CENTRALE NANTES

MASTER OF SCIENCE, TECHNOLOGY AND HEALTH

2025-2026

YEAR 2

MECHANICAL ENGINEERING

ADVANCED MANUFACTURING

PROGRAMME SUPERVISOR(S):
Matthieu RAUCH

YEAR 2 - Autumn Semester

CORE COURSES

Course code	Title	ECTS Credits
ADMAN	Additive Manufacturing and Advanced Manufacturing Processes	5
CAXNC	Advanced CAD/CAM/CNC	5
COPRO	Composites Constituents and Processes	4
DOEXP	Design of Experiments Methods for Manufacturing	5
MULTI	Multi-Physics Modeling for Processes	4
OPTIM	Optimization in Manufacturing Engineering	5

LANGUAGE COURSES

Course code	Title	ECTS Credits
CCE3	Cultural and Communication English	2
ESP3	Spanish Language	2
FLE3	French Language	2

YEAR 2 - Spring Semester

CORE COURSES

Course code	Title	ECTS Credits
THESIS	Master Thesis or Internship	30

Additive Manufacturing and Advanced Manufacturing Processes [ADMAN]

LEAD PROFESSOR(S): Matthieu RAUCH

Objectives

On completion of the course the students will be able to:

- Understand the methods and tools to be implemented within the framework of Computer Aided Manufacturing with Numerical Control Machine-Tools
- Implement Design for Manufacturing approaches dedicated to Additive Manufacturing and other processes.
- Understand the challenges associated with Additive Manufacturing and other processes

Course contents

This course covers:

- Evaluation of the industrial situation of Rapid Manufacturing Processes
- Definition of the setup of Additive Manufacturing and High-Speed Milling in a CadCam Context.
- Tutorials of manufacturing scenarios: Reception of the design specifications, Setup of the reverse engineering, Generation of the multi-axis trajectories, High Speed Machining on Parallel Kinematic Machine, Additive Manufacturing,

A combination of lecture and lab sessions will develop the tools and student skills.

Course material

- CADAM Theory and Practice, I. Zeid, Mc Graw-Hill
- Surface Modeling for CadCam, BK. Choi, Elsevier
- Fundamentals of Computer Integrated Manufacturing, A.L. Foston, CL Smith, T. Au, Prentice Hall
- NC Machine Programming and Software Design, CH Chang, MA Melkanoff, Prentice Hall
- Lecture and tutorial notes

Sustainable Development Goals (SDGs) covered by this course

Industry, innovation and infrastructure

Sustainable Development and Social Responsibility Positioning

Industry, innovation and infrastructure

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

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

Advanced CAD/CAM/CNC [CAXNC]

LEAD PROFESSOR(S): Matthieu RAUCH

Requirements

Basics of CAD and design

Objectives

On completion of the course the students will be able to:

- Create, manipulate and organise the numerical model of industrial products
- Understand, control and optimize the links in the manufacturing numerical data chain
- Design solid and surface components using complex CAD functions

Course contents

This course covers:

- Curves and surfaces for component design
- Management of new product development - Product methods and development tools
- Knowledge Engineering, capitalise on know-how - Advanced CADCAM systems
- Data management
- Product data management, PDM Integration
- Product structure management
- Databases, DBMS - Product data exchanges.

A combination of lecture and lab sessions will develop the tools and student skills

Course material

- CADAM Theory and Practice, I. Zeid, Mc Graw-Hill
- Surface Modeling for CadCam, BK. Choi, Elsevier
- Fundamentals of Computer Integrated Manufacturing, A.L. Foston, CL Smith, T. Au, Prentice Hall
- NC Machine Programming and Software Design, CH Chang, MA Melkanoff, Prentice Hall
- Lecture and tutorial notes

Sustainable Development Goals (SDGs) covered by this course

Industry, innovation and infrastructure

Sustainable Development and Social Responsibility Positioning

Industry, innovation and infrastructure

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	5	12 hrs	0 hrs	20 hrs	0 hrs	0 hrs

Composites Constituents and Processes [COPRO]

