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CENTRALE NANTES

MASTER OF SCIENCE, TECHNOLOGY AND HEALTH

CIVIL ENGINEERING

MATERIALS AND STRUCTURES IN THEIR ENVIRONMENT

YEAR 1

PROGRAMME SUPERVISORS:
ANNE-LAURE FAUCHILLE, GIULIO SCIARRA

Établissement public sous tutelle du ministère de l'Enseignement supérieur, de la Recherche et de l'Innovation

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CIVIL ENGINEERING - MATERIALS AND STRUCTURES IN THEIR ENVIRONMENT

YEAR 1 - AUTUMN SEMESTER

Numerical Methods

Fluid Mechanics 1

Vibrations and Differential Equations

Continuum Mechanics

Algorithmics for Engineering Modeling

Business Environment

Cultural and Communication English

French Language

NUMERICAL METHODS

CIVIL ENGINEERING - MATERIALS AND STRUCTURES IN THEIR ENVIRONMENT
YEAR 1 - AUTUMN SEMESTER

LEAD PROFESSOR: Grégory LEGRAIN

Objectives

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

- Classify standard PDEs (elliptic, parabolic, hyperbolic)
- Solve simple elliptic problems by means of finite differences or finite elements
- Solve simple parabolic problems, and assess their stability
- Assess the accuracy of the schemes they use
- Program finite differences and finite elements in both 1D and 2D

Course contents

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

- Classification of PDEs
- Classification of boundary conditions, well-posedness
- Introduction to finite differences
- Introduction to finite elements
- Parabolic problems

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

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LABO	PROJECT	EXAM
English	4	14 hrs	6 hrs	10 hrs	0 hrs	2 hrs

FLUID MECHANICS 1

CIVIL ENGINEERING - MATERIALS AND STRUCTURES IN THEIR ENVIRONMENT
YEAR 1 - AUTUMN SEMESTER

LEAD PROFESSOR: 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 specificities 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.

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

VIBRATIONS AND DIFFERENTIAL EQUATIONS

CIVIL ENGINEERING - MATERIALS AND STRUCTURES IN THEIR ENVIRONMENT
YEAR 1 - AUTUMN SEMESTER

LEAD PROFESSOR: Panagiotis KOTRONIS

Objectives

At the end of the course (30 hours + personal work) 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
- Apply the Rayleigh-Ritz method

Course contents

These lectures aim at presenting the main aspects of the non-linear behaviour of steel, of concrete and of civil engineering structures. The main items of these lectures are:

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

Course material

- M. Geradin and D. Rixen. Mechanical vibrations (second edition). Theory and application to structural dynamics. John Wiley and Sons Ltd, 1997.
- K. Chopra. Dynamics of Structures. Theory and Applications to Earthquake Engineering (second edition).

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

CONTINUUM MECHANICS

CIVIL ENGINEERING - MATERIALS AND STRUCTURES IN THEIR ENVIRONMENT
YEAR 1 - AUTUMN SEMESTER

LEAD PROFESSOR: Thomas HEUZE

Objectives

At the end of the course (30 hours + personal work), the students will:

- understand strain and stress notions, and be able write their mathematical representation correctly.
- know that there are different kinds of equations with different purposes (balance equations, constitutive equations, boundary conditions).
- Be able to define the problem of the equilibrium of a deformable elastic solid body in infinitesimal strain by writing a Boundary Value Problem (BVP), and to choose the right set of boundary conditions.
- know the different possible approaches available to solve that BVP, and be able to solve it.

Course contents

This course is an introduction to continuum mechanics, and more generally to modelling in mechanics. The basic concepts required for more advanced fluid and solid mechanics courses are introduced here. The course then focuses on the study of the equilibrium of deformable solid bodies in linear elasticity and infinitesimal strain. This provides some basic tools required for engineers to design mechanical systems.

After some necessary lectures, the course is built on alternating the introduction of fundamental concepts and training examples, each lasting approximately 2hours.

