CENTRALE NANTES

MASTER OF SCIENCE, TECHNOLOGY AND HEALTH

2025-2026

YEAR 1

CIVIL ENGINEERING

MATERIALS AND STRUCTURES IN THEIR ENVIRONMENT

PROGRAMME SUPERVISOR(S):
Siddhartha Harsha OMMI

YEAR 1 - Autumn Semester

CORE COURSES

Course code	Title	ECTS Credits
COMEC	Continuum Mechanics	5
FLUM1	Fluid Mechanics 1	5
NUMAN	Numerical Analysis	4
NUMME	Numerical Methods	5
TOME1	Tools and Methods for Research 1	4
VIBRA	Vibrations and Differential Equations	5

LANGUAGE COURSES

Course code	Title	ECTS Credits
CCE1	Cultural and Communication English	2
ESP1	Spanish Language	2
FLE1	French Language	2

YEAR 1 - Spring Semester

CORE COURSES

Course code	Title	ECTS Credits
CONLA	Constitutive Laws	5
CONST	Nonlinear Constitutive Modeling of Steel and Concrete with Applications to Reinforced Concrete Structures	5
GEOTC	Geotechnical Engineering	5
IMAGI	Imaging in Civil Engineering	5
PHYMD	Physical Modelling	4
TOME2	Tools and Methods for Research 2	4

LANGUAGE COURSES

Course code	Title	ECTS Credits
CCE2	Cultural and Communication English	2
ESP2	Spanish Language	2
FLE2	French Language	2

Continuum Mechanics [COMEC]

LEAD PROFESSOR(S): Siddhartha Harsha OMMI

Requirements

This course is designed as a Masters level course for those who have graduated with an engineering or corresponding applied mathematics degree.
The students are expected to have familiarity with,
- statics
- elementary stress analysis
- applied math for engineering
- basic notions of vector algebra (a recall is done at the beginning of the course)

Objectives

This course introduces Continuum Mechanics and more generally modeling in mechanics. It covers the fundamental concepts required for more advanced fluid/solid mechanics courses, while providing basic tools for engineering design.

A brief recall to vector algebra, followed by an introduction to tensor algebra and analysis, are performed at the very beginning to provide the mathematical tools needed for the rest of the course. Afterwards, the course focuses on the various balance laws, thermodynamic restrictions and the study of equilibrium of deformable solids in linear elasticity under the hypothesis of infinitesimal transformations by analyzing suitable Boundary Value Problems (BVPs).

The concepts developed here support first-semester courses of fluid mechanics (concepts that the students need to assimilate by themselves) and numerical methods (it provides models to be discretized with numerical methods). It forms the basis for second-semester structural mechanics for students of “solid” or “civil engineering” track and also provides useful tools for the course of “Mechanical design analysis"

At the end of the course, the students should at least be able to:

1) Describe the notions of Continuum mechanics and be at ease with the terminology
- Deformation and measures of deformation (stretch, strain, strain-rate)
- Stress and its measures
- Balance equations (Basic principles)
- Constitutive equations (material models)

2) Formulate and solve Boundary Value Problems (BVPs) within infinitesimal elasticity.
- Identifying the right set of equations and boundary conditions to solve engineering problems.
- Know the different possible approaches available for the solution of that BVP, and to solve it.

Note 1: The focus here will be BVPs in solid mechanics (fluid mechanics problems are treated in another course).
Note 2: We restrict ourselves to infinitesimal elasticity which suffices for a majority of engineering problems.

Course contents

The course consists of 30h of classes in presence, alternating between theory sessions (CMs) and tutorial sessions (TDs), each lasting 2h.

The outline of the course is as follows:
- Chp 0. Introduction
- Chp 1. Mathematical basics for Continuum Mechanics
- Chp 2. Kinematics of continuous media
- Chp 3. Stresses

- Chp 4. Balance Equations
- Chp 5. Constitutive Equations
- Chp 6. Linear Elasticity under Infinitesimal transformations

Course material

Books in english (available at ECN):
- Introduction to Continuum Mechanics, W. Michael Lai, David Rubin and Erhard Krempl, Elsevier, 2010.
- Continuum Mechanics, A.J.M. Spencer, Dover Publications, 2004.
- Nonlinear solid mechanics: a continuum approach for engineering, G.A. Holzapfel, Chichester, New York : Wiley , 2000.
- Nonlinear continuum mechanics for finit element analysis, J. Bonet, R.D. Wood, Cambridge University Press , 1997.

