

PEOPLE'S DEMOCRATIC REPUBLIC OF ALGERIA

**MINISTRY OF HIGHER EDUCATION AND
SCIENTIFIC RESEARCH**

**STANDARDIZATION
MASTER ACADEMIC
PROGRAM**

Establishment	Faculty	Department
DJLALI BOUNAAMA KHEMIS MILIANA UNIVERSITY	NATURE AND LIFE SCIENCES AND EARTH SCIENCES	EARTH SCIENCES

Domain : Earth and Universe Sciences

Field : Applied Geology

Specialty: Hydrogeology

Academic Year :2016-2017

Semester 1

Master : Hydrogeology

Semester : 1

Heading of the subject : General Hydraulics

Code : FEU 1.1

Coefficient : 2

Credit : 4

Objectives of the course

Basic knowledge of the fluid mechanics theories in rivers and the porous media

Recommended Prerequisite Knowledge

Good knowledge of physics and mathematics

Course content :

1. Fluid Properties

- Definition of a fluid
- Dimensions and units
- liquid properties (density, viscosity, surface tension, capillarity, etc.)

2. Hydrostatic

- Pressure at a point
- Fundamental equation of fluid statics
- Pressure measuring equipment
- Hydrostatic force on flat and curved surfaces
- Floating bodies in a liquid (Archimedes principle, stability of bodies...)

3. Fluid Cinematics

- Liquid flow regimes
- Description of flow configurations

- Volume flow and mass flow
- Movement of a fluid
- Continuity equation

4. Hydrodynamics of fluids

- Euler equation for perfect fluid in motion
- Bernoulli equation for perfect fluid
- Fundamental equation of the real fluid in motion.
- Interpretation of the Bernoulli equation (in terms of energy, in terms of height...)
- Kinetic energy correction factor

5. Flow in laden Pipelines

- Liquid flow regimes (Reynolds experiment)
- Study of pressure drops (linear and singular)
- The different flow systems
- Calculation and simulation of networks (dimensioning of a branch network, simulation of mesh networks)

6. Flow through orifices, nozzles and weirs

- Non-flooded and flooded orifices
- Emptying a tank with an orifice
- Cylindrical and conical nozzles
- Application of nozzles
- Flow in a weir (thin wall weir, thick crested weir,...)
- Depressed water flow
- Flow by drowned water table
- Emptying of a reservoir by a weir
- Use of weirs as a regulator of water bodies

Tutorials

1. Properties of fluids
2. Hydrostatics
3. Kinematics of fluids
4. Fluid hydrodynamics
5. Flow under load
6. Flow in orifices

Assessment method

tutorials			exam	Average
participation	involvement	test	20pts	0.4 TUTORIALS +0.6 exam
3	5	12		

References :

- Carlier : Hydraulique générale
- ENCASTRE : Hydraulique générale
- Comolet R 1982, Mécanique expérimentale des fluides (tomes 1 et 2)
- Michel Carlier 1986, Hydraulique générale et appliquée
- Armendo Lancastre 2005, Hydraulique générale
- Saad Bennis 2009, Hydraulique et hydrologie
- Dupon, hydraulique urbaine, Tome 1, 2
 - J. Bonnin, aide mémoire d'hydraulique urbaine appliquée aux agglomérations de petites et moyennes importances.
- Walter Graf A 2004, Hydraulique fluviale

Master : Hydrogeology

Master : Hydrogeology

Semester: 1

Heading of the subject : General Hydrogeology

Code : FEU 1.2

Coefficient : 2

Credit : 4

Objectives of the course

Basic knowledge of the distribution of water , physical properties of groundwater

Recommended prior knowledge

Basic knowledge of the fundamental aspects of aquifers and groundwater tables.

Content of the subject :

1. Reminders :

Aquifers

The different types of groundwater

Permeability

Transmissivity

2. Aquifer behaviour and flow systems

General behaviour of aquifers

The aquifer system and its environment

Aquifer types

Piezometry and flow network

3. Characteristic of aquifers

Groundwater recharge

Groundwater outlets

Surface water - groundwater relations

Diagram of the boundaries of aquifer systems

Alluvial and fluvio-glacial deposits

Sedimentary rocks

Deep and layered aquifers

Crystalline rock aquifers

4. Methods of interpreting pumping teste data

Dupuit and Thiem method in steady state conditions

Theis' bi-logarithmic method in transient conditions

Jacob's bi-logarithmic method in transient conditions

Walton's bi-logarithmic method

Bi-Logarithmic method of Hantush

Tutorials

1. Problem posed on hydrogeology

2. Exercise on Darcy's law

3. Example of interpretation of pumping test data

4. Understanding and reading a geological and hydrogeological map

5. Drawing hydrogeological cross section

Assessment method

tutorials			exam	Average
Assiduity	involmment	test	20pts	0.4 TUTORIALS +0.6 EXAM
3	5	12		

References :

G. Castany : Principes et méthodes de l'Hydrogéologie F. Zwahlen et P. Renard : Hydrogéologie générale

Semester : 1

Heading of the subject : Hydrology

Code : FEU 1.3

Coefficient : 2

Credit : 4

Objectives of the course

This module aims at establishing the basis of knowledge of general hydrology. It is composed of two parts. The first part deals with surface water with the watershed as a hydrological unit. The second part deals with the methods of gauging of flows. Flow and rainfall-flow relationship.

Recommended prior knowledge

Basic knowledge of the water cycle, physical properties of surface flows.

Content of the subject:

1. Hydrometric stations - flow measurements

1.1 Gauging method

1.2 Height measurements

1.3 Water gauges

1.4 Linnigraphs

1.5 Material of gauging.

1.6 Reel gauging

1.7 Reel gauging analysis

1.8 Float gauges

1.9 Chemical gauging

1.10 Use of flow formulas

2. Statistics in hydrology

2.1 Some general definitions

2.2 Gauss (normal law)

2.3 Galton's law (loilog-normal)

- 2.4 Gumbel's law
- 2.5 Notions of correlation
- 2.6 Regression curves and lines
- 2.7 Test of χ^2
- 3. The flows
 - 3.1 The flowing layer of water
 - 3.2 Flow coefficient
 - 3.3 Runoff coefficient
- 4. Study of floods
 - 4.1 Study of a rainfall - flood couple
 - 4.2 Production functions
 - 4.3 Transfer function
 - 4.4 Reconstitution of floods from rainfall
 - 4.5 Empirical methods of studying floods
 - 4.6 Statistical methods of flood study
- 5. Solid transport.
 - 5.1 Continental erosion and solid transport
 - 5.2 Theoretical aspect of the solid transport problem
 - 5.3 Measurement of solid flows (suspended and cartage)

Tutorials

- 1. Gauging
- 2. Adjustment laws
- 3. Methods of evaluating flow parameters
- 4. Empirical and statistical methods of studying floods
- 5. Solid transport

Assessment method

tutorials			exam	Average
assiduity	involvement	test	20pts	0.4 TUTORIALS +0.6 EXAM
3	5	12		

References

André Musy : Cours "Hydrologie générale" [echo2.epfl.ch/e-drologie
www.doc-etudiant.fr/.../Cours-HYDROLOGIE-GENERALE-6586.html](http://echo2.epfl.ch/e-drologie/www.doc-etudiant.fr/.../Cours-HYDROLOGIE-GENERALE-6586.html)

Sari Ahmed : initiation à l'hydrologie de surface

Remenieras G, 1960 : l'hydrologie de l'ingénieur

Roche M., 1963 : hydrologie de surface

Bennis Saad, 2007 : Hydraulique et hydrologie

Musy André, 2004 : Hydrologie une science de la nature Volume 1,

Master : Hydrogeology

Semester: 1

Heading of the subject : Groundwater Dynamics

Code : FEU 1.4

Coefficient : 3

Credit : 6

Teaching objectives

The main objective of the course is based on the theoretical principles, which constitute a basis for the quantitative study of the laws of groundwater movement and to have the necessary knowledge of the methods and techniques of quantitative analysis of the various forms of water movement in the subsurface, in order to receive expertise for solving practical problems in hydrogeology.