LEAD PROFESSOR(S): Sébastien COMAS-CARDONA

Objectives

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

- Describe the constituents' synthesis & main properties (fibres, reinforcements, matrices)
- Simulate the chemo-rheological behavior of a thermosetting resin
- Describe the main composite processing technologies
- Produce a thermoplastic composite part by consolidation process and a thermoset composite
- part by infusion process.
- Select the best process to manufacture a given part.
- Calculate capacity planning and evaluate manufacturing cost
- Numerically solve simplified engineering problems (optimization and ordinary differential equation solving)

Course contents

These introductory lectures aim to present the main markets and applications of fibre reinforced composites. The main physico-chemical and mechanical background on constituents (fibres, textiles, reinforcements and organic matrices) will be given. This course also presents Composite processing technologies, their various limits and advantages.

- Markets and applications
- Constituents: fibres and matrices (nature, synthesis, main properties)
- Fibrous reinforcements (manufacturing, properties)
- Semi-products, microstructures
- Short, long, chopped, discontinuous and continuous fibres technologies
- Thermosetting vs thermoplastic polymer challenges
- Process control (filling, heat, cure etc)
- Manufacturing planning – cost evaluation
- Lab sessions: Composite and Constituents Characterization, Consolidation Process, Infusion Process

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

Course material

- Traité des matériaux (Editions Ecole Polytechnique Fédérale de Lausane)
- P. Boisse, Composite Reinforcements for optimum performance, 2011
- Friedrich Klaus, Fakirov Stoyko, & Zhang Zhong. (2005). Polymer Composites: From Nano- to Macro-Scale. Boston, MA: Springer Science+Business Media, Inc
- Campbell Flake C. Manufacturing Processes for Advanced Composites. New York: Elsevier, 2004

Sustainable Development Goals (SDGs) covered by this course

Industry, innovation and infrastructure / Responsible consumption and production

Sustainable Development and Social Responsibility Positioning

In a composite materials and processes course, it is essential to study current materials (such as carbon fibers and petroleum-based resins) and existing manufacturing processes to transition toward more environmentally friendly alternatives. This involves examining both traditional and bio-based composites and the physics associated to their processes. The analysis helps raise students' awareness of the trade-offs between performance, environmental impact, and sustainability.

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

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

Design of Experiments Methods for Manufacturing [DOEXP]

LEAD PROFESSOR(S): Jean-François PETIOT

Requirements

basics of statistics
basics on the linear model

Objectives

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

- Define suitable Design of Experiments (DOE) for the identification of systems or processes
- Interpret the results of a DOE
- Analyze the results of experiments with statistics and data modeling tools (Analysis of Variance)
- Optimize the systems or processes according to design variables

Course contents

This course covers:

- Introduction: Screening and Response Surface Modelling
- Full factorial designs 2k
o Effects graphs – interactions
- Fractional factorial designs
o Fractional 2k-p (aliase theory – interpretation – orthogonality)
o Plackett-Burman DOE
o Taguchi tables
o Order of experiments - blocking
- Statistics for DOE
o Multiple linear regression and analysis of variance (ANOVA)
o Data modelling (cross validation, prediction error)
- DOE for Response surface modelling
o Optimal designs (D-optimal) – exchange algorithm
o Optimization (desirability – simplex algorithm)
o Case of Computer experiments (Latin Hypercube Sampling)
The robust design TAGUCHI approach

- 3 tutorials (4h) with various exercises on Excel, MODDE, and Matlab software
- Project (8h) on the optimization of a system

Course material

- Gilles & Marie-Christine SADO. Les plans d'expérience. AFNOR Technique
- Jacques GOUPY, Lee Creighton. Introduction aux plans d'expériences. DUNOD
- Méthodologie Expérimentale. Baléo, Bourges, Courcoux, Faur-Brasquet, Le Cloirec. Editions TEC &DOC
- Droesbeke J-J, Fine J., Saporta G. Plans d'expériences. Applications à l'entreprise. Editions TECHNIP.
- Jacques GOUPY, Plans d'expériences pour surfaces de réponse. DUNOD
- Maurice PILLET. Introduction aux plans d'expériences par la méthode TAGUCHI. EO.Sup
- Anthony JIJU: Design of experiments for engineers and Scientists. 1st edition, Elsevier 2003

