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# MASTER OF SCIENCE, TECHNOLOGY AND HEALTH

2025-2026

YEAR 1

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## MECHANICAL ENGINEERING

## ADVANCED MANUFACTURING

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PROGRAMME SUPERVISOR(S):

Laurent GORNET



# YEAR 1 - Autumn Semester

## CORE COURSES

Course code	Title	ECTS Credits
ALEMO	Algorithmics for Engineering Modeling	4
COMEC	Continuum Mechanics	5
CONF	Conferences	-
FLUM1	Fluid Mechanics 1	5
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

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## CORE COURSES

Course code	Title	ECTS Credits
BUSEN	Business Environment	3
CAMED	Computer Aided Design	5
CONLA	Constitutive Laws	5
ENGMA	Engineering Materials	5
MEDET	Mechanical Design	5
STRME	Structural Mechanics	5

## LANGUAGE COURSES

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

# Master Programme - Mechanical Engineering - Advanced Manufacturing

YEAR 1 - Autumn Semester

## 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 Python
- Use standard libraries for scientific computing
- Produce reports and notebooks using Jupyter

### 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
- Deepnote Labs
- An Introduction to Programming and Numerical Methods

### Sustainable Development Goals (SDGs) covered by this course

Industry, innovation and infrastructure / Partnership s for the goals

### Sustainable Development and Social Responsibility Positioning

A Python course for engineering modeling supports sustainable development and CSR by equipping students to quantify, compare, and optimize technical choices. Programming is used to model systems, analyze data, and simulate scenarios (energy, materials, emissions, reliability), helping identify more resource-efficient solutions and make trade-offs between cost, performance, and impact explicit. Emphasis on reproducibility, code traceability, and data quality improves transparency, which is key to justifying responsible decisions. By building models and metrics, students learn how to monitor impact and support continuous improvement.

### Assessment

Individual assessment: EVI 1 (coefficient 1)

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

# Master Programme - Mechanical Engineering - Advanced Manufacturing

YEAR 1 - Autumn Semester

## 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

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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 finite 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

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

## Sustainable Development and Social Responsibility Positioning

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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

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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

# Master Programme - Mechanical Engineering - Advanced Manufacturing

YEAR 1 - Autumn Semester

## Conferences [CONF]

*LEAD PROFESSOR(S): Laurent GORNET*

### 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

### Sustainable Development Goals (SDGs) covered by this course

Quality education

### Sustainable Development and Social Responsibility Positioning

A teaching program on scientific writing and presentation primarily contributes to (Quality Education) and (Innovation and Infrastructure), but it also indirectly touches SDGs like (Responsible Consumption), and (Strong Institutions), especially if the focus is on ethics and science accessibility. Skills targeted: rigor, critical thinking, information synthesis, clear communication. Skills targeted: summarizing results, science communication, oral and visual communication. Associated SDGs: Quality Education: Promotes skills in research, critical reading, and scientific communication. Industry, Innovation and Infrastructure: By facilitating the dissemination of reliable scientific results, it supports innovation and technological progress. Responsible Consumption and Production: Scientific writing encourages transparency, ethics, and responsible use of data.

### 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

# Master Programme - Mechanical Engineering - Advanced Manufacturing

YEAR 1 - Autumn Semester

## 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

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

## Sustainable Development and Social Responsibility Positioning

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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

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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

# Master Programme - Mechanical Engineering - Advanced Manufacturing

YEAR 1 - Autumn Semester

## 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 / Good 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

# Master Programme - Mechanical Engineering - Advanced Manufacturing

YEAR 1 - Autumn Semester

## 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 INTR 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

# Master Programme - Mechanical Engineering - Advanced Manufacturing

YEAR 1 - Autumn Semester

## 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

# Master Programme - Mechanical Engineering - Advanced Manufacturing

YEAR 1 - Autumn Semester

## 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

# Master Programme - Mechanical Engineering - Advanced Manufacturing

YEAR 1 - Autumn Semester

## 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

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Affordable and clean energy / Climate action / Decent work and economic growth / Gender equality / Good health and well-being / Industry, innovation and infrastructure / No poverty / Partnerships 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