The course outline is as follows:

- Mathematics for continuum mechanics
- Introduction
- Kinematics
- Stresses
- Equations of conservation
- Constitutive equations
- Equations of linear elasticity in infinitesimal strain

Course material

- Introduction to Continuum Mechanics, W. Michael Lai, David Rubin and Erhard Krempl, Elsevier, 2010.
- Continuum Mechanics, A.J.M. Spencer, Dover Publications, 2004.
- Mécanique des Milieux Continus et discrets, Handbook of N. Moës, 2011,
- Mécanique, P. Germain, 1985, Ecole Polytechnique, volumes 1 & 2.

- 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.

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

ALGORITHMICS FOR ENGINEERING MODELING

CIVIL ENGINEERING - MATERIALS AND STRUCTURES IN THEIR ENVIRONMENT
YEAR 1 - AUTUMN SEMESTER

LEAD PROFESSOR: Jose-Vicente AGUADO / Domenico BORZACCHIELLO

Objectives

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

- Identify and properly apply numerical methods to different engineering problems
- Understand algorithmic aspects and handle practical implementation issues
- Program and optimize algorithms in Matlab/Octave
- Use standard libraries for scientific computing in Matlab/Octave

Course contents

The course proposes a gentle introduction to numerical methods in scientific computing and their respective algorithms through practical problems that are often encountered in engineering applications. It will cover five fundamental topics : interpolation and differentiation, numerical quadrature, time-stepping integration techniques for ordinary differential equations, iterative solvers and nonlinear solvers.

Each topic will be presented through a practical application, that will serve as a basis to review implementation aspects as well as theoretical principles of the numerical methods involved. Several exercises in Matlab/Octave are proposed.

Course material

- Slides and Course Notes

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LABO	PROJECT	EXAM
English	4	10 hrs	20 hrs	0 hrs	0 hrs	2 hrs

BUSINESS ENVIRONMENT

CIVIL ENGINEERING - MATERIALS AND STRUCTURES IN THEIR ENVIRONMENT
YEAR 1 - AUTUMN SEMESTER

LEAD PROFESSOR: Spencer HAWKRIDGE

Objectives

- Understand the general concepts of business English and marketing principles
- Understand the principles of given business models (for example: the collaborative economy)
- Build a professional project and explore international opportunities
- Develop strategies for inter-cultural practice
- Organize, lead and participate in discussions, interviews and meetings
- Strengthen self-confidence and level of conviction
- Develop active listening and understanding to reformulate, explain and argue
- Acquire notions of corporate culture and values
- Develop well-being at work and a sense of responsibility
- Enhance team work

Course contents

Business Environment: exercises to explore in practice the areas of business and marketing

Field-related or inter-cultural project:

- Field-based radio project: prepare, conduct and promote interviews for ECN's radio programme: L'Heure Centralienne (http://www.euradionantes.eu/emission/l-heure-centralienne), with the contribution of professors, doctorate students, industrial partners, industry players at fairs, etc.
- Inter-cultural project: construct a myplace4U eZoomBook, using the eZoomBook template. Devise a place branding strategy and analyse its impact on potential users of the myplace4U eZoomBook.

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).
Our own eZoomBook template for the Intercultural project.

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

CULTURAL AND COMMUNICATION ENGLISH

CIVIL ENGINEERING - MATERIALS AND STRUCTURES IN THEIR ENVIRONMENT
YEAR 1 - AUTUMN SEMESTER

LEAD PROFESSOR: Spencer HAWKRIDGE

Objectives

Introduction to Cultural and Communicational English:

- Understand the general concepts of communication English (different levels of language, etc.)
- Build a communicational project
- Develop strategies for enhanced interaction
- Organize, lead and participate in discussions, interviews and meetings
- Behavioral skills in an inter-cultural environment:
- Strengthen engagement and level of conviction
- Develop a capacity to explain and argue
- Acquire notions of corporate culture and values
- Enhance team work

Course contents

Cultural and Communicational English: exercises to explore in practice the areas of culture and communication
Inter-cultural project (for example, documentary project, publishing project: construct a work of fiction or of educational value and experience the complete publishing process)

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).
Our own eZoomBook template for the Intercultural project.

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

FRENCH LANGUAGE

CIVIL ENGINEERING - MATERIALS AND STRUCTURES IN THEIR ENVIRONMENT
YEAR 1 - AUTUMN SEMESTER

LEAD PROFESSOR: Silvia ERTL

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).

