NATIONAL UNIVERSITY OF ENGINEERING
COLLEGE OF ENVIRONMENTAL ENGINEERING

ENVIRONMENTAL ENGINEERING PROGRAM

GE121 - HYDROGEOLOGY

I. GENERAL INFORMATION

CODE	**:**	GE121 – Hydrogeology
SEMESTER	**:**	6
CREDITS	**:**	03
HOURS PER WEEK	**:**	04 (Theory – Practices)
PREREQUISITES	**:**	AA – 215
CONDITION	**:**	Mandatory

II. COURSE DESCRIPTION

The course prepares the student to know the complex world of groundwater from its origin, storage and use. The course provides theoretical and practical instruments concerning the laws that govern the flow of groundwater, as well as fosters the investigation, evaluation and management of aquifers.

Underground hydric resources have made the exploitation of groundwater a very important complementary resource to meet water needs. Additionally, the growth of mining activity has generated social conflicts due in large part to the effect of environmental impact such as the contamination of rivers and springs that includes the interaction of surface waters and groundwater. In this direction, the modeling of the aquifer system through computational tools to study the hydraulic behavior of the flow and the dynamics of the solute transport in the subsoil are necessary for the theoretical and practical development of the different events that take place in the underground environment.

III. COURSE OUTCOMES

At the end of the course the student will:

- Know and dominate hydrogeological concepts.
- Know principles of groundwater flow and equations, groundwater and surface water interactions
- Interpret hydrogeological data adequately, both quantitatively and qualitatively.
- Learn about the dynamics of coastal aquifers and groundwater pollution.

IV. LEARNING UNITS

1. BASIC CONCEPTS

Concepts of geology, hydrogeological cycle, vertical water distribution in the soil, aquifer types, porosity, mechanical energy, water movement, Darcy's law, transmissivity and storage.

2. **UNDERGROUND WATER FLOW**
   Equation of groundwater flow, groundwater flow to wells

3. **INTERACTION BETWEEN SURFACE AND SUBTERRANEAN WATERS**
   Relations between rivers and groundwater, change in the relationships between surface water and groundwater, relations between lakes and groundwater.

4. **COASTAL AQUIFERS AND TRANSPORTATION OF MASS IN SATURATED MEDIUM**
   Previous definitions, interface and mixing zone, salinization mechanisms of coastal aquifers. Transport by advection, dispersion; general equation of mass transport

5. **BASIC CONCEPTS OF MATHEMATICAL MODELING**
   General introduction, objectives and applications, flow model in finite differences, generalities MODFLOW, flow model in finite elements, computer practice.

6. **HYDROGEOCHEMICAL AND POLLUTION OF UNDERGROUND WATER**
   Quality control of analytical data, computer practices, types of water using the Pipper diagram, Groundwater contamination, Pollutants, Pollution centers.

7. **REGIONAL AND APPLIED HYDROGEOLOGY**
   Hydrogeology of igneous and metamorphic rocks / Hydrology of detrital sedimentary rocks / Hydrogeology of karstified sedimentary rocks / Hydrogeology of unconsolidated sedimentary deposits.

V. LABORATORIES AND PRACTICAL EXPERIENCES

- Laboratory 1: Generation of random signals
- Laboratory 2: Determination and graph of the probability density function.

VI. METHODOLOGY

The course is developed in theory and practice sessions. In the theory sessions, the professor presents the concepts, theorems and applications. In the practical sessions, various problems are solved and their solution is analyzed. In all the sessions, the active participation of the student is promoted.

VII. EVALUATION FORMULA

The learning will be evaluated through the "F" system.

- Partial Exam: Weight 1
- Final Exam: Weight 2
- Practices Average: Weight 1.

Calculation of the Final Average:

$$FA = \frac{PE + 2 * FE + PA}{4}$$

PE: Partial Exam; FE: Final Exam, PA: Practices Average

For the Practices Average the three practices with the highest grades:

$$PA = \frac{QP1 + QP2 + Q3}{3}$$

VIII. BIBLIOGRAPHY

- Custodio, E. & Llamas, M. R. (1996). Hidrología Subterránea. Segunda Edición. Capítulo 14.1, pp. 1393-1407.

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