Centrale Nantes

Foundation Master

MECHANICS and ENVIRONMENT

ACADEMIC YEAR 2017 / 2018

1. The teaching plan

The Centrale Nantes Foundation Master programme is a one-year programme with a workload of 60 credit points and 360 teaching hours.

The courses are taught exclusively in English. All the courses are compulsory.

Students learn a set of essential disciplines designed to offer the range of scientific and language skills necessary to meet the complex challenges of the 12 Master's programmes of Centrale Nantes.

Each scientific course will focus on the technical and technological devices vocabulary as well as fundamental formulation. The academic programme consider 360 hours face to face with professor. The total student workload is 410 hours per year.

Each student will have a personal academic advisor as well as an administrative one for all the year.

The standard academic year in Europe is 60 ECTS credits.

2. The programme

Courses	First Semester			Second Semester		
	Hours	Student workload (hours)	ECTS Credits	Hours - Semester 2	Student workload (hours)	ECTS Credits
French language	30	60	3	30	60	3
English and Business Environment	30	60	3	30	60	3
Mathematics	20	40	4	20	40	4
Computer Programming and Data Analysis	20	40	4	20	40	4
Mechanics	20	40	4	20	40	4
Civil and Environmental Engineering	20	40	4	20	40	4
Energetics and Environment	20	40	4	20	40	4
Material Science	20	40	4	20	40	4
Total	**180**	**360**	**30**	**180**	**360**	**30**

3. Requirements

Applicants

- must start their last year of Bachelor degree in September 2017
- must have a high quality background in engineering fields
- is required to pass a recognized international English test such as IELTS (score 6.0 or higher) or other English equivalent test.

4. Tuition fees

€6,000 for one year

€3,000 for one semester

Centrale Nantes

Foundation Master – Program 312

SYLLABUS MECHANICS and ENVIRONMENT

ACADEMIC YEAR 2016 /2017

First Semester: from September to January

French Language (S117FRL)

Course Information

Code: S117FRL

Responsible: Sylvia ERTL

Contact: sylvia.ertl@ec-nantes.fr

Department: Communication, languages and business

Language: French

Credits (ECTS): 3

Number of hours: 30

Semester: 1

Recommended prerequisites: None

Evaluation: 25% continuous assessment, 25% oral exam, 25% final exam, 25% project work (booklet)

Organization: French for beginners/intermediate level. The students are dispatched into different groups according to their level.

Link: https://centralefle.wordpress.com/

Objective

The main 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 pedagogical 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.

After completing this course, 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 to French culture.

Content

A full range of practical communication language exercises is used: reading comprehension, listening comprehension, written expression, oral expression.

Educational projects are adapted to the level of the group:

- Main project : Log book project “One year at Centrale Nantes” (Booklet)
- France vs China/Nantes vs Hometown project
- French way of life project (traditions, housing, iconic objects…)
- Photo-Babble project
- Field studies and interviews
- Flipped classroom – grammar project
- Family tree project

English and Business Environment (S117ENL)

Course Information

Code: S117ENL

Responsible: Christine EVAIN

Contact: christine.evain@ec-nantes.fr

Department: Communication, languages and business

Language: English

Credits (ECTS): 3

Number of hours: 30

Semester: 1

Recommended prerequisites: None

Evaluation: 50% continuous assessment (class participation), 30% oral exam (presentation), 20% final exam (TOEIC practice exam)

Organization: The students are dispatched into different groups according to their level.

Link: pedagogical server (https://hippocampus.ec-nantes.fr; anglais LVO)

Objective

In this course, you will learn how to:

- Develop an understanding of inter-cultural practice
- Develop oral and written communication adapted to different contexts (mainly inter-cultural situations)
- Organize, lead and participate in a meeting
- Strengthen self-confidence and level of conviction
- Work on professional documents in English
- Acquire presentation skills
- Express feelings and practice assertiveness
- Develop active listening and understanding to reformulate, explain and argue
- Develop well-being at work and a sense of responsibility
- Negotiate, innovate and propose innovative solutions
- Enhance team work

Content

Those objectives will be achieved by doing:

- English: full range of practical communication language exercises (reading comprehension, listening comprehension, written expression, oral expression)
- Business English: introduction to marketing and business practices

Educational projects are adapted to the level of the group (scenarios, role plays, simulations).

Analysis of a short story or an extract of a novel in order to explain the cultural components of the text.

Projects in a cultural context "Ted talk presentation", "Edge.org assignment", etc.

Mathematics (S117MAT)

Course Information

Code: S117MAT

Responsible: Sébastien BOURGUIGNON

Contact: sebastien.bourguignon@ec-nantes.fr

Department: Automatic control and robotics

Language: English

Credits (ECTS): 4

Number of hours: 20

Semester: 1

Recommended prerequisites: None

Evaluation: Final exam

Organization: Ten x 2 hours lectures, with personal homework

Link:

Objective

The objective of this course is to complete students' needs both for theoretical and practical use of mathematical tools required in advanced engineering.

The first semester is dedicated to linear algebra.

Content

Vectors and matrices: basic operations. Linear systems of equations. Gauss elimination. Linear independence. Matrix rank. Solutions of linear systems: existence, uniqueness, resolution. Determinants. Matrix inversion. Inner product spaces, linear transformations. Matrix eigenvalues problems. Definitions. Determining eigenvalues and eigenvectors. Applications. Symmetric and orthogonal matrices. Eigenbases. Diagonalization. Applications. Vector differential calculus. Functions of several variables. Gradients. Divergence. Laplacian. 2D, 3D vector functions. Curves.

Reference:

[1] Erwin Kreyszig, *Advanced Engineering Mathematics*, 10th edition, John Wiley & Sons, 2010, 1264 p. (Chapters 7, 8)

Computer Programming and Data Analysis (S117CMD)

Course Information

Code: S117CMD

Responsible: Sébastien BOURGUIGNON

Contact: sebastien.bourguignon@ec-nantes.fr

Department: Automatic control and robotics

Language: English

Credits (ECTS): 4

Number of hours: 20

Semester: 1

Recommended prerequisites: None

Evaluation: 25% continuous assessment, 75% final exam

Organization: Ten x 2 hours sessions with Matlab

Link:

Objective

This course aims to provide basic knowledge of computer programming with Matlab. It will also introduce more advanced tools for data analysis (visualization, statistical analysis, numerical methods).

Content

This course includes an introduction to the Matlab programming environment, the use of matrix variables and matrix manipulations.

Scripts and functions are introduced, together with basic programming structures, conditions and loops.

Graphics manipulation and statistical tools for data analysis are presented, and general programming rules and tips for efficient computations are provided.

Mechanics (S117MEC)

Course Information

Code: S117MEC

Responsible: Patrick ROZYCKI

Contact: patrick.rozycki@ec-nantes.fr

Department: Computational Structural Mechanics Department

Language: English

Credits (ECTS): 4

Number of hours: 20

Semester: 1

Recommended prerequisites: Mathematical skills (Vectors and their use, derivative/partial derivative and integration, trigonometry)

Evaluation: 10% continuous assessment, 10% homework, 80% project exam

Organization: Ten x 2 hours lectures, with personal homework

Link:

Objective

In everyday life, there are many systems (e.g. assembly of rigid body elements) that evolve over time. In the field of mechanics we can cite, for example, robots, mechanisms, physical crash tests dummies, vehicles… Whatever the field of application, an engineer should always be able to ensure the feasibility, the implementation, the dimensioning and the safety of these systems.

This course is designed in order that engineers meet the above objectives using simple analytical approaches or more complex modeling which are based on the two mains approaches (fundamental principle of dynamics and Lagrange equations).

Concepts will be applied through a final project concerning the field of transportation, mechanisms or robots.

Content

Part 1 - Dynamics of rigid bodies:

- Introduction
- Problem analysis
- Modelling of loads and mechanical actions
- Power, work and potential energy
- Balancing unknown quantities / equations
- Fundamental Principle of Dynamics
- Lagrange equations

References:

[1] M. Geradin, D.J. Rixen, *Mechanical Vibrations: Theory and Application to Structural Dynamics*

[2] H. Hahn, *Rigid Body Dynamics of Mechanisms*

[3] L. Huang, *A concise introduction to mechanics of rigid bodies*

Civil and Environmental Engineering (S117SCE)

Course Information

Code: S117SCE

Responsible: Frédéric Grondin

Contact: frederic.grondin@ec-nantes.fr

Department: Mechanics, Material and Civil Engineering Department

Language: English

Credits (ECTS): 4

Number of hours: 20

Semester: 1

Recommended prerequisites: None

Evaluation: Final exam

Organization: Ten x 2hours lectures, with personal homework

Link: Hippocampus

Objective

The objective of this course is to give skills to the students in theoretical and practical use of mechanical tools required in advanced engineering. The first semester is dedicated to continuum mechanics.