-Understanding of the hydrodynamic behaviour of groundwater.

Recommended prerequisites

Perfect knowledge of the acquired lessons of the subjects General Hydraulics and General Hydrogeology.

Content of the subject :

Chapter 1 - The hydrogeological basis for the study of groundwater movement

1-1. Natural hydrogeological systems

1-2. Properties and categories of hydrogeological systems

1-3. Systematic approach and hydro-geodynamic systems

1-4. Groundwater flows and their hydrogeological characteristics

Chapter 2 - Basic physical basis for the study of groundwater movement

2-1. Water's properties

2-2. Pressure forces and viscosity

2-3. Hydrodynamic regime of waters, geometry and properties

Chapter 3 - Basic hydrodynamics of flow in a hydrogeological system

hydrogeological system

3-1. Principle of the law of infiltration and its general expression

3-1. -Types of underground flows and their schematisation

3-2. Schematic representation of groundwater flow problems

Chapter 4 - Hydrodynamic Properties of Flows

4-1. Hydrodynamic structure of flows,

4-2. Differential representation of the flow equations

4-3. hydrodynamic liquid flow and its properties,

4-4. Groundwater flow field and boundary conditions.

Chapter 5: Hydrodynamic calculations

5-1. Mathematical equations of groundwater flow

5-1.1- Stationary state

5-1.2- Non-stationary state

5-2. Study of the hydrodynamic state

5-2.1. Evaluation of the hydrogeological parameters by the analytical equations

5-2.2 Evaluation of the hydrogeological parameters by the finite difference equations method.

5-2.3 Evaluation of hydrogeological parameters by the numerical integral functions Method.

5-3. Determination of hydrogeological parameters by pumping tests

5-3.1 -Hydrodynamic parameters,

5-3.2 -Pumping and recovery tests.

5-3.3 - Type of drawdown graph,

5-3.4 -Interpretation of steady state tests.

5-3.5 -Interpretation of transient tests.

Tutorial program :

1. Basic concepts and definitions of groundwater dynamics, exercises
2. Determination of physical parameters of groundwater and their characteristics, exercises
3. Hydrodynamic problem schematic, exercises
4. Hydrodynamic schematisation of boundary conditions
5. Demonstration of mathematical equations, Euler, Lagrange, Gromeko and Bernoulli
6. Exercises on analytical, numerical and finite difference equations in hydrodynamics
7. Determination of hydrodynamic parameters by pumping tests

Assessment method

tutorials			Lab practices			exam	average
assiduit y	involvme nt	tes t	assiduit y	repor t	tes t	20	0.2Tutorials +0.2 lab practices+0 .6 exam
3	5	12	5	7	8		

References

1. Hiscock, K. M. (2009). Hydrogeology: principles and practice. John Wiley & Sons.
2. Letchenko. N. (2004) Dynamique des eaux souterraines , Moscow University
3. Fetter, C. W. (2000). Applied hydrogeology. Prentice hall.
4. Gavich, I. K. (1997). Hydrogeodynamics, Taylor & Francis
5. G. Castany.(1982). Principes et méthodes de l'Hydrogéologie
6. Schoeller, H. (1962). Les eaux souterraines: hydrologie dynamique et chimique, recherche, exploitation et évaluation des ressources (Vol. 642). Paris: Masson.

Master : Hydrogeology

Semester: 1

Heading of the subject : Integrated water resources management

Code : MEU 1.2

Coefficient : 1

Credit : 1

Objectives of the course

Knowledge, mobilization of the water potential, integrated management of the resource, elaboration of the water resources development plan, design and management, decision making.

Recommended prior knowledge

Good knowledge of hydrogeology and hydrology

Content of the subject :

1. Overview of water resources:

- Introduction
- Surface water resources
- Groundwater resources.
- Non-conventional resources
- Artificial groundwater recharge.
- Perspective.

2. Quantification of water resources:

- Introduction
- Methods of water resources quantification.

3. Modelling :

- Importance of modelling in the preservation and quantification of water resources
- Hydrological models

- Spatial models and geographic information systems
- Mapping of resources (regionalisation).
 - Knowledge of water resources
 - Mobilisation of water resources
 - Conservation of water resources.

4. General approach (main features) in the development of water of water resource systems:

- Multiple use (supply, demand.)
- Sectors using the water resource (human consumption, agriculture, industry,..)
- Spatial distribution
- Temporal distribution
- Competing interests
- Dynamic character
- Economics of water resource systems
- Social aspects
- Development-environment relationship

5. Integrated water resources management:

- Management context
 - Decision-making context
 - Methodological context
- Modelling
- Water resource management plan (master plan)
- Database design
- Integrated Planning
- Decision-making

Assessment method

exam	average
20pts	Exam

References :

Info_General/Focus_1_03_Gestion_Integree_Ressource_Eau_FR.
http://www.arenidf.org/medias/fichiers/Gestion_integree_des_re.pdf
Global water : Manuel de Gestion Intégrée des Ressources en Eau par Bassin

Master : Hydrogeology

Semester : 1

Heading of the subject : GIS applied to hydrogeology

Code : MEU1.2

Coefficient : 2

Credit : 4

Objectives of the course

The theoretical and technical knowledge that the students will have at the end of the training is related to the engineering skills of geographic information processing.

The course is designed to provide students with the skills to use GIS tools in a practical setting for hydrogeological applications.

Recommended prior knowledge

Knowledge of computers, Windows operating systems, cartography and Hydrogeology

Content of the subject :

Chapter 1 Introduction to GIS

1.1 Geographic Information Systems

1.2 A GIS is a model of reality

1.3 An example of a GIS

Chapter 2 - Modelling

2.1 Cartographic Modelling

2.1.1 The concept of a layer

2.1.2 Cartographic modelling in vector mode

2.1.3 Cartographic modelling in raster mode

2.2 Entity-relationship modelling

2.2.1 Definitions

2.2.2 Connectivity and cardinalities

2.2.3 Some examples of simple conceptual diagrams

2.2.4 Expression of relationships between layers

2.3 Analytical construction of the conceptual schema

Chapter 3: Data structuring and computer representation

3.1 Vector structuring

3.1.1 Spaghetti

3.1.2 Topological

3.1.3 Block representation

3.1.4 Representation of complex polygons

3.2 Raster structuring

3.2.1 Types of rasters

3.2.2 Normal rasters

3.2.3 The embedded mesh

3.2.4 Mathematical curves

3.3 Relational structuring

3.3.1 Definitions (field, record, key, relationship, etc.)

3.3.2 Computer representation of numbers and characters

3.3.3 The third normal form

3.3.4 Three types of tables

3.3.5 Visualisation

3.3.6 Referential integrity

3.3.7 Join types

3.3.8 SQL

3.4 Moving from conceptual schema to relational structure

3.5 Surface topology representation

3.6 Representing the network topology

Chapter 4: Database Management Systems

4.1 History and usefulness

4.2 The components

4.3. Data archiving and compression

4.4 Macro programming

4.5 Conventional programming

Practises :

1. Getting started with ArcGIS software, QGIS
2. Principle of georeferencing and spatial location by GPS
3. Vectorisation and topological relation technics
4. Conception of a relational hydrogeological Geodatabase
5. Visualisation and spatial analysis (thematic requests)
6. Mastering hydrogeological symbolization in ArcGIS
7. Layout of the digital hydrogeological map -ArcGis and QGIS.

