

Manonmaniam Sundaranar University, Tirunelveli - 12

PG DIPLOMA IN GROUNDWATER EXPLORATION UNDER DIRECTORATE OF DISTANCE AND CONTINUING EDUCATION Effective from the Academic Year 2014-2015 onwards

Eligibility for Admission:

Degree in Geosciences/ Earth Science/ Geology/ Applied Geology/ Geophysics/ Applied Geophysics/ Physics/ Maths/ Chemistry/ Electronics/ Civil Engineering/ Mining Engineering/Agriculture Engineering / Agriculture Science/ Forestry

Duration: 1 Year

PG DIPLOMA IN GROUNDWATER EXPLORATION SCHEME OF EXAMINATION (EFFECT FROM 2014-2015 ONWARDS)

S. No.	SUBJECT
1	Basics of Geology
2	Basics of Hydrology
3	Basics of Groundwater
4	Hydro-geochemistry
5	Geophysical Exploration - I
6	Geophysical Exploration - II
7	Remote sensing Applications in Groundwater
8	GIS Fundamentals and Applications in Groundwater
9	Practical – I: Hydrology and Groundwater*
10	Practical – II: Remote sensing and GIS*

* Hands on training and practical for a period of 30 days will be conducted at the University Department or Department identified by the University.

SYLLABUS

Paper 1: Basics of Geology

Unit – 1

Introductory Geology: Rock as an aggregate of minerals, Igneous, Sedimentary and Metamorphic rocks. Structure and textures and classification of these rocks. Distribution of geological formations of India and its importance in relation to water bearing characteristics.

Unit 2

Weathering, mechanical weathering, Chemical weathering, factors affecting weathering, Weathering of Granite and Basalt, Soils, Soil formation, factors affecting soil formation, Soil profile and constituents of soil.

Unit 3

Physical properties of soils- texture, structure, mineral nutrients of plants, role of essential nutrients, soil fertility and its evaluation, types of soils in India. Soil erosion factors affecting erosion, Types of soil erosion-universal loss equation.

Unit 4

Rock as layers (beds), their attitude. Use of clinometer and Brunton compass. Simple geologic structures like folds, faults, joints and unconformities – their nomenclature, classification and recognition. Importance of these structures in groundwater exploration and management.

Unit 5

Geomorphology- geomorphic processes, endogenic and exogenic. Geological work of wind, river, glaciers, underground water –erosion, transportation and deposition.

REFERENCE

1. Ravindra Kumar, Fundamentals of Historical Geology.
2. Billing M.P Structural Geology.
3. Savindra Singh, Geomorphology.
4. Marshak and Mitra , Basic Methods in Structural Geology, Printicee Hall.
5. Parbin Singh, Text Book of Engineering Geology.
6. Mukerjee P.K Text Book of Geology.
7. Potter and Skinner, Dynamic Earth.
8. Patwardhan , The Dynamic Earth System, Printce Hall Inc.

Paper 2: Basics of Hydrology

Unit 1

Precipitation-Forms and Characteristics of Precipitation, Measurement of Precipitation, mean precipitation over an area. Evaporation- process, empirical evaporation equations, analytical methods of evaporation estimation. Transpiration, evapo-transpiration, measurement of evapo-transpiration, Infiltration- infiltration capacity, measurement of infiltration, classification of infiltration capacity, infiltration indices.

Unit 2

Measurement and runoff - measurement of velocity, area velocity method, dilution techniques, electromagnetic method, ultrasound method, indirect methods, stage discharge relationship, exploration of rating curves. Runoff characteristics of streams, runoff volume, flow-duration curve, flow mass curve, droughts.

Unit 3

Hydrographs, Factors affecting Hydrograph, Components of hydrograph, Base flow separation, Effective rainfall, Unit Hydrograph, Derivation of unit hydrograph, Unit Hydrograph of different durations, Use and limitations of unit hydrograph.

Unit 4

Floods-Rational method, Empirical formulae, Unit hydrograph method, Flood frequency studies, Gumbel's method, Log-Pearson distribution, partial duration series, regional flood frequency analysis, data for frequency studies, design floods. Flood Routing-Basic equations, hydrologic storage routing, attenuation, hydrologic channel routing, hydraulic method of flood routing, Flood control.

Unit 5

Erosion and Reservoir Sedimentation-Erosion Processes, Estimation of sheet Erosion, Channel Erosion, Movement of sediments from watersheds, Sediment yield from watersheds, Trap Efficiency, Density of sediments deposits, Distribution of Sediments in the Reservoir, Life of a reservoir, Reservoir Sedimentation Control.

REFERENCES

1. Engineering Hydrology- K. Subramanya 3rd Ed. The McGraw-Hill Company.
2. Hydrology – Principles, Analysis and Design – H.M. Raghunath 2nd Ed. New Age International Publishers. New Delhi

Paper 3: Basics of Groundwater

Unit 1

Groundwater occurrence- vertical distribution of groundwater. Hydrologic properties and groundwater flow, grain size distribution, porosity, specific yield, specific retention, relation to texture, storage coefficient.

