CENTRALE NANTES

MASTER OF SCIENCE, TECHNOLOGY AND HEALTH

2021-2022

YEAR 1

MECHANICAL ENGINEERING

COMPUTATIONAL MECHANICS

PROGRAMME SUPERVISOR(S):
Christian BURTIN

YEAR 1 - Autumn Semester

CORE COURSES

Course code	Title	ECTS Credits
ALEMO	Algorithmics for Engineering Modeling	4
BUSEN	Business Environment	4
COMEC	Continuum Mechanics	5
CONF	Conferences	-
FLUM1	Fluid Mechanics 1	5
NUMME	Numerical Methods	4
VIBRA	Vibrations and Differential Equations	4

LANGUAGE COURSES

Course code	Title	ECTS Credits
CCE1	Cultural and Communication English	4
ESP1	Spanish Language	4
FLE1	French Language	4

YEAR 1 - Spring Semester

CORE COURSES

Course code	Title	ECTS Credits
FLUII	Fluid Mechanics 2	5
INITR	Conferences and Initiation to Research	2
NUMAN	Numerical Analysis	5
PROGR	Programming and Algorithmics	4
PRSTA	Probability and Statistics	5
STRME	Structural Mechanics	5

LANGUAGE COURSES

Course code	Title	ECTS Credits
CCE2	Cultural and Communication English	4
ESP2	Spanish Language	4
FLE2	French Language	4

Algorithmics for Engineering Modeling [ALEMO]

LEAD PROFESSOR(S): Domenico BORZACCHIELLO / Jose-Vicente AGUADO

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
- An Introduction to Programming and Numerical Methods in MATLAB

Assessment

Individual assessment: EVI 1 (coefficient 1)

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

Business Environment [BUSEN]

LEAD PROFESSOR(S): 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.
  - BookHoof project: Write, illustrate, edit and format, using Scribus software, a vulgarisation of one of 14 Engineering Challenges of the future, pitched at teenagers. (http://www.engineeringchallenges.org/challenges.aspx). Study the business model of the book industry and how the traditional book publishing world has been disrupted by technology.
  - Escape Game: Design, create and implement an escape game (including props and materials) with cultural, scientific and mathematical references and a narrative that runs through the game.

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.
BOOKHOOF websites: https://bhnetwork.hypotheses.org/
http://bookhoof.org/
BUSEN padlet: https://padlet.com/spencer_hawkridge/BUSEN

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

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

Continuum Mechanics [COMEC]

LEAD PROFESSOR(S): Thomas HEUZE

Objectives

This course is an introduction to continuum mechanics, and more generally to the modelling in mechanics. The basic concepts are introduced here, which will be required for more advanced fluid and solid mechanics courses. In its second part, the course focuses on the study of the equilibrium of deformable solid bodies in linear elasticity and infinitesimal strain. This allows to supply some basic tools required for engineers to design simple mechanical systems.
The fundamental concepts introduced in this course are also useful for the courses of fluid mechanics (though recalled within it) and numerical methods (it provides models to be discretized with numerical methods) occuring during the first semester. It is also used as a basis for the course of structural mechanics occuring during the second semester for students that will have chosen the "solid" or "civil engineering" options. A last, it provides useful tools for the course of "Mechanical design analysis" to mechanically design parts.

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

- understand strain and stress notions, and be able to write correctly their mathematical representation.
- 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

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
- Balance equations
- 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.

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

Conferences [CONF]

LEAD PROFESSOR(S): Christian BURTIN

Objectives

how to write a report
how to make a technical presentation

Course contents

how to write a report
how to make a technical presentation
homework
oral defense

Course material

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	-	6 hrs	0 hrs	0 hrs	0 hrs	0 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.

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 Methods [NUMME]

LEAD PROFESSOR(S): 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
- 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 (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

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

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

Vibrations and Differential Equations [VIBRA]

LEAD PROFESSOR(S): Panagiotis KOTRONIS

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
- Apply the Rayleigh-Ritz method

Course contents

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

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.
- A. K. Chopra. Dynamics of Structures. Theory and Applications to Earthquake Engineering (second edition). Prentice-Hall, 2001.
- Differential equations for engineers, Wei-Chau Xie, Cambridge

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

Cultural and Communication English [CCE1]

LEAD PROFESSOR(S): 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)
VEC (Virtual Environmental Challenge) Challenge - international competition to design an Eco-campus with participants from French and foreign universities.