Assessment method :

tutorials			exam	Average
assiduity	involvement	test	20pts	0.4 Tutorials +0.6 EXAM
4	8	8		

References

1. Johnson, L. E. (2016). Geographic information systems in water resources engineering. CRC Press.
2. Dixon, B., Uddameri, V., & Ray, C. (2015). GIS and Geocomputation for Water Resource Science and Engineering. John Wiley & Sons.
3. Pornon, H. (2015). SIG: la dimension géographique du système d'information. Dunod. 11. Singh, V., & Fiorentino, M. (Eds.). (2013). Geographical information systems in hydrology (Vol. 26). Springer Science & Business Media.
4. Poudry G., 2005. Numérisation et amélioration d'image
5. Joliveau T. Concepts, Usages et Méthodes des SIG. Université Jean Monnet Saint-Etienne. 14. Steinberg, J. (2002). Cartographie: systèmes d'information géographique et télédétection.

6.Paegelow M., 2000. Expression cartographique. 16.Girard M.C., Girard C.M., 1999. Traitement des données de télédétection.

Master : Hydrogeology

Semester : 1

Heading of the subject : Statistics and data analysis

Code :MEU1.3

Coefficient : 2

Credit : 4

Objectives of the course

Introduction to the tools of teledetection for the cartography of water resources

Recommended prior knowledge

Knowledge in mathematics and statistics

Content of the subject :

1 Variables, statistical data, tables, numbers

1.1 Basic definitions

1.2 Nominal qualitative variable

1.3 Ordinal qualitative variable

1.4 Discrete quantitative variable

2. univariate descriptive statistics

2.1 Positional parameters

2.2 Dispersion parameters

2.3 Moments

2.4 Shape parameters

2.5 Change of origin and unit

2.6 Means and variances in groups

2.7 Stem and leaf plot

2.8 The Whisker Box

3. Bivariate Descriptive Statistics

3.1 Bivariate statistical series

3.2 Two quantitative variables

3.3 Two qualitative variables

4. Calculation of probabilities and Random Variables

4.1 Probability

4.2 Combinatorial Analysis

4.3 Random Variables

4.4 Continuous Random Variable

4.5 Bivariate Distribution

5. Time series, filters, moving averages and seasonal adjustment

5.1 General definitions and examples

5.2 Description of the trend line

5.3 Shift and difference operators

5.4 Linear filters and moving averages

5.5 Seasonal adjustment

Tutorials program

1. Characterisation of a statistical series (drawing up bar diagrams, in stick, and histogram).
2. calculation of quantiles and representation of repartition functions
3. calculation of position, dispersion and shape parameters, and drawing of the whisker box.
4. bivariate statistical study.
4. bivariate statistical study by determining the regression line for categorical
4. bivariate statistical study by determining the regression line for categorical variables and the Cramer coefficient for qualitative variables.
5. Application of the laws governing random phenomena to the formal framework of probabilistic models.

Assessment method

tutorials			exam	Average
assiduity	involvement	test	20pts	0.4 TUTORIALS +0.6 EXAM
3	5	12		

References

- Legendre R et Legendre P., 1984. Ecologie numérique
- Escofier B. Et Pages J. , 1999. Analyses factorielles simples et multiples
- Marcote D., 2000. Traitement des données statistiques

Master : Hydrogeology

Semester : 1

Heading of the subject : Topography

Coefficient: 1

Credit : 2

Code : UED1.2

Objectives of the course

Knowledge of the tools for measuring distances and differences in level necessary for various piezometric surveys and worksite surveys, etc.

Recommended prior knowledge

Knowledge of trigonometry, geometry and geodesy

Content of the course :

1. General topography

- Purpose of topography
- Units of measurement
- Geographical coordinates, azimuth
- Rectangular coordinates

2. Distances measurement

- General principles of distance measuring instruments
- Stakeout
- Flat measurement
- Accuracy of measurement
- Measurement of indirect lengths
- Reminder of trigonometry

3. Measurement of angles

- Units of measurement of angles
- Theodolite

- The tacheometer
- 4. Direct and indirect levelling
 - Direct levelling
 - Indirect levelling
 - Slope and distance
 - Longitudinal profile
- 5. Topographic survey
 - Closed path
 - Open path
 - Determination of surfaces

Tutorials

1. Reminder on trigonometric methods
 2. Measurement of distances
 3. Measurement of angles
 4. Setting up and measuring distances and angles in the field
 5. Realization on the field of the closed and open paths
1. Reminder on trigonometric methods
 2. Measurement of distances
 3. Measurement of angles
 4. Setting up and measuring distances and angles in the field
 5. Realization on the field of the closed and open paths

Assessment method

tutorials			exam	Average
assiduity	involvement	test	20pts	0.4 TUTORIALS +0.6 EXAM
3	5	12		

References

- Cours élémentaire de topographie. Dubuisson, B. Paris : Eyrolles, 1988
- Introduction à la topographie générale et souterraine. Merabet, D. Alger : OPU, 1994 • Maitriser la topographie : des observations au plan. Brabant, Michel. Paris : Eyrolles, 2003 • Topographie appliquée aux travaux publics, bâtiment et levés urbains. Lapointe, Lucien. Gilles, Meyers. Paris : Eyrolles, 1986
- Topographie et topométrie moderne.T.2, Calculs. Mille, Serge. Paris : Eyrolles, 1999 • Topographie et topométrie modernes.T.1, Techniques de mesure et de représentation. Milles, Serge. Paris : Eyrolles, 1999. • Topographie. Merlin, Pierre. Paris : Presses universitaires de France, 1972
- <http://geodesie.ign.fr/>
- <http://www.universalis.fr/encyclopedie/topographie/>

Master : Hydrogeology

Semester : 1

Heading of the subject : Technical English I

Code : TEU1.1

Coefficient : 1

Credit : 1

Objectives of the course :

Understand and learn to effectively use geological, hydro-geological and environment

terms in English and become more familiar with using English language in the field of

hydrogeology.

Connaissances préalables recommandées

Basic reading and oral communication, grammar, vocabulary building, listening and

speaking. Reading of simple scientific texts, their analysis, comprehension of the main idea and a basic ability to communicate and exchange information in a simple way.

Course content

1. Understanding basic hydrogeology concepts in English Speaking: logical development of ideas, participation in a discussion presentation, dialogue, interview, discussions, interpretation, assessment and generalization on the speciality topics.

2. Listening: to simulate texts (presentations, academic discussions, conversations) of

average complexity on speciality topics. Types of texts: practical guidelines and instructions, descriptions of a process, an interview, a conversation.

3. Language in use: forming and expanding professional / speciality vocabulary on the basis of the topics discussed, learning to use grammatical structures typical of scientific texts in all language skills: tenses of the

verbs, active/passive voices, order of adjectives, nominal adjectives, and adverbs.

4. Topics to be studied : Pollution of surface and groundwater, aquifers, water resources, soil pollution, geography, water cycle, Poverty and environmental damage, Sustainable development, climate change.

