SYLLABUS
FOR THE SESSION
2013-2014

P.G. DIPLOMA IN HYDROGEOLOGY

DEPARTMENT OF GEOLOGY
ALIGARH MUSLIM UNIVERSITY
ALIGARH
### Course Structure

P.G. Diploma in Hydrogeology for the session 2013-2014

<table>
<thead>
<tr>
<th>Papers</th>
<th>Code No.</th>
<th>Title</th>
<th>Weightage</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td><strong>Theory</strong></td>
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<tr>
<td>Paper-I (a) (DHG-401)</td>
<td>Mathematics and Statistics (for Geology students)</td>
<td>100</td>
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<tr>
<td>Paper-I (b) (DHG-401)</td>
<td>General Geology (for Engineering students)</td>
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<tr>
<td>Paper-II (DHG-402)</td>
<td>Hydrogeology and Hydrometeorology</td>
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<tr>
<td>Paper-III (DHG-403)</td>
<td>Groundwater Geology and Environmental Impact</td>
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<td>Paper-IV (DHG-404)</td>
<td>Computer Application &amp; Groundwater Modelling</td>
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<td>Paper-V (DHG-405)</td>
<td>Hydrochemistry</td>
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<td>Paper-VI (DHG-406)</td>
<td>Groundwater Exploration and Well Hydraulics</td>
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<td><strong>LAB WORK:</strong></td>
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<tr>
<td>Practical-I (DHG1p1)</td>
<td>Lab.course for papers DHG-2,3 &amp; 5</td>
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<tr>
<td>Practical-II (DHG1p2)</td>
<td>Lab.course for papers DHG-4 &amp; 6</td>
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<td>Practical-III (DHG1IV)</td>
<td>Field Training:</td>
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<td>Report</td>
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<td>Viva-voce</td>
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<td><strong>Total</strong></td>
<td><strong>800</strong></td>
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Unit-I
Functions, limits and continuity of functions.
Derivative of a function and its geometrical meaning, differentiation from the first principle (simple cases).
Formulae for finding derivatives of sum, product and quotient of functions. Applications of derivatives (Motion in u st. line and Motion under Gravity).

Unit-II

Unit-III

Unit-IV (Descriptive Statistics)
Definition of Statistics, Measures of locations and Dispersion, Quartiles, Percentiles, correlation coefficient, Equations of Linear regression.

Unit-V
Axiomatic definition of probability, sample space and events, conditional probability, Independence of events, Addition and multiplication theorems of probability, Bayes’s theorems, Definition of Random variable, Definition of probability distribution, some standard probability distributions (their definitions examples of application and some numericals). Binomial, poisson and Normal distribution.

Unit-VI
Books Recommended:
1. Introductory Probability and statistical application- P.L. Mayer
Unit-I

Unit-II

Unit-III
The nature and importance of rocks, their three classes ad mode of formation. Classification of igneous, sedimentary and metamorphic rocks. Forms and structure of extrusive and intrusive igneous rocks. Important primary sedimentary structures. Structures of metamorphic rock-slaty schistose, granulose, cataclastic and mylonitic.

Unit-IV
Geologic concept of time: Important method of geologic age determination. Basic principles of radiometric dating. Standard geological time scale; from Archean to Cenozoic, their sub-divisions and time intervals. Brief idea about major igneous and tectonic activities through time.

Unit-V
Description and nomenclature of folds, Geometric classification of folds. Recognition and interpretation of folds in the field and geological map. Unconformities, their types and recognition in the field and geological map. Description of faults, classification of faults, criteria for recognition of faults in the field and geological map. Joints and their classification. Significance of joints in geology.

Unit-VI
Books Recommended:

2. Physical Geology-Arthur Holmes
5. A Text Book of Geology-Mukherjee P.K.
6. Environmental Geology by Edward A. Keller
Unit-I
Introduction: Definition and scope of Hydrology, Practical Applications.
Precipitation: Introduction, forms of precipitation, characteristics of precipitation in India, measurement of precipitation, presentation of rainfall data. Computation of mean precipitation over an area by Arithmetic mean method, Thiessen polygon method and Isohyetal method.
Evaporation: Evaporation process, factors affecting evaporation, empirical equations and analytical methods of evaporation estimation.
Evapotranspiration: Transpiration, evapotranspiration, measurement of evapotranspiration, Evapotranspiration equations.