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.
VEC padlet and PMooc ('The stories we live by' - Professor Arran Stibbe lecturing on Ecolinguistics)

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	4	0 hrs	64 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

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	4	0 hrs	64 hrs	0 hrs	0 hrs	0 hrs

French Language [FLE1]

LEAD PROFESSOR(S): 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).

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	4	0 hrs	64 hrs	0 hrs	0 hrs	0 hrs

Fluid Mechanics 2 [FLUII]

LEAD PROFESSOR(S): Guillaume DUCROZET

Objectives

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

- Apply the potential flow theory to simple configurations in fluid dynamics.
- Identify the limitations of the potential flow theory.
- Identify the sources of head loss in an internal flow.
- Evaluate the necessary power of a pump in a hydraulic system.
- Calculate the forces exerted on an object in a flow using Euler's theorem.
- Design experimental facilities for head loss identification and force measurements.

Course contents

This course is a follow-up to 'Fluid Mechanics 1', which presents the fundamentals and general principles of fluid mechanics. The aim is now to provide simple tools/formula to extract global information which is useful from an engineering point of view for fluid mechanics problems. The lectures cover the following topics:

- Potential flows
- Transport theorems and integral balances in fluid mechanics
- Head losses and the generalized Bernoulli's equation
- Momentum balance: Euler's theorem

In addition to those lectures, tutorials and lab sessions (4 3h-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.

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	5	8 hrs	10 hrs	12 hrs	0 hrs	2 hrs

Conferences and Initiation to Research [INITR]

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.

Course material

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

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

Numerical Analysis [NUMAN]

LEAD PROFESSOR(S): Anthony NOUY

Objectives

This course covers both theoretical and practical aspects of numerical analysis. At the end of the course (30 hours + personal work) the students will be able to understand classical numerical methods used in computational science for the solution of systems of equations, the computation of eigenvalues of matrices, the approximation or integration of functions.

Course contents

- Fundamentals of linear algebra.
- Linear systems of equations.
- Eigenvalue problems.
- Nonlinear systems of equations.
- Approximation and interpolation of functions.
- Numerical integration.

Course material

- G. Allaire and S. M. Kaber. Numerical linear algebra. Springer, 2007.
- E. Suli and D. Mayers. An Introduction to Numerical Analysis. Cambridge University Press, 2003.

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

Programming and Algorithmics [PROGR]

LEAD PROFESSOR(S): Alexis SALZMAN

Objectives

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

- Handle creation and compilation of simple programs in C++ with basic algorithms (loop, function, computing with array, etc)
- Understand programs using all kind of variables (standard, pointer reference, array and enumeration)
- Understand programs using object-oriented paradigm (basic concept, Inheritance, Polymorphism) and associated algorithms (encapsulation, etc)
- Understand programs using template paradigms (template function, template class) and associated algorithms (generality, etc)
- Understand programs using STL library and associated algorithms (linked list, trees, hash function, etc)
- Acquire knowledge on development tools.

Course contents

Lectures present, step by step, all the programmatic and algorithmic components of a rich programming language: C++. This language first offers a way to learn the key concepts of structured programming and compilation which are rather common in other languages (C, Fortran, Basic etc). Some advanced aspects such as pointers and references will also be studied in this first part of the course. Basic algorithmic concepts (bloc, scope, loop, function, etc) are given in this introduction.

Then, based on this knowledge, the students will learn other programming paradigms that are also available in this language:

- Object-oriented programming. Basic concept and design are presented first. Then two important aspects, Inheritance and Polymorphism, are explained to have a general idea of object-oriented strength.
- Template programming. Function and class template are briefly presented to understand the concept of genericity in a strongly typed language like C++.

Finally linked to C++ standard, an explanation of STL Library is provided. Understanding of the two previous paradigms is a pre-requisite to follow this last part of the course. It is an introduction designed to help students to navigate in this vast library that offers really efficient tools and encapsulates complex algorithms.