Sustainable Development Goals (SDGs) covered by this course

Industry, innovation and infrastructure / Responsible consumption and production

Sustainable Development and Social Responsibility Positioning

Design of systems minimizing the energy required with the theory of design of experiments

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

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

Multi-Physics Modeling for Processes [MULTI]

LEAD PROFESSOR(S): Guillaume RACINEUX

Objectives

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

- Read and explain scientific articles or bibliography related to multi-physics modeling of processes
- Identify the formulation of proper modelling including domain, physics, boundary conditions, constitutive equations and assumptions
- Generate appropriate modelling for a given process and question to answer

Course contents

This course covers:

- Mathematical background (vectors, tensors and partial differential equations)
- Governing equations (conservations and principles, elasticity, fluid mechanics, electro-magnetism, plasticity, heat transfer etc)
- Constitutive equations (identification)
- Existence and unicity of solutions
- Resolution of problems (exact solutions, analytical approximates, numerical approaches)
- Multi-physics coupling

A combination of lectures, homework and lab sessions will develop the tools and student skills.

Course material

- Process Modeling in Composites Manufacturing, Second Edition, 2010 by CRC Press, 630 Pages, Suresh G. Advani, E. Murat Sozer
- P. Boisse, Composite Reinforcements for optimum performance, 2011
- Friedrich Klaus, Fakirov Stoyko, & Zhang Zhong. (2005). Polymer Composites: From Nano- to Macro-Scale. Boston, MA: Springer Science+Business Media, Inc

Sustainable Development Goals (SDGs) covered by this course

Climate action / Responsible consumption and production

Sustainable Development and Social Responsibility Positioning

This course places multiphysics modeling at the heart of contemporary technological and environmental challenges, exploring

the complex interactions between physical, mechanical, thermal, electrical, and chemical phenomena within materials, processes, and systems. It enables students to master the analytical modeling tools needed to predict, optimize, and design innovative solutions. By combining theory, practice, and critical analysis, this course prepares students to make robust and responsible technical decisions in a context where industrial and societal challenges demand a systemic and interdisciplinary approach.

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

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

Optimization in Manufacturing Engineering [OPTIM]

LEAD PROFESSOR(S): Raphaël CHENOUARD

Requirements

Python programming language

Objectives

The lectures present different theoretical and computational aspects of a wide range of optimization methods for solving a variety of problems in mechanical engineering. The main objective of this course is to give the students the ability to formalise, select the appropriate method, implement the optimisation problem and then analyse the results in order to take the best decision regarding the objectives, variables and the constraints

Course contents

This course covers:

- Basic concepts of optimization,
- Gradient based methods,
- Evolutionary algorithms,
- Multi objective optimization methods

Practical Work: exercises and project work on the design optimization of a mechanical product, manufacturing process or system.

The students will:
- understand different theoretical and computational aspects of a wide range of optimization methods,
- realize the possibilities offered by the different optimization methods,
- use optimization libraries.

Course material

- R. Fletcher, Foundation of structural optimization.
- Melanie Mitchell, An Introduction to Genetic Algorithms

Sustainable Development Goals (SDGs) covered by this course

Industry, innovation and infrastructure

Sustainable Development and Social Responsibility Positioning

Use optimization to innovate technically to reduce the carbon footprint from the moment a product is created.

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

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

Cultural and Communication English [CCE3]

LEAD PROFESSOR(S): David TROYA

Objectives

- Understand the fundamental principles of scientific writing and the importance of clarity and precision in communication.
- Structure scientific documents effectively, adhering to genre-specific conventions.
- Employ appropriate language and tone for diverse scientific audiences.
- Integrate and cite sources correctly to support research arguments and findings.
- Edit and revise their writing for coherence, style, and grammatical accuracy.
- Prepare and deliver scientific presentations, both written and oral.