Assessment method

exam	average
20pts	exam

References :

1- G.Tyler Miller , Jr : Living in the environment (ITP Wadsworth Eighth Edition) 1994

2- John Swales : Writing scientific English (Nelson Edition 1971)

3- L. G Alexander : Developing skills : an integrated course for intermediate students

(Longman Edition 1972)

SEMESTER

2

Master: Hydrogeology

Semester: 2

Heading of the subject : Groundwater Flow System and mapping

Code : UEF1.1

Coefficient : 2

Credit : 4

Objectives of the course

Understand the quantitative system of groundwater flow and its mapping for the different hydrogeological environments, understanding of hydrogeological

hydrogeological mapping

Recommended prerequisite knowledge

Mapping, hydrogeology, piezometry, water chemistry

Content of the course :

Chapter 1 Flow systems, properties and characteristics

1-1. Basic hydraulic concept of groundwater flow

1-2. Systematisation of groundwater flow

1-3. Types of groundwater flow systems

1-4. Flow system and aquifer types

1-5. Hydrodynamic behaviour of aquifers,

1-6. Formation of the groundwater regime

1-7. Typology of hydrogeological mapping

Chapter 2: Piezometric mapping

2-1. Basic concept of piezometric head

2-2. Reporting of piezometric levels,

2-3. Drawing of hydroisohypses-isopiezes curves

2-4. Piezometric variations

- 2-5. Piezometric network
- 2-6. Piezometric measurement density
- 2-7. Frequency of piezometric measurement
- 2-8. Interpretation of piezometric maps

Chapter 3: Hydrogeochemical mapping

- 3-1. Principle of hydrogeochemical mapping and profiling
- 3-2. Index approach
- 3-3. Spatial interpolation approach
- 3-4. Spatial point approach
- 3-5. Hydrogeochemistry and groundwater flow systems

Chapter 4: Standards and cartographic symbolisation in hydrogeology

- 4-1. Basic information for hydrogeological mapping
- 4-2. Map presentation and scale
- 4-3. Characteristics and components of hydrogeological maps
- 4-4. Types and classification of hydrogeological maps
- 4-5. Techniques for preparing and publishing hydrogeological maps
- 4-6. Development in hydrogeological mapping

Tutorials :

- 1:** Basics of the groundwater flow system (exercises)
- 2:** Groundwater flow schematisation (exercises)
- 3:** Design of a piezometric map and determination of its parameters
- 4:** Hydrogeochemical mapping (groundwater quality index map)
groundwater quality index map)
- 5:** Establishment of a hydrogeochemical map (map of equal chemical elements content)
- 6:** Interpretation and analysis of hydrogeology map; case study
- 7:** Computer based hydrogeological symbolisation

8: Use of GIS and spatialization techniques in hydrogeological mapping (practice software).

Assessment method

tutorials			exam	Average
Assiduity	Involvement	Test	20pts	0.4 TUTORIALS +0.6 EXAM
3	5	12		

References

1. Hiscock, K. M. (2009). Hydrogeology: principles and practice. John Wiley & Sons.
2. Delleur, J. W. (Ed.). (2006). The handbook of groundwater engineering. CRC press.
3. Letchenko. N (2004) Dynamique des eaux souterraines, Moscow University,.
4. Fetter, C. W. (2000). Applied hydrogeology. Prentice hall.
5. Gavich, I. K. (1997). Hydrogeodynamics, Taylor & Francis.
6. Castany, G. (1982). Principes et méthodes de l' hydrogéologie. Bordas.
7. Verruijt, A. (1970). Theory of groundwater flow.
8. Schoeller, H. (1962). Les eaux souterraines: hydrologie dynamique et chimique, recherche, exploitation et évaluation des ressources (Vol. 642). Paris: Masson.
9. Girinski, N. K.: Some problems of groundwater dynamics., Moscow ,1947.

Master: Hydrogeology

Semester : 2

Heading of the subject : Applied geophysics

Code : MEU1.2

Coefficient : 2

Credit : 4

Objectives of the course

Initiation to the recognition and prospecting technics of the subsoil and its resources (application to groundwater resources)

Recommended prior knowledge

Knowledge in geology, hydrogeology and physics.

Contents of the course :

Chapter 1: Geophysical prospecting by the electrical method

1. Basic concepts
2. Direct current resistivity method
3. Instrumentation and application
4. Vertical electrical probing: VEP
5. Electrical trailing
6. Electrical tomography / electrical panel

Chapter 2: Geophysical prospecting by the seismic method

1. Elastic properties of rocks
2. Seismic theory
3. Seismic refraction
4. Seismic reflection
5. Seismic tomography

Chapter 3: Electromagnetic method

1. Introduction

2. Rocks and their mineral properties
3. Homogeneous Maxwell equations
4. Constitutive relations
5. Electromagnetic waves
6. Boundary conditions
7. The galvanic effect in electromagnetism
8. Reflection and refraction of an EM plane wave
9. Plane wave incidence on a tabular medium

Chapter 4: Georadar method

1. Principle of the method
2. Data acquisition method
3. Interpretation of the georadar profiles
4. Application in the field of hydrogeology and environment

Practical work programme

1. Realization of a vertical electrical sounding, and establishment of the resistivity map and interpretation.
2. Realization of the trails, establishment of the pseudo-section map and interpretation.
3. Interpretation of a seismic profile composed of direct and reverse shot and determination of the bedrock shape
4. Identification of subsurface structures by measuring the resistivity of rocks
5. Interpretation of a georadar profile

Assessment method :

tutorials			exam	Average
Assiduity	Involvement	Test	20pts	0.4 TUTORIALS +0.6 EXAM
5	8	7		

References

1. Richard LAGABRIELLE : Géophysique appliquée
2. Michel Chouteau et Bernard Giroux : Géophysique appliquée –méthode électrique
3. Bernard Giroux : Techniques géophysiques de haute résolution Sismique réflexion
4. Bernard Giroux, Michel Chouteau : Géophysique appliquée -Notes de cours – Magnétisme
5. Bernard Giroux : Techniques géophysiques de haute résolution Micro gravimétrier.wikipedia.org/.../Géophysique_appliquée
6. Bernard Giroux : Techniques géophysiques de haute résolution-méthodes électromagnétiques

Master : Hydrogeology

Heading of the subject : Modelling and simulation of flows

Code : UEF1.3

Coefficient : 2

Credit : 4

Objectives of the course

At the end of the course, the student will have a training in aquifer modelling, he will be able to : make adequate conceptual choices according to the problem to be simulated, collect and organise the data necessary for hydrogeological modelling, choose boundary conditions; use the software and programmes such as :

MODFLOW, MODPATH and MT3D to treat real hydrogeological problem.

Recommended prior knowledge

Perfect knowledge of the acquired skills of the subjects: General Hydraulics, Hydrogeology and groundwater dynamics

Content of the course :

Chapter 1: Introduction to hydrogeological modelling

- 1.1. Principle of modelling
- 1.2 Modelling steps
- 1.3 Conceptual model
- 1.4. Mathematical model
- 1.5. Numerical model
- 1.6. The Code and its Verification
- 1.7. Model Validation
- 1.8. Calibration
- 1.9. Parameters estimation

Chapter 2: Basic mathematics and computer code

- 2.1 Introduction

- 2.2. Groundwater Flow Equation
- 2.3. Boundary Conditions
- 2.4. Analytical models
- 2.5. Numerical Models
- 2.6. Code selection
- 2.7. Code execution
- 2.8. Modelling errors
- 2.9. Uncertainty

Chapter 3. Model dimensioning and boundary setting

- 3.1. Spatial dimensions
- 3.2. Selection of boundary conditions
- 3.3 Implementation of boundaries in a numerical model
- 3.4. Extraction of local boundary conditions from a regional model
- 3.5. Simulation of water table
- 3.6. Common modelling errors

Chapter 4 The modelling report, archive and review

- 4.1 Introduction
- 4.2. The Modelling Report
- 4.3. Archiving the model
- 4.4 Review of the modelling report
- 4.5. Common errors in the preparation and review of reports and archives

Tutorials :

- 1:** Getting started with the Modflow, GMS and Visual Modflow software
- 2:** Acquisition and preparation of necessary data (case study)
- 3:** Exercises on groundwater dynamic equations
- 4:** Criteria for choice and selection of model code
- 5:** Integration of the input parameters of the model

6: Calibration technics and uncertainties

7: Simulation technics (case study)

8: Presentation of results and exporting

Assessment method :

tutorials			exam	Average
Assiduity	Involvement	Test	20pts	0.4 TUTORIALS +0.6 EXAM
3	5	12		

References

1. Anderson, M. P., Woessner, W. W., & Hunt, R. J. (2015). Applied groundwater modeling: simulation of flow and advective transport. Academic press.
2. Kresic, N. (2006). Hydrogeology and groundwater modeling. CRC press.
3. Ledoux, E. (2003). Modèles mathématiques en hydrogéologie. Centre d'Informatique Géologique Ecole Nationale Supérieure des Mines de Paris.P.Wiley & Sons, LTutorials, p.
4. Fetter, C. W. (2000). Applied hydrogeology. Prentice hall.
5. Wang, H. F., & Anderson, M. P. (1995). Introduction to groundwater modeling: finite difference and finite element methods. Academic Press.
6. Dassargues, A. (1990). Modèles mathématiques en hydrogéologie et paramétrisation. Annales de la Société géologique de Belgique.

