Master in Civil Engineering

Intern. Program of Hydraulics and Civil Engineering

http://master-hydraulic.grenoble-inp.fr/

ENSE³ — GreEn-Er

École Nationale Supérieure de l'Énergie, l'Eau et l'Environnement
21 Avenue des Martyrs
CS 90624
38031 GRENOBLE Cedex 1 — FRANCE

Prof. G.Combe
Program Director
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v092023

M1 program description

Semester 1

Sept. — Jan.

7 compulsory modules

Semester 2

Feb. — Aug.

4 compulsory modules
1 compulsory module of your choice

→ M2 HCE

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M1 HCE

Semester 1
30 ECTS, 300 Teaching Hours

7 compulsory modules

- **Scientific course for newcomers**, 1 ECTS, 10 h
- **Applied Structural Analysis,** 3 ECTS, 32 h
- **Continuum Mechanics and Finite Element Method**, 6 ECTS, 60 h
- **French Language,** 2 ECTS, 40 h
- **Engineering Hydrology,** 6 ECTS, 60 h
- **Materials and Structures**, 6 ECTS, 60 h
- **Pressurized Flow Hydraulics**, 6 ECTS, 60 h
- **Professional Skills Support**

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M1 HCE Semester 1 : compulsory modules description

- **Scientific course for newcomers**, 1 ECTS, 10 h

Tutorial classes	10h

Module leader

Ass. Prof. Bruno CHAREYRE

- **Applied Structural Analysis,** 3 ECTS, 32 h

— Objectives and Content —

- to acquire independency in the study of a global structure
- to apply the parallel theory of courses on this structure
- to design parts of the structure in conditions close to an engineer office

The subject deals with a dam on river which is replaced by a new technology of dam. The students study the civil engineering aspects of the projects such as strength of materials, hydraulic leaks, steel conception, reinforced concrete design.
In order to achieve the different objectives, theoretical aspects are developed during the session or for other aspects, students have to find information and data by themselves.

Engineering work	32h

Module leader

Dr. Ludovic MISSEMER

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M1 HCE Semester 1 : compulsory modules description

- **Continuum Mechanics and Finite Element Modeling**, 6 ECTS, 60 h

— Objectives and Content —

First part: Continuum Mechanics (Prof. G.Combe)
- Continuum description of solids and strain-stress description

Second part: Basis of the FEM approach (Prof. B. Loret)
This module prepares for simulating mechanical problems (solid) on which the body geometry which may be complex and the physical properties can be spatially varied

- Understand the methods of quantification and solving equations of solid mechanics
- Know how to isolate a structure and define its boundary conditions
- Know how to implement and configure a simulation, validate and analyze the results

Module Leader

Prof. Gaël COMBE

Prof. Frédéric DUFOUR

Lecture courses	22h
Tutorial classes	24h
Engineering work	10h
Practicals	4h
Exams	*3h*
Optional learning support	*20h*

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- **French Language (FLE),** 2 ECTS, 40 h

— Objectives and Content —

During 10 weeks, 4 hours of FLE per weeks
Grade level small group

Lecture courses	40h

- **Professional Skills Support**

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▪ **Engineering Hydrology,** 6 ECTS, 60 h

Module leader

Ass. Prof.
Louise CROCHEMORE

Objectives

To learn the principles of data analysis and data screening in hydrology.
To acquire the necessary concepts for the design of hydraulic works aimed either at risk protection against floods or droughts, or at water resources storage and management.
To master the necessary steps to reproduce the hydrological behaviour of a natural or urbanized watershed by choosing the most appropriate tools.

Content

1. Engineering hydrology: water cycle, hydrological budget and hydrological regimes. Elements of metrology. Runoff generation: loss or production function and Unit Hydrograph or transfer function approach.
2. Statistical hydrology: basics of statistics for hydrology, model fitting techniques on a data sample and hypothesis testing. Stochastic relations between variables: simple and multiple linear correlation. Data screening and error detection.
3. Hydrological prediction and hydraulic works design: return period, design rainfall and design discharge. Main methods for extreme events prediction and for hydrological design at different scales: hydraulic works, natural watersheds, urban and anthropic watershed.
4. Hydrological modelling: main types of existing hydrological models and modeling steps.