Content

Vectors and tensors: basic operations. Stress. Strain and deformation. Mohr's circles. Body Forces. Measures of strain. Displacements. Conservation of mass. Energy balance. Principle of virtual displacements. Hooke's law. Theory of elasticity. Traction. Applied mechanics to civil engineering structures.

Reference:

[1] W. Michael Lai, *Introduction to continuum mechanics*, 4th edition, Elsevier, 2010

Energetics and Environment (S117E&E)

Course Information

Code: S117E&E

Responsible: Jean-François HETET

Contact: jean-francois.hetet@ec-nantes.fr

Department: Fluids mechanics and energetics department

Language: English

Credits (ECTS): 4

Number of hours: 20

Semester: 1

Recommended prerequisites: None

Evaluation: 25% homework, 75% exam

Organization: 9 lessons (2h) - 1 exam (2h)

Link:

Objective

No need to present the interest of having a deep knowledge of all the processes involved in energy transformation and use. Our century will be the century of energy: new form of energy, renewable energy, and availability of energy sources.

Moreover, this big challenge is associated with the concern of pollution and environment preservation.

This course intends to bring theoretical and practical tools in order to face these challenges.

Content

Part 1 - Applied thermodynamics basis

- History of the main ideas in thermodynamics
- Laws of thermodynamics and selected elementary results: closed/open systems, perfect and real fluids - a phenomenological study
- Energy transformations - compressors, turbines
- Thermodynamic cycles and thermal machines. Direct cycles: Carnot, Joule's cycle, Beau de Rochas and Diesel cycles. Introduction to turbocharging

Reference:

[1] R.E. Sonntag, C. Borgnakke, G.J. Van Wylen, *Fundamentals of Thermodynamics*, Ed Wiley

Material Science (S117MAT)

Course Information

Code: S117MAT

Responsible: Anaïs BARASINSKI

Contact: anais.barasinski@ec-nantes.fr

Department: Mechanics, Material and Civil Engineering Department

Language: English

Credits (ECTS): 4

Number of hours: 20

Semester: 1

Recommended prerequisites: None

Evaluation: 10% continuous assessment, 25% homework, 65% exam

Organization: 6 lessons + tutorial (6x3h) - 1 exam (2h)

Link:

Objective

Innovation in engineering often means the clever use of a new material - new to a particular application, but not necessarily (although sometimes) new in the sense of “recently developed”.

Plastic paper clips and ceramic turbine-blades both represent attempts to do better with polymers and ceramics what had previously been done well with metals. And engineering disasters are frequently caused by the misuse of materials. When the plastic tea-spoon buckles as you stir your tea, and when a fleet of aircraft is grounded because cracks have appeared in the tailplane, it is because the engineer who designed them used the wrong materials or did not understand the properties of those used.

So it is vital that the professional engineer should know how to select materials which best fit the demands of the design - economic and aesthetic demands, as well as demands of strength and durability.

The designer must understand the properties of materials, and their limitations. (citation from [1])

Content

Part 1 - Material Science:

- Introduction
- Material cohesion (from micro physics to macro properties)
- Material structure (atomic organization for crystal solid)
- Thermodynamic equilibrium and phase transformation
- Diffusion

Reference:

[1] D.R.H. Jones, M. Ashby, *Engineering Materials 1 & 2*, Elsevier

Second Semester: from February to June

French Language (S217FRL)

Course Information

Code: S217FRL

Responsible: Sylvia ERTL

Contact: sylvia.ertl@ec-nantes.fr

Department: Communication, languages and business

Language: French

Credits (ECTS): 3

Number of hours: 30

Semester: 2

Recommended prerequisites: None

Evaluation: 25% continuous assessment, 25% oral exam, 25% final exam, 25% project work (booklet)

Organization: French for beginners/intermediate level. The students are dispatched into different groups according to their level.

Link: https://centralefle.wordpress.com/

General course objective

The main 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 pedagogical 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.

After completing this course, 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 to French culture.

At the end of course (60 hours), the complete beginners can achieve the level A1 and some aspects of A2 of The Common European Framework of Reference for Languages. More advanced students may aim the levels B1/B2.

Content

A full range of practical communication language exercises is used: reading comprehension, listening comprehension, written expression, oral expression.

