### UNIVERSITY DEPARTMENTS

**ANNA UNIVERSITY:: CHENNAI 600 025**

**REGULATIONS-2013**

**CURRICULUM I TO II SEMESTERS (FULL TIME)**

**M.Phil (GEOLOGY)**

#### SEMESTER I

<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>CODE NO</th>
<th>COURSE TITLE</th>
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#### SEMESTER II

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#### ELECTIVES

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TOTAL CREDITS: 33
OBJECTIVES
To prepare the students to understand the concepts of Earth system

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

UNIT I PETROLOGY

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

UNIT III HYDROGEOLOGY
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
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, semi-arid and arid environments. Glacial and coastal forms and processes. Sea level change, natural hazards and environmental management

UNIT V REMOTE SENSING AND GIS

TOTAL: 60 PERIODS

REFERENCES:
GY8102 RESEARCH METHODOLOGY

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

TOTAL : 60 PERIODS

REFERENCES:

GY8001 ADVANCED PETROLOGY

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 equilibria & 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:

GY8002  ADVANCED TECHNIQUES IN SEDIMENTOLOGY

<table>
<thead>
<tr>
<th>UNIT I</th>
<th>TEXTURAL ANALYSIS OF SAND AND CLAY</th>
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<td>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.</td>
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<tr>
<th>UNIT II</th>
<th>GRAPHIC REPRESENTATION OF PARTICLE SIZE DISTRIBUTION</th>
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<td>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.</td>
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UNIT III  HEAVY MINERAL ANALYSIS 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.

REFERENCES:

TOTAL : 60 PERIODS
UNIT V APPLICATION OF ANN, PATTERN RECOGNITION
W~velet transforms, OEM and SAR data analysis to urban mapping. Land use and land cover mapping. extraction of linear features. forestry and agriculture. geological mapping and mineral exploration.

REFERENCES:
4. Digital Photogrammetry, Yves Egels and Michel Kasser, 304 pages

TOTAL : 60 PERIODS

GY8004 APPLIED ENGINEERING AND ENVIRONMENTAL GEOLOGY

UNIT I ENGINEERING PROPERTIES OF ROCKS AND SOILS
Classification – rock strength – methods of determination – field and laboratory tests

UNIT II DAMS AND TUNNELS
Geological investigation for dams and reservoirs – Indian examples – coastal protection and beach engineering – design and construction of tunnels

UNIT III FOUNDATION GEOLOGY

UNIT IV ENVIRONMENTAL HAZARDS
Biotic and symbiotic degradation – causes in tanneries – degradation of soil and groundwater – nature and man made hazards

UNIT V ENVIRONMENTAL IMPACT ASSESSMENT

TOTAL : 60 PERIODS

REFERENCES:

GY8005 APPLIED GEOMORPHOLOGY

UNIT I INTRODUCTION
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 palaeosols 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 GEOMORPHOLOGY 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 climatic reconstruction, causes and mitigation of natural hazards such as floods, landslides, drought and earthquakes, with case studies.

TOTAL : 60 PERIODS

REFERENCES:

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 water 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
REFERENCES:

GY8007 APPLIED MICROPALAEONTOLOGY

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

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

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

TOTAL : 60 PERIODS

REFERENCES:
UNIT I INTRODUCTION  12

UNIT II METALLIC AND NON-METALLIC DEPOSITS  12

UNIT III ORE GENESIS AND RESERVE ESTIMATION  12

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

REFERENCES:
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
8. R.M. Umathay, Mineral Deposits of India, Dattsons, New Delhi, India, 2006

TOTAL : 60 PERIODS

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 photos and satellite images – interpretation elements for rock type description – digital analysis for lithological discrimination.
UNIT III  STRUCTURAL ANALYSIS  
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  
Remote sensing for mineral and groundwater exploration – Application to petroleum, environmental and engineering geology studies.

UNIT V  ADVANCES IN REMOTE SENSING  
Recent remote sensing platforms – Thermal images – stereovision – Airborne sensors.

TOTAL : 60 PERIODS

REFERENCES:

GY8010  GIS FOR GEOLOGICAL STUDIES  

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

UNIT II  DATA ENTRY, STORAGE AND MAINTENANCE  

UNIT III  GEOLOGICAL DATA ANALYSIS  
Spatial data in geology – data input – retrieval – overlay analysis – modeling using GIS – digital elevation model in geological studies

UNIT IV  GIS APPLICATION  
Lithological and structural studies – geomorphology and soil studies.

UNIT V  GIS APPLICATION  

TOTAL : 60 PERIODS

REFERENCES:
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

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:
2. François M. M. Morel and Janet G. Hering, Principles and Applications of Aquatic Chemistry, John Wiley, 1993
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

TOTAL : 60 PERIODS

REFERENCES:

GY8013 HYPERSPECTRAL REMOTE SENSING

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UNIT I INTRODUCTION

12

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

TOTAL: 60 PERIODS
REFERENCES:

GY8014 INTEGRATED APPROACH FOR WATERSHED MANAGEMENT L T P C
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

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:
GY8015 MARINE RESOURCES AND OFFSHORE GEOPHYSICS

UNIT I MINERAL RESOURCES, POLYMETALLIC NODULES
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
Offshore oil & gas fields of fields of India; exploration & exploitation of offshore deposits. Well logging methods.

UNIT III SEA WATER AS A RESOURCES
Fresh Water, Salts, Bromine, Iodine, Chemicals, Origin, distribution & exploration & exploitation of deposits.

UNIT IV OFFSHORE SEISMIC PROSPECTING
Application of seismic methods in stratigraphy & mineral oil prospecting; Well logging methods, Interpretation techniques.

UNIT V MAGNETIC PROSPECTING
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:
3. M. B. Collins (Editor), P. S. Balson (Editor) Coastal and Shelf Sediment Transport 2007., Geological Society Publishing House

GY8016 OPTIMISATION TECHNIQUES IN REMOTE SENSING

UNIT I CONCEPTS - MATHEMATICAL PROGRAMMING
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

UNIT IV  QUEUING THEORY  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

TOTAL : 60 PERIODS

REFERENCES: