SHAKE THE FUTURE.

CENTRALE NANTES

MASTER OF SCIENCE, TECHNOLOGY AND HEALTH

MECHANICAL ENGINEERING

COMPUTATIONAL MECHANICS

YEAR 1
SPRING SEMESTER

PROGRAMME SUPERVISORS:
CHRISTIAN BURTIN, SEBASTIEN COMAS-CARDONA

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

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PROBABILITY AND STATISTICS

MECHANICAL ENGINEERING - COMPUTATIONAL MECHANICS

YEAR 1 - SPRING SEMESTER

LEAD PROFESSOR: Marie Billaud-Friess, *marie.billaud-friess@ec-nantes.fr*

Objectives

At the end of the course (30 hours + personal work) 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

In this course, we are interested in the modelling of random experiments (e.g. playing cards, playing dices, voting intentions, life duration of an electronic component, efficiency of a drug, defects of a material etc.) To that end, we will introduce in the first part the mains tools needed in probability theory to describe such an experiment:

- Probability definition
- Random variables
- Random vectors
- Function of random variables
- Sequences of random variables.

Then, in the second part we will be interested in observations and study of the data associated to some random experiments through statistics. In particular, we will focus on statistical models.

- Pointwise estimation
- Estimation by confidence interval
- Tests
- Regression

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.

Keywords

Random experiment, probability, random variables, usual distribution, moment of random variables, function and sequences of random variables, estimation, test, regression

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

NUMERICAL ANALYSIS

MECHANICAL ENGINEERING - COMPUTATIONAL MECHANICS

YEAR 1 - SPRING SEMESTER

LEAD PROFESSOR: Anthony Nouy, *anthony.nouy@ec-nantes.fr*

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.

Keywords

Numerical analysis, Numerical linear algebra, Eigenvalue problems, Approximation, Interpolation, Numerical integration

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

STRUCTURAL MECHANICS

MECHANICAL ENGINEERING - COMPUTATIONAL MECHANICS

YEAR 1 - SPRING SEMESTER

LEAD PROFESSOR: Thomas Heuzé, *thomas.heuze@ec-nantes.fr*

Objectives

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

This course is an introduction to structural mechanics. We focus 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 mechanical systems. 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 course outline is as follows:

- Study of 3D solutions of beams: torsion and pure bending
- Introduction to the beam theory:
- kinematics,
- modeling 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); examples.
- Opening:
- buckling of beams,
- Vibration of 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,

Keywords

Beam theory, Lattice trusses

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

FLUID MECHANICS 2

MECHANICAL ENGINEERING - COMPUTATIONAL MECHANICS

YEAR 1 - SPRING SEMESTER

LEAD PROFESSOR: Guillaume Ducrozet, *guillaume.ducrozet@ec-nantes.fr*

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 different 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.

Keywords

Fluid Mechanics, Potential flows, Integral balances, Head losses, Force, Viscosity, Pressure, Navier-Stokes, Hydraulic system

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

MECHANICAL DESIGN

MECHANICAL ENGINEERING - COMPUTATIONAL MECHANICS

YEAR 1 - SPRING SEMESTER

LEAD PROFESSOR: Stéphane CARO, *stephane.caro@ls2n.fr*

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)

Keywords

Design process, Optimization, Product, Innovative design, Conceptual design

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

CONFERENCES AND INITIATION TO RESEARCH

MECHANICAL ENGINEERING - COMPUTATIONAL MECHANICS

YEAR 1 - SPRING SEMESTER

LEAD PROFESSOR: Christian Burtin, *christian.burtin@ec-nantes.fr*

Objectives

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

- write a scientific and technical paper on a mechanical engineering topic
- Establish the reasoning behind a scientific paper
- Present orally and clearly scientific data in the context of mechanical engineering

Course contents

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

Part A: Conferences (2 hours)
Part B: Scientific paper reading (4 hours)
Part C: Oral presentation (2 hours)

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

Course material

Keywords

Mechanical Engineering, Conference, Scientific Paper, Oral communication

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

MODERN LANGUAGES - FRENCH

MECHANICAL ENGINEERING - COMPUTATIONAL MECHANICS

YEAR 1 - SPRING SEMESTER

LEAD PROFESSOR: Silvia Ertl – *silvia.ertl@ec-nantes.fr*

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

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).

Keywords

reception (listening and reading), production (spoken and written), interaction (spoken and written), knowledge, skills, linguistic competence, sociolinguistic competence, pragmatic competence, register, cultural differences, non-verbal communication

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

MODERN LANGUAGES - CULTURAL AND COMMUNICATIONAL ENGLISH

MECHANICAL ENGINEERING - COMPUTATIONAL MECHANICS
YEAR 1 - SPRING SEMESTER

LEAD PROFESSOR: Spencer Hawkridge- *spencer.hawkridge@ec-nantes.fr*

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.

Keywords

Culture and communication, inter-cultural environment, team-building, digital tools, etc.

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LABO	PROJECT	EXAM
English	4	0 hrs	30 hrs	0 hrs	0 hrs	2 hrs