Educational projects adapted to the level of the group:

- Main project: Log book project “One year at Centrale Nantes” (Booklet)
- French way of life project (traditions, housing, iconic objects…)
- Expressing emotions and theatre project
- Photo-Babble project
- Field studies and interviews
- Flipped classroom - grammar project

Culture and business Environment (S217ENL)

Course Information
Code: S217ENL **Responsible**: Christine EVAIN **Contact**: christine.evain@ec-nantes.fr **Department**: Communication, languages and business **Language**: English **Credits (ECTS)**: 3 **Number of hours**: 30 **Semester**: 2 **Recommended prerequisites**: None **Evaluation**: 50% continuous assessment (class participation), 30% oral exam (presentation), 20% final exam (TOEIC practice exam) **Organization**: The students are dispatched into different groups according to their level. **Link**: pedagogical server (https://hippocampus.ec-nantes.fr; anglais LVO)

Objective

In this course, you will learn how to:

- Understand the general concepts of business English and marketing principles
- Build a professional project and explore international opportunities
- Develop strategies for inter-cultural practice
- Develop oral and written communication adapted to different contexts
- Organize, lead and participate in a meeting
- Work on professional documents in English
- Acquire a professional lexicon
- Understand the principles of corporate business models
- Acquire notions of corporate culture and values
- Develop well-being at work and a sense of responsibility
- Negotiate, innovate and propose innovative solutions

Content

Those objectives will be achieved by doing:

- English: full range of practical communication language exercises
- Business English: exercises to explore in practice the areas of management and marketing

Educational projects adapted to the level of the group (scenarios, role plays, simulations).

Analysis of a short story or an extract of a novel in order to explain the cultural components of the text.

Projects in a professional context "Start-up simulation", "marketing assignment", "advertising assignment", etc.

Mathematics (S217MAT)

Course Information

Code: S217MAT

Responsible: Sébastien BOURGUIGNON

Contact: sebastien.bourguignon@ec-nantes.fr

Department: Automatic control and robotics

Language: English

Credits (ECTS): 4

Number of hours: 20

Semester: 2

Recommended prerequisites: Calculus fundamentals

Evaluation: Final exam

Organization: Ten x 2 hours lectures, with personal homework

Link:

Objective

The objective of this course is to complete students' needs both for theoretical and practical use of mathematical tools required in advanced engineering.

The second semester is dedicated to ordinary differential equations, probability and statistics.

Content

Part 1 - Ordinary differential equations

- First-order ordinary differential equations: Implicit form, explicit form. Direction fields. Separable ODEs. Exact ODEs. Linear ODEs. Applications and modelling.
- Linear ordinary differential equations: Homogeneous second-order linear ODEs. Homogeneous second-order linear ODEs with constant coefficients. Non-homogeneous ODEs. Laplace transforms. Fourier transforms. Systems of linear ODEs.

Part 2 - Probability and statistics

- Data analysis: mean, variance, standard deviation. Probabilities of events, combinations.
- Random variables, probability distributions (discrete and continuous). Gaussian distributions.

References:

[1] Erwin Kreyszig, *Advanced Engineering Mathematics*, 10th edition, John Wiley & Sons, 2010, 1264 p. (Chapters 1, 2, 6, 24)

Computer Programming and Mechanical Application (S217CMD)

Course Information

Code: S217CMD

Responsible: Patrick ROZYCKI

Contact: patrick.rozycki@ec-nantes.fr

Department: Computational Structural Mechanics Department

Language: English

Credits (ECTS): 4

Number of hours: 20

Semester: 2

Recommended prerequisites: Skills to write equations of motion for a rigid bodies system by using fundamental principle of dynamics and Lagrange equations

Evaluation: 10% continuous assessment, 10% homework, 80% project exam

Organization: Ten x 2 hours sessions in the computer room

Link:

Objective

This course offers to the students with knowledge and skills in modelling of rigid body systems, to go into in depth on the numerical resolution of equations of motion.

It is compulsory for engineers using softwares to have a strong background in order to guarantee their results regarding assumptions and problematic of numerical solving.

Concepts will be applied through a final project on the field of transportation, mechanisms or robotics.

Content

Numerical methods to solve equations of motion:

- Implicit or explicit Euler
- Runge Kutta
- Implicit or explicit Newmark,
- Concepts of schemes stability and critical time step

Literature:

[1] Mechanical Vibrations: Theory and Application to Structural Dynamics - M. Geradin, D.J. Rixen

Mechanics (S217MEC)

Course Information

Code: S217MEC

Responsible: Patrick ROZYCKI

Contact: patrick.rozycki@ec-nantes.fr

Department: Computational Structural Mechanics Department

Language: English

Credits (ECTS): 4

Number of hours: 20

Semester: 2

Recommended prerequisites: Skills to write equations of motion for a rigid bodies system and in programming (Matlab or Scilab)

Evaluation: 10% continuous assessment, 10% homework, 80% project exam

Organization: Ten x 2 hours lectures, with personal homework

Link:

Objective

This course offers to the students with knowledge and skills in modelling of rigid body systems, to go into in depth on two important aspects: the vibrations and the numerical resolution of equations of motion.