Master: Hydrogeology

Semester: 2

Heading of the subject : Hydrochemical and isotopic methods

Code : UEF1.4

Coefficient : 3

Credit : 6

Objectives of the course

Interpretation method of physicochemical and isotopic analyses results.

This course is designed to help the students to understand the hydrogeological conditions of groundwater.

Recommended prior knowledge

Basic knowledge of geology and geochemistry, water chemistry and analysis.

Content of the course :

1-Introduction and interest of hydrochemistry

1-1 Physicochemical parameters

- Definition
- Measurements
- Interpretation

1-2 Different methods of water classification

- Chemical facies and origin
- Evolution of the mineralization of waters
- Saturation and aggressiveness of waters (Equilibrium pH, CO₂ content, saturation

Saturation indices, calco-carbonic equilibria and their importance for the evolution of water mineralisation in the groundwater environment

1-3 Establishment and interpretation of hydrochemical maps

2-Isotopes, definition and utility in hydrogeology

2-1 Use of some isotopes of the water molecule for the knowledge of the hydrogeological behaviour of aquifers (origin of the water, impluvium dating, ...)

2-1-1 Overview

- Isotopes of the water molecule
- Isotopes of dissolved substances
- Application of these methods to mineral waters

2- 1-2 Use of isotopes of the water molecule

- Meteoric origin of mineral waters
- Location of the Recharge Area
- Verification of exchanges with the host rock.
- Tritium dating of water
- Evidence of emergence mixtures

Tutorial

- 1 Classification of waters according to the vertical diagram methods
- 2 Classification of waters according to the triangular diagram methods
- 3 Determination of equilibrium pH and saturation indices
- 4 Comparison of water mineralisation and aquifer permeability maps
- 5 Drawing of chemical element maps and hydrogeological interpretations in relation to geological and hydrodynamic factors (flow direction and boundary conditions)

Lab practices

1. Measurement of physico-chemical parameters (pH, RS, Conductivity)
 2. Determination of major cations and anions by titrimetry
 3. Drawing of chemical element content maps and hydrogeological interpretations
- interpretations according to geological and hydrodynamic factors
(flow direction and boundary conditions)

Assessment method :

tutorials			Lab practices			exam	average
assiduit y	involvmen t	tes t	assiduit y	repor t	tes t	20	0.2Tutorial s +0.2 lab practices +0.6 exam
3	5	12	5	8	7		

References

<http://www.aquamania.net/science/eauisotope>

Rodier : Analyse de l'eau

Master: Hydrogeology

Semester: 2

Heading of the subject : Groundwater catchment

Code : MEU1.1

Coefficient : 2

Credit : 4

Objectives of the course

Mastery of the techniques of drilling and groundwater catchment in order to introduce the student to design programs for the realization or follow-up of groundwater catchment works.

Recommended prior knowledge

Knowledge of geology, hydrogeology and civil engineering (basic).

Course content :

- 1- The different types of aquifers and possible ways of collecting water according to the geometry of aquifers.
- 2- Spring catchment and development,
- 3- Management of a spring
- 4- Development with a catchment unit and dimensioning of the volume of the tank, the overflow and pipes
- 5- Development with a catchment unit and filter
- 6- Catchment area of a well
 - 6-1 Drilling in soft and hard ground
 - 6-2 Well casing
 - 6-3 Installation of the well
 - 6-4 Filter cake
 - 6-5 Ground slab
 - 6-6 Equipment (margelles, anti-bourbier, closure, pump)

7- Drilling technics

7-1 Comparison of different drilling methods (advantages and disadvantages) and criteria for choice

7-2 Installation and organisation of the site

7-3 Description of the equipment

7-4 Pre-drilling (interest and method)

7-5 Drilling diameters and drilling programme according to the objectives

7-6 Drilling fluid: types and properties, drilling fluid circuits and sizing mud pits

7-7 Compressed air for hammering down the borehole

8- Exploration drilling

8-1 Drilling log (cuttings analysis, lithological section of the borehole and granulometry)

8-2 Evaluation of drilling productivity (cuttings use, mud behaviour during drilling and behaviour of the mud during drilling and logging)

8-3 Aquifer tests

9- Tubular equipment and gravel pack

9-1 Use of the lithological section and logs

9-2 Description of tubing and type of strainers

9-3 The equipment column and choice of materials

9-4 Sizing of the strainer slots

9-5 Filter cake (sizing, nature and role)

10- Drilling development (interest and method of realisation)

10-1 Development with compressor (air lift)

10-2 Pump development

11- Well test stages and sizing of electromechanical equipment

12- Design and technical description

Tutorials

1. Implementation of catchment works (methodology and application to a real case: use of geological, geophysical, hydrogeological and environmental criteria)
2. Individual work (comparison of drilling methods (advantages and disadvantages))
3. Report of a drilling site field visit: description of in situ cuttings, supervision of the borehole data registration operation, etc.
4. Calculation of different stresses (crushing and buckling) of the casing
5. Sizing of the screen slot and gravel pack from the grading curve
6. Pumping test by flow rate step: calculation of head losses in the structure and and sizing of the electromechanical equipment.

Assessment method :

tutorials			exam	Average
Assiduity	Involvement	Test	20pts	0.4
3	5	12		TUTORIALS +0.6 EXAM

References :

BRGM : Techniques de forage www.exofofor.fr/forage-traitement-tech.php
www.scribd.com › Research › Science

Master : Hydrogeology

Semester : 1

Heading of the subject : Teledetection

Code : MEU1.2

Coefficient : 2

Credit : 4

Objectives of the course :

The use of the teledetection to solve hydrological
Hydrogeological and geological problems.

Recommended prior knowledge

GIS and mapping techniques, basic knowledge of electromagnetism and physics.

