# Scientific Modules

## Mathematics
- Adapted Maths I: Algebra-Analysis
- Adapted Maths II: Probability and Statistics
- Applied analysis
- Numerical Analysis
- Probability and Statistics

## Computer Science
- Algorithms and Data Structures: Design, analysis and implementation
- Object-Oriented Design and Programming
- WebApp Lab (Learning by doing)

## Electrical Energy and Systems Control
- Autonomous work
- Control and electrical drive
- Electrical Energy
- Linear Control

## Information Science and Techniques
- Analog to Digital Conversion
- Autonomous work
- Electronic systems
- Signal processing

## Fluids and Energy
- Introduction and theoretical bases
- Numerical and experimental methods
- Thematic project

## Mechanical Engineering
- Mechanism Design
- Modelling and Design
- Practical Activities in Mechanical Engineering
- Technology - Mechanics - Strength of Materials

## Mechanics of Solids and Structures
- Continuum solid mechanics – experiments
- Digital Mock-Up
- Elastic Solid Mechanics
- Plasticity and Metal Forming
- Structural Dynamics
SUMMARY

MATERIAL ENGINEERING

From Matter to Materials: Structure and Properties
Practical courses in Material and Surface Science

PHYSICS AND CHEMISTRY OF MATTER

Chemistry
Physics
Practical works in Physic and chemistry

ECONOMICS AND CORPORATE FINANCE

Business Administration
Economics

HUMANITIES AND SOCIAL SCIENCES

Ethics
Individuals and society
Working nowadays

IN-DEPTH ELECTIVE MODULES

ADVANCED COURSES

Acoustics and Waves in Fluids
Amorphous Materials for Innovative Functional Structures
Automatic control with nonlinear phenomena
Biomechanics of living tissues and biomaterials for artificial joint
Damage and Ruin of Materials
Data analysis and pattern recognition
Deterministic and probabilistic approach for the heat equation
Digital computing and information processing architectures
Electrochemistry and Chemitronic
Electromechanic Conversion
Embedded systems architectures
Inelastic behaviour of structures
Java application programming: Android development, concurrency, distributed applications and graphical user interfaces
Materials and Innovative surface treatments
Mathematical Statistics and Econometrics
Mechanical Engineering
Molecular and Supramolecular Chemistry
Multibody mechanical systems
Multimedia: Concepts and technologies
Multi-sensor, Multi-activator Control
Numerical approximation of ordinary and partial differential equations
Optimal filtering and Information Transmission ................................................. 86
Power Electronics ......................................................................................... 59
Probability theory and introduction to random processes ......................... 78
Problem Solving Issues ................................................................................ 73
Quantum mechanics and applications ......................................................... 82
Semiconductor solid-state physics ................................................................. 84
Smart Sensor Networks : interface systems .................................................. 88
Supersonic Flows .......................................................................................... 65
Thermal Science and Combustion ................................................................. 67
Turbulences and instability ............................................................................ 63
Vibration Analysis ......................................................................................... 76

Professional modules ................................................................................... 89

The engineering profession ......................................................................... 90
Blue-collar internship ................................................................................... 94
Career plan - tutoring ................................................................................... 97
CLIC - Centrale Lyon Innovation Camp ....................................................... 100
Company visit ............................................................................................... 93
Conferences .................................................................................................. 91
Discovering engineering ............................................................................... 92
Industrial Application Project ....................................................................... 98
Research Project ............................................................................................ 99
Sport and physical education ......................................................................... 95
Study Project .................................................................................................. 96

Languages and culture ................................................................................. 101

Languages and Cultures ................................................................................ 102
arabic ............................................................................................................. 104
Chinese ......................................................................................................... 112
English .......................................................................................................... 106
French as a foreign language ....................................................................... 108
German ......................................................................................................... 103
Italian ............................................................................................................ 107
Japanese ....................................................................................................... 110
Portuguese ................................................................................................... 109
Russian ......................................................................................................... 111
Spanish ........................................................................................................ 105
SCIENTIFIC MODULES

DEAN

Grégory VIAL, Dean of Studies
Ségolène CALLARD, Vice Dean of Studies
**Introduction**
The skills developed in the teaching unit Mathematics are transverse in the sense that they can be apply to other teaching units of the common-core syllabus. This teaching unit deals with tools for solving classes of abstract problems that need determinist or not determinist models. These models can describe phenomena appearing in physics, mechanics, economy, management, etc.
The proposed courses bring a rigorous framework in order to analyze and solve problems.

**Semester**
S5

**Department**
Mathématiques Informatique

**Teaching Staff**
Mathématiques

### Programme
- MTH tc 1 : Applied analysis
- MTH tc 2 : Numerical Analysis
- MTH tc 3 : Probability Statistics
- MTH tc 4 : Adapted Maths I Algebra Analysis
- MTH tc 5 : Adapted Maths II Probability Statistics

**Learning Outcomes**
- Use a concept or a mathematical principle to describe a problem
- Model a random experiment by means of random variables
- Identify the various stages of the numerical simulation of phenomena
- Master the basic tools in mathematical analysis
- Use the basic functions of a software for numeral calculation or statistics

**Requirements**
Integrals of piecewise continuous functions, convergence of sequences and series, vectorial space, normed space, matrix, eigenvalue, probability theory on a finite or countable universe, discrete random variable

**Assessment**
weighted average: MTH tc1/tc4 : 40%, MTH tc2 : 30%, MTH tc2/tc5 : 30 %
ANALYSE APPLIQUÉE
APPLIED ANALYSIS

Lecturers: Elisabeth Mironescu, Philippe Michel
| Lectures: 14 h | TC: 20 h | PW: 0 h | Autonomy: 0 h | Study: 0 h | Project: 0 h | Language: |

Objectives

The aim of this course is to give the basic analysis methods (theoretical and computational) to solve classical problems arising in engineering.

Keywords: Analysis, Topology, Integration, Optimization, Ordinary Differential Equation

Programme

Differential and integral calculus
Optimization
Ordinary Differential Equation

Learning outcomes

◊ Be able to apply theoretical and computational methods in Dif.f and Int. Calculus
◊ Solving optimization problems
◊ Study nonlinear systems of Ordinary Diff. Equations.

Independent study

Objectives: To learn easily theoretical concept and train to computational methods
Methods: work on exercises (with corrections given)

Core texts


Assessment

1) Exam without any document, 80%
2) Solving an ODE problem under the guidance of a teacher 20%
Lecturers: Grégory Vial, Laurent Seppecher

| Lectures: 12 h | TC: 14 h | PW: 0 h | Autonomy: 0 h | Study: 0 h | Project: 0 h | Language: ❖ |

Objectives

We will present basic numerical methods useful for engineering. Applications are given, which motivate the development of such methods, together with a systematic analysis of the accuracy.

Keywords: Approximation, linear systems, numerical integration, differential equations, optimization

Programme

Linear systems, eigenvalues
Optimization, nonlinear equation
Interpolation, numerical integration
Numerical approximation of ordinary differential equations
Discretization of linear partial differential equations

Learning outcomes

◊ Identify the procedure of numerical simulation
◊ Make a choice between different methods
◊ Implement simple algorithms with Matlab
◊ Combine several numerical methods

Independent study

Objectives: Learning basics, preparation of numerical simulations with Matlab.
Methods: Training exercises.

Core texts


Assessment

Individual matlab test, and final written test.
Objectives

This first part of the course deals with the modelisation with random variables. We introduce the notion of density. Some methods of probability calculus, approximations and asymptotics theorems are studied. An important part of the course is devoted to the numerical simulation with MATLAB.

The second part of the course deals with statistics. The notions of estimators and tests are introduced. A chapter is devoted to linear regression.

Keywords: Probability laws, Random variables with density, Gaussians vectors, numerical simulations, estimators, parametric tests, linear regression

Programme

1) Random Variables (Probability, density, distribution function)
2) Mean, Variance
3) Random vectors
4) Asymptotics Theorems
5) Estimators
6) Estimators with confidence intervals
7) Statistical tests
8) Linear Regression

Learning outcomes

◊ Doing some calculus with computers
◊ Simulations with MATLAB
◊ Be able to run numeric calculus to solve statistical inference problem
◊ Be able to construct and analyse a linear regression

Independent study

Objectives: First steps in random simulation with MATLAB
Methods: Exercises and previous tests

Core texts


Assessment

Practical test in tutorial classes (25%)
Final individual written test (75%)
**Objectives**

This AF deals with basic tools used in Algebra and Mathematical Analysis: Vectorial spaces, Polynomials, Matrices and reduction, Integration, Differential calculus, optimization, ordinary differential equations.

**Keywords:** Polynomials, Hilbert spaces, Projection, Matrix reduction, Integration, Functional spaces, ODE

**Programme**

<table>
<thead>
<tr>
<th>A-Algebra</th>
<th>B-Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polynomials</td>
<td>Refresher course</td>
</tr>
<tr>
<td>Hilbert space, Euclidean space</td>
<td>Lebesgue integral</td>
</tr>
<tr>
<td>Matrix, determinant</td>
<td>Basic theorems and basic functionnal spaces</td>
</tr>
<tr>
<td>Eigenvalue, eigenvector and applications</td>
<td>Differential calculus and optimization</td>
</tr>
<tr>
<td></td>
<td>Ordinary differential equations</td>
</tr>
</tbody>
</table>

**Learning outcomes**

◊ Master the basic concepts of algebra
◊ Justify the integral calculation for multivariate functions
◊ Find the extrema of a function defined on $\mathbb{R}^d$
◊ Study the qualitative properties of the solution of an ordinary differential equation

**Core texts**


**Assessment**

- Individual test during tutorial classes (25%)
- Final individual written test (100%)
Mathématiques Adaptées II: Probabilités et Statistiques

Adapted Maths II: Probability and Statistics

Lecturers: Céline Helbert, Christophette Blanchet

| Lectures: 14 h | TC: 16 h | PW: 0 h | Autonomy: 0 h | Study: 0 h | Project: 0 h | Language: fr |

**Objectives**

This first part of the course deals with the modelisation with random variables. We introduce the notion of density. Some methods of probability calculus, approximations and asymptotics theorems are studied. A important part of the course is devoted to the numerical simulation with MATLAB.

