NATIONAL UNIVERSITY OF ENGINEERING
COLLEGE OF CIVIL ENGINEERING

CIVIL ENGINEERING PROGRAM

SYLLABUS: DRAINAGE

I. GENERAL INFORMATION

CODE	**:**	HH433
SEMESTER	**:**	9
CREDITS	**:**	3
HOURS PER WEEK	**:**	4 (Theory – Practice)
PREREQUISITES	**:**	General Hydrology
CONDITION	**:**	Elective
DEPARTMENT	**:**	Hydrology and Hydraulics
INSTRUCTOR	**:**	Alfredo Mansen
INSTRUCTOR E-MAIL	**:**	amansen@mk.com.pe

II. COURSE DESCRIPTION

The course prepares students to design drainage systems aiming to ensure the efficiency and durability of civil works. The different design considerations of drainage systems are analyzed and used to design practical and realizable drainage systems for diverse applications and suited for their particular hydrological, hydraulic and environmental conditions. Students complete the design project of a drainage system integrating knowledge of diverse areas such as Topography, Geology, Hydrology, Hydraulics, Structures and Costs and Budgets.

III. COURSE OUTCOMES

1. Understand and appraise the importance of drainage systems to assure the durability and functionality of civil works.
2. Understand and appraise the importance of water in civil works.
3. Understand the environmental impact of drainage systems.
4. Analyze and design drainage systems in urban areas, roads and railways and airports according to the particular hydraulic conditions.
5. Understand the application of geo-synthetic material for drainage systems design.

IV. LEARNING UNITS

1. INTRODUCTION

Drainage. Drainage history. Reviews of drainage. Drainage types. Soil permeability. Erosion control.

2. DRAINAGE TYPES

Natural drainage systems. Geological drainage. Biological drainage. Synthetic drainage systems. Superficial drainage. Sanitation, urban, agriculture, mining, airports, coastal defenses, aquifers. Special applications. Sub-superficial drainage systems.

3. HIGHWAYS DRAINAGE

Longitudinal drainage. Cross drainage. Under drainage and special works. Bridges and ravines.

4. **URBAN DRAINAGE**
Minor drainage systems. Great drainage systems. Special works (gutters, drains and pumping stations).

5. **AIRPORTS DRAINAGE**
Drainage patterns. Drainage in central and auxiliary roads. Drainage in parking areas.

6. **SPECIAL APPLICATIONS**
Aquifers. Tailing drying.

7. **EROSION CONTROL**
Bioengineering. Special soils. Bio-techniques. New materials. Geo-synthetics. Plastic piling.

V. STUDENT REPORTS AND PRACTICAL EXPERIENCES

Student work 1: Evaluation and recognition of Lima-Canta highway.
Student work 2: Sewerage design by Traffic Message Channel (TMC).
Student work 3: Creative laboratory experience - Permeability test.
Student work 4: Applications of geo-synthetic materials in highway drainage.

VI. METHODOLOGY

The course includes theory and practices sessions, as well as field visits. In theory sessions the instructor presents the main aspects for drainage analysis and design. Actual drainage systems are analyzed in a critical way promoting student participation. In practice sessions, students solve diverse problems related to drainage systems. Several visits to actual drainage systems are carried in Lima city and its outskirts. Laboratory tests are performed to analyze soil permeability. Students complete and defend a project report.

VII. EVALUATION FORMULA

The final grade (PF) is obtained as follows:

PF = (EP + EF + PC) / 3

Where:

EP: Mid-term exam EF: Final exam
PC: Average of three quizzes and four reports

VIII. BIBLIOGRAPHY

1. **Keller Gordon**
   Low- Volume Roads Engineering
   Geoscience Library. AEG Foundation

2. **Ministry of Transports and Communications (Peru)**
   Design of Low Transit Roads.