Course content :

Chapter 1. Spatial information

- 1.1 Structure of spatial information
- 1.2. Systems of cartographic representation
- 1.3 Analysis of spatial structure

Chapter 2. Teledetection

- 2.1 Introduction to teledetection
- 2.2. The Physical basis of teledetection
- 2.4. Energy sources and radiation principles
- 2.5. Energy interactions in the atmosphere
- 2.6 Energy interactions with earth objects
- 2.7. Data acquisition and interpretation
- 2.8. Visual interpretation of the image

Chapter 3: Digital Image Processing

- 3.1 Image rectification and restoration

3.2. Image enhancement and contrast manipulation

3.3. Image Transformation

3.4. Image Classification

3.5. Cartographic restitution of the image

Chapter 4. Active remote sensing

4.1. Principle

4.2 Synthetic Aperture Radar (SAR)

4.3 Wave interaction with the surface

4.4. The Backscatter Phenomenon

4.5. Practical applications

Practical work :

1: Introduction to the practical work and use of Google earth

2: Introduction to ENVI and ERDAS software

3 : Data acquisition and image downloading

4 : Visualisation techniques and image file management

5 : Image rectification (geometric, spectral and radiometric corrections)

6: Image pre-processing and processing (filtering and enhance)

7: Use of spectral indices

8 : Cartographic processing of an image

Assessment method :

tutorials			exam	Average
Assiduity	Involvement	Test	20pts	0.4 TUTORIALS +0.6 EXAM
5	8	7		

References

1. Campbell, J. B. and R. H. Wynne (2011). Introduction to Remote Sensing, Guilford Press. Télédétection, Presses de l'Université du Québec.
2. Girard, M. C. and C. M. Girard (2010). Traitement des données de télédétection – 2 éd.: Environnement et ressources naturelles, Dunod.
3. Joseph, G. (2005). Fundamentals of Remote Sensing, Universities Press.
4. Poudry G., 2005. Numérisation et amélioration d'image
5. Collet, C. (2001). Précis de Télédétection: Traitements Numériques d'Images
6. Paegelow M., 2000. Expression cartographique.
7. M.C., Girard C.M., 1999. Traitement des données de télédétection.
8. Bonn, F., G. Rochon, et al. (1996). Précis de télédétection: Principes et méthodes, Presses de l'Université du Québec.

Master: Hydrogeology

Semester : 2

Heading of the subject : Thermo mineral waters

Code : MEU1.3

Coefficient : 1

Credit : 1

Objectives of the course

Introduction to approach methods of the hydrodynamic and hydrological behaviour of the thermo-mineral waters and their importance in Algeria.

Recommended prior knowledge

Hydrogeology, hydrodynamics, geology, geochemistry

Course content

I General

1. Definitions
2. Distribution and classification of Algerian thermo-mineral waters
3. Physico-chemical characteristics
4. Condition of emergence
5. Thermo-mineral hydrogeology

II Geographical location of thermal waters, research and protection

- 1 Location: relationship to tectonics, importance of structural geology
- 2 Prospecting: mapping of CO₂ or Radon emitted by the subsoil
- 3 Catchment. Problem of diffuse arrivals.

III Hydrothermal circuits: thermosyphon.

- 1 Origins of thermal water
- 2 The thermosyphon

IV Alteration of the physico-chemical characteristics of the water during their ascension.

- 1 Cooling: mineral precipitation, change of chemical equilibrium
- 2 Mixing with surface water (dilution effect)
- 3 Recharge or loss of gases (O₂, CO₂, etc.).
- 4 Pressure decrease

V The problem of estimating the characteristics of the deep tank

1. General principle
2. Precautions for use
3. Working hypothesis
4. The silica geothermometer
5. Cation geothermometers
 - 5.1 NA/K geothermometer
 - 5.3 NA/IL geothermometer
6. Developments, corrections
7. Other Geothermal Meters
- 8-Sources of error

VI Presentation of two common types of thermal water

Assessment method

exam	average
20pts	exam

References :

1. Djorfi S. Étude des eaux minérales et thermales du nord-est algérien et leur importance • socio-économique. Th. Doct. PhD, Univ. d'état d'Azerbaïdjan (URSS),1988:196p.
2. Djorfi S. Étude des conditions lithostructurales et hydrogéologiques des sources thermominérales du nord-est algérien. Colloque Intern. Terre et eau, Univ. Annaba – Algérie.

3. S. Ouali, 1996, 'Etude géothermique du Sud de l'Algérie', Mém. Magister, Université M'hamed Bouguerra – Boumerdes.
4. K. G. Pierce, B. J. Livesay, 1994, 'A study of geothermal drilling and the production of electricity from geothermal energy' Master, Sandia report - Sand92- 1728 uc-2d.
5. [G. M. Reistad, 1995, 'Direct application of geothermal energy', Master, Oregon State University, New York
6. M. Rezig, 1991, 'Etude géothermique du Nord-Est de l'Algérie', DEA- Université des sciences et des techniques du Languedoc (Montpellier).

Master: Hydrogeology

Semester: 2

Heading of the subject : Hydrogeology of Algeria

Code : UED1.1

Coefficient : 2

Credit : 2

Objectives of the course

Discover the distribution of groundwater resources in Algeria, their particularities (rarity, mineralization) according to the distribution of climates and geological facies.

Recommended prior knowledge

Good knowledge of general geology of Algeria (aquifer systems and groundwater tables).

Course content :

1. Distribution of groundwater
2. The major aquifers in Algeria and their properties
3. Coastal aquifers and problems of seawater intrusion
4. The aquifers of the large plains (Mitidja plain and Cheliff plain)
5. Aquifers of the high plains (Sersou plain, karstic aquifers of Saida and Tlemcen)
6. The Barremian aquifer in the Saharan Atlas
7. The main aquifers of southern Algeria and their properties ("Terminal complex aquifer and the intercalary continental aquifer)

Tutorials

Workshops: presentation of hydrogeological maps of Biskra, Algiers region, Mostaganem plateau, Mostaganem plateau, Bechar, Hoggar

Assessment method :

tutorials			exam	Average
Assiduity	Involvement	Test	20pts	0.4
3	5	12		TUTORIALS +0.6 EXAM

References :

- ORGM : Carte géologique de l'Algérie au 1/500000
- ANRH : Carte des ressources en eau souterraines
- Cornet, N. Gouskov, 1952, 'La géologie et les problèmes de l'eau en Algérie', Tome II. Données sur l'hydrogéologie algérienne. Les eaux du crétacé inférieur continental dans le Sahara algérien (nappe dite albienne).
Ouvrage
- Introduction a l'hydrogéologie du Sahara, Algérie', Revue de géographie physique et de géologie dynamique Dynam. Volume 6

Master: Hydrogeology

Semester: 2

Heading of the subject : Technical English II

Code : TEU1.1

Coefficient : 1

Credit : 2

Objectives of the course

Introduction to Scientific English

Recommended prior knowledge

Knowledge of English (spoken and written)

Content of the subject :

Recommended prior knowledge

Knowledge of English (spoken and written)

Course content :

This course will introduce the student to the scientific aspects of the English language. The aim is to create the communication skills needed to present scientific work and to defend their ideas in English.

The course is divided into personal work sessions on topics, discussion sessions and an oral and written presentation, ear training.

Assessment method:

exam	average
20pts	exam

References :

- 1- G.Tyler Miller , Jr : Living in the environment (ITP Wadsworth Eighth Edition) 1994
- 2- John Swales : Writing scientific English (Nelson Edition 1971)
- 3- L. G Alexander : Developing skills : an integrated course for intermediate students (Longman Edition 1972)

Semester 3

Master: Hydrogeology

Semester: 3

Heading of the subject : Water treatment and reuse

Code : UEF1.1

Coefficient : 2

Credit : 4

Objectives of the course

Knowledge of the chemical and microbiological composition of water and the origin of mineralization.

Recommended prior knowledge

Basic knowledge of water chemistry and analysis.

Course content

1. General information on natural waters

1.1 Physicochemical and bacteriological constituents of water

1.2 Norms for the use of natural waters for different purposes

2. Treatment of non-conventional waters :

2.1 Wastewater treatment processes (Pre-treatment, Primary treatment, Secondary treatment, Tertiary treatment, Odour treatment)

2.2 Treatment of **brackish** water (thermal and membrane processes)

3. Water reuse

3.1 Wastewater reuse

3.2 Artificial groundwater recharge

Tutorials

1. dimensioning of pretreatment works (screening, grit removal, oil removal system)

2. Osmotic pressure

3. dimensioning of artificial recharge devices

Assessment method :

tutorials			exam	Average
Assiduity	Involvement	Test	20pts	0.4
3	5	12		TUTORIALS +0.6 EXAM

References

R. SALGHI : DIFFERENTS FILIERES DE TRAITEMENT DES EAUX

www.ensa-agadir.ac.ma/gpee/.../Pollution%20GPEE%205.pdf

www.fndae.fr/documentation/PDF/fndae12.pdf

environnement.ecole.free.fr/pollution_eau_qualite_des_eaux_continentales.htm

Master: Hydrogeology

Semester: 3

Heading of the subject : Pollution and protection of groundwater

Code : UEF1.2

Coefficient : 2

Credit : 4

Objectives of the course

Protection of groundwater and catchment works against the degradation of their physicochemical and microbiological quality.

