICAL DATA ANALYSIS 12

Spatial data in geology – data input – retrieval – overlay analysis – modeling using GIS – digital elevation model in geological studies

UNIT IV GIS APPLICATION 12

Lithological and structural studies – geomorphology and soil studies.

UNIT V GIS APPLICATION 12

Groundwater resource management – landslide zonation – economic minerals and mining – oil field zonation.

TOTAL : 60 PERIODS

REFERENCES:

1. Burrough, P. A., Principles of GIS for land resource management. Oxford Publ., London, 1990.
2. Star, J. and Estes, J., GIS – An Introduction. Prentice Hall, New York, 1990.
3. Schuurman. N. GIS – A short introduction. Blackwell Publishing. Massachusetts. USA. 2004.

GY8011 GROUNDWATER GEOCHEMISTRY L T P C
4 0 0 4

UNIT I CARBONATE SYSTEM 12

Scope - hydrochemistry - units of concentration – ion balance – equilibrium thermodynamics - equilibrium constant - Activities vs concentrations - Acids & bases – Carbonate chemistry - carbonic acid - calcite/dolomite - carbon dioxide alkalinity-acidification of groundwater - carbonate-rich aquifers and their chemistry - case studies

UNIT II OXIDATION AND REDUCTION 12

Donors and receivers - SHE and redox reactions – relation between pe and Eh –Redox measurements - pH – Eh diagrams - redox conditions in natural waters –importance in groundwater reactions – redox and mineralisation in aquifers

UNIT III SILICATE WEATHERING 12

Weathering and clay minerals - solubility of aluminosilicates - stability diagrams – kinetics - silicate weathering reactions - Mass – balance approach- Case studies –Geology vs groundwater composition

UNIT IV ADSORPTION AND ION EXCHANGE 12

Surface charge - Adsorption, ion exchange - empirical relationships –surface complexation - metal complexation on surfaces - representations of mineral surfaces

UNIT V METALS & GEOCHEMICAL MODELLING 12

Metal sources, speciation - aqueous complexation - pH – Eh diagrams - Iron chemistry - controls on metals concentrations in natural waters - Solution equilibrium – precipitation – Adsorption – Geochemical modelling

TOTAL: 60 PERIODS

REFERENCES:

1. William J. Deutsch, Groundwater Geochemistry: Fundamentals and Applications to Contamination, CRC-Press; 1 edition, 1997.
2. François M. M. Morel and Janet G. Hering, Principles and Applications of Aquatic Chemistry, John Wiley, 1993
3. James F. Pankow, Aquatic Chemistry Concepts, CRC Press, 1991.
4. Werner Stumm and James J. Morgan, Aquatic Chemistry, John Wiley, 1995.
5. James I. Drever, The Geochemistry of Natural Waters: Surface and Groundwater Environments, Prentice Hall, New Jersey, 1997
6. Donald Langmuir, Aqueous Environmental Geochemistry, Prentice Hall, 1997
7. Kehew, A.E. (2001) Applied Chemical Hydrogeology. Prentice-Hall, Upper Saddle River, New Jersey.

GY8012 GROUNDWATER MODELLING L T P C
4 0 0 4

UNIT I INTRODUCTION 12

Groundwater flow equation- steady and unsteady flow-radial flow- estimation of aquifer parameters - Axi symmetric flow-derivation of discrete model-numerical solution-vertical flow-field examples.

UNIT II MODELING PROTOCOL 12

Data requirement for Modeling-steady State flow models-time variant flow- numerical techniques-boundary and initial conditions – estimation of recharge and discharge- Conceptual model-mathematical model- initial results- model calibration-sensitivity analysis- uncertainty analysis

UNIT III GROUNDWATER FLOW MODELLING 12

Modflow - conceptual model design - model construction - parameter selection and calibration - risk assessment -running model scenarios – case studies to simulate and predict effects of changes

UNIT IV CONTAMINANT TRANSPORT MODELLING 12

Contaminant transport using Modflow, ModPath and MT3D - advection dispersion and particle tracking techniques - parameter selection - calibration and validation - running model scenarios - case studies - simulate and predict contamination due to passive and reactive contaminants

UNIT V FRACTURED ROCK MODELS 12

Advection-dispersion equation- mass balance models- Regional groundwater quality-use of popular modeling software-case studies. Flow and transport in fractured aquifers: running - discrete fracture flow models - impact of fractures on flow in permeable and impermeable aquifers - contaminant transport modelling using equivalent porous media models.