Books in french (available at ECN):
- Mécanique des Milieux Continus et discrets, Handbook of N. Moës, 2011,
- Mécanique, P. Germain, 1985, Ecole Polytechnique, volumes 1 & 2.
- Mécanique des milieux continus: cours et exercices corrigés, J. Coirier, C. Nadot-Martin, S. Liviu, 2013, Dunod. Available at the library of the school. (Good appendix on tensor algebra)
- Exercices corrigés de mécanique des milieux continus, H. Dumontet, F. Léné, P. Muller, N. Turbé, G. Duvaut. Paris, Dunod , 1998. (only available at the library of the university)

Other books:
- Introduction to the mechanics of a continuous medium, L.E. Malvern, Prentice-Hall, 1969.
- An introduction to continuum mechanics, M.E. Gurtin, Academic Press, 1981.

Sustainable Development Goals (SDGs) covered by this course

Affordable and clean energy / Industry, innovation and infrastructure / Sustainable cities and communities

Sustainable Development and Social Responsibility Positioning

This course contributes to sustainable development by providing the mechanical modeling tools required to design safer, more durable, and resource-efficient structures and mechanical systems. By promoting rigorous analysis and responsible engineering practices, it supports the reduction of material waste through informed decision-making.

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	5	16 hrs	14 hrs	0 hrs	0 hrs	2 hrs

Fluid Mechanics 1 [FLUM1]

LEAD PROFESSOR(S): Guillaume DUCROZET

Objectives

At the end of the course (30 hours + personal work) the students will be able to:

- Describe the main physical properties of a fluid.
- Identify the specificity of fluid mechanics in the continuum mechanics framework (i.e. compared to solid mechanics).
- Identify the non-dimensional numbers at play in any fluid mechanics problem and deduce how to perform experiments with appropriate similarity.
- Understand the notion of stresses and its representation through stress tensor.
- Describe the physical meaning of each term in the Navier-Stokes' equations
- Identify the different flow regimes.
- Evaluate the generalized force applied on any object in still water.
- Understand when the perfect fluid assumption is valid.

Course contents

This course aims to present the foundations and general principles of fluid mechanics. The lectures cover the following topics:

- Physics of fluids
- Dimensional analysis
- Stress tensors and fluids
- Navier Stokes' equations
- Flow regimes: introduction to turbulence
- Fluid statics
- Bernoulli's equation for a perfect fluid

In addition to those lectures, tutorials and lab sessions will allow the students to apply the theoretical knowledge to practical configurations.

Course material

- F. White, Fluid mechanics, McGraw-Hill, New York.
- B.R. Munson et al., Fundamentals of fluid mechanics, John Wiley, New York.

Sustainable Development Goals (SDGs) covered by this course

Affordable and clean energy / Clean water and sanitation / Climate action / Goo health and well-being / Industry, innovation and infrastructure / Life below water / Life on land / Sustainable cities and communities

Sustainable Development and Social Responsibility Positioning

The Fluid Mechanics 1 course incorporates sustainable development considerations, notably through the application examples presented in the lectures and the topics addressed during tutorial sessions. Owing to its disciplinary nature, the knowledge and skills acquired may be applied across a wide range of fields related to sustainable development.

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	5	14 hrs	12 hrs	4 hrs	0 hrs	2 hrs

Numerical Analysis [NUMAN]

LEAD PROFESSOR(S): Anthony NOUY

Requirements

Fundamentals in analysis and linear algebra (see e.g. program of Foundation Master)

Objectives

The aim of this course is to introduce numerical analysis methods for solving mathematical problems such as linear and non-linear equations, approximation and integration of functions.

Course contents

1. Solution of non-linear equations: bisection method, fixed-point method, Newton's method...
2. Complements of matrix analysis : localization of eigenvalues, matrix norms.
3. Solution of (large) systems of linear equations: direct methods (Gauss, LU), iterative methods (Jacobi, Gauss-Seidel).
4. Interpolation and approximation: polynomial interpolation, piecewise polynomial interpolation, least squares approximation.
5. Numerical integration: quadrature formulas, composite method.

Course material

[1] Allaire, G., Kaber, S.M., Numerical linear algebra, Springer (2008)
[2] Quarteroni, A, Sacco, R., Saleri, F. Numerical mathematics, Springer (2000)
Syllabus update date
17/10/2024

Sustainable Development Goals (SDGs) covered by this course

Industry, innovation and infrastructure

Sustainable Development and Social Responsibility Positioning

Numerical methods for mathematical models used in SD and CSR

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	4	22 hrs	0 hrs	8 hrs	0 hrs	2 hrs

Numerical Methods [NUMME]

LEAD PROFESSOR(S): Grégory LEGRAIN

Requirements

Mathematics for engineers
Programming basis

Objectives

At the end of the course (30 hours + personal work) the students will be able to:
- Classify standard second order PDEs (elliptic, parabolic, hyperbolic)
- Solve simple elliptic problems by means of finite differences or finite elements
- Determine the level accuracy of the schemes they use (convergence order)
- Program finite differences and finite elements in both 1D and 2D

Course contents

These lectures aim to present standard numerical methods, their features and limitations.