The second part of the course deals with statistics. The notions of estimators and tests are introduced. A chapter is devoted to linear regression.

**Keywords:** Probability laws, Random variables with density, Gaussians vectors, numerical simulations, estimators, parametric tests, linear regression

**Programme**

1) Random Variables (Probability, density, distribution function)
2) Mean, Variance
3) Random vectors
4) Asymptotics Theorems
5) Estimators
6) Estimators with confident intervals
7) Statistical tests
8) Linear Regression

**Learning outcomes**

◊ Doing some calculus with computers
◊ Simulations with MATLAB
◊ Be able to run numeric calculus to solve statistical inference problem
◊ Be able to construct and analyse a linear regression

**Independent study**

Objectives: First steps in random simulation with MATLAB
Methods: Exercises and previous tests

**Core texts**


**Assessment**

Practical test in tutorial classes (25%)
Final written test (75%)
Introduction

Computing is ubiquitous, both at the heart of complex systems engineers are facing, as well as well as in our daily lives: mobile computing, embedded computing, new human-machine interactions, artificial intelligence... In this context, the UE Computer Science has two objectives. First, to provide students with computing methods as a scientific discipline, particularly in the field of algorithms and programming. Then, learn to break down a complex problem and code it using the Python programming language. Those methods are learned progressively, and implemented during a collaborative project to build a dynamic Web application based on a client-server architecture.

Semester
S5 ou S6

Department
Département Math-Info

Teaching Staff
Equipe d’Informatique (E6), Equipe Ingénierie du Traitement et de la Transformation de l’Information (H9)

Programme
INF tc1 : Algorithms and data structures : design, analysis and implementation
INF tc2 : Design and object programming
INF tc3 : Web application project

Learning Outcomes
◊ Know how to pick data structures and algorithms that can effectively solve a given problem.
◊ Be able to analyze and break down a large scale IT problem into functional entities.
◊ Be able to implement an efficient and robust solution, using the Python programming language.
◊ Know how to implement a client-server architecture based on Web services.
◊ Be able to apply Computer Science concepts in a collaborative project.

Requirements
Computer Science program from preparatory classes.
Practice of the Python language.

Assessment
Average of the three Actions de Formations : INF tc1 (1/3), INF tc2 (1/3), INF tc3 (1/3)
**ALGORITHMS AND DATA STRUCTURES: DESIGN, ANALYSIS AND IMPLEMENTATION**

**Lecturers: Romain Vuillemot**

- Lectures: 8 h  |  TC: 17 h  |  PW: 0 h  |  Autonomy: 5 h  |  Study: 0 h  |  Project: 0 h  |  Language: **F**

**Objectives**

The objective of this course is to introduce the fundamentals of algorithms and data structures, needed for students who are planning to pursue an engineering career. Students will be introduced to problem analysis, design and implementation of algorithms and their applications in industry through lectures, practical work sessions and a professional approach. The concepts discussed will be implemented in Python language.

**Keywords:** algorithmic, data structures, problem solving, algorithm implementation, algorithm complexity, algorithmic complexity.

| Programme | Data structures  
|           | Introduction to complexity  
|           | Sorting algorithms  
|           | Graph algorithms  
|           | General paradigms and examples: divide and conquer, dynamic programming, greeding algorithms, heuristics.  

| Learning outcomes | ◊ Know how to model a problem and how to solve it algorithmically.  
|                  | ◊ Know how to implement an algorithm and evaluate its complexity.  

| Independent study | Objectives: Understand and assimilate the concepts of courses implemented in the TDs.  
|                   | Methods: Question-and-answer sessions with teachers following the TDs to help with analyses and achievements.  


| Assessment | Knowledge Grade (60%): Written exam  
|           | Know-how Grade (40%): Average of the two home assignments  

CONCEPTION ET PROGRAMMATION OBJET

OBJECT-ORIENTED DESIGN AND PROGRAMMING

Lecturers: DERRODE Stéphane

| Lectures: 8 h | TC: 17 h | PW: 0 h | Autonomy: 5 h | Study: 0 h | Project: 0 h | Language: |

Objectives

Provide students with the basic knowledge dealing with objet-oriented design and programming. This will be implemented with Python for programming and UML for modeling. Usual lectures will be limited to emphasize practical sessions on computers with programming exercises and small projects.

Keywords: Object programming, Object design, Python, UML.

Programme

- Introduction to Software Engineering
- Modeling languages
- Object-oriented Design
  - Think object: classes and instances
  - Encapsulation, attributes, methods
  - Inheritance, aggregation, composition
  - Polymorphism, genericity
- Object programming with Python

Learning outcomes

◊ Know how to build an object model of an application.
◊ Know how to implement an object model using Python language.
◊ Know how to use UML.
◊ Know how to implement a computer science project.

Independent study

Objectives: Understand notions studied during lectures and implemented during practical sessions.
Methods: Question/Answering sessions with teachers following practical sessions to help realizing assignments.

Core texts


Assessment

Savoir score (60%): written exam
Savoir-faire score (40%): average of the two assignments
**Objectives**

The objective of this Training Action is to put into practice the notions and skills introduced by the other courses within the framework of a group project, involving the design and development of a web application. The architecture of this application will be based on a dynamic web interface, and a service developed in Python on the server side. The project will consist in designing an application from the data model to the user interfaces (UI) through client-server interactions.

**Keywords:** Computer project, web application, web service, client-server, HTML5, CSS3, Javascript, Ajax, JSON, Python, SQL

---

**Programme**

<table>
<thead>
<tr>
<th>Web development context and tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Model</td>
</tr>
<tr>
<td>User Interfaces</td>
</tr>
<tr>
<td>Client-server architecture and application protocol</td>
</tr>
</tbody>
</table>

**Learning outcomes**

- Master the basic tools and languages for web programming (HTML, CSS, Javascript)
- Understand client-server architecture based on web services
- Know how to carry out a software acceptance testing
- Master the specificities of IT project management (versioning)

**Independent study**

**Objectives:** Design, development and testing of an application.

**Methods:** Students are divided into project groups of 4 to 5 people. They have to write a specification, deliver a functional and tested application, and carry out the acceptance testing of an application made by a competitor group.

**Core texts**


**Assessment**

Knowledge grade (50%): Written Examination

Know-how grade (50%): Deliverable grade
**Introduction**

The Electrical Energy and systems control teaching unit brings together lessons on systems control and the modern use of electrical energy. The wealth of these areas lies in the diversity of applications encountered (electric traction, renewable energies, distribution, lighting, communication ...) and in the constant updating of knowledge and know-how. In many fields (transport, energy ...) the main added value of modern devices lies in control systems and conversion of electrical energy to improve the performance and energy efficiency of the systems. All this makes these teachings a must-have brick in the basic knowledge of a generalist engineer.

**Semester**

S5 ou S6

**Department**

département EEA

**Teaching Staff**

Electrotechnique, Automatique et Traitement du Signal

**Programme**

ECS tc 0: Autonomy
ECS tc 1: Electrical energy course
ECS tc 2: Automatic of linear processes course
ECS tc 3: Regulation and electric drive

**Learning Outcomes**

◊ To know how to use the recent technologies of the domains of the electrical energy and the control of the systems.
◊ To be able to apply basic concepts in automatic and electrical engineering.
◊ Know how to implement the tools of design and analysis of complex systems.
◊ To be able to design simple control laws for linear processes.
◊ To be able to manipulate orders of magnitude and specific vocabulary in the field of electrical energy.
**AUTONOMIE**

**AUTONOMOUS WORK**

**Lecturers:** Christian Vollaire

| Lectures: 0 h | TC: 18 h | PW: 0 h | Autonomy: 0 h | Study: 0 h | Project: 0 h | Language: **French** |

**Objectives**

Acquire additional knowledge in electrical energy courses and automatic linear processes by working autonomously around the use of software applications (Matlab or dedicated).

**Keywords:** Automatic and electrotechnic

**Programme**

Theme 1: linear Automatic, analysis of a physical device, modeling, synthesis of regulators
Theme 2: Electrical Engineering, magnetostatic, power electronics

**Learning outcomes**

◊ Being able to analyze a complex problem
◊ To be able to acquire specific knowledge in order to solve a problem.
◊ To implement the methods seen in the course.
◊ Analyze simulation results and make sense of them.
**ÉNERGIE ÉLECTRIQUE**

**ELECTRICAL ENERGY**

**Lecturers:** VOLLAIRE Christian, BREARD Arnaud

Lectures: 12 h  |  TC: 14 h  |  PW: 4 h  |  Autonomy: 0 h  |  Study: 2 h  |  Project: 0 h  |  Language:  

**Objectives**

The analysis of electrotechnical systems allows the understanding of the functioning of the electrical equipment used for the production, the transport and the modern and rational use of the electrical energy vector. Particular attention is paid to the issues related to these technologies in terms of industrial and economic development of countries as well as issues related to sustainable development.

**Keywords:** Electrical Engineering, Electric Power, Electrical Power Systems (Production, Transportation and Processing).