Unit 2

Groundwater flow- Movement of groundwater, Darcy's law and its validity, three dimensional flow, permeability, conductivity, anisotropy and heterogeneity, formation constants, transmissibility, leakage factor.

Unit 3

Aquifers, types of aquifers- unconfined, confined, semi confined and leaky aquifers. Water level measurement-unconfined and confined aquifer. Water level hydrographs

Unit 4

Evaluation and interpretation of groundwater data groundwater maps- water table maps, depth to water table map, groundwater fluctuation map, hydraulic head difference map, groundwater quality map. Causes of fluctuation of groundwater levels.

Unit 5

Evaluation of groundwater contour map - flow direction, hydraulic gradient, groundwater structure, influent and affluent seepage, use of flow nets. Evaluation of water table fluctuation, hydraulic difference and groundwater quality maps.

REFERENCES

1. Karanth K.R, Groundwater Assessment Development and Management.
2. Rangunath, Hydrology
3. Todd D.K , Groundwater Hydrology.
4. Mahajan, Groundwater Evaluation
5. Davis and Dewest :Geohydrology.
6. Fetter C.W, Applied Hydrology.
7. Gautam Mhajan, Groundwater Surveys and Investigations.
8. RamKrishna S, Groundwater.
9. Schwartz, Fundamentals of Groundwater, J. Wiley's
10. Domenico, Physical and Chemical Hydrogeology, Wiley's

Paper 4: Hydro-geochemistry

Unit 1 :

Physical, chemical and bacteriological quality. Dissolved constituents in groundwater (major, minor and trace elements). Changes in the chemical composition.

Unit 2

Diagrammatic representation of geochemical data- Collins diagram, Vector diagram, Stiff diagram, Pie diagram, Isogram maps. Trilinear plots- Palmer, Emmons, Hill, Piper diagrams.

Unit 3

Interpretation of chemical Data- Ionic formula, Ionic ratios, Trilinear Plots, Piper, Logarithmic diagram-Schoeller, Mixing diagrams, Natural classification of water.

Unit 4

Chemical processes occurring in groundwater-Dissolution and precipitation, Adsorption and Ion Exchange, Mixing, Oxidation, Reduction, membrane effects.

Unit 5

Quality criteria for groundwater-Drinking and Domestic, Irrigation and industrial use-
Pollution-surface and groundwater quality monitoring-health hazards-preventive measures

REFERENCES

Standard methods for examination of water and waste water analysis-APHA-AWWA-WEF.

2. Hem J.D, Study and Interpretation of Chemical Characteristics of Groundwater.
3. Karanth K.R, Groundwater Assessment Development and Management.
4. Raymahashay , Geochemistry for Hydrogeologist , Allied Pub.
5. Freeze and Cherry J.A , Groundwater, Oxford and IBH
6. Domenico, Physical and Chemical Hydrogeology, Wileys

Paper 5 : Geophysical Exploration - I

Unit 1

Electrical properties of rocks and minerals and their determinations, fundamentals of direct current flow.

Unit 2

Measuring System: Quantities measured in various electrical methods and description of instruments used, discussion of various configurations used in electrical method and field procedure adopted.

Unit 3

D.C. Resistivity Methods : Potential distribution at the surface of a horizontally stratified earth, Vertical Electrical Sounding, Electrical Profiling : Profiling near a vertical contact and thin vertical dykes.

Unit 4

Interpretation of resistivity VES data, empirical methods for interpretation of resistivity sounding data, computer-aided resistivity data interpretation (softwares),

Unit 5

Self Potential Method : Mechanism of SP, field techniques, field due to vertically polarized sphere and interpretation. Induced Polarization Method: Mechanism of IP instruments and principles of measurements both in time and frequency domain and its interpretation.

REFERENCES

1. Bhattacharya & Patra : D.C. Geoelectric Sounding : Principles and Interpretation
2. Kunetz : Principles of Direct Current Resistivity Prospecting
3. Keller & Frischknecht : Electrical Methods in Geophysical Prospecting
4. Nostrand & Cook : Interpretation of Resistivity Data

5. Wait : Overvoltage Research and Geophysical Application
6. Koefoed : Geosounding Principle-I : Resistivity Sounding Measurements

Paper 6 : Geophysical Exploration - II

Unit 1

Surface geophysical methods. Electromagnetic Methods, Instruments, Field procedures, Data collection, Interpretation and Applications.

Unit 2

Seismic Methods-Reflection method and Refraction Methods- Principle, Instruments and equipments, Field operational methods, data collection, Interpretation and Applications.

Unit 3

Magnetic Methods: Principles, Instruments, field procedures, data collection, Interpretation and Applications.

Unit 4

Gravity Methods: Principles, Instruments, Field procedures, data collection, Interpretation and Applications.