- Classification of PDEs
- Classification of boundary conditions, well-posed problems
- Introduction to finite differences (1D, 2D)
- Introduction to finite elements (1D, 2D)

Homework and lab sessions will provide an understanding of the programming and main features of the methods.

Course material

- The Finite Element Method: Linear Static and Dynamic Finite Element Analysis. T.J.R. Hughes
- Numerical Methods for Engineers and Scientists. J.D. Hoffman and S. Frankel

Sustainable Development Goals (SDGs) covered by this course

Affordable and clean energy / Goo health and well-being / Industry, innovation and infrastructure

Sustainable Development and Social Responsibility Positioning

The course presents the use of mathematics and the numerical approaches necessary for the modelling of environmental phenomena. It also discusses their use for the optimization of industrial designs and processes.

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	5	16 hrs	4 hrs	10 hrs	0 hrs	2 hrs

Tools and Methods for Research 1 [TOME1]

LEAD PROFESSOR(S): Christian BURTIN

Objectives

At the end of the course, the students will be able to:

- Write a scientific and technical paper on mechanical engineering area
- Establish the reasoning of scientific paper writing
- Present orally and clearly scientific data in the context of mechanical engineering
- Write the abstract on an article

Course contents

The goal is preparing undergraduate students to start a PhD or any relative research activity (academic or industrial) in the context of mechanical engineering. The course INITR is composed of four main parts :

Part A : lecture on IMRAD concept
Part B : Scientific paper reading and analysis based on IMRAD
Part C : Oral presentation and discussion
Part D: How to write the abstract of an article

These parts represent how to organize and publish (Part B and part D), how to communicate (Part C) and how to prepare and present a technical and scientific report (Part A). Applications are given for engineering works.

Sustainable Development Goals (SDGs) covered by this course

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	4	2 hrs	12 hrs	0 hrs	0 hrs	0 hrs

Vibrations and Differential Equations [VIBRA]

LEAD PROFESSOR(S): Panagiotis KOTRONIS

Requirements

Continuum mechanics, mechanics of structures, mathematics

Objectives

At the end of the course the students will be able to:
- Derive the dynamic equilibrium equation using variational principles
- Calculate the stiffness and mass matrices of discrete systems using the Lagrange equations
- Study linear vibrations about an equilibrium position
- Calculate the eigenmodes of discrete and continuum systems
- Apply the modal superposition technique

Course contents

- Discrete and continuum systems
- Hamilton principle
- Lagrange equations
- Linear vibrations about an equilibrium position
- Eigenmodal analysis
- Modal superposition technique

In parallel, an introduction is given on differential equations

Course material

- M. Geradin and D. Rixen. Mechanical vibrations (second edition). Theory and application to structural dynamics. John Wiley and Sons Ltd, 1997.
- Jurnan Schilder' videos https://www.youtube.com/watch?v=gXitAxK28pc&list=PLMXj6GKKnHI6Lftj7CXr9WusMkXi5s9yH
- Differential equations for engineers, Wei-Chau Xie, Cambridge

Sustainable Development Goals (SDGs) covered by this course

Industry, innovation and infrastructure / Sustainable cities and communities

Sustainable Development and Social Responsibility Positioning

The study of small perturbation vibrations aims to provide innovative and safe solutions for industrial and civil applications, serving a more resilient society.

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	5	16 hrs	14 hrs	0 hrs	0 hrs	2 hrs

Cultural and Communication English [CCE1]

LEAD PROFESSOR(S): David TROYA

Objectives

This course aims at improving your critical thinking and persuasion skills in English. Using documentaries, we will explore, discuss and debate a range of cultural, political, social, and environmental issues relevant to current world events.

Speaking and understanding English as a second or third language is a great achievement, but does it mean you are an effective communicator? The next step involves, among other things, critical thinking and persuasive skills, both of crucial importance in the modern professional environment. We will address these issues by analyzing documentaries that will lead to formal debates.

Several competencies will be developed through class exercises. Oral presentations will be an opportunity put your verbal as well as your non-verbal communication skills into practice. During debate, you will be able to sharpen your analytical skills, provide constructive feedback, defend an argument, and prove a point.