**Programme**

Kirchhoff Network  
Three-phase systems  
Electromagnetism  
Induction - application to the transformer -  
Static conversion of electrical energy

**Learning outcomes**

◊ Be able to manipulate the orders of magnitude of the domain.
◊ Be able to analyze the operation of an electrical energy treatment system (actuator, converter, etc.)
◊ Know how to understand energy aspects in power systems.
◊ To understand inactions with other fields of sciences for the engineer

**Core texts**

THÉODORE WILDE et GILBERT SYBILLE. Électrotechnique, 4e édition. Québec, Presse de l'Université Laval / De Boeck, 2005.
AUTOMATIQUE LINÉAIRE
LINEAR CONTROL

Lecturers: Catherine Musy-Bassot, Emmanuel Boutleux

| Lectures: 12 h | TC: 14 h | PW: 4 h | Autonomy: 0 h | Study: 2 h | Project: 0 h | Language:  |

Objectives

This course aims to identify the common features of any linear control problem: the choice of instrumentation, the expression of the specifications and the choice of the control structure. Analysis and resolution procedures are presented with pole placement (including RST control) and frequential analysis.

Keywords: Structure and Control laws, SISO Process, poursuit and regulation, reference model, pole placement, RST, frequential analysis

Programme

Problematics
From specifications to reference model
Regulators implementation
Empirical methods
Modelisation, a survey
Pole placement design
Frequential design

Learning outcomes

◊ To formulate a control problem from its specifications
◊ To predict process temporal behaviour from poles position
◊ To elaborate a mere control law allowing pole placement ou frequential properties
◊ To implement a numerical regulatorf from his continous transfer

Core texts

**Objectives**

The aim here is to show the concepts and technological aspects of an automated process involving an electric power drive.

**Keywords:** Regulation, correctors, power electronics converters, DC motor

**Programme**

- 2 hours of problem analysis
- 4 hours of experimental work on one of the two themes
- 2 hours of capitalization and oral restitution in front of the other part of the group and a teacher

**Learning outcomes**

- To be able to distinguish the different subsystems of an automated process and those of power, of an electric drive.
- Be able to identify setpoint, command and disturbance quantities.
- Be able to associate in the control-process chain, actuator, sensor and regulator.
- To know how to choose the structure and the parameters of the necessary control law.

**Independent study**

**Objectives:** Preparation of the oral restitution

**Methods:** Construction of visual aids and related explanations
Introduction

Communication and information processing systems have grown considerably in recent years. These systems, which are increasingly efficient, achieve a high level of complexity. It is therefore necessary to acquire basic skills in these fields, but also to acquire scientific methods and tools to understand them.

The educational objective of the UE STI is therefore the acquisition of a global understanding of the information processing processes and their implementation, necessary to face the challenges that a general engineer will encounter during his professional life.

The targeted level is sufficient to implement basic methods, to interact with specialists in the field or to pursue a career in the disciplinary fields associated with information technology systems (Electronics and Signal Processing).

Semester
S5 ou S6

Department
Département EEA

Teaching Staff
Automatique et Traitement du signal, Électronique

Programme
- STI tc 0 : Autonomous work
- STI tc 1 : Electronic systems
- STI tc 2 : Signal processing
- STI tc 3 : A / D conversion for audio systems

Learning Outcomes
- Master the scientific bases of information processing (signal processing and electronics)
- Ability to understand key functions in information systems
- Master the main techniques associated with it
- Master the technological principles underlying these information processing systems.

Requirements
Electrical laws, analog filtering, operational amplifiers, binary coding, logic, integration, convergence (functional analysis), complex numbers, elementary probabilities

Assessment
STI tc0 : 15%, STI tc1 : 40%, STI tc2 : 40%, STI tc3 : 5%
Objectives

Autonomous work allows students to learn more about electronics and signal processing using simulations (PSPICE and MATLAB). The autonomy linked to TC1 (electronic systems) consists in the simulation of electronic assemblies studied in TD. The autonomy related to TC2 consists of a project-like work (simulations MATLAB). The autonomous work is initiated during a launching session (one by AF TC1 and TC2).

Keywords: simulation, PSPICE, MATLAB

Programme

Introductory session each semester in TC1 and TC2
Autonomous work during the semester
Evaluation by an individual oral restitution session

Learning outcomes

◊ Ability to implement simulation tools
◊ Knowledge of existing methods and know how to implement them
◊ Ability to analyze simulation results

Assessment

This autonomous work is evaluated at the end of the semester during a specific session (oral evaluation of 15 minutes)
SYSTÈMES ÉLECTRONIQUES

Electronic Systems

Lecturers: Ian O'Connor

| Lectures: 14 h | TC: 14 h | PW: 6 h | Autonomy: 2 h | Study: 0 h | Project: 0 h | Language:  

Objectives

The evolution of electronic systems is linked to Moore's law. The complexity of integrated circuits doubles every eighteen months. In order to understand the complexity of current systems and their evolution, it is necessary to know the basics of electronic technology.

The aim of the course "Electronic Systems" is therefore to provide the student with the scientific and technological bases that are necessary for understanding the functioning of electronic systems and their evolution as well as the design of complex systems composed of processing circuits Information in analogue and digital.

Keywords: Junction PN, transistor CMOS, analog circuits, digital circuits, processors

Programme

- Introduction to electronics
- MOS Transistor
- High frequency modeling, presentation of the CMOS amplifier
- Detailed study of the MOS inverter
- Digital circuits, combinational logic. Boolean algebra and Karnaugh tables
- Digital Circuits, Sequential Logic
- Microprocessor architecture

Learning outcomes

◊ Being able to understand the scope of electronics: from device to processor
◊ Be able to describe the evolution of microelectronic systems
◊ Know how to identify circuit design methods and techniques

Independent study

Objectives: Deepen the topics covered
Methods: Perform electrical simulations with a simulator (PSPICE) to analyze the operation of devices and circuits

Assessment

The theoretical note known to know is that of the final test of 2 hours (no document).
Note of Knowledge: 90% AF note
Know-How Rating: 10% AF Rating
Objectives

Signal processing consists of all the techniques used to describe the acquisition, storage, modification and transmission of information. Faced with the mass of the signals that need to be processed, often in real time, technological systems of great complexity have invaded our society. In response to current challenges, powerful scientific methods have been developed to manage such complexity. The mastery of these methods becomes inescapable in the practice of the engineer whatever the field to which it is destined. The objective of this course is to present the preliminary bases for the acquisition and mastery of these methods and to illustrate them by their application.

Keywords: Deterministic and random signals, Analog and digital signals, Time and frequency analysis, Fourier transforms and Laplace, Analog and digital filtering, Sampling, Fast Fourier transform, Generator filters.

Programme
- Modeling and characterizing a signal: Time and frequency analysis
- Modeling and characterizing a system: Convolution and filtering
- Autocorrelation and deterministic intercorrelation
- From analogue to digital
- Digital Frequency Filtering
- From deterministic signals to random signals

Learning outcomes
- ◇ Be able to apply time and frequency analysis
- ◇ Knowing how to sample signals
- ◇ Be able to design analog and digital filters
- ◇ Be able to model signals.

Independent study
Objectives: Follow an engineering approach by mobilizing knowledge and know-how acquired during the AF
Methods: Solve a practical and original signal processing problem by applying the numerical methods and tools acquired.

Core texts

Assessment
The control of Knowledge is based on the preparatory work of TD, microtest and final test and Know-How on a TP and a restitution session.
**Objectives**

Through the study of analog-digital conversion, this AF illustrates the complementarity of electronics and signal processing for the design of information management systems. The operation, simulation and then realization of an analog-digital converter "Sigma-Delta" will be studied. This converter has an excellent behavior with respect to the quantization error inherent in the analog-to-digital conversion. These good performances justify its important use in the audio field for consumer applications such as CD recorders. In this AF, we focus on highlighting the link between the theoretical and technical aspects that accompany the design of an electronic system.

**Keywords:** Analog-digital conversion, electronic systems, Sigma-Delta modulator, digital signal, quantification, signal-to-noise ratio, filtering.

**Programme**

**First session** (BE 2 h): uniform conversion

I - Presentation of analogue / digital conversion.

II - Principle and properties of uniform analog / digital conversion.

Practical Activity (1h): Simulation and study of a uniform converter with matlab

**Second session** (BE 2 h): Conversion Sigma-Delta

III - Principle and properties of the Sigma-Delta converter.

Practical Activity (1h): Simulation and study of a Sigma-Delta converter under matlab / simulink

**Third session** (TP 4 h): Electronic realization of a Sigma-Delta modulator

Design of the electronic circuit carrying out a Sigma-Delta modulation

Observation and analysis of signals in the space of time and frequency

**Learning outcomes**

- Know how to describe the theoretical principle of the Sigma-Delta converter
- Be able to conduct a simulation of the system under Matlab-Simulink
- Being able to design an electronic circuit making a Sigma-Delta modulator
- Be able to analyze signals in time and frequency

**Core texts**


**Assessment**

A report must be given at the end of each of the 3 sessions. The AF score (know-how only) corresponds to the average of the 3 notes.
**Introduction**
This course unit reviews the key concepts and the modeling tools required to study flow problems and heat transfer applications. The conservation laws associated with various levels of approximation are described. The theoretical lectures are complemented with numerous hands-on activities: introductory experiment, physical and numerical experiments, thematic project performed as a group (4-5 students) on a panel of 31 test-rigs. The concepts and tools presented in the course are of use in most of the industrial domains hiring engineers: car industry, aerospace, energy, environment, health and biology.