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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

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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

# Master Programme - Mechanical Engineering - Advanced Manufacturing

YEAR 1 - Autumn Semester

## 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. 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

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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

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Quality education

## Sustainable Development and Social Responsibility Positioning

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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

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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

# Master Programme - Mechanical Engineering - Advanced Manufacturing

YEAR 1 - Spring Semester

## Business Environment [BUSEN]

*LEAD PROFESSOR(S): David TROYA*

### Objectives

1. Learn the essentials of business environment analysis
2. Understand the context, firms and markets.
3. Be able to apply concepts to management activities.
4. Develop as a student and business professional.

### Course contents

This course covers the many issues professionals face when managing a company. It gives insight into a company's external and internal environments so that students can anticipate the nature and extent of necessary changes. CMs are followed by case studies giving the students real-life examples.

### Course material

Course materials

The Business Environment – A Global Perspective 8th edition Ian Worthington, Chris Britton, Ed Thompson – Pearson Education

### Sustainable Development Goals (SDGs) covered by this course

Decent work and economic growth / Industry, innovation and infrastructure / Partnership s for the goals / Quality education

### Assessment

Individual assessment: EVI 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	3	14 hrs	16 hrs	0 hrs	0 hrs	2 hrs

# Master Programme - Mechanical Engineering - Advanced Manufacturing

YEAR 1 - Spring Semester

## Computer Aided Design [CAMED]

*LEAD PROFESSOR(S): Stéphane CARO*

### Objectives

- To provide students with the main CAD skills they need to design a mechanism with CAD software (CATIA V5 is used in the framework of this lecture)
- To design and model (CAD model) a real product
- To generate manufacturing drawings with tolerances

### Course contents

The course comprises two main parts:

- Part design, Surface design, Parametric design, Detailed design, Assembly design, Simulation and Structural Analysis
- Design of a product, which has been previously defined and analysed in the Mechanical Design course (with Stéphane Caro)

### Course material

- French, M. J. Conceptual Design for Engineers, 3rd ed., 1999 (Springer)
- Pahl, G. and Beitz, W. Engineering Design: A Systematic Approach, 2nd ed. Wallace, K.M. (editor); Blessing, L., Bauert, F. and Wallace, K.M. (translators), 1996 (Springer-Verlag, London)

### Sustainable Development Goals (SDGs) covered by this course

Decent work and economic growth / Industry, innovation and infrastructure / Responsible consumption and production

### Sustainable Development and Social Responsibility Positioning

Decent work and economic growth Industry, innovation and infrastructure Responsible consumption and production

### 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

# Master Programme - Mechanical Engineering - Advanced Manufacturing

YEAR 1 - Spring Semester

## Constitutive Laws [CONLA]

LEAD PROFESSOR(S): *Giulio SCIARRA*

### Requirements

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Continuum mechanics

### Objectives

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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

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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

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- 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.enstaparis.fr/~mbonnet/mec551/mec551.pdf>
- J. Lubliner Plasticity theory, Dover publications 2006

## Sustainable Development Goals (SDGs) covered by this course

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Industry, innovation and infrastructure / Sustainable cities and communities

## Sustainable Development and Social Responsibility Positioning

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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

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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

# Master Programme - Mechanical Engineering - Advanced Manufacturing

YEAR 1 - Spring Semester

## Engineering Materials [ENGMA]

*LEAD PROFESSOR(S): Christian BURTIN*

### Objectives

At the end of the course the students will be able to understand and control:

- The characteristics of dislocations and their involvement in plastic deformation and how to design with strengthening for a metallic alloy
- The mechanism of crack propagation, the difference between the stress concentration factor and the toughness and how to design with the fatigue.
- The structure of polymers and how to design with viscoelasticity
- The different types of fiber-reinforced composites and how to design with a unidirectional composite material
- The thermodynamics and kinetics of corrosion and how to design a metal in presence of corrosion
- The tribology and how to design with contact mechanics, wear and lubrication

### Course contents

These introductory lectures aim to present some fundamentals of materials science:

- Physical plasticity. Application to metals
- Effect of defects on failure. Application to the fatigue case (ceramics and metals)
- Effect of time on mechanical behaviour: Viscoelasticity. Application to polymers.
- Effect of direction on the mechanical behaviour. Application to composites
- Effect of degradation on mechanical behaviour: corrosion (metals)
- Effect of the surface on mechanical behaviour: Tribology (metals and ceramics)

Homework will provide an understanding of the topics discussed during the lessons.