Course objectives

- Improving your communication skills

- Becoming an active listener

- Enhancing your non-verbal communication skills

- Developing critical thinking toward media

- Boosting leadership skills through moderating

- Organizing evidence and arguments

Course contents

Each session will be dedicated to a particular cultural, political, social or environmental topic of relevance in the wider anglophone world. Each topic will include multimedia material in the form of a short documentary or documentary excerpt. During class, students will lead a primer presentation, a moderated discussion and a formal debate.

Primer Presentation:

In pairs, you will hold a short talk to prime us on the topic of that week's documentary: you will introduce us to the topic by setting it in a wider context and establishing what's at stake.

Moderated Discussion :

In pairs, you will moderate a discussion related to the themes explored by the documentary. Moderators will come prepared with open-ended questions pertaining to the strengths and weakness of the documentary. They will distinguish between content and form and encourage critical, constructive opinions.

Formal Debate:

What's the difference between an opinion and an argument? You will soon find out. After the moderated discussion, we will brainstorm potential topics for debate, and follow the British Parliamentary model to sharpen your research, critical thinking, and persuasive skills.

During the debate, each speaker will be assigned an audience member who evaluates their individual performance and provides a short debrief. A panel of two judges will determine which side wins.

Course material

Written and televised press, information and digital tools, general documents, business environment and company strategies. Internet conferences (Ted Talks, etc.), our own educational materials on Hippocampus (Moodle).

Sustainable Development Goals (SDGs) covered by this course

Climate action / Industry, innovation and infrastructure / Partnership s for the goals / Quality education / Reduced inequalities

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	2	0 hrs	32 hrs	0 hrs	0 hrs	0 hrs

Spanish Language [ESP1]

LEAD PROFESSOR(S): Marta HERRERA

Objectives

For beginners:
Practice and reinforcement of the five skills (oral and written expression and comprehension as well as interaction)
Acquisition of vocabulary and linguistic structures
Be able to talk about yourself and those around you
Be able to express oneself during daily activities
Know how to give your opinion

For advanced students:
Practice and reinforcement of the five skills (oral and written expression and comprehension as well as interaction)
Acquisition of specialised vocabulary
Be able to understand the essential content of concrete or abstract subjects including a technical discussion
Be able to communicate spontaneously and fluently
Be able to express oneself in a clear and detailed manner, to express an opinion on a topical subject

Course contents

For beginners:
Personal environment (introduce yourself, express yourself, your tastes, your character, your hobbies, etc.), your surroundings (friends, family, location, climate), your interests (sports, leisure)
Present tense (regular and irregular)
Language patterns to express habit, obligation, "gustar" and its equivalents,
Possessive adjectives
Differences between "es", "está", "hay"
Use of "por" and "para"
Adverbs and frequency patterns
Numeral adjectives

For advanced students:
Knowledge of the Hispanic world (economic, technical, cultural and social environment)
Present tense (regular and irregular)
Imperative
Past tenses
Direct / indirect style
Future tense
Conditional tense
Present and past subjunctive moods

Course material

Preparation manuals, our own tailor-made documents, written and internet press, general civilization documents, digital tools

Sustainable Development Goals (SDGs) covered by this course

Affordable and clean energy / Climate action / Decent work and economic growth / Gender equality / Goo health and well-being / Industry, innovation and infrastructure / No poverty / Partnership s for the goals / Peace, justice and strong institutions / Quality education / Reduced inequalities / Responsible consumption and production / Sustainable cities and communities / Zero hunger

Sustainable Development and Social Responsibility Positioning

Key competencies for sustainability Collaboration: the abilities to learn, to understand and respect others; to deal with conflicts in a group; and to facilitate collaborative and participatory problem solving. Critical thinking: the ability to reflect on one's own values, perceptions and actions. Self-awareness: the ability to reflect on one's own role in a group; to continually evaluate and further motivate one's actions; and to deal with one's feelings and desires.

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
Spanish	2	0 hrs	32 hrs	0 hrs	0 hrs	0 hrs

French Language [FLE1]

LEAD PROFESSOR(S): Silvia ERTL

Requirements

N/A

Objectives

The objective is to familiarize the learner with the French language and French culture through an entertaining task-based communicative language teaching, focused on speaking combined with:

- Phonetics
- Self-correcting exercises on our learning platform
- Learning Lab activities
- Project work
- Tutoring

Course objectives include the acquisition and reinforcement of vocabulary, syntax, and pronunciation by both traditional means and through the use of digital resources.
Students will learn general French, develop language skills of oral and written comprehension and expression.

After completing this course (32 hours + personal work), the students will be able to communicate in spoken and written French, in a simple, but clear manner, on familiar topics in the context of study, hobbies etc. Another important goal of this course is to introduce the student to French culture. At the end of the course (2 semesters), complete beginners can achieve an A1 level and some aspects of the A2 of The Common European Framework of Reference for Languages. More advanced students may aim for B1/B2 levels.