**Semester**
S5 ou S6

**Department**
Département Mécanique des Fluides, Acoustique et Energétique

**Teaching Staff**
Mécanique des fluides, Energétique, Acoustique

**Programme**
- FLE tc1 : Introduction and theoretical bases
- FLE tc2 : Experimental and numerical techniques
- FLE tc3 : Thematic project

**Learning Outcomes**
- Be able to describe the fundamental laws of fluid flows and heat transfers and their various levels of approximation.
- Be able to identify the main flow features and flow regimes
- Be able to perform a dimensional analysis and an order of magnitude analysis for a boundary problem
- Know the basics of continuous flux systems and head balances.
- Be able to apply experimental and numerical techniques

**Requirements**
Concept of velocity, temperature, pressure, density, viscosity, stress.
Partial differential equations

**Assessment**
Weighted average : FLE tc1 : 60%, FLE tc2 : 15%, FLE tc3 : 25%
Objectives

This teaching component (AF) introduces the whole FLE (Fluids & Energy) teaching unit (UE) through a hands-on exploration of flow physics and presents next the key concepts of fluid mechanics and heat transfers.

Keywords: Discovery of fluid mechanics, fundamental governing equations, simplifying frameworks

Programme

- Introduction
- Kinematics and fundamental laws
- Newtonian viscous fluid
- Reynolds number
- Flow regimes and flow features as a function of the Reynolds number
- Turbulent flows
- Vorticity and introduction to aerodynamics
- Energy, thermodynamics and compressible flows
- Heat transfer
- Mixtures
- Combustion and flame

Learning outcomes

◊ Be able to describe the fundamental laws of fluid flows and heat transfers and their various levels of approximation.
◊ Be able to identify the main flow features and flow regimes
◊ Be able to perform a dimensional analysis and an order of magnitude analysis for a boundary problem
◊ Know the basics of continuous flux systems and head balances.

Core texts


Assessment

Final exam without lectures notes (85%), report on the introductory experiment (15%).
MÉTHODES EXPÉRIMENTALES ET NUMÉRIQUES

NUMERICAL AND EXPERIMENTAL METHODS

Lecturers: DRAGNA Didier, MAFFIOLI Andrea

| Lectures: 0 h | TC: 0 h | PW: 8 h | Autonomy: 4 h | Study: 6 h | Project: 0 h | Language: ❑ |

Objectives

This module provides an overview of experimental and numerical techniques in use for fluid flow analysis and introduces the students to the procedure or protocol to follow when applying these techniques in practice.

Keywords: Experimental protocol, measurement techniques, numerical simulation, comparison between physical models and measurements, uncertainties

Programme

Practical work on velocity field measurement within a turbulent jet
Practical work on the assessment of Bernoulli relationships or on an air cooling system
Computer lab using Ansys Fluent flow analysis software

Learning outcomes

◊ Know how to apply experimental and numerical techniques
◊ Know how to define an experimental protocol to assess some physical features
◊ Know how to report the results from a series of simulations or experiments
◊ Know how to compare a physical model with measurements

Independent study

Objectives: Application of a fluid flow analysis software (Ansys Fluent) to the simulation of a turbulent jet + analysis of the results with respect to experimental measurements
Methods: 2 x 2h of Computer Lab and flow analysis

Assessment

Know-how grade based on 2 reports (one for the jet and one for Bernoulli or air cooling) and the involvement during the practical work.
**PROJET THÉMATIQUE**

**THEMATIC PROJECT**

Lecturers: GIAUQUE Alexis, GERON Michel

| Lectures: 0 h | TC: 0 h | PW: 9 h | Autonomy: 5 h | Study: 6 h | Project: 0 h | Language: |}

**Objectives**

This module aims at applying all the knowledge and know-how acquired throughout the whole "Fluid Mechanics and Energy" course. From the choice of a topic and the set-up of the relevant practical work sessions, to the presentation of the results, going through performing and interpreting the experiments, the students will have to illustrate a scientific theme (head losses, similarity, heat transfer, hydraulic networks, ...) in order to deliver both an oral presentation to fellow students and a written report.

**Keywords:** Experiments and numerical simulations. Team work and project mode.

---

**Programme**

- Defining the project and setting-up of the practical work sessions
- Performing the experiments
- Post-processing and analyzing the results
- Oral and written reporting

**Learning outcomes**

- Be able to identify key flow features and flow regimes
- Be able to perform a dimensional and an order of magnitude analysis
- Be able to apply fundamental tools on flow analysis: flux balance, head loss analysis
- Be able to apply experimental and numerical techniques

**Independent study**

**Objectives:** Performing the measurements, post-processing and analyzing the results

**Methods:** 1h during each practical work session

2h devoted to post-processing and analysis following the 3 4h practical work sessions

**Assessment**

- N1 = individual involvement in practical works
- N2 = deliverables grade (1/3 oral, 2/3 written report)
- Module (know-how) grade = 0.3 x N1 + 0.7 x N2
Introduction
The Mechanical Engineering Unit covers a set of knowledge and know-how for designing, manufacturing and analyzing the performance of a mechanical system. It is a fundamental element in the training of a general engineer. The diversity of the industries concerned goes well beyond the mechanical industries: most objects and products have a solid material base. Their performance and lifespan are largely due to the quality of this hardware base.

Programme
- GM tc 1 : Technology / General and Analytical Mechanics / Resistance of Materials
- GM tc 2 : Practical Mechanical Engineering
- GM tc 3 : Modeling and Design
  or GM tc 4 : Design of Mechanisms

Learning Outcomes
- Know how to analyze the architecture of a mechanical system and its geometrical description from the technical drawings
- Know how to design a mechanical system
- To know how to define the tolerated geometry of a mechanical part and to use manufacturing means which respect the conditions of good operation
- Be able to analyze the dynamic behavior of a rigid solids system
- Knowing how to dimension a slender piece subjected to static loading

Requirements
Notion of rigid solid, kinematic torsion, torsion of efforts
Fundamental Principle of Dynamics
Objectives

The aim of this module is to study the technical design, dimensioning and realization of a mechanical system, as well as the study of its functioning.

The first part allows to understand the architecture of a mechanical system from the description of the connections between the parts and to define the tolerated geometry of the functional surfaces.

The second part allows to establish the equations of motion of a system of rigid bodies, using a Newtonian or a Lagrangian approach based on the principle of virtual powers.

The third part makes it possible to dimension thin deformable structures as beams, according to stresses and displacements criterion, starting from the internal forces induced by the loading and the reactions to the connections.

Keywords: Effects and connections, Functional dimensioning, Analytical mechanics, Principle of virtual powers, Lagrange equations, Beam theory, Stresses / strains

Programme

Mechanical Technology
- Efforts and connections in mechanical systems
- Functional specifications and product definition
- Obtaining parts by machining using cutting tools

General and analytical mechanics of rigid solids systems
- Description of the movement, fundamental principle, principle of the virtual powers (PVP), hypotheses of the model.
- PVP for a single solid, definition of different torsors, kinetic energy theorem
- PVP for a system of solids, schematization of the connections, equations of Lagrange
- Discussion on the limitations of the model

Strength of materials
- Definition, schematization of a beam and model hypotheses
- Elastic dimensioning (stresses, displacements)
- Constitutive relation.

Learning outcomes

◊ To know how to analyze the architecture of a mechanical system and its geometrical description from the technical drawings
◊ To know how to design a mechanical system and define its functional tolerancing that respect the conditions of good functioning
◊ To be able to analyze the dynamic behavior of a rigid solids system
◊ To know how to dimension a slender piece subjected to static loading

Independent study

Objectives: Understanding and assimilating the course
Methods: Exercises complementary to the tutorials available online, to be solved in self-evaluation. Corrected exercises available on teaching server.

Core texts


Assessment

Written exam (4 hours)
Activités pratiques de génie mécanique

Practical Activities in Mechanical Engineering

Lecturers: Bertrand Houx, Olivier Dessombz, Hélène Magoariec

| Lectures: 0 h | TC: 0 h | PW: 16 h | Autonomy: 0 h | Study: 16 h | Project: 0 h | Language: FR |

Objectives

The objective of the training activity is to put into practice the competences of the Teaching Unit. The technological product development project aims to implement all the stages of design, manufacture and control of the geometrical conformity of a mechanical system. The other practicals works aim to analyze the architecture of a real mechanical system, perform a performance diagnosis, depending on the external stresses and the technological elements used to carry out the links between solids or to activate the system.

Keywords: Architecture of a mechanical system; Building elements; Conception; Manufacturing; Metrology; Elastic dimensioning; Diagnosis of performance.

Programme

- Discovery practical work - Technological analysis
- Drawing tutorial - Technology Project
- Functional tolerancing tutorial - Technology Project
- Manufacturing tutorial - Technology Project
- Machining practical work - Technology project
- Dimensional metrology practical work - Technology project
- Sizing in RdM practical work
- Dynamic practical work

Learning outcomes

- To know how to analyze the architecture of a mechanical system.
- To master the design and manufacturing stages of a mechanical system.
- To be able to control the geometric conformity of a mechanical system.
- To be able to perform a diagnostic of the performance of a mechanical system.

Assessment

- Intermediates exam (3) (Technology Project) (75%) + deliverables of practical works (25%)
Modelling and Design

Lecturers: Olivier Dessombz, Francesco Froiio

| Lectures: 4 h | TC: 4 h | PW: 0 h | Autonomy: 0 h | Study: 12 h | Project: 0 h | Language:  |

Objectives

To provide more advanced concepts and tools in solid and structural mechanics, with a direct link with applications.

Keywords: Structural design, trusses, static and dynamic analysis

Programme

Course #1 and Tutorial #1: Static analysis and design of isostatic and hyperstatic trusses. Buckling.
Course #2 and Tutorial #2: Small displacements in vibration.
Tutorials #3 and #4: Design of a gym roof (static and dynamic analysis, resp.)