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LABO	PROJECT	EXAM
French	4	0 hrs	32 hrs	0 hrs	0 hrs	0 hrs

YEAR 1 - SPRING SEMESTER

Concrete and Structures

Geotechnical Engineering

Constitutive Laws

Imaging in Civil Engineering

Conferences and Initiation to Research

Physical Modelling

Cultural and Communication English

French Language

CONCRETE AND STRUCTURES

CIVIL ENGINEERING - MATERIALS AND STRUCTURES IN THEIR ENVIRONMENT

YEAR 1 - SPRING SEMESTER

LEAD PROFESSOR: Panagiotis KOTRONIS

Objectives

At the end of the course (30 hours + personal work) 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 static and dynamic 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:

- Examples of non-linear calculations of reinforced concrete structures
- Yield criteria for steel
- Failure criteria for concrete
- Numerical implementation

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.

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

GEOTECHNICAL ENGINEERING

CIVIL ENGINEERING - MATERIALS AND STRUCTURES IN THEIR ENVIRONMENT
YEAR 1 - SPRING SEMESTER

LEAD PROFESSOR: Giulio SCIARRA

Objectives

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

- Describe the particle-scale interactions in granular materials
- Identify the link between microscale interactions (forces) and macroscopic behavior (stresses) in granular media
- Describe the principles behind numerical simulations with the Discrete Element Method
- Describe the macroscopic behaviour of soils
- Identify the experimental set-ups necessary to provide a characterization of the constitutive response of soils
- Identify the peculiar states which characterize the behaviour of soils (dilatancy, shear bands formation, liquefaction etc.)
- Use enhanced constitutive model of soils.

Course contents

These lectures aim to present two different approaches to geotechnical engineering: the first based on the micro-scale description of granular materials (in particular soils) and the second based on a macro-scale approach to the same problem. Links between these two viewpoints are presented and discussed.

The lectures will cover the following:

- Introduction to the physics of granular materials (compaction, segregation, pattern formation, flows and instabilities)
- Granular micromechanics: contact laws, discrete element modelling
- Granular statics: packing properties, from contact forces to macroscopic stresses
- Granular rheology: experimental and numerical evidence on granular flow, rheological models & boundary conditions
- Tests and experimental results on sands and clays
- The stress path concept: application in the description of drained and undrained conditions
- Peculiar behaviours of soils: dilatancy, shear band formation, liquefaction
- Constitutive model of soils

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

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

CONSTITUTIVE LAWS

CIVIL ENGINEERING - MATERIALS AND STRUCTURES IN THEIR ENVIRONMENT
YEAR 1 - SPRING SEMESTER

LEAD PROFESSOR: Giulio SCIARRA

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
- Describe the main aspects of (brittle) fracture
- Calculate stress singularities in linear elasticity

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 and fracture mechanics are 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
- Basic formulation of fracture mechanics
- Stress singularities in prototype problems

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

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

IMAGING IN CIVIL ENGINEERING

CIVIL ENGINEERING - MATERIALS AND STRUCTURES IN THEIR ENVIRONMENT
YEAR 1 - SPRING SEMESTER

LEAD PROFESSOR: Anne-Laure FAUCHILLE

Objectives

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

- Grasp the theory of a few 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 in 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 students may encounter during their research internships. The advantages and drawbacks of such methods will be presented, as well as their combination with classical 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 preliminary background and training on 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 classical 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, petroleum and nuclear waste contexts

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)

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

CONFERENCES AND INITIATION TO RESEARCH

CIVIL ENGINEERING - MATERIALS AND STRUCTURES IN THEIR ENVIRONMENT

YEAR 1 - SPRING SEMESTER

LEAD PROFESSOR: Anne-Laure FAUCHILLE

Objectives

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

- Read (efficiently) a scientific paper on civil engineering research
- Establish the reasoning of scientific papers
- Present orally and clearly scientific data in the context of civil engineering
- Participate in a scientific debate on civil engineering research

Course contents

The goal is to prepare graduate students to start a PhD or any relative research activity (academic or industrial) in the context of civil engineering. The course is composed of three main parts:

- Part A: Conferences (10 hours)
- Part B: Scientific paper reading and writing (10 hours)
- Part C: Oral presentation (10 hours)

These parts represent how to organize and publish (Part B), how to communicate (Part C) and how to discuss scientific data (Part A). Applications are given for civil engineering works.

