SHAKE THE FUTURE.

CENTRALE NANTES

MASTER OF SCIENCE, TECHNOLOGY AND HEALTH

MECHANICAL ENGINEERING

ADVANCED MANUFACTURING

YEAR 2

PROGRAMME SUPERVISORS:
MATTHIEU RAUCH, SEBASTIEN COMAS-CARDONA

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

GROUPE CENTRALE

École Centrale de Nantes | 1 rue de la Noë | BP 92101 | F 44321 Nantes Cedex 3
T +33 (0)2 40 37 16 00 | F +33 (0)2 40 37 16 97 | www.ec-nantes.fr

MECHANICAL ENGINEERING - ADVANCED MANUFACTURING

YEAR 2 - AUTUMN SEMESTER

Advanced CAD/CAM/CNC

Design of Experiments Methods for Manufacturing

Multi-Physics Modeling for Processes

Additive Manufacturing and Advanced Manufacturing Processes

Integrated Design Engineering of PSS

Project

Optimization in Manufacturing Engineering

Cultural and Communication English

French Language

ADVANCED CAD/CAM/CNC

ADVANCED MANUFACTURING

YEAR 2 - AUTUMN SEMESTER

LEAD PROFESSOR: Jean-Yves HASCOËT

Objectives

At the end 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

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LABO	PROJECT	EXAM
English	4	12 hrs	0 hrs	20 hrs	0 hrs	0 hrs

DESIGN OF EXPERIMENTS METHODS FOR MANUFACTURING

ADVANCED MANUFACTURING

YEAR 2 - AUTUMN SEMESTER

LEAD PROFESSOR: Jean-François PETIOT

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 modelling tools
- Optimize the systems or processes according to design variables

Course contents

This course covers:

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

Course material

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

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LABO	PROJECT	EXAM
English	4	12 hrs	0 hrs	12 hrs	8 hrs	0 hrs

MULTI-PHYSICS MODELING FOR PROCESSES

ADVANCED MANUFACTURING

YEAR 2 - AUTUMN SEMESTER

LEAD PROFESSOR: 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

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

ADDITIVE MANUFACTURING AND ADVANCED MANUFACTURING PROCESSES

ADVANCED MANUFACTURING

YEAR 2 - AUTUMN SEMESTER

LEAD PROFESSOR: Jean-Yves HASCOËT

Objectives

At the end 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

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LABO	PROJECT	EXAM
English	4	8 hrs	8 hrs	16 hrs	0 hrs	0 hrs

INTEGRATED DESIGN ENGINEERING OF PSS

ADVANCED MANUFACTURING

YEAR 2 - AUTUMN SEMESTER

LEAD PROFESSOR: Alain BERNARD

Objectives

At the end of the course, the students will be able to understand the main concepts and methods of integrated design engineering applied to new approaches related to product service systems

Course contents

This course proposes six modules related to integrated design engineering methods:

- Methods and tools of engineering design
- Definition of Product-Service system
- Innovation methods for product-service systems design
- Managing complexity in integrated design engineering
- Knowledge management and knowledge-based engineering applied to decision making
- Product-service systems lifecycle management based on an integrated platform

Course material

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

PROJECT

ADVANCED MANUFACTURING

YEAR 2 - AUTUMN SEMESTER

LEAD PROFESSOR: Matthieu RAUCH

Objectives

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

- Solve an industrial engineering problem dealing with technical, economic and environmental constraints
- Put in practice the scientific, numerical and technical skills acquired in the past semesters
- Strengthen interpersonal skills
- Be part of or manage a project
- Organize tasks, analyze results and build deliverables

Course contents

The topics are provided by the instructors. The project is evaluated after the submission of a written report and an oral defense. Topics may also be submitted by companies.

Course material

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

OPTIMIZATION IN MANUFACTURING ENGINEERING

ADVANCED MANUFACTURING

YEAR 2 - AUTUMN SEMESTER

LEAD PROFESSOR: Fouad BENNIS

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 courses 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,
- Robust optimization methods,
- Multidisciplinary optimization problems,
- Programming aspects,

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

The students will be able to:

- Understand different theoretical and computational aspects of a wide range of optimization methods,
- Realize the possibilities offered by the different optimization methods,
- Use optimization toolboxes.

Course material

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

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

CULTURAL AND COMMUNICATION ENGLISH

ADVANCED MANUFACTURING

YEAR 2 - AUTUMN SEMESTER

LEAD PROFESSOR: Spencer HAWKRIDGE

Objectives

Team-building and Communicational English:

- Understand the general concepts of team-building
- Build a team-building project
- Understand and nurture the creative process
- Enhance self-belief and self-empowerment

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
Field-related or inter-cultural project (for example, construct content for inter-cultural teambuilding activities; example WIOBOX website 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).

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

FRENCH LANGUAGE

ADVANCED MANUFACTURING

YEAR 2 – AUTUMN SEMESTER

LEAD PROFESSOR: Silvia ERTL

Objectives

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

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

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

After completing this course (32 hours + personal work), the students will be able to communicate in spoken and written French, in a simple, but clear manner, on familiar topics in the context of study, hobbies etc. Another important goal of this course is to introduce the student to French culture.

At the end of the course (2 semesters), complete beginners can achieve an A1 level and some aspects of the A2 of The Common European Framework of Reference for Languages. More advanced students may aim for B1/B2 levels. 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.

Course material

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

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

YEAR 2 - SPRING SEMESTER

Master Thesis / Internship

MASTER THESIS / INTERNSHIP

ADVANCED MANUFACTURING

YEAR 2 - SPRING SEMESTER

LEAD PROFESSOR: 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 validated by the program 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.

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