Course structure
&
Outcome Based Syllabus

P.G. Diploma in Hydrogeology
2019-2020

DEPARTMENT OF GEOLOGY
ALIGARH MUSLIM UNIVERSITY
ALIGARH
Programme Objectives (POs): P.G. Diploma in Hydrogeology

Some major programme outcomes of P.G. Diploma in Hydrogeology are:

1. To impart knowledge of Hydrogeological Sciences.
2. To apply the knowledge of geology, physical sciences, mathematics, statistics and allied disciplines in understanding hydrogeology.
3. To develop understanding of Groundwater, Environment with emphasis on sustainable development.

Programme Specific Objectives (PSOs): P.G. Diploma in Hydrogeology

Some major programme specific outcomes of P.G. Diploma in Hydrogeology are:

1. To develop hydrogeological concepts of aquifer system, groundwater exploration, well hydraulics, groundwater modeling etc.
2. To impart knowledge of geochemical characteristics of groundwater and its inter-relation with meteorology.
3. To develop understanding of applications of various softwares including GIS in hydrogeology.
4. To carry out Hydrogeological field training projects to enhance various skills among students like working as team, communication and project management etc.
### Programme PG Diploma in Hydrogeology

**Choice Based Credit System (CBCS)**

#### Semester I

<table>
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<th>S. No.</th>
<th>Course Type</th>
<th>Course Title</th>
<th>Course Code</th>
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P.G. Diploma in Hydrogeology
Semester: I

Course code: DHG151 | Course title: Mathematics and Statistics
Credits: 4 | Course No: DHG1(a)

Course objective
1. To impart knowledge about the basic and advanced elements of real analysis, differential equations, matrix theory, statistics, and geostatistical data analysis.

Course outcome
Upon successful completion of course the students would be able to
1. Demonstrate an understanding of the concepts of mathematics and statistics.
2. Apply the mathematical and statistical techniques in geological applications.
3. Understand the spatial data and spatial models.

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: Sum, Product and Quotient of functions.
Applications of derivatives (motion in st. line and motion under gravity).
Integration of elementary functions: Integration by substitution and by parts.
Some properties of definite integral.
Evaluation of definite integrals.

Unit II:
Differential equations: order and degree of d.e . Formation of differential equations (simple cases) by eliminating arbitrary constants. Solution of differential equations (simple cases).

Unit III:
Definition of statistics, Measures of location (or central tendency) and dispersion. Measures of skewness and kurtosis, Correlation coefficient, Equations of simple linear regression.
Axiomatic definition of probability, sample space and events, conditional probability, Independence of events, Addition and multiplication theorems of probability, Bayes’s theorems.
**Unit IV:**
Definition of random variable, Discrete and continuous random variables, Probability mass function, Probability density function, Cumulative distribution function, some standard probability distributions (Binomial, Poisson and Normal distributions).

**Books Recommended:**
2. Introductory to Probability Models – Sheldon M. Ross
Course Code: DHG152  
Course Title: General Geology

Credits: 4  
Course No: DHG1(b)

Course Objective
1. To impart knowledge of geology to civil engineering students.

Course Outcome
Upon successful completion of course the students would be able to
1. Understand origin, structure and composition of earth; understand rock and rock forming minerals.
2. Understand the nature, importance and classification of rocks
3. Understand various structures such as fold, fault, unconformities and their classification.
4. Understand major erosional and depositional features caused by running water and wind; understand soil, its profile and classification.

Unit I:

Unit II:
The nature and importance of rocks, their three classes of 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 III:
Description and nomenclature of folds, Geometric classification of folds. Unconformities, and their types. Description of faults, classification of faults, Joints and their classification.

Unit IV:
Books Recommended:
2. Physical Geology-Arthur Holmes
5. A Text Book of Geology-Mukherjee P.K.
6. Environmental Geology by Edward A. Keller
Course objective
1. To impart knowledge of various components of hydrologic cycle, their measurements and techniques used in the interpretation.

Course outcome
Upon successful completion of course the students would be able to
1. Understand precipitation, forms characteristics and method of measurements and presentation.
2. Understand evaporation and evapotranspiration factors affecting and method of their measurement.
4. Understand hydrograph analysis and stream flow measurement techniques.

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.

Unit II:
Evaporation: Evaporation process, factors affecting evaporation, empirical equations and analytical methods of evaporation estimation.
Evapotranspiration: Transpiration, evapotranspiration, measurement of evapotranspiration, Evapotranspiration equations.

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

Books Recommended:
1. Engineering Hydrology-K. Subramanya
Course code: DHG154  
Course title: Hydrometeorology  
Credits: 2  
Course No: DHG3

Course objective
1. To impart knowledge about hydrometeorological elements, their classification and relevant governing laws. 
2. To impart knowledge of instruments used for recording heat, humidity, precipitation, evaporation, sunshine duration, etc.