Unit-II
Infiltration: Infiltration process, factors affecting infiltration, infiltration capacity, measurement of infiltration, infiltration equations, infiltration indices, Runoff.
Introduction, components of runoff, factors affecting runoff, methods of estimating, annual runoff volume, flow duration curve, flow mass curve.
Hydrograph Analysis: Introduction components of a hydrograph, base flow separation, effective rainfall, unit hydrograph theory, assumption and limitation of unit hydrograph, applications of unit hydrograph, Derivation of unit hydrograph.

Unit-III
Stream Flow Measurement: Introduction, measurement of stage, measurement of velocity; area-velocity method, dilution technique of stream flow measurement, electromagnetic method, ultrasonic methods, stage discharge relationship.

Unit-IV
Unit-V
Condensation adiabatic rate of cooling condensation nuclei precipitation growth of cloud droplets, precipitation processes, coalescence processes, ice crystal processes. Clouds and precipitation: classification and various forms of clouds. Airmass nature and classification of airmass. Fronts, their general characteristics, types of fronts, the Wave theory of cyclones, development of cyclones.

Unit-VI
Weather Symbol and weather charts, weather analysis and forecasting. Role of satellites in weather forecasting. Anticyclones, Thunderstorms, Tornales, weather, instruments used for Metereological observation. Instrument and observations: Thermometer, humidity instrument, wind observations, upper air observation. Evaporation measurement; measurements and apparatus, rain gauges, sunshine recorder, pan evapometer.

Books Recommended:

1. Engineering Hydrology-K. Subramanya
2. Physical Geography-Savindra Singh
4. Climatology D.S. Lal.
Unit-I
Utilization of groundwater, groundwater in hydrologic cycle, history of groundwater resources development in India. Geological formations as an aquifer, attributes of an ideal aquifer. Aquifers characteristics: Homogeneity and Isotropy Types of aquifers, perched, unconfined, semi-confined and confined aquifers. Storage coefficient, phenomena, Elasticity of an artesian aquifer.

Unit-II

Unit-III

Unit-IV
Groundwater levels and environmental influences. Time variation levels, seassional variation, short term variation. Stream flow and groundwater levels. Bank storage, base flow. Water level fluctuation due to evapotranspiration. Evaporation effect on groundwater levels, transpiration effect, fluctuation due to metereological phenomena, fluctuation due to tides. Urbanization, earthquake, external loads, land subsidence and groundwater, hydrocompaction.

Unit-V
Occurrence of saline water intrusion, relation to fresh water, shape of fresh and salt water interface upcoming of saline water, Groundwater Exploration extension identification of saline zones and interfaces, presentation and control of saline water intrusion (case studies). Waterlogging and impacts.

Unit-VI

**Books Recommended:**

1. Applied Hydrogeology-C.W. Fetter
3. Freez & Chery.
4. Text Book of Engineering Geology-Kesavulu, NIC
5. Environmental Geology-Valdiya K.S.
6. Environmental Science- V. Subramaniam
8. Understanding our Atmospheric Environment by Morris Nel burger, James G.Edinger and William D. Bonner
Unit-I
Introduction to Computers: Definition, Capabilities, Limitations, Block diagram of the computer. Hardware: Input unit, CPU, Memory, Output unit, Latest configuration of the PC. Software: System Software and Application Software, Operating systems, Utility packages Introduction to Data processing: Data & Information, Data Processing cycle and Data processing operations.

Unit-II
Introduction to office Automation tools using Windows. MS-Office (MS-word, MS-Excel, Powerpoint) Introduction to Databases: Advantages and disadvantages of using databases, concept of Character, Field, Record and Files, Primary Key, Secondary Key, Foreign Key. Introduction to DBMS using My SQL.

Unit-III

Unit-IV

Unit-V

Unit VI
Books Recommended:
1. C-Language-Venu Gopal
3. Let US.C-Yasvant Kanitkar
4. Applied Hydrogeology-C.W. Fetter
5. Regional Groundwater Modeling- M. Thangarajan
Unit-I
Water and aqueous solutions.
Internal structure of the water molecule, structure of liquid water, isotopic composition of water.
Physical, chemical and biological properties of water.
Chemical equilibrium-equilibrium in Homogeneous Systems,
Dissociation constant, the theory of strong electrolytes, solubility product, distribution law.
Acidity and Alkalinity of solutions-Hydrogen ion concentration, Active and total acidity,
Acid base Indicators, Buffer solutions properties of Buffer solutions, determining pH of solution, The phase rule.