Course contents

Introduction to Scientific Writing

Overview:

This course provides an essential foundation in scientific writing, equipping students with the skills necessary to effectively communicate research findings and scientific concepts. Through a combination of lectures, workshops, and practical assignments, students will learn the conventions of scientific writing, including structure, style, and clarity. The course will cover various types of scientific documents, such as research papers, literature reviews, grant proposals, and poster presentations.

Course Structure:

The course will be organized into weekly sessions that include lectures on theoretical concepts, hands-on writing exercises, peer review workshops, and discussions of exemplary scientific literature. Students will engage in collaborative projects and receive constructive feedback to enhance their writing skills.

Assessment:

Students will be assessed through a combination of assignments, including written documents, peer review participation, and presentations. Active participation in workshops and discussions is also required to foster a collaborative learning environment.

Course material

Hoogenboom BJ, Manske RC. How to write a scientific article. Int J Sports Phys Ther. 2012 Oct;7(5):512-7. PMID: 23091783; PMCID: PMC3474301.

Paré G, Kitsiou S. Chapter 9Methods for Literature Reviews. In: Lau F, Kuziemsky C, editors. Handbook of eHealth Evaluation: An Evidence-based Approach [Internet]. Victoria (BC): University of Victoria; 2017 Feb 27. Available from: https://www.ncbi.nlm.nih.gov/books/NBK481583/

How to Create a Research Poster. A guide fo creating a research poster. https://guides.nyu.edu/posters

Sustainable Development Goals (SDGs) covered by this course

Industry, innovation and infrastructure / Quality education

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 [ESP3]

LEAD PROFESSOR(S): Marta HERRERA

Requirements

N/A

Objectives

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

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

Course contents

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

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

Course material

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

Sustainable Development Goals (SDGs) covered by this course

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

Sustainable Development and Social Responsibility Positioning

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

Assessment

Individual assessment: EVI 1 (coefficient 1)

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

French Language [FLE3]

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, 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. Those who already completed the first year of the French course will be prepared for working in a French business environment.

Course contents

Two different tracks are proposed: track 1 for students newly arrived at Centrale Nantes and track 2 for students who have completed the first year of the French course. Track 1:
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

Track 2:
This track follows on directly from the first-year French course, developing and completing the concepts studied thus far. The main themes are: housing, health and work. These topics will help prepare students for their future work environment. For example, housing is explored in the form of a search for accommodation upon arrival in a new city. Special workshops for CVs and cover letters, elevator pitches and job interviews.

Course material

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

Sustainable Development Goals (SDGs) covered by this course

Quality education

Sustainable Development and Social Responsibility Positioning

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

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

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

Master Thesis or Internship [THESIS]

LEAD PROFESSOR(S): Matthieu RAUCH

Objectives

- Be exposed to and adapt to an industrial or research environment
- Put in practice the scientific and technical skills acquired in the previous semesters
- Strengthen interpersonal and communication skills
- Be part of or manage a project
- Organize tasks, analyze results and build deliverables

Course contents

Students should be pro-active and career-oriented in the search for their thesis/internship. The topics are approved by the programme supervisor to ensure an adequate Master level. The thesis/internship is evaluated through the submission of a written report and an oral defense.

Course material

- Turabian Kate Larimore, Booth Wayne Clayton, Colomb Gregory G., Williams Joseph M., & University of Chicago press. (2013). A manual for writers of research papers, theses, and dissertations: Chicago style for students and researchers (8th edition.). Chicago (Ill.) London: University of Chicago Press.
- Bui Yvonne N. How to Write a Master's Thesis. 2nd ed. Thousand Oaks, Calif: Sage, 2014.
- Evans David G., Gruba Paul, et Zobel Justin. How to Write a Better Thesis. 3rd edition. Carlton South, Vic: Melbourne University Press, 2011.

Sustainable Development Goals (SDGs) covered by this course

Industry, innovation and infrastructure

Sustainable Development and Social Responsibility Positioning

Industry, innovation and infrastructure

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	30	0 hrs	0 hrs	0 hrs	0 hrs	0 hrs