In part A, researchers from the GeM laboratory at ECN and external researchers are invited to give keynote lectures followed by a discussion or debate. Keynote lectures mostly concern experimental and modelling studies on deformation and fracturing of civil engineering materials (rocks, soils and concrete) subjected to various stresses (mechanical loadings, temperature and humidity loadings, chemical alteration etc), from large scale (building scale, or gallery scale for underground works) to small scale (micrometre scale).

In part B, students learn how to efficiently read scientific papers on experiments, constitutive modelling, numerical analysis and review in civil engineering works. Five different papers are carefully analysed to identify quick and efficient ways to read scientific papers, to improve the understanding of the paper, and the skill of summarizing each section's highlights in the paper.

In part C, students learn how to prepare a short scientific talk (typically 10 to 20 min) in terms of content, vocal, verbal and visual communication, and gesture. In particular, communication techniques to arrange quantitative data are given.

Part C is composed of lectures, videos and practice.

Course material

- Hedan, S., Fauchille, A.L., Valle, V., Cabrera, J. and Cosenza, P., 2014. One-year monitoring of desiccation cracks in Tournemire argillite using digital image correlation. International Journal of Rock Mechanics and Mining Sciences, 68, pp.22-35.

- Hedan, S., Cosenza, P., Valle, V., Dudoignon, P., Fauchille, A.L. and Cabrera, J., 2012. Investigation of the damage induced by desiccation and heating of Tournemire argillite using digital image correlation. International Journal of Rock Mechanics and Mining Sciences, 51, pp.64-75.
- Hedan, S., Hubert, F., Prêt, D., Ferrage, E., Valle, V. and Cosenza, P., 2015. Measurement of the elastic properties of swelling clay minerals using the digital image correlation method on a single macroscopic crystal. Applied Clay Science, 116, pp.248-256.
- Guide pratique du mémoire et autres TFE : rédaction et soutenance, Bonnechère & Bouancheaux Zuckermandl, 2016
- Les fondamentaux de la négociation, Lionel Bellenger, ESF Ed, 2004
- L'essentiel de la gestion de projet, Roger Aïm, Gualino Ed, 2017
- Réussir mémoire, thèse et HDR, Mementos LMD, Constant & Lévy, Gualino Ed, 2017
- http://doctorants-chercheurs.blogspot.fr/2015/12/conseils-pour-faire-une-bonne.html, Fabrice Prat (2001)
- Les 6 règles de base en communication visuelle, 2015 http://evolutiongraphique.com/les-6-regles-de-base-en-communication-visuelle/
- 1001 trucs publicitaires, Luc Dupont, 3e ed, Les Ed transcontinental

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LABO	PROJECT	EXAM
English	**2**	**16 hrs**	**14 hrs**	**0 hrs**	**0 hrs**	**2 hrs**

CULTURAL AND COMMUNICATION ENGLISH

CIVIL ENGINEERING - MATERIALS AND STRUCTURES IN THEIR ENVIRONMENT
YEAR 1 - SPRING SEMESTER

LEAD PROFESSOR: Spencer HAWKRIDGE

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).
Our own eZoomBook template for the Intercultural project.

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

PHYSICAL MODELLING

CIVIL ENGINEERING - MATERIALS AND STRUCTURES IN THEIR ENVIRONMENT
YEAR 1 - SPRING SEMESTER

LEAD PROFESSOR: 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, 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
- Acoustics
- Geophysics

Course material

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

FRENCH LANGUAGE

CIVIL ENGINEERING - MATERIALS AND STRUCTURES IN THEIR ENVIRONMENT
YEAR 1 - SPRING SEMESTER

LEAD PROFESSOR: Silvia ERTL

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).

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LABO	PROJECT	EXAM
French	**4**	**0 hrs**	**32 hrs**	**0 hrs**	**0 hrs**	**0 hrs**