NATIONAL UNIVERSITY OF ENGINEERING

COLLEGE OF GEOLOGICAL, MINING AND METALLURGICAL ENGINEERING

GEOLOGICAL ENGINEERING PROGRAM

HH115 - HYDROGEOLOGY

I. GENERAL INFORMATION

CODE	**:**	HH115 - Hydrogeology
SEMESTER	**:**	9
CREDITS	**:**	3
HOURS PER WEEK	**:**	5 (Theory – Practice – Field)
PREREQUISITES	**:**	GE282 Geochemistry, GE290 Environmental Geology
CONDITION	**:**	Compulsory

II. COURSE DESCRIPTION

The course prepares students for the understanding and application of hydrogeology concepts, methods and techniques related to the origin and formation of underground water, its geometrical distribution, diffusion, movement, regimen and reserves, interaction with soils and rocks, state, properties (physical, chemical, bacteriologic and radioactive), and conditions for the proper and effective use.

III. COURSE OUTCOMES

At the end of the course, students:

1. Understand and explain the different concepts of Hydrology and Hydrogeology emphasizing their scope and applications.
2. Understand the objectives of hydrogeological prospecting, pumping tests, wells and fountains inventory,
3. Determine the regional pluviometric column.
4. Analyze column graphics, Schoeller vertical logarithm diagrams.

IV. LEARINING UNITS

1. INTRODUCTION

Definition of Hydrology and Hydrogeology / Hydrology cicle / Watershed / Rainfall and pluviometry / Evaporation / Atmosphere evaporating power / Evaporation module / Turc equation / Control of atmosphere temperature.

2. INFILTRATION , BALANCE OF PLUVIOMETRIC COLUMN

Definitions / Infiltration coefficient / Determination methods: direct, indirect / Total balance of pluviometric rainfall column in a watershed / Balance through evapo-transpiration and infiltration.

3. GROUND PROPERTIES ASSOCIATED TO MOVING WATER

Porosity / Porosity reduction in deep stratum / Permeability / Darcy experiment / Hydraulic load or gradient / Storage coefficient / Actual porosity (effective porosity) / Transmissivity / Flows computation.

4. AQUIFEROUS - PIEZOMETER

Aquiferous / Geological classification / Permeable and impermeable hydrogeological formations / Deep aquiferous / Geothermal aquiferous / Origin of thermo-mineral water / Piezometers, use and implantation / Iso-piezometric curves / Triangulation method and interpretation / Groundwater table, classes / Flows computing.

5. HYDROGEOLOGICAL RESEARCH

Hydrogeological prospecting / Test wells / Inventory of Wells and fountains / Determination of regional pluviometric column / Geophysical prospecting / Electric resistivity method.

6. WELL DRILLING AND WELL EXPLOITATION

Well drilling / Rotating and percussion methods / Drilling equipment / Piping and casing types / Drilling geological profiles, diameters / Filters and their classes / Control of drilling verticality / Well foundations and finishing / Well development and exploitation Disinfection and flow tests / Well output and performance / Construction and interpretation of performance curves.

7. WELL TESTS

Prolonged pumping tests / Well equipment / Jacob logarithmic approximation method / Construction of declining curves and recover curves of phreatic level / Determination of hydrogeological parameters: transmissivity, permeability and storage coefficient / Balance of sweet and salad waters in ocean edges (phreatic level).

8. WATER CHEMICAL PROPERTIES

Drinking water / Drinkability conditions / Water resistivity and conductance / Water hydrogen potential (pH) / Acid water / Alkaline water.

9. WATER CHEMICAL ANALYSIS

Chemical equivalent / Concentration units / Chemical elements / Dry residue / Alkalimetry degree / Total alkalimetry degree / Water hardness / Hydrotimetric degree. Units.

10. GRAPHICAL REPRESENTATION OF WATER CHEMICAL ANALYSIS RESULTS

Column graphics / Schoeller vertical logarithmic diagram / Hydrogeochemical charts / Relevant chemical parameters / Geographical and zone representation / Water classification depending on use.

11. PROTECTION OF AQUIFEROUS FROM POLLUTION

Relation between surface water course and phreatic level (aquiferous) / Chemical and bacteriological analysis of underground water for human consumption / Aquiferous contamination by filtration / Contamination by hydrocarbon, black water, pesticides, mining waste and so on.

12. WATER TREATMENT

Catchment and protection of underground water and fountains for human consumption / Water reservoir and sedimentation / Sand filters / Seawage and black water elimination: oxidation pond, septic tank / Wells protection according to their influence radius.

13. IMPACT OF CIVIL ENGINEERING WORKS ON UNDERGROUND WATER FLOWS

Interference of underground water flows on foundations and civil engineering works / Tunnel drilling / Lake drying / Fountain drying

14. AQUIFEROUS FEEDING

Artificial feeding of aquiferous ("water sowing") / Non-saturated aquiferous / Recovery of depressed aquiferous.

V. PRACTICAL WORK

Computing the area of a watershed using GIS software / Digital elevation model DEM / Hipsometric curve of a watershed using DEM / Generation of micro watersheds using DEM / Determination of the order of a watershed using DEM / Determination of the volume of a watershed using DEM / Problems and issues on hydric balance / Application of Darcy law / Problems and issues on piezometers / Application of Jacob method for well analysis.

VI. METHODOLOGY

This course is carried out in theory, practical and field work. In theory sessions, the instructor introduces concepts, theorems and applications. In practical sessions, several problems are solved and their solution is analyzed. In field sessions, students visit aquiferous and underground water fields to take data and analyze their characteristics. At the end of the course, students should submit and defend an integrating project. In all sessions, students' active participation is encouraged.

VII. EVALUATION FORMULA

The final grade PF is calculated as follows:

PF = (EP + EF + PC) / 3

EP: Mid-Term Exam EF: Final Exam PC: Average of six practical work reports

VIII. BIBLIOGRAPHY

1. C.W. FETTER

Applied Hydrogeology
Pearson New International Edition (2012)

2. ZEKAI SEN

Practical and Applied Hydrogeology
Elsevier Publications (2012)