Unit-II
The colloidal state-classification, preparation, properties, structure causes of solubility,
Electrokinetic phenomena of a Colloidal system. Destruction of a disperse system,
surface phenomena suspensions, emulsions.
Oxidation-Reduction processes, Oxidation-reduction reactions,
Oxidation-reduction potential.
Determination of oxidation-reduction conditions of fresh water in open bodies.
Characteristics of natural waters.
Water pollutants.
Biological contamination of water, oil pollution of water.

Unit-III
Sampling of water in lakes, rivers, ponds, open wells, bore wells. Objective of sampling plan, extent, frequency of sampling and preventions.
Sanitary and chemical analysis of natural water.
Interpretation of physical and chemical data of water; Methods of illustration pictorial stiff diagram, horizontal and vertical scale diagram. Plotting of piper diagram, Willcox, Gibbs and urov plots.

Unit-IV
Groundwater contamination; saptic tanks and pools, landfills, chemical spills and leaking underground tanks, mining and other source of contamination.
Outline of global hydrochemical software wateq, PHREEQ, AQUACHEM, MINTEQAZ Groundwater restoration.
Unit-V
Requirements for water quality.
Main process in water purification-Removal of suspended particles coagulation, disinfection of water, corrosion of metals, action of sea water on concrete.
Removal of gas, smack and odour from water.
Softening and desalting of water.
Removal of Fe, Mn, silica, fluorine and other metals from water.
Purification of water from radio-active substances.
Magnetic treatment of water.
Characteristics of Municipal and Industrial sewage.
Sanitary chemical analysis of sewage.

Unit-VI
Water Quality Deterioration: Natural Pollutants-Man-made Pollutants, Municipal wastes Industrial wastes, Agricultural wastes.
Pollution in relation to water use.
Biological factors of water self purification.

Books Recommended:

1. Chemistry of Water & Microbiology (Mir Publication)-N.F. Voznaya.
Unit-I

Unit-II
Basic concepts and scope of geophysical exploration for groundwater. Surface geophysical method: Electrical resistivity method-The schlumberger array, the Wenner array, seismic refraction method, Gravity method and magnetic methods.
Sub-surface: Geophysical well logging for delineation of aquifer and estimation of water quality bore hole geophysical logs, their principles and application. Electrical Logging; Resistivity and spontaneous potential logging, Radiation logging; Natural Gamma logging, Gamma-Gamma logging, neutron logging, Calliper logging, Temperature logging, Fluid conductivity logging. Comparison of lithologs in the light of bore hole geophysical data and correlation. Application of well logging in groundwater exploration.

Unit-III
Types of Water Well Drilling Methods: Cable tool, direct rotary, reverse rotary, Water well construction in hard rock and unconsolidated rock formations. Drilling fluid and its function.
Drill site operation: Preparation of drill time logs and lithologs. Design of tubewell assembly criteria, housing, reducer, blind pipe, well screen and slot sizes, reaming of pilot hole. Size analysis of aquifer material and gravel, gravel packing, benefits of gravel packing. Well development methods, Yield test air lift, eductor test, various specific capacity and its determination.

Unit-IV
Well Hydraulics: Basic concept, purpose and scope, groundwater flow equation steady unidirectional flow in unconfined aquifer, steady unidirectional flow in confined aquifer. Radial flow to wells, cone of depression, equilibrium equation for radial flow, partial differential equation for radial flow.
Well in uniform flow, unsteady radial flow in confined aquifer unconfined and leaky aquifer, hydraulic gradient, movement of water due to other forces. Flow-net concept and flow net analysis.
Unit-V
Evaluation of aquifer parameters using Theis-Non-equilibrium well equation, using type curve and data curve, Jacob’s straight line method, Waltons method, Boulton’s method, water level recovery data analysis (Theis recovery method) distance draw down method. Image well theory, recharge boundary condition, barrier boundary. Determination of aquifer boundary, multiple well system, partially penetrating wells, well interference and well spacing.

Unit-VI

Books Recommended:

1. Photogrammetry-S.N. Pandey.
2. Ground Water & Well-Driss Coll.
3. Ground Water Assessment Development & Management-Karanth.KIR.
7. Fundamentals of GIS – M. Demers