Learning outcomes

◊ To perform static analysis for the design of truss structures
◊ To perform dynamic analysis for the design of truss structures
◊ To use numerical calculation platforms (Matlab, Scilab) for structural analysis
◊ To report on the static and dynamic analysis of structures

Independent study

Objectives: Finalize the design work of Tutorial #3 and #4
Methods: Group work: case study and report writing

Core texts


Assessment

Evaluation of the written report and oral presentation on the work carried out in Tutorial #3 and #4
CONCEPTION DE MÉCANISMES
MECHANISM DESIGN

Lecturers: Paul Clozel
| Lectures: 4 h | TC: 4 h | PW: 0 h | Autonomy: 0 h | Study: 12 h | Project: 0 h | Language: | |

Objectives

Knowledge and dimensioning of power transmission elements, particularly those used in ground transport, understand their operation and analyze their performance.

Keywords:

Programme

Elements of technology for power transmission
Epicyclic trains and applications
Gearboxes and drives
Stacking of a gear box, performance.
Hybrid Vehicle Architectures

Three 4h Studies:
- Analysis of the operation of a DSG7 gearbox.
- Simulation of the operation of a gearbox and a DPC differential (with Catia software and applications).
- Analysis of the power transmission system of a 4x4 vehicle

Learning outcomes

◊ Be able to perform functional analysis of a mechanical transmission system.
◊ Be able to analyze and simulate the operation of a mechanical transmission system.

Core texts


Assessment

Reports from studies, involvement
Introduction
Continuum mechanics aims at modeling the displacements, strains, and stresses for materials considered to be continuous at macroscopic scale, thus providing essential information on the kinematics and strength of structures. Most mechanical systems are designed to work in the context of reversible strains that remain proportional to the applied loads. The framework of linear elasticity is then of particular importance for the design of mechanical systems and structures.

Moreover, the specific dynamic phenomena (vibrations, resonances, instabilities) have to be understood to ensure the mechanical strength of structures, and also to minimize the associated discomfort: resistance of civil engineering structures to earthquakes, comfort and safety in transport, reduction of acoustic emissions and vibratory nuisance, etc. The computation techniques (finite element method) now allow to integrate in the design process predictive simulations of the behavior of structures. The Digital Mock-Up thus becomes central for managing manufacturing, simulating the assembly and behavior of systems in their mechanical environment.

Semester
S6 ou S7

Department
Mécaniques des Solides, Génie Mécanique, Génie Civil (MS.GM.GC)

Teaching Staff
Mécanique des solides, Mécanique des vibrations, Technologie mécanique

Programme
MSS tc 1 : Continuum Mechanics
MSS tc 2 : Laboratory Works in Solid Mechanics
MSS tc 3 : Digital Mock-Up
MSS tc 4 : Structures Dynamics
MSS tc 5 : Plasticity and Metal Forming

Learning Outcomes
- To be able to formulate and solve linear elastic problems for simple configurations
- To be able to perform modal analysis to predict the dynamic behavior of simple structures
- To know how to use a finite elements software to solve complex problems
- To know how to choose the modelization type according to the awaited model precision
- To know how to interpret simulation results

Requirements
Mathematics: vectors, torsors, tensors, variational methods, linear algebra.
Knowledge of Fundamental Laws of Mechanics.

Assessment
Weighted average: MSS tc1: 70%, MSS tc2: 10% , MSS tc3: 10%, MSS tc4/tc5: 10%
OBJECTIVES

On the first hand, in the context of the Continuous Solid Mechanics: solid elasticity and introduction of stress and strain analytical concepts.

The momentum equations of the elastodynamics are derived from the main energy balance theorems. On the other hand: introduction of the techniques for the design and the sizing of structures. The vibrational modes are defined. Their properties are used to calculate the dynamical response by means of the modal synthesis. Discrete models are established in the view of their implementation for the design of structures.

Keywords: Strain, stress, elastic solid, elasto-dynamics; Energy method, continous modes, modal synthesis; Rayleigh-Ritz method, discrete modes; Finite element method

PROGRAMME

Chapter 1: Cinematics in continuous media
Chapter 2: Stress and momentum equation in continuous media
Chapter 3: Elastodynamics and elastic laws
Chapter 4: Variational formulation
Chapter 5: Structural models – continuous modes
Chapter 6: Modal analysis and modal synthesis
Chapter 7: Rayleigh Ritz method – discrete modes
Chapter 8: Finite element method

LEARNING OUTCOMES

◊ Basic concept about strain and stress in continuum solid mechanics
◊ Elasto-dynamic problem statement and analytical solution
◊ Modal analysis tools and modal synthesis technique
◊ Use and analysis of the Rayleigh-Ritz method.

INDEPENDENT STUDY

Objectives: Self-study using optional exercises distributed in TD and exercises with answers.

Methods: Students receive two documents of about 40 questions for the continuous assimilation of the course. The questions allow to validate the acquired knowledge. Two micro-tests are programmed on the basis of these two questionnaires.

CORE TEXTS


ASSESSMENT

Micro-test (chap.1-4) 20 min, Micro-test (chap. 5-8) 20 min, Written exam 3h.

Evaluation = 85% written test + 15% micro-tests
AF MSS tc 2

EXPÉRIMENTATIONS ET SIMULATIONS EN MÉCANIQUE DES SOLIDES

CONTINUUM SOLID MECHANICS – EXPERIMENTS

Lecturers: Olivier Bareille et Alexandre Danescu

| Lectures: 0 h | TC: 0 h | PW: 16 h | Autonomy: 0 h | Study: 4 h | Project: 0 h | Language: 🇫🇷 |

Objectives

Through a set of practical activities, in parallel with the theoretical notions discussed in MSS tc 1, this training activity should enable students to: sensitize themselves to physical phenomena in mechanics, know various techniques for measuring variables used in mechanics (extensometry, accelerometry, photoelasticimetry, stroboscopy, etc.), implement the concrete situation of theoretical concepts and promote their assimilation, perform the validation of the experimental results (critical analysis of the quality and relevance of the measurements, confrontation of results from theoretical or numerical approaches)

Keywords: Strain, stress, eigenmodes, resonance, static and dynamic measurements, experimental and numerical methods, finite element method

Programme

Exploration PW
PW1 : study of resonance of a flexible structure
PW2 : photoelasticimetry, visualization of the stress field in 2D solids, stress measurement by photoelasticimetry.

Measurements and analysis PW
PW3 : determination of continuous elastic structure eigenmodes
PW4 : extensometry (strain gage measurements), analytical calcul, application to determination of stress field

Finite elements tutorial : structural mechanics using software based on the finite element method: static case interpreted in terms of stress and strain, dynamic case interpreted in terms of eigenmodes

Learning outcomes

◊ Master the basic notions of strain and stress for the deformable solid
◊ Understand the link between hypotheses, modeling and associated physical phenomena
◊ Know how to identify the elements of a measurement chain
◊ Know how to write a report of practical works

Independent study

Objectives: To be aware and to experiment the requirements and the rigorous approach of experimental analysis

Methods: Learning and experiencing the use of experimental equipments, under the supervision of a professor.

Assessment

Each PW's report is given a mark as well as the attendance and the attitude during the courses, which contribute to the overall individual evaluation.
MAQUETTAGE NUMÉRIQUE
DIGITAL Mock-Up

Lecturers: Didier Lacour

| Lectures: 2 h | TC: 0 h | PW: 0 h | Autonomy: 4 h | Study: 14 h | Project: 0 h | Language: FR |

Objectives

The aim of this training course is to enable engineers to understand the various aspects of digital modeling (volume and surface modeling, integration with simulation (kinematics, calculation, manufacturing, etc.), which are necessary in particular for other training Two Mechanical and Mechanical Engineering Units of Solids and Structures.

Keywords: Digital Mock-Up, Numerical modeling, Simulation, Finite element calculations, PLM, Bézier surfaces, Modeling curves and surfaces

Programme

Mathematical modeling of pole surfaces
Getting Started with the Catia V5 Software (Part Design)
Surface modeling with Catia V5
Mini-project: Implementation of modeling, simulation and calculation tools on a concrete problem of design or optimization of a technical system.

Learning outcomes

◊ Be able to model a technical solution using computer tools
◊ Know how to manipulate current modeling and simulation tools
◊ To be able to understand all the scientific and technical aspects of a project
◊ Knowing the software tools of numerical modeling used in industry.

Independent study

Objectives: Develop and deepen the subject of the mini-project
Methods: CAD sessions with teacher assistance

Core texts


Assessment

The final report of the mini-project gives rise to a note.
DYNAMIQUE DES STRUCTURES

STRUCTURAL DYNAMICS

Lecturers: Sébastien Besset

Objectives

The aim of this course is to deepen the techniques of modal synthesis: truncation effects, structural modifications, and to extend the dynamic models to the situations of structures subjected to large displacements and/or combined loads, to anticipate and control the associated phenomena during the design process: risks of instability and floating. The pedagogical content is based on additional training in the form of courses and TD, a practical session on the effect of a static pre-load on the dynamic behavior of a structure and a project which will serve as a support example.

Keywords: Component mode synthesis, Large displacements, Prestress loading

Programme

Modal synthesis: description of the dynamic behavior of a structure based on the eigenmodes.
- Definition of the number of modes taken into account depending on the domain
- Frequency of excitation, effects of modal truncation. Prediction of the effect of a localized structural change.
- Large displacements, static pre-stresses: equations on simple cases, qualitative prediction of the expected phenomena, implementation of simulations using a software of calculation of structures by the finite element method.
- TP: modifications of the eigenmodes of a structure subjected to a static loading increasing.
- Buckling phenomenon.
- BE: project to design a structure or to simulate the behavior of a structure.