Course contents

Full range of practical communication language exercises: reading comprehension, listening comprehension, written expression, oral expression.

Learners will be able to use the foreign language in a simple way for the following purposes:

1. Gving and obtaining factual information:
- personal information (e.g. name, address, place of origin, date of birth, education, occupation)
- non-personal information (e.g. about places and how to get there, time of day, various facilities and services, rules and regulations, opening hours, where and what to eat, etc.)

2. Establishing and maintaining social and professional contacts, particularly:
- meeting people and making acquaintances
- extending invitations and reacting to being invited
- proposing/arranging a course of action
- exchanging information, views, feelings, wishes, concerning matters of common interest, particularly those relating to personal life and circumstances, living conditions and environment, educational/occupational activities and interests, leisure activities and social life

3. Carrying out certain transactions:
- making arrangements (planning, tickets, reservations, etc.) for travel, accommodation, appointments, leisure activities
- making purchases
- ordering food and drink

Course material

Preparation manuals, our own tailor-made documents, written and televised press, internet, general civilization documents, digital tools, our own educational materials on Hippocampus (Moodle).

Sustainable Development Goals (SDGs) covered by this course

Quality education

Sustainable Development and Social Responsibility Positioning

Targeted competencies extracted from: Education for sustainable development goals, learning objectives (UNESCO) https: //unesdoc.unesco.org/ark:/48223/pf0000247507 https://www.coe.int/fr/web/common-european-framework-reference-languages/official-translations-of-the-cefr-global-scale

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	2	0 hrs	48 hrs	0 hrs	0 hrs	0 hrs

Constitutive Laws [CONLA]

LEAD PROFESSOR(S): Giulio SCIARRA

Requirements

Continuum mechanics

Objectives

At the end of the course (30 hours + personal work) the students will be able to:

- Use thermodynamics to get restrictions on the constitutive laws
- Describe the inelastic behaviour of materials and structures
- Model the elastoplastic response of materials within the framework of continuum mechanics
- Calculate the response of elastoplastic structures
- Theorems of limit analysis

Course contents

These lectures aim to present the main aspects of modelling irreversible processes within the framework of continuum mechanics. The thermodynamics of irreversible processes (TPI) is introduced as a fundamental tool to obtain a proper characterization of constitutive laws, then plasticity theory is presented in detail.

The lectures will cover the following:

- TPI: conservation laws, the first and the second principle of thermodynamics
- Rheological models
- Modelling the elastoplastic behaviour of materials, main postulates and principles
- Perfect plasticity and hardening plasticity
- Plasticity of structures
- The static and the kinematic theorem

Course material

- J. Lemaitre, J.L. Chaboche Mechanics of solid materials, Cambridge University Press, 2000
- J.-J. Marigo Plasticité et Rupture https://cel.archives-ouvertes.fr/cel-00549750v1
- P. Suquet Rupture et Plasticité http://perso.enstaparistech.fr/~mbonnet/mec551/mec551.pdf
- J. Lubliner Plasticity theory, Dover publications 2006

Sustainable Development Goals (SDGs) covered by this course

Industry, innovation and infrastructure / Sustainable cities and communities

Sustainable Development and Social Responsibility Positioning

The course provides solid bases necessary to characterize the behavior of materials and structures of civil and mechanical engineering. This course is therefore propedeutic to all those one proposed during the M2 and more oriented towards industrial innovation and sustainability.

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	5	16 hrs	14 hrs	0 hrs	0 hrs	2 hrs

Nonlinear Constitutive Modeling of Steel and Concrete with Applications to Reinforced Concrete Structures [CONST]

LEAD PROFESSOR(S): Panagiotis KOTRONIS

Requirements

Reinforced concrete, theory of materials, numerical analysis

Objectives

At the end of the course the students will be able to:

- Describe the elastic and inelastic behavior of concrete and steel
- Understand the principles of hydrostatic-pressure-independent yield surfaces
- Understand the principles of hydrostatic-pressure-dependent yield surfaces
- Describe the main properties of a proper yield criterion for steel
- Describe the main properties of a proper failure criterion for concrete
- Give examples of plasticity models for steel
- Give examples of plasticity and damage mechanics models for concrete
- Criticize the results of non-linear calculations of reinforced concrete structures

Course contents

These lectures aim to present the main aspects of the non-linear behaviour of steel, of concrete and of civil engineering structures. The lectures will cover the following:

- 1D Numerical implementation (plasticity)
- Yield criteria for steel
- Failure criteria for concrete
- Examples of non-linear calculations of reinforced concrete structures

Course material

- Inelastic Analysis of Structures, M. Jirásek and Z. Bažant, Wiley, 2002.
- Plasticity in reinforced concrete, WF. Chen, J. Ross Publishing, 2007
- Engineering damage mechanics. J. Lemaitre, R. Desmorat, Springer 2005.
- Computational Inelasticity. J.C. Simo and T.J.R. Hughes, Springer, 2000.