Recommended prior knowledge

Good knowledge of hydrogeology and hydrodynamics, biology and chemistry.

Course content :

1. Pollution of groundwater :

Natural and anthropological pollution, etc.

2. Characteristics of pollutants:

- Aqueous solubility,
- Vapour pressure ;
- Adsorption,
- Biodegradability
- Physico-chemical properties of pollutants

3. Transport and attenuation mechanisms of the pollutant in the groundwater environment

4. Protection of groundwater catchment structures:

(Soil purification capacity, Flush criterion, Transit time, Distance from pollution point to the emergence, flow limits, recharge zones)

5. Protection areas (immediate, close-WHPA, distant)

6. Methods for delineation of wellhead protection areas WHPA

(piezometric mapping, fixed radius method, analytical methods (Bear and Jacob, Simpson, Grubb, Wyssling method), determination by abaque, numerical modelling)

7. Protection of groundwater resources against pollution :

Assessment of the vulnerability of groundwater to pollution

8. Groundwater decontamination techniques (Natural defences against pollution, purifying power of soils, biological self-purification of self-purification of soils)

Tutorials :

1: Presentations on pollution

2: Presentations on point pollution, contamination plume (transport, advective, dispersive and diffusive of contaminants), examples of modelling by CTRAN/W software from the Geoslope company.

3: Calculation of transit times analytically

4: Numerical examples of contaminant transit time calculations.

5: Analytical dimensioning of the WHPA by using analytical methods

6: Numerical determination of contaminant transit times

7: Presentation on groundwater decontamination techniques

Assessment method :

tutorials			exam	Average
Assiduity	Involvement	Test	20pts	0.4 TUTORIALS +0.6 EXAM
3	5	12		

References

Lallemand Baresse : Délimitation des périmètres de protection des captages d'eau
Lallemand Baresse : Méthodes de dépollution des eaux souterraines

Master: Hydrogeology

Semester: 3

Heading of the subject : Karstic Aquifers (Methods of study)

Code : UEF1.3

Coefficient : 2

Credit : 4

Objectives of the course :

Introduction to approach methods of hydrodynamic and hydrological behaviour of karst aquifer systems and their importance in Algeria.

Recommended prior knowledge

Hydrogeology, hydrodynamics, geology,

Course content :

1. Geological characteristics of karst systems
2. Importance and distribution of fissured and karstic aquifers in Algeria.
3. Hydrodynamic characteristics of flows in fissured and karstic environments (characteristics of recharge zones or epikarst, vertical transfer zone or vadose zone and groundwater flooding)
4. Study method :
 - 4-1 Role and importance of fracturing in groundwater flow
statistical study of fracturing (field measurements and determination from photoaerial data and use of karstic networks explored by speleologists and report
on maps and projections),
 - 4-2 Comparison of geophysical prospection methods and their interest in locating fractured and karstified zones
 - 4-3 Chemical tracing,
 - 4-3-1 Natural tracing (reminder of hydrochemical and isotopic methods in the characterisation of reservoirs and flows)
 - 4-3-2 Artificial tracing

- Introduction
- Methodological reminders
- Artificial tracings
- The tracer
- Experimental conditions
- Preparation
- The injection
- Monitoring of the restitution
- Restitution curve and interpretation (calculation of flow rate, transit time and reserves: coloured volume)

4-4 Hydrological balance, recharge surface and estimation of infiltration by Schoeller method.

4-5 Evaluation of hydrodynamic properties and reserves

4-5-1 Drying curve formulas

4-5-2 Establishment of the drying rate curve

4-5-3 Qualitative interpretation

4-5-4 Quantitative interpretation

4-5-5 Maillet model,

4-5-6 G. Tison's model

4-5-7 Drying coefficient and characteristics of the recharge area

4-5-8 Evaluation of the regulatory reserves and the storage coefficient

4-6 Particularities and interpretation of pumping tests in fractured media

4-6-1 Concept of porous media equivalent to fractured media

4-6-2 Methods of interpretation of pumping tests in fractured media

4-6-2-1 Case of an isotropic aquifer affected by a crack

Single vertical fracture

Principle and procedure for interpretation at the pumping well

Principle and procedure for interpretation at the piezometer

Single horizontal fracture

4-6-2-2 Double porosity aquifer

TUTORIALS

1. Delineation of a karst hydrogeological watershed according to the limits of geological and structural facies
2. Study of the billing: determination of the frequent directions of the groundwater flows directions (measurements in the field and by aerial photography)
3. Drawing of the drying rate curve
4. Calculation of the drying coefficient and the volume of the regulating reserves of a spring draining a karst system.
5. Calculation of hydrodynamic parameters by interpretation of a pumping test using the model of a karst aquifer affected by a vertical fissure
6. Calculation of the supply and discharge of a spring by using the restitution curve

Assessment method :

tutorials			exam	Average
Assiduity	Involvement	Test	20pts	0.4 TUTORIALS +0.6 EXAM

References

Pierre-Yves Jeannin : Structure et comportement hydraulique des aquifères karstiques

Master: Hydrogeology

Semester : 3

Heading of the subject : Geostatistics

Code : UEF1.4

Coefficient : 3

Credit : 6

Objectives of the course

Training the student to analyze the spatial structure of natural phenomena, to proceed to correct spatial estimations and to evaluate the quality of the accuracy of the map

Recommended prior knowledge

Knowledge of cartography, statistics and computing

Content of the course :

I. Introduction

1.1 History

1.2 Notions of random function and regionalized variable

II. Basic assumptions in geostatistics

2.1. Stationarity

2.2 Intrinsic hypothesis

III. Variography

3.1. Definition-objective

3.2 Calculation of the experimental variogram

3.3. Adjustment of the variogram

3.4. Directional variograms and anisotropy

3.5. Variance estimation

IV. Kriging

4.1. Definition-Properties

4.2 Types of kriging

- 4.2.1. Simple kriging
- 4.2.2 Ordinary Kriging
- 4.2.3 Indicator Kriging
- 4.4. Validation

Tutorials :

- 1: Geostatistical reminders-exercises
- 2 : Laws of distributions -exercises
- 3: Getting started with Variowin - Geostatistical analyst-Surfer software
- 4: Variographic analysis -Practical
- 5: Experimental variogram -Practical
- 6: Variogram fitting and models-exercise and practice
- 7: Anisotropy
- 8: Spatial estimation by kriging-exercise-practice

Lab practices :

- 1: Getting to grips with the Variowin software-Variographic analysis
- 2: Getting to grips with the Surfer software - Interpolation techniques
- 3: Getting to grips with the ArcGis software - Geostatistical analysis

Assessment method :

tutorials			Lab practices			exam	average
assiduit y 3	involvmen t 5	tes t 12	assiduit y 5	repor t 8	tes t 7	20	0.2Tutorials +0.2 Lab practices +0. 6 exam

References

Journel A. 1977. Géostatistique minière Rivoirard J., 1995. Concepts et méthode de la géostatistique Wackernagel H. 1995. Multivariat geostatistic

Master: Hydrogeology

Semester: 3

Heading of the subject : Sampling and analysis techniques

Code : MEU1.1

Coefficient : 2

Credit : 4

Objectives of the course

To initiate the students to deal with the laboratories, to become familiar with the measuring devices, acquire the various precautions to obtain reliable and coherent values in the chemical, physicochemical and bacteriological analysis analyses of water.