TOTAL : 60 PERIODS

REFERENCES:

1. Anderson, M.P. and Woessner, W.W., Applied groundwater Modelling-simulation of flow and advection transport. Academic press, New York,1991
2. Bear, J and Verruijt, A., Modelling groundwater flow and pollution, D.Reidal Publ., Berlin, 1987.
3. Rushton, K.R. and Redshaw.S.C., Seepage and groundwater flow. John Wiley, NewYork, 1979.

GY8013 HYPERSPECTRAL REMOTE SENSING L T P C

4 0 0 4

UNIT I INTRODUCTION 12

Multispectral and hyperspectral remote sensing, Comparison of Multispectral and Hyperspectral Image Data, Spectral Signatures and BRDF in the Visible, Near Infrared and Shortwave Infrared regions of EMR, Hyperspectral Issues.

UNIT II HIGH RESOLUTION SENSORS AND HYPERSPECTRAL IMAGING DEVICES 12

Scanner types and characterization --specifications' of various sensors Spectrographic imagers-hyperspectral sensors, Design tradeoffs. Data formats and systems, AVIRIS,CASI, NASA Terra Moderate Resolution Imaging Spectrometer (MODIS), Hyperion.

UNIT III PREPROCESSING OF HYPERSPECTRAL DATA 12

Hyperspectral Data Cube, Hyperspectral Profiles, Data Redundancy. Problems with Dimensionality, Principal Component, Minimum Noise Fraction (MNF), Atmospheric Correction, Atmospheric Correction Measures, Flat Field Correction, Empirical Line Calibration, Empirical Flat Field Optimized, Reflectance Transformation (EFFORT), Continuum Removal, Spectral Feature Fitting.

UNIT IV HYPERSPECTRAL DATA ANALYSIS 12

Derivative spectral analysis, techniques for analysis of hyperspectral data, first-order and second-order derivative spectra, Theoretical basis and relevance, Methods of generating derivative spectra, electronic, electro-mechanical, numerical techniques, case studies.

UNIT V APPLICATIONS 12

Applications of Hyperspectrallmage Analysis Forestry to Mineral exploration, soil mapping, coastal water quality studies, quantification of biophysical parameters.

TOTAL: 60 PERIODS

REFERENCES:

1. Schowengerdt, R.A., 1997. Remote cS'en!!!wg -Models and Methods ,for Image Processing, Academic Press, London.
2. Jensen, J. R.. 1996. Introductory Digital Image Processing: A Remote Sensing Perspective. Prentice Hall, 2nd Edition.
3. Mather, P. M., 1987. Computer processing of remotely sensed images- An introduction, St. Edmundsbury Press Ltd.
4. Thomas M. Lillesand & Ralph W. Keifer, 2000. Remote Sensing and image interpretation (John Wiley & sons, Inc).
5. Pramod K. Varshney and Manoj K. Arora, 2004 " Advanced Image Processing Techniques for Remotely Sensed Hyperspectral Data", Springer publication.

GY8014 INTEGRATED APPROACH FOR WATERSHED MANAGEMENT L T P C
4 0 0 4

UNIT I INTRODUCTION 12

Watershed as a basic unit in development planning — delineation and codification of watersheds — Remote Sensing for sustainable development of watersheds.

UNIT II ISSUES, PRINCIPLES AND APPROACHES TO WATERSHED MANAGEMENT 12

Land degradation-Agriculture productivity-Reservoir sedimentation- Depletion of bio-resources- floods and drought. Principles of watershed management- Different approaches in watershed management-Steps in watershed management.

UNIT III WATERSHED CONSERVATION, PLANNING & MANAGEMENT & ROLE OF REMOTE SENSING 12

Resources mapping - watershed characterization-water balance studies and runoff estimation-Surface water harvesting- Ground water recharge-land capability classification-land degradation and problem soils-Sediment yield modelling and watershed prioritization- Universal soil loss equation-Sediment yield index -Statistical Regression model-European soil erosion Model- Site selection for conservation measures- GIS for integrated watershed management.

UNIT IV MANAGEMENT TECHNIQUES 12

Soil erosion control - vegetative measures- Structural measures - Land treatment measures — Composite land development units -Prescription for sustainable development measures.

UNIT V INTEGRATED SURVEYS FOR WATERSHED MANAGEMENT 12

Land use and vegetal cover mapping - Soil mapping- Mapping geomorphic unit -Topography - Drainage density -Assessment & influence of watershed characteristics-Watershed Response Analysis- Integrated surveys for watershed development-Impact of socio-economic conditions-Optimal solution for watershed development.