Sustainable Development Goals (SDGs) covered by this course

Sustainable cities and communities

Sustainable Development and Social Responsibility Positioning

Studying the yield surfaces of concrete and steel and their behavioral laws means building better and more sustainably: by avoiding material waste, choosing more resilient solutions, and ensuring safe structures for the future.

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	5	16 hrs	6 hrs	10 hrs	0 hrs	0 hrs

Geotechnical Engineering [GEOTC]

LEAD PROFESSOR(S): Siddhartha Harsha OMMI

Requirements

This course is intended for Masters students who have graduated in a Civil Engineering or similar degree.
A familiarity is expected with,
- Fundamentals of Soil Mechanics: soil classification, physical and hydraulic properties, common lab tests.
- Fundamentals of Continuum mechanics: tensor algebra, analysis, stress–strain measures, linear elasticity, balance equations, notion of constitutive laws.

Objectives

At the end of the course (30 hours + personal work) the students will be able to:

- Describe the macroscopic behavior of soils using proper measures and identify their peculiar states (dilatancy, shear bands formation, liquefaction etc.)
- Master the field equations applicable to soils viewed as a porous media
- Identify the experimental set-ups necessary to provide a characterization of the constitutive response of soils
- Master the mathematical modeling of observed constitutive response of soils
- Describe the particle-scale interactions in granular materials
- Identify the link between micro-scale interactions (forces) and macroscopic behavior (stresses) in granular media

Course contents

This course aim to present two different approaches to geotechnical engineering: the macro-scale description of granular materials (in particular soils) and the micro-scale approach to the same problem. Links between these two viewpoints are presented and discussed.

The lectures (CMs) and tutorials (TDs) will cover the following topics:

- Introduction to the constitutive laws and field equations applicable to soils
- Experimental observations of soil behavior (Sand and Clay) and their interpretation
- Mathematical modeling of soil constitutive laws
- Physics of granular materials (compaction, segregation, pattern formation, flows and instabilities)
- Introduction to the micro-mechanics of granular materials, and on its numerical simulation through "discrete element methods" (DEM)

The TPs involve 8hrs of experimental campaigns to introduce and perform tests required for describing soil behavior:
- Oedometer test on coarse and fine grained soils
- Casagrande direct shear test

Course material

- R. Nova Soil mechanics Wiley, 2010
- R. Lancellotta Geotechnical engineering Taylor & Francis 2009
- Andreotti, Forterre & Pouliquen, Les Milieux Granulaires, EDP Sciences, 2011
- Nedderman, Statics and Kinematics of Granular Materials, CUP, 1992

Sustainable Development Goals (SDGs) covered by this course

Affordable and clean energy / Industry, innovation and infrastructure / Sustainable cities and communities

Sustainable Development and Social Responsibility Positioning

This course contributes to sustainable development by improving the scientific understanding and modeling of soil and granular material behavior across scales, enabling more reliable, optimized, and resource-efficient geotechnical designs. By linking experimental observation, continuum modeling, and micro-scale numerical methods, it promotes responsible engineering practices that reduce material waste, limit environmental disturbance, and enhance the long-term safety and resilience of infrastructure.

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	5	16 hrs	6 hrs	8 hrs	0 hrs	2 hrs

Imaging in Civil Engineering [IMAGI]

LEAD PROFESSOR(S): Benoit HILLOULIN

Objectives

At the end of the course, the students will be able to:

- Grasp the theory of some of the imaging techniques commonly used in civil engineering
- Use the basics of ImageJ software in image data analysis
- Calculate the displacement and deformation field of a sample deformed in the laboratory, using digital image correlation (2D)
- Choose the most compatible method from a range of imaging techniques for different civil engineering applications.

Course contents

Imaging techniques are used to an ever-increasing extent in academic and private research to understand and optimize the mechanical behaviour of various materials (concrete, rock, soil, glass etc). This course provides an overview of the main imaging techniques that Master's students may encounter during their research internships. The advantages and drawbacks of such methods will be presented, as well as their combination with standard techniques in civil engineering.

The course will focus on digital image and volume correlation in particular, with direct applications in deformation monitoring in underground structures.