A lecture on development tools which help programmers concludes the course.

Homework and lab sessions will provide a way to assimilate lecture content.

Course material

- The C++ Programming Language (4th edition), Bjarne Stroustrup, Addison-Wesley Professional ISBN 978-0-321-56384-2
- The C++ Standard Library: a tutorial and reference (2nd edition), Nicolai M. Josuttis ISBN 978-0321623218

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

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

Probability and Statistics [PRSTA]

LEAD PROFESSOR(S): Marie BILLAUD

Objectives

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

- Describe and model a random experiment (sample set, set of events, probability, using random variable, random vectors) together with probability axioms, independence, conditionality
- Calculate the probability distribution, moments of random variable and random vectors
- Manipulate the usual probability distributions (Bernoulli, Binomial, Poisson, Exp, Normal, Chi-quare, etc)
- Construction of approximations of probability distributions using different definitions of convergence, and convergence theorems for sequences of random variables
- Apply tools developed for probability to statistics
- Calculate some statistical estimators by means of point wise estimation, interval estimation
- Undertake some statistical tests and apply regression

Course contents

This courses gives an introduction to probability and statistics. In the first chapters, we present fundamental notions of probability theory. Then, the last chapters are dedicated to Statistics where we focus on estimation.

1. Probability definition
3. Random vectors
4. Functions of random variables
5. Sequences of random variables
6 . Pointwise estimation
7. Estimation by confidence interval

Course material

- D. Fredon, M. Maumy-Bertrand, F. Bertrand: Statistiques et Probabilités en 30 fiches - 2009 - Dunod.
- J. Jacod and P. Protter: Probability Essentials - 2004 - Springer.

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

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

Structural Mechanics [STRME]

LEAD PROFESSOR(S): Thomas HEUZE

Objectives

This course is an introduction to structural mechanics, focuses more particularly on the study of the equilibrium of linear elastic slender structures like beams, but also lattice trusses, undergoing infinitesimal strain and displacements in order to design them with respect to external loads. This will provide some of the basic tools for engineers to design simple mechanical systems with simplified approaches. The basic concepts required for this course will have already been introduced in the continuum mechanics course during the first semester. These concepts are here particularized for slender structures; the same methodology of analysis of a problem is also followed during this course.

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

- understand what are the key points in defining the kinematics of a beam.
- define the problem of the equilibrium of a beam or a lattice trusses in infinitesimal strain by writing a Boundary Value Problem (BVP), and choose the right set of boundary conditions.
- understand the different possible approaches available for the solution of that BVP, and solve it.

Course contents

The course outline is as follows:

- Study of 3D solutions of beams: torsion and pure bending
- Introduction to the Bernoulli beam theory:
- kinematics,
- modelling of internal forces,
- equilibrium and boundary conditions,
- writing of the Boundary Value Problem (BVP).
- Study of the in-plane bending subproblem.
- Force and displacement solution approaches
- Isostatic/hyperstatic beams, and strength criteria applied to beams
- Study of lattice trusses
- writing of the Boundary Value Problem (BVP); solution.
- Opening. Choice between (depending on the year):
- buckling of beams,
- Vibration of beams
- introduction to curved beams

Course material

- Beams, plates and shells. Donnell Lloyd Hamilton (1976). Mc Graw-Hill.
- Poutres et arcs élastiques. Patrick Ballard, (2009), Editions de l'Ecole Polytechnique.
- Handbook of Structural Mechanics. (2001) Patrice Cartraud.
- Poutre et plaques. Jean-Louis Batoz (1990). Editions Hermès.
- Théorie des poutres. Serge Laroze (1980). Paris Eyrolles.
- Mécanique des structures. Tome2: Poutres. Serge Laroze. Éditeur Toulouse Cépaduès-Éd. DL 2005.
- Mécanique des structures. Tome 5: Poutres exercices. Serge Laroze. Éditeur Toulouse Cépaduès-Éd. DL 2005,

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 [CCE2]

LEAD PROFESSOR(S): 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.

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

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

Assessment

Individual assessment: EVI 1 (coefficient 1)

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

French Language [FLE2]

LEAD PROFESSOR(S): 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).

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

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