TOTAL : 60 PERIODS

REFERENCES:

1. Biswas, A. K., Water Resources Management (No.4): From Ganges -Bhramhaputra to Mekong. Oxford University Press. 1997.
2. Debarry, P. A. GIS Modules and Distributed Models of the Watershed. ASCE. 1999.
3. Morgan R.P.C. Soil erosion and Conservation -Longman Scientific and Technical, England.1986.
4. Murtuy. V.V.N. Land and Watershed Management Engineering - Kalyani Publications, Ludhiana. 1985.

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5 Conservation Technology Information Centre. Purdue University. Home Page. Know Your Watershed. http://www.ctic.purdue.edu/KYW/. 1999.
6 Indian Society of Remote Sensing. Proceedings of the National Symposium on Remote Sensing for Sustainable Watershed Management. Dehradun. 2000.

GY8015 MARINE RESOURCES AND OFFSHORE GEOPHYSICS L T P C
4 0 0 4

UNIT I MINERAL RESOURCES, POLYMETALLIC NODULES 12

Classification of Marine mineral deposits; Polymetallic nodules; genesis distribution, geochronology, strategy & mining concepts, relationship between nodules & sediments; India's nodules programme in CIOB; massive Polymetallic sulfides; Black & White smokers

UNIT II OIL & NATURAL GAS 12

Offshore oil & gas fields of fields of India; exploration & exploitation of offshore deposits. Well logging methods.

UNIT III SEA WATER AS A RESOURCES 12

Fresh Water, Salts, Bromine, Iodine, Chemicals, Origin, distribution & exploration & exploitation of deposits.

UNIT IV OFFSHORE SEISMIC PROSPECTING 12

Application of seismic methods in stratigraphy & mineral oil prospecting; Well logging methods, Interpretation techniques.

UNIT V MAGNETIC PROSPECTING 12

Elements of earth's magnetic field and extra terrestrial fields; Magnetic properties of rock, Instruments used in Magnetic prospecting – Fluxgate, proton, precession and Alkali vapour Magnetometer, Magnetic models studies.

TOTAL: 60 PERIODS

REFERENCES:

1. Bhatt, J.J., Oceanography – Exploring the planet ocean Nostrand company, New York, 1987
2. Eric, C. F., Bird, I., Coasts, An Introduction to coastal geomorphology, III edition, Basil Blackwell publ., New York, 1984.
3. M. B. Collins (Editor), P. S. Balson (Editor) Coastal and Shelf Sediment Transport 2007., Geological Society Publishing House
4. E. G. Gurvich, Evgeny Gurvich Metalliferous Sediments of the World Ocean : Fundamental Theory of Deep-sea Hydrothermal Sedimentation 2005., Springer Verlag, London
5. Jones E. J. W. Jones., New Marine Geophysics., 1999 **,**John Wiley & Sons Inc**.,**Australia

GY8016 OPTIMISATION TECHNIQUES IN REMOTE SENSING L T P C
4 0 0 4

UNIT I CONCEPTS - MATHEMATICAL PROGRAMMING 12

Linear programming and its applications - Single and Multidimensional unconstrained techniques, Non- traditional optimisation techniques, Constrained optimisation problems, Kuhn Tucker optimility conditions, Lagrange multipliers concept - probability and its applications.

UNIT II DECISIONS UTILITY THEORY 12

The concept of utility, Scales of measurement, utility curves, assessing utility, Decisions under certainty and uncertainty, concept of decision trees.

UNIT III SIMULATION 12

Simulation - Methodology - Computer generation of random numbers - Modelling theoretical distributions - validation of simulation models. Application of simulation in various functional area Flowcharting / Programming.

UNIT IV QUEUING THOERY 12

Notation, single server queue (M/M/1), finite storage(M/M/1/K) and finite customer population(M/M/1/N) models, multi server queue (M/M/S) and (M/M/S/K) models (M/G/1) queuing model, queues with priorities for service, applications.

UNIT V APPLICATION TO REMOTE SENSING DATA ANALYSIS 12

Constrained Linear- and Non-linear mixing of spectra of ground cover classes – mixtures - convex hull approach in selection of end members in unmixing- uncertainty rules in hard classification - membership functions and decision concept in fuzzy classification of satellite data- simulation of satellite data. Application of statistical software/ packages.

TOTAL : 60 PERIODS

REFERENCES:

1 Taha. H. A. Operations Research: An introduction, 6th edition, Prentice Hall, New Delhi. 1997.
2 Schowengerdt, R. A., Remote sensing - Models and methods for image processing. Academic Press. London. 1997.
3 Deb, K. Optimisation for engineering design- Algorithms and Examples. Prentice Hall India, New Delhi. 1995.
4 Hiller, F. S., Lieberman, G. J., Introduction to Operations Research , McGraw Hill, Inc. 6th edition, 1995.
5. Users manual, SPSS for windows. SPSS Inc. USA. 1998.