The first aspect is an important part for an engineer because taking into account the vibration of a structure could have a strong influence on the system's behaviour.

The second aspect is compulsory for an engineer who uses software: he must have a strong background in order to guarantee their results regarding assumptions and problematic of numerical solving.

Content

Part 2 - Vibrations:

- Single degree of freedom system
- Governing equations of a N degree of freedom system
- Eigen values and eigen vectors in Dynamics
- Free vibrations and response under harmonic excitation of an undamped system

Part 3 – Numerical methods to solve motion equations:

- Implicit or explicit Euler
- Runge Kutta
- Implicit or explicit Newmark
- Concepts of schemes stability and critical time step

Reference:

[1] Mechanical Vibrations: Theory and Application to Structural Dynamics - M. Geradin, D.J. Rixen

Civil and Environmental Engineering (S217SCE)

Course Information

Code: S217SCE

Responsible: Frédéric GRONDIN

Contact: frederic.grondin@ec-nantes.fr

Department: Mechanics, Material and Civil Engineering Department

Language: English

Credits (ECTS): 4

Number of hours: 20

Semester: 1

Recommended prerequisites: None

Evaluation: Final exam

Organization: Ten x 2 hours lectures, with personal homework

Link: Hippocampus

Objective

The objective of this course is to skills to the students in theoretical and practical use of mechanical tools required in advanced engineering. The second semester is dedicated to strength of materials.

Content

Ordinary differential equations.

Tension and compression. Uniaxial problems. Castigliano's theorem. Stress. Strain and deformation. Mohr's circles. Displacements. Hooke's law. Menabrea's thorem. Static equilibrium. Strain energy. Lattice structure. Applied mechanics to civil engineering structures. Tresca's criterion.

Reference:

[1] S.H. Crandall, N.C. Dahl and T. J. Lardner, *An introduction to the mechanics of solids*, 2th edition, McGraw-Hill Sciences, 1999, 604 p.

Energetics and Environment (S217E&E)

Course Information

Code: S217E&E

Responsible: Jean-François HETET

Contact: jean-francois.hetet@ec-nantes.fr

Department: Fluids mechanics and energetics department

Language: English

Credits (ECTS): 4

Number of hours: 20

Semester: 1

Recommended prerequisites: None

Evaluation: 25% homework, 75% exam

Organization: 9 x 2 hours lectures - 1 exam (2H)

Link:

Objective

No need to present the interest of having a deep knowledge of all the processes involved in energy transformation and use. Our century will be the century of energy: new form of energy, renewable energy, and availability of energy sources. And moreover, this big challenge is associated with the concern of pollution and environment preservation. This course intends to bring theoretical and practical tools in order to face these challenges.

Content

Part 2 - applied thermodynamics practice & applications:

- Flow in nozzles
- Liquid- vapor equilibrium
- Water steam cycle (Rankine) for energy production
- A/C systems and heat pumps
- Heat transfer calculation
- Notions of thermal radiation

Reference:

[1] R.E. Sonntag, C. Borgnakke, G.J. Van Wylen, *Fundamentals of Thermodynamics*, Ed Wiley

Material Science (S217MAT)

Course Information

Code: S217MAT

Responsible: Anaïs BARASINSKI

Contact: anais.barasinski@ec-nantes.fr

Department: Mechanics, Material and Civil Engineering Department

Language: English

Credits (ECTS): 4

Number of hours: 20

Semester: 2

Recommended prerequisites: Basics of Material Science (Part 1)

Evaluation: 10% continuous assessment, 30% homework, 60% project exam

Organization: 1 lesson + tutorial (4H), 1 project (12H +homework 20H), project presentations (4H)

Link:

Objective

This course offers to the students with knowledge and skills in material science, to go into in depth on two important aspects: choice of material and strength of material. The first aspect could be an important part for an engineer because taking into account link between material, properties and design of a product. The second aspect is compulsory for the engineers who want to create a part: they must be able to propose a rapid dimensioning of the part based on basic notions of strength of material.

Content

Part 2 - Choice of material:

- Price and availability
- Study of a real case.

Part 3 - Part Dimensioning:

- Basics of strength of material
- Study on a real case

References:

[1] D R H Jones, Michael Ashby, *Engineering Materials 1 & 2* - Elsevier

[2] Software CES Edupack