Unit 5

Well Logging Methods: Electrical logging methods- Self Potential logging, Resistivity logging and other miscellaneous logging methods; Interpretations and Application of well logging methods.

REFERENCES

1. Ramchandra Rao, Outline of Geophysical Exploration.
2. Brooks K, Geophysical Exploration.
3. Dobrin M.B, Geophysical Exploration.
4. Bhattacharya and Patra, Direct Current Geoelectric Sounding- Principles and application. Allied /Elsevier
5. Agrogysawamy , Geotechnical methods in Exploration and exploitation of groundwater. Allied pub.
6. Nath S.K , Geophysical Prospecting for Groundwater Oxford and IBH,

Paper 7 : Remote sensing applications in Groundwater

Unit 1

Fundamentals of Geological-Image Interpretation-Image elements- tone / colour, texture, pattern, shape, size, shadows, sites, associations. Terrain elements- drainage patterns, drainage density, landforms, erosion.

Unit 2

Remote sensing for lithological discrimination and geological mapping, spectral signatures of rocks, interpretation processes, significance of drainage analysis, criteria for lithological discrimination, criteria for structural mapping.

Unit 3

Application of thermal remote sensing in geology- basic concepts- thermal properties of material- Atmospheric windows of thermal infrared remote sensing - interpretation of thermal infrared data.

Unit 4

Remote sensing application for land use / land cover mapping, methodology, phases in interpretation. Spectral behavior of soils, Soil categorization, mapping of degraded land, erosion assessment, crop acreages estimation.

Unit 5

Remote sensing in groundwater studies- groundwater prospect mapping, groundwater resource estimation and budgeting, groundwater draft estimation, groundwater balance studies and augmentation of groundwater resource.

References

1. Drury, Image Interpretation in Geology.
2. Lillistand and Keifer, Principles of Remote Sensing and Image interpretation.
3. Sabins, Remote Sensing Principles and Interpretations.

Paper 8: GIS Fundamentals and Applications in Groundwater

Unit 1

Components of GIS- computer hardware and software-GIS technology and application. Geographical data- point, lines and areas. Data base structure-flat file, hierarchical data structure-Relational data base structure

Unit 2

Spatial relationships, Map overlays, Raster and Vector data. Data input and editing. Data query and analysis-Spatial data analysis- integrated data analysis of spatial and attribute data, data retrieval, reclassification operations, overlay operations, regional transformation, neighborhood operation, connectivity operations, and spatial auto correlation.

Unit 3

Hydrological components - Hydrological cycle, Estimation of various components of hydrological cycle, rainfall, runoff, evaporation, transpiration, evapotranspiration, crop evapotranspiration, depression and interception loss, infiltration and percolation losses.

Unit 4

Hydrological studies - Hydrological aspects- mapping and monitoring, management, soil moisture estimation, drought zonations, Agricultural, meteorological and hydrological, flood mapping pre and post flood area estimation and control measures –GIS applications for hydrological disaster studies

Unit 5

Ground water resources applications - Types of Aquifers formations confined and unconfined aquifers Assessment of Groundwater potential zones and Groundwater mapping. Water harvesting structures, in-situ and Ex-situ survey-Watershed management-Site selection for recharge structures - Hydrogeological Mapping - GIS applications to ground water studies-Water logging and salt affected area GIS applications to surface water studies.

REFERENCES

1. Aronoff, S. Geographic Information Systems.
2. Chang kT, Introduction to Geographic Information Systems.
3. Clarke, K.C. Getting started with Geographic Information System. Prentice Hall.
4. Anji Reddy.M, Geoinformatics for Environmental Application. B.S. Publication
5. Demers, Fundamentals of Geographic Information System, J.Wileys
6. Lo and Yeung , Concepts and techniques of Geographic Information System, Printce Hall Inc.

Paper 9: Practical - Hydrology and Groundwater

1. Determination of mean aerial depth of rainfall by Thiessen polygons and by Isohytal methods.
2. Estimation of stream velocity and run-off.
3. Analysis of hydrographs and estimation of infiltration capacity.
4. Preparation and interpretation of water table maps.
5. Delineation of hydrological boundaries on water-table contour maps and estimation of permeability.
6. Numerical problems based on theory related to paper Water Management and Irrigation water management.
7. Site selection for groundwater recharge structures

Paper 9: Practical - Remote sensing and GIS

1. Concept of entity and relationship. Creation of Tables
2. Concept of SQL
3. Performing various actions over table. Merging of tables by using primary key. Maintaining database.
4. Introduction to image processing software. Study of the marginal information given on the C.D. Rom/Digital data
5. Import / Export of files using software. Geo-reference of the toposheets and imageries
6. Display, Analysis and interpretation of black & white images and FCC
7. Study of various contrast enhancement techniques
8. Sub-setting of area of interest from the satellite image
9. Principal Component Analysis
10. Unsupervised and Supervised Classification
11. Map composition.