### Course material

- Ashby & Jones, Engineering Materials, Volume 1 & 2

### 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	5	12 hrs	12 hrs	6 hrs	0 hrs	2 hrs

# Master Programme - Mechanical Engineering - Advanced Manufacturing

YEAR 1 - Spring Semester

## Mechanical Design [MEDET]

LEAD PROFESSOR(S): Stéphane CARO

### Objectives

This course presents an overview of the product design process:

- How to identify customer needs and to transform it into specifications
- Basic knowledge in product design development
- Functional analysis and value analysis
- Interviews and focus groups

### Course contents

Design is an engineering activity that affects almost all areas of human life, using the laws and insights of science, building upon special experience, and providing the prerequisite for the physical realisation of solution ideas.

This course will deal with all the phases of the design process of a product, namely: task definition, conceptual design, embodiment, detailed design.

Particular attention will be paid to the conceptual design phase as it is a distinct phase of the design process and 75% of total product life-cycle cost is committed at that stage.

The course is evaluated with a final project that is conducted by groups of two students. Projects are suggested by the instructor. Project proposals are discussed during the first lecture to allow students an early start. A final report is due at the end of the course. The final project is also presented orally.

The instructions for the project are the following:

- a market study of the product (enterprises, patents, etc)
- a definition of the need and a system analysis of the product
- the search for innovative solutions according to the product requirements
- a comparison of the different technical solutions identified by the student

### Course material

- French, M. J. Conceptual Design for Engineers, 3rd ed., 1999 (Springer)
- Pahl, G. and Beitz, W. Engineering Design: A Systematic Approach, 2nd ed. Wallace, K.M. (editor); Blessing, L., Bauert, F. and Wallace, K.M. (translators), 1996 (Springer-Verlag, London)
- Suh, N.P. The Principles of Design, 1990 (Oxford University Press, Oxford)
- Suh, N.P. Axiomatic Design. Advances and Applications, 2001 (Oxford University Press, Oxford)

### Sustainable Development Goals (SDGs) covered by this course

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Decent work and economic growth / Industry, innovation and infrastructure / Responsible consumption and production

### Sustainable Development and Social Responsibility Positioning

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Responsible consumption and production Industry, innovation and infrastructure Decent work and economic growth

### Assessment

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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

# Master Programme - Mechanical Engineering - Advanced Manufacturing

YEAR 1 - Spring Semester

## Structural Mechanics [STRME]

*LEAD PROFESSOR(S): Patrice CARTRAUD*

### Requirements

Continuum mechanics, finite element method

### 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. The first part of the course focuses on theory and analytical methods. The last one is dedicated to the use of finite element method for trusses and beams.

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.
- Finite elements modeling
  - case of trusses, beams and frames

### 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,

## Sustainable Development Goals (SDGs) covered by this course

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Industry, innovation and infrastructure / Quality education

## Sustainable Development and Social Responsibility Positioning

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This course aims in particular to provide students with the skills to design structures effectively, thereby contributing to more sustainable design.

## Assessment

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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

# Master Programme - Mechanical Engineering - Advanced Manufacturing

YEAR 1 - Spring Semester

## 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

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Affordable and clean energy / Climate action / Decent work and economic growth / Gender equality / Good health and well-being / Industry, innovation and infrastructure / Life on land / No poverty / Partnerships 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

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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

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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

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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

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Quality education

## Sustainable Development and Social Responsibility Positioning

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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

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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