Learning outcomes

◊ To be able to propose a model of predictive simulation of dynamic behavior of a structure
◊ To be able to gather the necessary information and estimate their degree of importance and reliability
◊ To know how to evaluate the validity limits of a model
◊ To understand the concepts necessary for the use of a dynamic computation code

Independent study

Objectives: Students are faced with a modeling problem in a quasi-industrial application
Methods: The teacher presents the problem and intervenes as a resource

Core texts

Objectives

The aim is to raise awareness of the link between materials forming processes and elastoplastic properties of metallic materials.

The first part of the course focuses on the main processes for metal forming: plastic metal stretching, foundry, etc. The second part of the course introduces the classical elastoplastic model. The objective is to understand the limits of the elastic model and the main issues to address in order to introduce plastic behaviour. The model is established following the interpretation of simple homogeneous mechanical tests (tension and tension-torsion) and a phenomenological approach. Practical works allow, among other things, an understanding of the influence of the metal forming process on the elastoplastic properties.

Keywords: Plastic metal forming, foundry. Yield stress, Elastic strains, Plastic strains, Isotropic hardening, Kinematic hardening, Yield criterion.

Programme

2 courses to present the basic concepts + 2 exercises to practice these notions on elastoplastic structures.
3 practical works:
PW1 - Metal forming: sand casting, permanent mould, machining operation with cutting tool
PW2 - Behavior identification: identification of the elastoplastic properties of the materials formed during PW1 (tension and torsion mechanical tests); Study of the influence of forming process on these mechanical properties.
PW3 - Structural design: finite element analyses of structures made of material identified during PW2.

Learning outcomes

◊ To know how to perform two foundry processes
◊ To understand phenomenological plasticity
◊ To know how to manage experiments to identify the elastoplastic behavior of materials
◊ To know how to interpret results of an elastoplastic finite elements simulation

Core texts


Assessment

Weighted average of the 3 practical works + participation
Introduction

In the design and manufacturing process of industrial parts and systems, the engineer is required to use wisely the materials, or even to give them new functionalities. This approach forms the basis of the design and innovation. It requires good knowledges in the field of science for engineers; This is what we call “materials engineering”. The aim of this teaching unit is to introduce the “Materials Science” to the student and to give him the best approach to solve some problems at different scales, with regard to the behavior of the material and taking into account its lifecycle, from its development to its recycling, including its elaboration, its specific optimization treatments and its damaging. The behavior of material during mechanical solicitation will be widely studied, but electrical, thermal and magnetic properties are also addressed. Thus, by organizing the pedagogy around the acquisition of a set of specific knowledge, know-how and methodologies, the student will acquire the skills that will allow him to solve industrial problems.

Programme

IDM tc 1 : From the matter to the Materials : Structure and Properties
IDM tc 2 : Practical Works in Science and Engineering of Materials and Surfaces

Learning Outcomes

- To know the different families of solid materials and their specificity.
- To know the elaboration processes of the materials
- To know the mechanical behavior laws (elasticity, plasticity, fracture) of the materials as well as their physical properties.
- To be able to explain the relationships between processes, structures and mechanical properties.
- To be able to chose a material for a specific application

Requirements

Crystallography (Crystal networks, Miller indices)
Thermodynamics (1st and 2nd principle)

Assessment

Weighted average : IDM tc1 : 70 %, IDM tc2 : 30 %
## Objectives

This course presents the main characteristics of the materials currently used (metal alloys, ceramics, polymers, composites), their structures, their properties and the main techniques to characterize these materials. In particular, we will make the link between the properties (mechanical and physical) and the structure of the materials at the relevant scale (from nano to macro for physical and mechanical properties).

**Keywords:** Mechanical behavior of materials (elasticity, plasticity, fracture, fatigue, creep), crystallography, thermal treatment, metal alloys, glasses, polymers, composites, solid physics, electrical conductivity.

## Programme

- General Introduction to Materials Engineering
- § 1: Materials: mechanical properties, structure
- § 2: The families of materials: elaboration, adaptation of properties
- § 3: Physical properties of materials

## Learning outcomes

- Knowing the main families of solid materials and their specificity
- Knowledge of the main elaboration processes of the materials
- Be able to use the laws of mechanical behavior of materials (elasticity, plasticity, fracture)
- Knowing the physical properties of materials

## Independent study

**Objectives:** Acquisition and oral presentation of knowledge, problem solving.

**Methods:** Personal work and group work.

## Core texts


## Assessment

- 2h exam with documents.
- Micro-tests without documents and oral presentations.


**AF IDM tc 2**

**TRAVAUX PRATIQUES EN SCIENCE ET GÉNIE DES MATÉRIAUX ET DES SURFACES**

**PRACTICAL COURSES IN MATERIAL AND SURFACE SCIENCE**

**Lecturers:** Clotilde Minfray, Gaylord Guillonneau, Michelle Salvia, Stéphane Valette, Clotilde Minfray

| Lectures: 0 h | TC: 0 h | PW: 32 h | Autonomy: 8 h | Study: 0 h | Project: 0 h | Language: **F** |

**Objectives**

The objectives of this training program are:
- to know and to perform the most used mechanical tests to access the properties and mechanical behavior of some materials belonging to the three main families of materials: metals, ceramics and polymers.
- to work (by a practical approach) on some basic problems of wear and lubrication in a multidisciplinary framework bringing together the mechanics and the materials and surfaces science.
- to establish, from an experimental approach, the link between chemical composition, thermal treatment, microstructure and mechanical properties.
- to acquire knowledge on the elaborations of polymers and composites.

**Keywords:** Mechanical behavior of materials, tribology, thermal treatment, metal alloys, glasses, polymers and composites

**Programme**

- Mechanical behavior of materials
- Tribology and surfaces
- Thermal treatment of metal alloys
- Polymers and composites

**Learning outcomes**

- To predict the mechanical properties of materials and their structures depending on the thermo-mechanical treatments applied to the materials.
- To identify the elaboration and treatment processes to adapt the properties of the materials to a specification
- To know how to identify the relevant scale for a given property
- Being able to explain the basic principles of tribology (friction, wear, lubrication)

**Independent study**

**Objectives:** Preparation of practical work, synthesis of knowledge and experience reports

**Methods:** Personal work and writing reports

**Assessment**

Average of the 4 marks obtained for each group of practical works.
No retake whatever the nature of the absence.
Introduction
The "Physics and Chemistry of matter" unit offers a high level fundamental training in the field of physics and chemistry. The concepts tackled in the courses concern the matter at the microscale (molecules, atoms, nucleus). The physical laws at stake at these scales allowed to explain the macroscopic properties of matter as their optical properties or chemical properties.

Semester
S6, S7

Department
STMS

Teaching Staff
Physique, Chimie

Programme
PCM tc 1 : Physics
PCM tc 2 : Chemistry
PCM tc 3 : Lab

Learning Outcomes
◊ Link the macroscopic properties of matter to their microscopic origins.
◊ Identify the different radiation/matter interactions and intermolecular interactions.
◊ Give the order of magnitude of the energy at stake in the different interaction
◊ Mobilize one's knowledge to resolve a transdisciplinary problem
◊ Mobilize one's knowledge to analyze measurements.

Requirements
Electromagnetism in vacuum (Maxwell equation, Poynting vector, ..), Wave optics (Interferences, diffraction, ...), Thermodynamics (1st and 2nd principles, chemical potential, Carnot cycle), Molecular chemistry (VSEPR method)

Assessment
PCM tc1 : 43.3%, PCM tc2 : 21.7%, PCM tc3 : 35%
Objectives

The aim of this course is to provide the basic knowledges of quantum physics necessary to describe both the matter at microscopic scale and the main processes of radiation - matter interaction (emission, diffusion, absorption). These processes will be addressed both from classical and quantum point of view, and studied in particular in the frame of applications such as light sources and detectors, and lasers.

Keywords: Quantum mechanics, atomic and nuclear physics, photon - matter interactions, wave propagation in media.

Programme

Wave propagation, dispersion.
Classical description of electromagnetic waves/material media interactions: optical properties of dielectrics and metals.
Limits of classical physics
Wave - particle duality.
Schrödinger equation and applications.
Atomic and molecular physics.

Learning outcomes

◊ To be able to apply the Schrödinger equation to simple systems.
◊ To know how to rely macroscopic properties of matter to their microscopic origins.
◊ To know how to describe the different radiation - matter interactions.
◊ To be able to give the orders of magnitude of the energies implied in these interactions.

Independent study

Objectives: Understanding and assimilating the course.
Methods: Know how to remake and interpret TD
On line exercises & multiple choice training.
Questions/Answers sessions with teachers.

Core texts


Assessment

Regular microtests without document 15%
Final exam 2h with personal manuscript form (2 sheets) 85%
Lecturers: Jean-Pierre Cloarec, Naoufel Haddour, Virginie Monnier,

| Lectures: 8 h | TC: 12 h | PW: 0 h | Autonomy: 5 h | Study: 0 h | Project: 0 h | Language: | |

Objectives

This course aims at introducing basis of materials schemistry & physicochemistry, in order to understand phenomena in materials at the microscale: kinetics, reactivity, thermodynamics, weak bonds, electrochemistry. Case studies based on new materials for producing energy (organic photovoltaics), surface metallization and power houses will be used for manipulating concepts based on quantum chemistry and molecular interactions.