At the end of the 32 hours, the students should have a basic foundation and training in image techniques and data analysis of civil engineering materials. As a rough guide, the course is broken down into the following parts:

- Why use imaging techniques? Introduction to non-destructive and destructive imaging techniques
- Definition of an image and overview of image acquisition techniques (camera with simple pictures, x-ray tomography, electron microscopy etc.)
- Continuity of techniques from 2D, 3D (laboratory experiments) to 4D (time-resolved Synchrotron imaging)
- Combination of imaging techniques with standard techniques in civil engineering (deformation in triaxial conditions under x-ray tomography for example)
- Overview of image analysis techniques to extract quantitative data (optical full measurement techniques, segmentation, filtering)
- Advantages and drawbacks of imaging techniques (resolution, scale, combination with other methods etc)
- Applications in civil engineering, and for petroleum and nuclear waste.

Homework and lab sessions will provide an understanding of the major processes used in the composites industry.

Course material

- Mesures en mécanique par méthodes optiques, Brémand et al., (2011). Techniques de l'Ingénieur
- Les techniques optiques de mesure de champ; essai de classification, 2005 Y.Surrel.
- Full field measurements and identification in solid mechanics, Mechanical engineering and solid mechanics series, Ed. Wiley (2013)

Sustainable Development Goals (SDGs) covered by this course

Industry, innovation and infrastructure / Responsible consumption and production

Sustainable Development and Social Responsibility Positioning

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Assessment

Individual assessment: EVI 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	5	16 hrs	0 hrs	10 hrs	6 hrs	0 hrs

Physical Modelling [PHYMD]

LEAD PROFESSOR(S): Luc THOREL

Objectives

Introduction to the use of reduced-scale models in Civil Engineering. We draw upon the exceptional concentration of large-scale test facilities and scientific expertise in the Nantes area (geotechnical centrifuge, wind tunnels, towing tank and wave tank, semi-anechoic room, laser interferometry measurement bench). Knowledge of the basics of physical modelling, use of scaling laws, interpretation of experimental results.

Course contents

The course starts with an overview of scaling laws and similitude problems, followed by a presentation of the main tools used for their analysis and by specific applications in the following fields:

- Geotechnics
- Aerodynamics
- Hydrodynamics
- Acoustics
- Geophysics

Sustainable Development Goals (SDGs) covered by this course

Industry, innovation and infrastructure / Quality education

Sustainable Development and Social Responsibility Positioning

In line with the principles established by Jacques ELLUL

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	4	16 hrs	14 hrs	0 hrs	0 hrs	2 hrs

Tools and Methods for Research 2 [TOME2]

LEAD PROFESSOR(S): Giulio SCIARRA

Objectives

This is the first introduction to laboratory research activities in view of testing the attitude of students to applied research and scientific development.

Course contents

The academic module consists of a project mostly within the domain of the research activities of the teaching staff.

Sustainable Development Goals (SDGs) covered by this course

Affordable and clean energy / Climate action / Industry, innovation and infrastructure / Sustainable cities and communities

Sustainable Development and Social Responsibility Positioning

Via this first, collaborative, laboratory research project students will gain practical insights and competences in research activities in the domain of durability of materials and structures as for instance: structures lifetime extension and vulnerability reduction, building material optimization and waste reduction through reuse and recycling, sustainable management of renewable energy resources.

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	4	0 hrs	0 hrs	0 hrs	32 hrs	0 hrs

Cultural and Communication English [CCE2]

LEAD PROFESSOR(S): David TROYA

Objectives

Interview techniques and communicational English:

- Understand the general concepts of interactive communication
- Build a media project
- Acquire interview techniques
- Understand the process of sourcing and checking facts and figures
- Understand issues related to plagiarism
- Create a bibliography
- Behavioral skills in an inter-cultural environment:
- Strengthen self-confidence and capacity for interaction
- Develop active listening and reformulation skills
- Develop networking skills

Course contents

Cultural and Communicational English: exercises to explore in practice the areas of culture and communication.
Media project (for example: prepare, conduct and promote interviews for a radio programme: L'Heure Centralienne (http: //www.euradionantes.eu/emission/l-heure-centralienne), with the contribution of professors, PhD students, industrial partners, industry players at fairs, etc.

Course material

Written and televised press, information and digital tools, general documents business environment and company strategies. Internet conferences (Ted Talks, etc.), our own educational materials on Hippocampus (Moodle).

