NATIONAL UNIVERSITY OF ENGINEERING
COLLEGE OF ENVIRONMENTAL ENGINEERING

ENVIRONMENTAL ENGINEERING PROGRAM

HH221 – FLUIDS DYNAMICS

I. GENERAL INFORMATION

CODE	**:**	HH221 – Fluids Dynamics
SEMESTER	**:**	5
CREDITS	**:**	02
HOURS PER WEEK	**:**	04 (Theory – Practice)
PREREQUISITES	**:**	HH223
CONDITION	**:**	Mandatory

II. COURSE DESCRIPTION

The subject is of theoretical and practical nature, this course deals with the study of the concepts of fluid dynamics covering the principles and the basic equations of fluid mechanics. The properties of the fluids will be analyzed, fluid kinematics based on the Lagrangian and Eulerian descriptions. The conservation equations of mass, Bernoulli and energy will be studied. An analysis of the movement quantity of the flow systems, dimensional analysis and modeling, flow in pipes, differential fluid flow analysis, Navier-Stokes and Turbomachinery equations will also be studied.

III. COURSE OUTCOMES

By the end this course the student will:

- Analyze the behavior properties of fluids: density and viscosity.
- Explain and determines the hydrostatic forces on flat surfaces and submerged curves.
- Describe the behavior of fluid kinematics based on the Lagrangian and Eulerian concepts, as well as the effects of vorticity and rotationality.
- Build models based on the mathematical physics of the conservation equations of mass, Bernoulli and energy.
- Develop the control volume of engineering problems to perform the analysis of the movement equation in flow systems.
- Perform dimensional and modeling analysis to perform experimental fluid dynamics tests
- Apply the approximate solutions of the Navier-Stokes equation.
- Apply the concepts of turbomachinery for the pump section.

IV. LEARNING UNITS

1. BASIC PRINCIPLES OF FLUID MECHANICS / 2 HOURS

Fluid and the continuum / dimensions and units / Law of dimensional homogeneity / Law of Newton's viscosity / Kinematic viscosity / Surface tension / The gradient.

2. PRESSURE AND STATIC FLUIDS / 6 HOURS

Variation of the pressure in an incomprempresible static fluid / Pressure measuring devices / Hydrostatic forces on flat surfaces and submerged curves / Flotation and stability

3. FLUID CINEMATICS / 4 HOURS

Lagrangian and Eulerian descriptions / Flow patterns and flow visualization / Current, trajectory and trace lines / Other kinematic descriptions / Vorticity and rotationality / The Reynolds transport theorem.

4. EQUATIONS OF CONSERVATION OF MASS, BERNOULLI AND ENERGY / 6 HOURS

Mass conservation / Mass balance for stationary flow processes / Special case Incomprehensible flow / The Bernoulli equation / Static, dynamic and stagnant pressure / Limitations in the use of ec. Bernoulli / Hydraulic gradient line and power line / Energy transfer by heat and work / Energy analysis of stationary flows / Correction factor of kinetic energy α.

5. ANALYSIS OF THE AMOUNT OF MOVEMENT OF THE FLOW SYSTEMS / 6 HOURS

Newton's laws / Choice of a volume of control / Forces acting on a volume of control / The equation of the linear momentum / Flow without external forces / Review of the movement of rotation and the angular momentum / The equation of angular movement / Special cases.

6. DIMENSIONAL AND MODELED ANALYSIS / 4 HOURS

Dimensions and units / Dimensional homogeneity / Dimensional analysis and similarity / The method of repetition of variables and the Buckingham Pi theorem / Incomplete similarity / Tests in the wind tunnel / Flow with free surfaces.

7. FLOW IN PIPES / 4 HOURS

Laminar and turbulent flows / Laminar flow in pipes / Turbulent flow in pipes / Turbulent velocity profile / The Moody graph and the Colebrook equation / Types of fluid flow problems / Minor losses / Pipe networks and pump selection

8. DIFFERENTIAL ANALYSIS OF FLUID FLOW - NAVIER STOKES ACTION / 4 HOURS

Conservation of mass: The continuity equation / Deduction with the use of the divergence theorem / The current function in cartesian and cylindrical coordinates / Conservation of linear momentum: Cauchy equation / The Navier-Stokes equation / Deduction of the equation of Navier-Stokes for incompressible isothermal flow / Differential analysis of fluid flow problems / Stokes flow approximation / Drag force on a sphere in Stokes flow / Irrotational flow approximation / Layer limit approximation / Layer equations limit / Turbulent boundary layer on the flat plate.

9. EXTERNAL FLOW: TRAIL AND SUSTAINABILITY / 4 HOURS

Drag and lift / Drag due to friction and pressure / Reduction of drag by aerodynamic design / Flow separation / Drag coefficient of common geometries / Vehicle drag coefficients / Parallel flow on flat plates / Coefficient of friction / Flow on cylinders and spheres.

10. TURBOMAQUINARIA / 4 HOURS

Classifications and terminology / Pumps / Pump performance curves / Pump cavitation and net suction load / Series and parallel pumps / Positive displacement pumps / Dynamic pumps / Centrifugal pumps / Axial pumps / Similarity laws for pumps / Turbines: positive displacement, dynamics, impulse or action, reaction, gas and steam, wind / Laws of similarity for turbines.

11. INTRODUCTION TO THE COMPUTATIONAL FLUID DYNAMICS / 4 HOURS

Introduction and basics / CFD calculations for laminar and turbulent flow / CFD with heat transfer / CFD calculations for understandable flow.

V. LABORATORIES AND PRACTICAL EXPERIENCES

Four groups of students will be formed in the first class, carrying out the following activities:
Guided tour I: Visit to a protected natural area for the development of a basic environmental management instrument / 48 HOURS.
Guided tour II: Visit to PATPAL for the preparation of a wildlife manual / 8 HOURS.

Research and group presentation of topics related to the course: Load capacity of an ecosystem / Situation of the ANP in the world / ANP and Ecotourism / The ACR in Peru / The ACP in Peru / Ethnic groups and culture in Peru-Jungle / Species of invasive flora and fauna / Ethnicities and cultures in Peru - Sierra and coast 8 HOURS

Exceptionally, the presence of a guest speaker or attendance at an academic event of a national scientific entity will be managed to reinforce the knowledge acquired. If successful, this presentation may be outside of class hours.

VI. METHODOLOGY

The course is carried out in theoretical and practical sessions. In theory sessions, the instructor presents the concepts of theory in the teaching-learning process, in which students participate individually or in working groups. The instructor exposes and gives examples to complement the activities of the students. The work in the classroom is complemented by homework.

VII. EVALUATION FORMULA

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

- Partial Exam: Weight 1
- Final Exam: Weight 2
- Average of Practices: Weight 1. Four practices are taken, one is eliminated.

Calculation of the Final Average:

$$FA = \frac{PE + 2FE + \frac{QP1 + QP2 + QP3}{3}}{4}$$

PE: Partial Exam; FE: Final Exam, QP: Qualified Practice

VIII. BIBLIOGRAPHY

- Yunus A. Çengel, John M. Cimbala (2012), Mecánica de fluidos, McGraw-Hill; 2nd edition.
- Robert L. Mott, Joseph A. Untener (2015), Mecánica de fluidos, Pearson Education; 7th editopn.