Keywords: Chemistry, materials, molecular orbitals, statistical thermodynamics, weak bonds, kinetics, electronic transfers

Programme

- Quantum theory of the covalent bond
- Introduction to statistical thermodynamics
- Chemical reactivity and kinetics
- Electronic transfers at interfaces
- Weak bonds

Learning outcomes

◊ Build, interpret and use molecular orbital diagrams for making prevision on a molecular scaffold
◊ Relate macroscopic and microscopic physicochemical properties of matter
◊ Identify molecular interactions and bond energies involved in molecules
◊ Be able to choose adapted theoric notions and use them for new concrete cases involving Chemistry

Independent study

Objectives: Study and learn the core concepts of the course before amphitheaters, for using them in amphitheaters and tutorials.
Understand the relationships between different notions of the course. Be able to mobilize concepts of the course in new concrete situations.
Methods: Reading course chapters before the amphitheater; work with self-evaluation exercises with the platform Moodle.

Core texts


Assessment

micro-tests in amphitheaters, without documents: 30% knowledge
Final exam (1h) without document: 70% knowledge
AF PCM tc 3

TRAVAUX PRATIQUES DE PHYSIQUE-CHIMIE

PRACTICAL WORKS IN PHYSIC AND CHEMISTRY

Lecturers: Christelle Yeromonahos, José Penuelas

| Lectures: 0 h | TC: 0 h | PW: 24 h | Autonomy: 0 h | Study: 0 h | Project: 0 h | Language: 法

Objectives

Using lab experiments, these practicals allow better understanding of fundamental concepts taught in physics and chemistry lectures and tutorials. They also make links between these concepts and applications, in particular in industry. Finally, notions that are important for an engineer, such as measurements validity and protocol set-up, are given.

Keywords: Nanotechnology, Imaging, Laser, Spectroscopy, Chromatography, Chemical reactivity and kinetics, Electrochemistry, Intermolecular bonds

Programme

Students will follow 3 practicals in physics:
Frequency analysis – Fourier optics
Infrared thermography/Solar cell
Spectrophotometry

Students will follow 3 practicals in chemistry:
Electrochemical study of metal corrosion
Redox reactions study using UV-Visible spectrophotometry – Chemical reactivity and kinetics
Gas-phase chromatography

Learning outcomes

◊ Be able to link frequency space properties to real space properties
◊ Know the detection and analysis mechanisms of visible and infrared light
◊ Be able to link spectrophotometric and voltamperometric measurements to redox reactions kinetics
◊ Know and set up the detection protocol of chemical species by chromatography

Independent study

Objectives: Preparation of practicals
Methods: Read documents on intranet
Answer to questions and include them in practicals reports

Assessment

Preliminary questions (Knowledge, 20% of the mark)
Practical work written report (Know-how, 80%)
Introduction
The course brings the basic knowledge to understand corporate finance and economics. The course Economics deals both with macro and micro economic concepts in order to make student understand economic data and policies as well as agents behaviors. The course Corporate finance helps to understand financial process in the firm: how to design profit and loss statement, cash flow statement and conduct a right diagnostic on the firm’s financial situation. The two courses are mandatory to understand the firm’s behavior in its economical environment.

Programme
SEM tc1 : Economics
SEM tc2 : Corporate finance

Learning Outcomes
◊ Understand economic and financial data
◊ Design financial documents
◊ Be able to diagnostic a firm’s situation
◊ Decision making for firm's management

Assessment
SEM tc1 : 50%, SEM tc2 : 50%
ECONOMICS

Lecturers: Christian de Perreti, Laure Flandrin

| Lectures: 18 h | TC: 10 h | PW: 0 h | Autonomy: 4 h | Study: 0 h | Project: 0 h | Language: FR |

Objectives

The objective of the course is to study theoretical basis to understand the major economic current issues and be able to process economic information and data as well as evaluate economic policies.

Keywords: macro economics micro economics, public policies, crisis, growth, monetary policy

Programme

- The basis of economics
- Monetary policy and growth and crisis
- Public economics

Learning outcomes

- Understand macro economic data
- Understand micro economic choices and their impact on the economy
- Understand the relationship between economics and markets

Independent study

Objectives: Understand the class sessions
Methods: Readings

Core texts


Assessment

Exam
Objectives

The objective of the course is to understand how financial flows are recorded and presented in a company as well as the methods to calculate profit and loss and the cash flows.

Keywords: Accountancy, corporate finance, cash flow, profit and loss

Programme

- Accountancy basis
- Profit and loss document
- Inventories
- Diagnostic of financial performance
- Financial decision making

Learning outcomes

- Understand accountancy documents
- Be able to implement a financial diagnostic
- Take decision to improve financial results
- Create and manage a start up within a business game

Independent study

Objectives: Financial decision making
Management of a start up within a business game

Methods: E-learning accountancy basis (2 hours of preparation before the class session)
Decision making on the business game

Core texts


Assessment

Business game : 40%
Exam : 50%
E-learning : 10%
**Introduction**

The Humanities and Social Sciences Teaching Unit has a dual objective. On one hand, develop students' general culture and critical thinking by providing to them analytical tools and interpretation keys to understand the society in which they live (particularly in the course "Individuals and society", but also in the two other training actions). On the other hand, develop their knowledge of the ethical and organizational issues that engineers face in their professional life ("Ethics" and "Working today" courses). Through this dual perspective the Humanities and Social Sciences teaching Unit offers an introduction to the concepts and methods of the human and social sciences and philosophy.

**Programme**

<table>
<thead>
<tr>
<th>Programme</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHS tc 1: Individuals and society</td>
</tr>
<tr>
<td>SHS tc 2: Working today</td>
</tr>
<tr>
<td>SHS tc 3: Ethics</td>
</tr>
</tbody>
</table>

**Learning Outcomes**

- Being able to use the Human and Social sciences' point of view to analyze the social context.
- Question one's representations, especially regarding to the professional world.
- Understand the organizational context of companies.
- Understand the ethical issues of the engineering profession.
- Understand and put into perspective a document or a current issue.

**Requirements**

None

**Assessment**

Same ponderation for all the courses: \( SHStc1 : 1 \); \( SHStc2 : 1 \); \( SHStc3 : 1 \).
**Objectives**

From the study of a general theme ("Individuals and Society"), this course aims to present the approaches of the Human and Social Sciences, as for their modes of investigation and their fundamental concepts. Beyond an introduction to social psychology and sociology, the goal is to provide students tools to analyze the human and social situations they face. Far from providing them with ready-made answers, the intention is to lead them to carry out a questioning that is well-constructed and well-argued serving their understanding of human and social issues. A secondary objective consists in enhancing the capabilities of the students to analyze a human sciences text, and, more broadly, of topicality.

**Keywords:** psychology, sociology, individuals, society

---

**Programme**

The lectures include sessions in social psychology and sociology. The main topics discussed are: the Human and Social sciences point of view; the deconstruction of social representations; the influence of groups on individuals and social change; the construction of social norms, socialization and forms of deviance; the coexistence of an egalitarian society and social inequalities...

---

**Learning outcomes**

◊ Being able to use the point of view of the human and social sciences to analyze the society
◊ Being able to question one’s representations about the world and society
◊ Question the social construction process of individuals and groups
◊ Understand and analyze a topicality document on a current issue
**Objectives**

This course questions the place occupied by work in our Western societies through the taking of a sociological perspective on contemporary organizations, their management’s modes and the roles played by engineers. The objective is to empower students with organizations analysis tools which they can apply to their own experiences in companies: in which they have been (during their work internship) or will be (during their future internships and professional life) confronted. More than practical advices, this teaching aims to achieve an awareness of the various issues they will encounter during their professional life, such as operating methods and processes at work, opportunities and choices implied by the forms of management.

**Keywords:** Work, organizations, companies, management, psychosocial risks, health and safety at work, engineers, managers

---

**Programme**

The course covers several topics:
- How and to what extent work structures Western societies.
- The evolution of the forms of organization and management of companies by detailing current methods.
- Focus on the situation of engineers and managers in organizations.
- The TDs deepen these themes, through the study of documents (films, texts ...). In particular, focusing on the theme of professional stress and psychosocial risks at work.

---

**Learning outcomes**

◊ Understand what work means and represents in our societies.
◊ Understand the organizational context of companies.
◊ Understand the engineers’ place in companies.
◊ Being able to understand the links between the organizational modes of companies to the social and economic context.
ETHIQUE

Ethics

Lecturers: Vincent Beaubois

Lectures: 14 h  |  TC: 4 h  |  PW: 0 h  |  Autonomy: 0 h  |  Study: 0 h  |  Project: 0 h  |  Language:  

Objectives

This course deals with the ethical issues related to engineers professions, and more broadly, with the contemporary issues in science and technology. Regarding the notion of responsibility, ethics characterizes an inherent dimension of human action, held in different areas such as personal or professional, individual or collective. Philosophy aims to help engineers to analyze and understand their ethic choices in order to make the best decision in complex and singular situations.

The course aims to allow a reflexive posture of students on their own rules of action, their value judgments, and to give them benchmarks to form their critical mind in order to analyze both speeches and acts.

Keywords: Ethics, responsibility, engineers, deontology

Programme

The 7 sessions of lectures offer
- a presentation of ethics, and its articulation with justice in a democracy;
- an analysis of the ethical issues involved in contemporary technosciences and engineering professions through different examples such as nuclear energy, nanotechnologies, environment, scientific and technical research.

Learning outcomes

◊ Understand ethical issues of engineering practices.
◊ Understand interest and limits of the professional deontology.
◊ Understand the new deontological and legal tools and concepts.
◊ Being able to articulate and differentiate legal, deontological and ethical issues.