Recommended prior knowledge

Basic knowledge of analytical chemistry

Course content

1. General

1.1 Validity and significance of results

1.2 Representativeness and integrity

1.3 Sampling objectives

1.4 Nature of the samples

1.5 Preparation of material

1.6 Sampling site

1.7 Sampling plan

2. Method of sampling, packaging and transporting samples

2.1 Use of sterile gloves

2.2 Hand washing technique

2.3 Collection equipment

2.4 Sampling technique

2.5 General procedure for transporting and shipment of water samples

3. Principle of analytical methods and measuring devices

3.1 In situ measurements

3.2 Analytical method

3.3 Elements of interpretation

3.4 Measuring equipment

4. Accuracy of measurements

4.1 Determination of toxic substances

4.2 Determination of heavy metals

4.3 Determination of certain organic pollutants

5. Performing the determinations

5.1 Atomic absorption

5.2 Colorimetry

6. Unstable parameters and in situ measurements

1. Temperature

2. Electrode concepts - reminders

3. Redox potential - measurement of Eh

4. Dissolved oxygen

5. ph

6. Alkalinity

7. Electrolytic conductivity

8. Order of measurement of the different parameters

Practical work

- A practical on the equipment necessary for the sampling and analysis of water,

- Experiments will be carried out to master the manipulation of the test

Equipment

References

Rodier 2005 : Analyse de l'eau

Master: Hydrogeology

Semester: 3

Heading of the subject : Diagraphy

Code : MEU1.2

Coefficient : 2

Credit : 4

Objectives of the course

To allow the student to acquire the methods of diagnosis of the structures of groundwater catchment and to know how to remediate in case of degradation

Recommended prior knowledge

Drilling techniques, hydrogeology, water chemistry and geophysics

Course content

1. Spontaneous polarisation

-Origin of SP

-Implementation

-Parasitic factors

-Qualitative interpretation

-Factors influencing the shape and amplitude of SP deflections

-Determination of R_w from PS

2) Electrical logs

-The single point or single electrode log

-Principle

-Single point response

-The normal device

-Principle

-Response of the normal probe

- The side probe
- Principle
- Response of the lateral probe
- Determination of the clay percentage
- Focused tools
- Electromagnetic tools
- 3) The gamma ray
 - Natural radioactivity
 - The recorded parameter
 - The measurement
 - The implementation
 - Qualitative and quantitative interpretation
- 4) Log gamma-gamma, log density
 - The principle
 - The response of the tool
 - Effect of clays
- 5) The log neutron
 - Principle
 - The measurement
 - Effect of clays
- 6) Sonic log
 - Principle
 - The measurement
 - Disturbances
 - Cementing

Assessment method :

tutorials			exam	Average
Assiduity	Involvement	Test	20pts	0.4 TUTORIALS +0.6 EXAM
5	8	7		

References

- D. Chapellier : DIAGRAPHIE PETROLE Cours de Diagraphies Différées - Option Réservoirs
- <http://www.techniques-ingenieur.fr/base-documentaire/construction-th3/structureet-gros-oeuvre-ti252/diagraphies-et-geophysique-de-forage-c225>
- Le forage d'eau

Master: Hydrogeology

Semester: 3

Heading of the subject : Regulation and rehabilitation of wells

Code : MEU1.3

Coefficient : 1

Credit : 1

Objectives of the course

To allow the student to acquire the methods of diagnosis of the works of catchment of groundwater and to know how to remedy them in case of degradation

Recommended prior knowledge

Drilling techniques, hydrogeology, water chemistry and geophysics

1-Reminders on the tubular equipment of drillings

2-Monitoring and decline of drilling productivity

3 Causes

4-Deterioration of the tubing and gravel packing materials

4-1-Identification of deteriorating elements

4-2-Chemical clogging of strainers

4-3-Physical clogging of the strainers

4-4-Bacteriological strainer clogging

4-5-Debunging / Perforation of the tube

5-Methods of auscultation

5-1-Auscultation by logging

5-1-2-Caliper

5-1-2-Density

5-2-Video auscultation

5-2-1-Description of equipment

- 5-2-1-Methods for diagnosis and reporting
- 6-Methods of treatment and rehabilitation
 - 6-1-Chemical treatment
 - 6-1-1-Hydrochloric acid treatment-Acidification
 - 6-1-2-Borehole sterilisation
 - 6-2-Physical treatment
 - 6-2-1-Air burst technique
 - 6-2-2-Hydraulic fracturing
 - 6-2-3-Air lift techniques
 - 6-2-4-Jetting techniques
 - 6-2-5-Brushing techniques
 - 6-3-Retubing and lining
 - 6-4-step drawdown test
 - 6-5-Mechanical repair

Assessment method:

exam	average
20pts	exam

References

- D. Chapellier : DIAGRAPHIE PETROLE Cours de Diagraphies Différées - Option Réservoirs
- <http://www.techniques-ingenieur.fr/base-documentaire/construction-th3/structureet-gros-oeuvre-ti252/diagraphies-et-geophysique-de-forage-c225>
- Le forage d'eau, guide pratique : Albert Mabillot, 1971

Master: Hydrogeology

Semester: 3

Heading of the subject : Project management and work safety

Code : UED1.1

Coefficient : 1

Credit : 1

Objectives of the course

To prepare the student to the management techniques of projects

Recommended prior knowledge

Basic knowledge of economics

Course content

1: Project design (master plan, project manager, delegated project manager, subcontracting)

2: Project planning (details of costs and deadlines, human resources, definition of responsibilities)

3: Carrying out a project (setting up the organisation, carrying out the work, cost-delay-specification management, execution networks,

Gantt chart)

4: Completion of a project (gap analysis between planned and executed, project evaluation)

5: Work hazards and risks

6: Preventive measures

7: Intrinsic and extrinsic motivation

8: Burkhardt's theory

Assessment method:

exam	average
20pts	exam

References

http://rb.ec-lille.fr/gestion_projet.htm

Master: Hydrogeology

Semester: 3

Heading of the subject : Legislation

Code : UED1.2

Coefficient : 1

Credit : 1

Course objectives

Knowledge of the Algerian and international regulations in the environmental and water protection

Recommended prior knowledge

Basic knowledge of economics.

Course content

- Legal aspects and regulations on the use, exploitation and protection of water quality and comparison with foreign regulations.
- Principles and rules for the sustainable use, management and development of water resources as a national collective advantage

Chapter 1. The need for a water law

- 1.1. The contributions of the water law
- 1.2. The objectives of the water law
- 1.3. National water policy in Algeria

Chapter 2. Legal and institutional reforms in the water sector

- 2.1. The main reforms
- 2.2. Other reforms
- 2.3. The legal framework of water in Algeria

Chap 3. Water regulations in Algeria

- 3.1. Water laws in Algeria
- 3.2. Water-related decrees in Algeria

Chap 4. Environmental regulations in Algeria

4.1. Environmental laws in Algeria

4.2. Decrees relating to the environment in Algeria

Assessment method:

exam	average
20pts	exam

References

Journal officiel 2005 et 2011

Master: Hydrogeology

Semester : 3

Heading of the subject : Tutored project

Code : TEU1.1

Coefficient : 1

Credit : 1

Course objectives

Introduction to scientific research.

Recommended prior knowledge

Knowledge of French and English (spoken and written)

Course content

1. Notion on the acts of plagiarism
2. Method of bibliographic research
3. Method of writing a thesis
4. Method of writing a scientific article
5. Preparation of a mini-project on a research topic that will eventually lead to a national or international communication, or submission of a scientific article.

Assessment method:

exam	average
20pts	exam