A global project-based learning assignment will be devoted to synthesize and link the themes provided by this module.

Lecture courses	28h
Tutorial classes	14h
Engineering work	18h
Exams	*3h*
Optional learning support	*6h*

MI HCE Semester 1 : compulsory modules description

❋ Materials and Structures, 6 ECTS, 60 h

Module leader

Dr. Ludovic MISSEMER

Objectives

- to present the basics of the mechanical behaviour depending on the time with an application to the concrete
- to use practically the notions of elasticity learnt in the first year class
- to be able to design at limit states elements in reinforced concrete under simple sollicitations (beam under bending moment, column in compression, compounded flexion)
- to understand the basis of reinforced concrete
- to take in hand a finite elements software in order to analyze structures in elasticity (beam, slab, dam)

Content

Civil engineering structures are mainly built in reinforced/prestressed concrete. This module wants to instruct students to the basics of structures design under various sollicitations, leaned on notions of limit states presented in the Eurocode 2 (course 1). The constitutive behaviour to design these elements leaned on the viscoelasticity lesson (course 2). This course enables to characterize and to formalize the behaviours of aging and non aging material by using simple models (spring, absorbe, pad). The whole notions is applied through an experimental practice on elasticity, a modelisation structure project and a project on the long term behaviour of concrete and its rheological modelisation.

Lecture courses	24h
Tutorial classes	24
Engineering work	12h
Exams	*2h*
Optional learning support	*20h*

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✷ **Pressurized Flow Hydraulics**, 6 ECTS, 60 h

Objectives

In the first part, the course presents practical approaches of the fluid mechanics conservation equations. It introduces some methods to treat pipes networks problems and trains students to solve industrial problems related to hydraulic machineries.
The second part of the course presents the theory of the transient hydraulic regimes. It sensitizes students to the problems of hydraulic instabilities and related issues.

Module Leader

Assis. Prof.
Rémi CHASSAGNE

Content

- Application of integral relations (conservation of mass, momentum, and moment of momentum, generalised Bernoulli) to real applications
- Basic knowledge of calculations for pipe networks
- Basic knowledge of hydraulic machines: operation and inner workings
- Analysis of transient conduit flow: pressure fluctuations and water hammer

Lecture courses	26h
Engineering work	12h
Practicals	16h
Exams	*3h*
Optional learning support	*10h*

M1 HCE

Semester 2
30 ECTS, 300 Teaching Hours

4 compulsory modules

- **Open Channel Hydraulics**, 6 ECTS, 60 h
- **Ground Hydraulics and Groundwater Works,** 5 ECTS, 54 h
- **Soil and Rock Mechanics**, 6 ECTS, 60 h
- **French Language,** 2 ECTS, 40 h

1 compulsory module of your choice

- **Team Project,** 6 ECTS
  +
- **Internship,** 5 ECTS

Op1

or

- **Industrial Project,** 11 ECTS

Op2

or

- **Research Project,** 11 ECTS

Op3

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M1 HCE Semester 2 : compulsory modules description

- **Open Channel Hydraulics**, 6 ECTS, 60 h

— Objectives and Content —

The objectives are that the students should be able to:
- determine the water depth in an open channel for a given flow rate
- draw and compute the shape of the free surface for gradually changing geometries
- qualitatively predict the shapes of the free surface for flows within channel geometries that are rapidly varied (singularities).

In a Second part the course will focus on the modeling and numerical simulation of incompressible fluid with a free surface (shock capturing methods for the shallow water equations). It will comprise complements centered on the Navier Stokes equations modeling in primitive variables and an applications with structured programing.

Basic concepts in open channel flows: the Froude number, critical depth, the hydraulic jump.
The uniform flow: velocity vertical profile, flow resistance, Chézy equation, normal depth
Nonuniform flow in gradually varying channel sections: water depth computation in non uniform flows, channel controls.
Channel transitions: bottom step, channel contraction, specific energy Hs, Hs-h diagram
Navier Stokes equation numerical resolution techniques in primitive variables with shock capturing techniques. A in-house Navier Stokes software will be used by the students during their personal project.