Course outcome
Upon successful completion of course the students would be able to
1. Understand atmosphere and its structure, mass and composition, understand heat and temperature changes. 
2. Understand condensation, cloud and precipitation. 
3. Understand formation of fronts and related weather phenomenon 
4. Understand weather charts and symbols, understand weather related equipment.

Unit I:
Hydrometeorology, Hydrometeorological elements. 
Atmosphere, Composition of the atmosphere, vertical structure of atmosphere, mass of the atmosphere. 
Heat and temperature changes, the heat budget, radiation process, conduction process and diurnal variations of temperature. Latitudinal heat balance. 
The nature and the laws of electromagnetic radiation, solar radiation, insolation at the earth surface.

Unit II:
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.

Unit III:
Fronts, their general characteristics, types of fronts. 
The Wave theory of cyclones, development of cyclones. 
Anticyclones, Thunderstorms, Tornadoes,
Unit IV:
Weather Symbol and weather charts, weather analysis and forecasting.
Role of satellites in weather forecasting.
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 evaporimeter.

Books Recommended:
1. Engineering Hydrology-K. Subramanya
2. Physical Geography-Savindra Singh
4. Climatology D.S. Lal.
Course code: DHG155  
Course title: Groundwater Geology and Environmental Impact  
Credits: 4  
Course No: DHG4

Course objective
1. To impart knowledge about relation of groundwater occurrence with the different geological environment and relevant governing principles.
2. To impart knowledge of the use of geology and hydrogeology in the construction of various civil engineering structures and their environmental implications.

Course outcome
Upon successful completion of course the students would be able to
1. Understand occurrence of groundwater in varied geological formation, coastal and desert area.
2. Understand aquifer properties and groundwater flow equations.
3. Understand groundwater and surface water interaction, groundwater levels and environmental influences on it.
4. Understand the saline water intrusion in costal aquifers and remedial measures, understand methods for selection of sites for Dams, Tunnels, highways and airports construction.

Unit I:

Unit II:

Unit III:
influences. Time variation levels, seasonal variation, short term variation. Water level fluctuation due to evapotranspiration. Evaporation effect on groundwater levels, transpiration effect, Fluctuation due to metereological phenomena, fluctuation due to tides.

**Unit IV:**

**Books Recommended:**
1. Applied Hydrogeology-C.W. Fetter
3. Groundwater, Freeze & Cherry
Course Objective:
1. To impart knowledge of chemical nature of water.
2. Evolution of dissolve solute in groundwater through chemical processes.
3. To determine the chemical characteristics of groundwater through analysis.

Course Outcome:
Upon successful completion of course the students would be able to
1. Understand the chemical nature of the water molecule and its interaction in natural environment.
2. Understand the impact of different chemical processes on groundwater chemistry.
3. Understand the nature of colloidal state in groundwater and the mechanism of groundwater pollution.
4. Determine the chemical characteristics of water and groundwater quality criteria for particular industry. Students will also learn the techniques to remove specific pollutant from water.

Unit I:

Unit II:

Unit III:
Unit IV:

Books Recommended:
1. Chemistry of Water & Microbiology (Mir Publication)-N.F. Voznaya.
3. Applied Hydrogeology-C.W. Fetter P.G. Diploma in Hydrogeology
Course objective
1. To impart knowledge about the laws and principles related to the occurrence and movement of groundwater
2. To impart knowledge to apply well hydraulics equations in analysis of pumping test data and determination of aquifer boundaries.

Course outcome
Upon successful completion of course the students would be able to
1. Understand well hydraulics concept and scope, understand flow equation in steady and non-steady conditions in various aquifers.
2. Understand application of various equations for evaluation of pumping test data.

Unit I:

Unit II:
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.

Unit III:

Unit IV:
Books Recommended:
1. DrissColl - Ground Water & Well
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<th>Course title: Hydrology, Hydrometeorology, Groundwater Geology &amp; Environment Impact</th>
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Exercise related to Precipitation and Infiltration and Surface Hydrograph.
Exercise on Darcy’s Law, Permeameter, Grain size analysis
Preparation of Hydrogeological maps: Depth to water table, water table contours, Three-point problem, water table fluctuation maps, Hydrogeological cross sections,
Course code: DHG251  |  Course title: Groundwater Modeling  
Credits: 4  |  Course No: DHG7

Course objective
1. To impart knowledge on groundwater modeling.