Sustainable Development Goals (SDGs) covered by this course

Gender equality / Industry, innovation and infrastructure / Partnership s for the goals / Quality education / Reduced inequalities / Sustainable cities and communities

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	2	0 hrs	32 hrs	0 hrs	0 hrs	0 hrs

Spanish Language [ESP2]

LEAD PROFESSOR(S): Marta HERRERA

Objectives

For beginners:
Practice and reinforcement of the five skills (oral and written expression and comprehension as well as interaction)
Acquisition of vocabulary and linguistic structures
Be able to talk about yourself and those around you
Be able to express oneself during daily activities
Know how to give your opinion

For advanced students:
Practice and reinforcement of the five skills (oral and written expression and comprehension as well as interaction)
Acquisition of specialised vocabulary
Be able to understand the essential content of concrete or abstract subjects including a technical discussion
Be able to communicate spontaneously and fluently
Be able to express oneself in a clear and detailed manner, to express an opinion on a topical subject

Course contents

For beginners:
Personal environment (introduce yourself, express yourself, your tastes, your character, your hobbies, etc.), your surroundings (friends, family, location, climate), your interests (sports, leisure)
Present tense (regular and irregular)
Language patterns to express habit, obligation, "gustar" and its equivalents,
Possessive adjectives
Differences between "es", "está", "hay"
Use of "por" and "para"
Adverbs and frequency patterns
Numeral adjectives

For advanced students:
Knowledge of the Hispanic world (economic, technical, cultural and social environment)
Present tense (regular and irregular)
Imperative
Past tenses
Direct / indirect style
Future tense
Conditional tense
Present and past subjunctive moods

Course material

Preparation manuals, our own tailor-made documents, written and internet press, general civilization documents, digital tools

Sustainable Development Goals (SDGs) covered by this course

Affordable and clean energy / Climate action / Decent work and economic growth / Gender equality / Goo health and well-being / Industry, innovation and infrastructure / Life on land / No poverty / Partnership s for the goals / Peace, justice and strong institutions / Quality education / Reduced inequalities / Responsible consumption and production / Sustainable cities and communities / Zero hunger

Sustainable Development and Social Responsibility Positioning

Key competencies for sustainability Collaboration: the abilities to learn, to understand and respect others; to deal with conflicts in a group; and to facilitate collaborative and participatory problem solving. Critical thinking: the ability to reflect on one's own values, perceptions and actions. Self-awareness: the ability to reflect on one's own role in a group; to continually evaluate and further motivate one's actions; and to deal with one's feelings and desires.

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
Spanish	2	0 hrs	32 hrs	0 hrs	0 hrs	0 hrs

French Language [FLE2]

LEAD PROFESSOR(S): Silvia ERTL

Requirements

N/A

Objectives

The objective is to familiarize the learner with the French language and French culture through an entertaining task-based communicative language teaching, focused on speaking combined with:

- Phonetics
- Self-correcting exercises on our learning platform
- Learning Lab activities
- Project work
- Tutoring

Course objectives include the acquisition and reinforcement of vocabulary, syntax, and pronunciation by both traditional means and through the use of digital resources.
Students will learn general French, develop language skills of oral and written comprehension and expression.

After completing this course (32 hours + personal work), the students will be able to communicate in spoken and written French, in a simple, but clear manner, on familiar topics in the context of study, hobbies etc. Another important goal of this course is to introduce the student to French culture. At the end of the course (2 semesters), complete beginners can achieve an A1 level and some aspects of the A2 of The Common European Framework of Reference for Languages. More advanced students may aim for B1/B2 levels.

Course contents

Full range of practical communication language exercises: reading comprehension, listening comprehension, written expression, oral expression.

Learners will be able to use the foreign language in a simple way for the following purposes:

1. Giving and obtaining factual information:
- personal information (e.g. name, address, place of origin, date of birth, education, occupation)
- non-personal information (e.g. about places and how to get there, time of day, various facilities and services, rules and regulations, opening hours, where and what to eat, etc.)

2. Establishing and maintaining social and professional contacts, particularly:
- meeting people and making acquaintances
- extending invitations and reacting to being invited
- proposing/arranging a course of action
- exchanging information, views, feelings, wishes, concerning matters of common interest, particularly those relating to personal life and circumstances, living conditions and environment, educational/occupational activities and interests, leisure activities and social life

3. Carrying out certain transactions:
- making arrangements (planning, tickets, reservations, etc.) for travel, accommodation, appointments, leisure activities
- making purchases

- ordering food and drink

Course material

Preparation manuals, our own tailor-made documents, written and televised press, internet, general civilization documents, digital tools, our own educational materials on Hippocampus (Moodle).

Sustainable Development Goals (SDGs) covered by this course

Quality education

Sustainable Development and Social Responsibility Positioning

Targeted competencies extracted from: Education for sustainable development goals, learning objectives (UNESCO) https: //unesdoc.unesco.org/ark:/48223/pf0000247507 https://www.coe.int/fr/web/common-european-framework-reference-languages/official-translations-of-the-cefr-global-scale

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	2	0 hrs	48 hrs	0 hrs	0 hrs	0 hrs