Module leader

Prof. Éric BARTHELEMY

Lecture courses	24h
Tutorial classes	16h
Engineering work	12h
Practicals	8h
Exams	*3h*
Optional learning support	*5h*

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M1 HCE Semester 2 : compulsory modules description

- **Ground Hydraulics and Groundwater Works,** 5 ECTS, 54 h

Lecture courses	20h
Tutorial classes	10h
Engineering work	20h
Practicals	4h
Exams	*2h*

Module leader

Ass. Prof. Isabella ZIN TOMASINO

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- **Soil and Rock Mechanics**, 6 ECTS, 60 h

— Objectives and Content —

Know the fundamental behavior of soils and rocks in relation to their nature, their geological history and the scale considered;
Know and master the implementation and operation of in situ and laboratory tests for the characterization of soil and rock and be aware of the variability of characteristics, uncertainties and measurement errors.

1 Physical properties (densities, water content, Atterberg limits, proctor)
2 Stress and strain in soils (effective stress)
3 Triaxial behaviour
4 Settlements
5 Earth pressure

Rock Mechanics:
1 Intact Rock Behaviour
2 Rock mass and discontinuities

Site investigation: Penetrometer, Permeability tests …

Applications / Projects: Investigation report analysis ; Analysis scouting Settlements studies ; reverse failure analysis ; Tunnel analysis.

Module Leader

Prof. Gaël COMBE

Lecture courses	20h
Tutorial classes	20h
Engineering work	8h
Practicals	12h
Exams	*3h*
Optional learning support	*10h*

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- **French Language,** 2 ECTS, 40 h

— Objectives and Content —

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Grade level small group

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Semester 2 : Compulsory modules of your choice

Op1

• **Team Project,** 6 ECTS

The main objective of this engineering project is to carry out an engineering design study by learning about project management in a group:

- analysing a need based on an open problem
- to know how to make a state of the art, a technological watch, a bibliographical study
- designing a solution to meet a technical need
- know how to implement the school's main subjects
- to show initiative, entrepreneurship and innovation
- implement project management (group management, resource management, implementation of the GoP methodology)

• **Internship,** 5 ECTS

Start : June, 2019.
At least 8 weeks of internship
Assistant Engineer

Can be performed in France or abroad:

- in a private company
- in a research lab
- at ENSE³ working on a project suggested by you or a teacher

You will have to write a report and **to make a defense: week 36 (31 of August -- 6th of September)**

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Op2

• Industrial Project, 11 ECTS

The main objective of the Industrial Project is to offer second-year students a first professional experience in order to implement an engineering approach to meet the specifications set by a client company and partner of the school.
This project concerns the development of experimental device (demonstrator, tests, validation), a technical feasibility study, a software program development or numerical simulations…

During the project, the students will have to organize themselves in order to carry out the following tasks:
· Understand the functional need expressed in the company's specifications
· Analyze this need and draft functional specifications.
· Write study specifications
· Design and develop the solution proposed and validated by the client
· Implement the taught project management method, ensure the planning of the tasks to be carried out and manage the resources, and in particular:
O Know how to manage a schedule and deadlines
O Manage the relationship with the client and the tutor (s) of the school
O Manage procurement and subcontracting of parts of the study as required
O Recipe the project deliverables with the company
O Seek the human resources needed for the successful implementation of the project
O Assist in planning technical work with relevant teams
· Ensure the transfer of knowledge and technology to the partner company at the end of the project.
At the end of the project, students must demonstrate their ability to manage a project and more generally their technical skills, and a professional behavior in accordance with the expectations of a future engineer.

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Semester 2 : Compulsory modules of your choice

Op3

- **Research Project, 11 ECTS**

The main objective of the Research Project is to offer second year students a first experience of research work in a partner laboratory of the school and the opportunity to acquire engineering skills through research training.
The early initiation to the world of Research can thus enable students to better understand the resolution of complex problems by mastering the methodology developed classically in a research structure.
This project associated with a research program proposed by a teacher-researcher or a researcher in a laboratory, will allow the student to become familiar with the research environment, the scientific approach associated with Research and to use his technical and scientific skills to respond to a given problem.
The research work may consist in contributing to the development of an experimental model to validate a theoretical concept, to carry out numerical simulations, to design a technical solution to answer the project's problematic.
The school is committed to accompanying the students throughout the project thanks to the monitoring of two coordinators.

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Hydraulics and Civil Engineering

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