Course outcome
Upon successful completion of course the students would be able to
1. Understand types of models and their principle application and limitations.
2. Understand governing equations in terms of aquifer versus flow system view point, understand Numerical Modeling, Finite difference and Finite element methods.
3. Understand model calibration technique, sensitive analysis and predictions.
4. Understand groundwater contamination modeling, principle and concept, understand use of modeling packages.

Unit I:

Unit II:

Unit III:
Unit IV:

Books Recommended:
1. C.W. Fetter - Applied Hydrogeology
2. M. Thangarajan - Regional Groundwater Modeling
Course code: DHG252  
Course title: Computer Application

Credits: 4  
Course No: DHG8

Course objective
1. To impart basic knowledge of computer application to students.
2. To impart basic knowledge on applications of software and GIS in hydrogeology

Course outcome
Upon successful completion of course the students would be able to
1. Understand Microsoft office, Word excel and Power point.
2. Understand data processing cycle and operations and data base management.
3. Understand C Algorithm and its characteristics.
4. Understand application of various software including GIS in hydrogeology.

Unit I:

Unit II:
Introduction to Data Processing: data and information; Data Processing, Data Processing Cycle & Data Processing Operations. Introduction to Database Management System (DBMS): Introduction to database, Database Management System (DBMS), Components of DBMS, Advantages & Disadvantages of using database & DBMS, Data Storage hierarchy: Characters, fields, records, files; Primary key, Secondary key, Foreign key. MS- Access: Database Basic concepts: Simple Database Creation using 2 or 3 Tables, and Very simple Queries.

Unit III:
Introduction to C Algorithm and its Characteristics, Flowchart, Overview of C, Structure of C programme, Constants, Variables, Keywords, Identifiers, Data Types, Operators: Arithmetic operators,relational operators and logical operators, Expressions, Input/Output Statements, Library Functions, Decision making and branching: If – Else statement,switch statement,goto
statement and label, continue and break statement. Looping: For loop, While loop, Do-while loop. Arrays and functions.

**Unit IV:**
Course code: DHG253  
Course title: Geochemical Survey and Water Quality  
Credits: 4  
Course No: DHG9

Course objective
1. To impart knowledge of groundwater quality monitoring and survey
2. Groundwater quality degradation, potential sources and purification techniques.

Course Outcome
Upon successful completion of course the students would be able to
1. Planning, monitoring and establishing the groundwater hydrochemistry.
2. Mechanism of groundwater pollution from potential contaminant sources.
4. Techniques commonly use in water purification and removal of specific elements from water.

Unit I:
Groundwater quality monitoring: Planning groundwater monitoring program. Installing groundwater monitoring wells. Withdrawing water samples from monitoring wells. Chemical analysis of natural water. Major ion chemistry. 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 Durov plots. Outline of global hydrochemical software wateq, PHREEQ, AQUACHEM, MINTEQAZ.

Unit II:

Unit III:
Unit IV:


Books Recommended:
1. Chemistry of Water & Microbiology (Mir Publication)-N.F. Voznaya.
Course code: DHG254
Course title: Groundwater Exploration
Credits: 4
Course No: DHG10

Course objective
1. To impart knowledge on groundwater exploration techniques.

Course outcome
Upon successful completion of course the students would be able to
1. Understand concept and types of remote sensing and GIS and its application on groundwater exploration.
2. Understand concept, scope and types of surface geophysical methods on groundwater exploration.
4. Understand water wells drilling methods and various drill site operations.

Unit I:

Unit II:
Basic concepts and scope of geophysical exploration for groundwater. Surface geophysical method: Electrical resistivity method-The Schumumberger array, the Wenner array, seismic refraction method, Gravity method and magmatic methods.

Unit III:
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 litho-logs in the light of bore hole geophysical data and correlation. Application of well logging in groundwater exploration.
Unit IV:

Books Recommended:
1. Photogrammetry-S.N. Pandey.
2. Sabbins, F.F- Remote Sensing-Principles and Applications
4. Pandey, S.N- Principles and Applications of Photogeology
5. Fundamentals of GIS – M. Demers
8. Driss Coll -Ground Water & Well
Course code: DH2P1
Course title: Groundwater modeling, Computer Application, Geochemical Survey and water quality
Credits: 2
Course No: DHGL2

Exercise related to Computer Application
Exercise related to Hydrochemistry and Groundwater Quality
Exercise related to Groundwater Modeling

Course code: DH2P12
Course title: Course for Groundwater Exploration and Well Hydraulics
Credits: 2
Course No: DHGL3

Exercise related to Groundwater Development and Management, Groundwater Resource Estimation
Remote Sensing: Identification of geomorphological landforms on stereo-pair, Land-use/Land cover mapping using aerial photograph and satellite images
Exercise on surface geophysical methods