Core texts

IN-DEPTH ELECTIVE MODULES

TEACHER IN CHARGE
Emmanuel BOUTLEUX

DEAN
Grégory VIAL, Dean of Studies
Ségolène CALLARD, Vice Dean of Studies
Unité d’enseignements d’Approfondissements

Advanced Courses

Director: Emmanuel Boutleux
96hTD, 6 ECTS

Introduction

<table>
<thead>
<tr>
<th>Semester</th>
<th>Programme</th>
</tr>
</thead>
<tbody>
<tr>
<td>S7</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Department</th>
<th>Teaching Staff</th>
</tr>
</thead>
<tbody>
<tr>
<td>EEA, MFAE, MI, MSGMG, STMS</td>
<td>Toutes les équipes d'enseignements scientifiques</td>
</tr>
</tbody>
</table>
AF GM a 1-FH

SYSTÈMES MÉCANIQUES POLYARTICULÉS
MULTIBODY MECHANICAL SYSTEMS

Lecturers: Emmanuel Rigaud, Bertrand Houx

Objectives

Keywords:
AF GM a 2-EG

INGÉNIERIE MÉCANIQUE

MECHANICAL ENGINEERING

Lecturers: Jean-Jacques Sinou, Olivier Dessombz

| Lectures: 4 h | TC: 4 h | PW: 0 h | Autonomy: 16 h | Study: 24 h | Project: 0 h | Language:  

Objectives

Study the dimensioning of mechanical systems and structures present in various fields of application (civil engineering, aeronautics, automobile, ...) by linking the technological, static and dynamic aspects.

Keywords: Design of structures, methodology and modeling.

Programme

Course / Seminar:
- Introduction to the dimensioning problem
- Static dimensioning
- Dynamic dimensioning

Synthesis Studies:
- Two studies (2 x 11h design classes) make it possible to show the links existing between the different aspects of the dimensioning of a system or of a mechanical structure.
- Examples of topics covered during the synthesis studies:
  - Dimensioning of a bridge
  - Mechanical stress in an assembly of an aeronautical structure
  - Dimensioning of a lifting clamp
  - Dimensioning of an automobile clutch

Learning outcomes

◊ To know the bases of the dimensioning of the mechanical structures and to implement them during design classes based on concrete problems.
◊ Working in groups and knowing how to give back during design classes
◊ Knowing how to combine knowledge acquired in several fields of mechanics
◊ To know how to analyze and shape a mechanical problem to propose a dimensioning and to make a synthesis

Independent study

Objectives: Work on design classes, formatting of results and drafting.
Methods: Study of proposed systems in design classes, preparation of evaluation reports

Core texts


Assessment

Knowledge: 0.8 * test + 0.1 * DC1 + 0.1 * DC2
know how: average ratings of design classes marks
Objectives

The course includes 3 parts (converter control, passive components and electromagnetic compatibility). The main goal is to present fundamental concepts and main power electronics converter structures. Most common converters are considered through the examples studied in each part of the course. During the course, trends and research works in power electronics are presented. Relationships between power electronics and others sciences (automatics, electromagnetics) are also highlighted.

Keywords: power converter control, passive components, electromagnetic compatibility

Programme

Chapters :
- Power converter control
- Passive components
- Electromagnetic compatibility

In practical works, students have to understand the principle of operation of a given power converter, the role of each component and what should be changed on the converter to meet slightly different requirements. For that, they can use measurements, datasheets and literature.

Learning outcomes

◊ Understand fundamental concepts of power electronics and operation principle of most common power converters
◊ Be able to size passive components for a power converter according to specifications
◊ Design a control scheme to control a voltage or a current
◊ Be aware of the open problems in power electronics

Independent study


Methods: Analytic calculations, simulations with Matlab/Simulink.

This work is performed in duo with a student from the option « Electromechanics ». It is concluded by a oral exam.

Core texts


Assessment

Final mark = 0,65 * final test + 0,25 * independant study mark + 0.10 * practical work mark
CONVERSION ELECTROMÉCANIQUE

ELECTROMECHANIC CONVERSION

Lecturers: VAGNON Eric

Lectures: 14 h | TC: 14 h | PW: 6 h | Autonomy: 14 h | Study: 0 h | Project: 0 h | Language: ❓

Objectives

Keywords:

Core texts


ERNEST MATAGNE. Electromécanique - Convertisseurs d'énergie et actionneurs. DUNOD, 2009.
AUTOMATIC CONTROL WITH NONLINEAR PHENOMENA

Objectives

The ever-increasing performance requirements in technological systems have led to the widespread use of feedback control and the emergence of non-linear phenomena. However, the most commonly used correctors are based on the linearity hypothesis, see AF ECS tc2 "Linear control".

The first objective is to present the behaviour of non-linear systems and to introduce methods for predicting the occurrence of these nonlinear behaviours in closed-loop systems designed under the linearity assumption. The course will address how to modify the control architecture to avoid the occurrence of these phenomena. The second objective is to present how to design a control architecture for a system which is described by a non-linear model.

Keywords: Automation, Nonlinear Systems, Control, Analysis

Programme

Introduction and problem formulation
Analysis of closed-loop systems in presence of nonlinearities
Analysis of nonlinear systems: a general approach
Control of nonlinear systems

Learning outcomes

◊ Analysis of a controlled dynamical system behavior in presence of nonlinearities
◊ Control of nonlinear systems
◊ Accounting for nonlinearities in industrial applications

Independent study

Objectives: Develop an engineering design procedure by relying on the knowledge acquired during the AF
Methods: Solve a practical and original control problem in the presence of non-linearities by applying the methods and tools acquired during the AF.

Core texts

G. Scorletti. Commande multi-actionneurs multi-capteurs. ECL.

Assessment

Individual written final test 2 hours (Knowledge) and individual oral evaluation of Autonomy (Know-How). Final note AF=2/3*K+1/3*KH.
Objectives

Increased performance requirements in technological systems have led to the use of advanced correctors (reserved in the past for high-tech systems as aeronautics, aerospace) for common systems (automotive, subway, dwelling or irrigation canals).

Actual industrial challenges lead to highly tight specifications, for more and more complex processes, with shorter and shorter development times. An important issue is therefore to design controllers for systems with several actuators and several sensors, so called multivariable systems (piloting aircraft, space launchers).

Keywords: Automatic, State-space model, State feedback control, MIMO control, Observer

Programme

- Modelling and analysis of dynamic using state-space approach
- Introduction of non-linear-systems analysis
- Modal control (pole assignment)
- Observer and virtual sensor
- Disturbance rejection and Set-point change
- Cases studies

Learning outcomes

- Analyze static and dynamic behaviour of a system
- Design a modal control strategy
- design an observer based on modal strategy

Independent study

Objectives: Apply an engineering process using theoretical and practical knowledge obtained in this course
Methods: Solve a practical and original problem of control using methods and numerical tools presented in this course

Core texts

Lecturers: Christophe Bailly - Julian Scott

| Lectures: 20 h | TC: 16 h | PW: 0 h | Autonomy: 12 h | Study: 0 h | Project: 0 h | Language: 🇫🇷 |

**Objectives**

---

**Keywords:**

---

**Core texts**

ACOUSTIQUE ET ONDES DANS LES FLUIDES
ACOUSTICS AND WAVES IN FLUIDS

Lecturers: Dragna Didier - Gilles Robert

| Lectures: 20 h | TC: 24 h | PW: 4 h | Autonomy: 0 h | Study: 0 h | Project: 0 h | Language: |  |

Objectives

Keywords:

Core texts

AF FLE a 3-EG

ECOULEMENTS SUPERSONIQUES

SUPersonic Flows

Lecturers: Didier Dragna

| Lectures: 16 h | TC: 16 h | PW: 2 h | Autonomy: 10 h | Study: 0 h | Project: 0 h | Language: FR |

Objectives

Keywords:

Core texts

**AF IDM a 1-FH**

**ENDOMMAGEMENT ET RUINE DES MATÉRIAUX**

**DAMAGE AND RUIN OF MATERIALS**

**Lecturers:** Vincent Fridrici, Bruno Berthel

| Lectures: 18 h | TC: 18 h | PW: 0 h | Autonomy: 12 h | Study: 0 h | Project: 0 h | Language: 🇫🇷 |

**Objectives**

**Keywords:**

**Core texts**


AF FLE a 4-EG

THERMIQUE ET COMBUSTION
THERMAL SCIENCE AND COMBUSTION

Lecturers: Jean-Marc Vignon, Mikhael Gorokhovski

Lectures: 20 h  |  TC: 18 h  |  PW: 10 h  |  Autonomy: 0 h  |  Study: 0 h  |  Project: 0 h  |  Language:  

Objectives

Keywords:

Core texts

AMORPHOUS MATERIALS FOR INNOVATIVE FUNCTIONAL STRUCTURES

Lecturers: Maria-Isabel De Barros Bouchet, Michelle Salvia

| Lectures: 12 h | TC: 14 h | PW: 4 h | Autonomy: 0 h | Study: 0 h | Project: 0 h | Language: |
AF IDM a 2-FH

MATÉRIAUX ET TRAITEMENTS DE SURFACE INNOVANTS
MATERIALS AND INNOVATIVE SURFACE TREATMENTS

Lecturers: Stéphane Valette, Stéphane Benayoun

| Lectures: 16 h | TC: 16 h | PW: 4 h | Autonomy: 0 h | Study: 0 h | Project: 0 h | Language:  |

Objectives

---

Keywords:

---

Core texts


AF INF a 1-FH

MULTIMÉDIA : CONCEPTS ET TECHNOLOGIES
MULTIMEDIA: CONCEPTS AND TECHNOLOGIES

Lecturers: Mohsen Ardabilian, Emmanuel Dellandrea

| Lectures: 16 h | TC: 0 h | PW: 18 h | Autonomy: 14 h | Study: 0 h | Project: 0 h | Language: FR |

Objectives

Keywords:

Core texts


BIOMÉCANIQUE DES TISSUS VIVANTS ET BIOMATÉRIAUX PROTHÉTIQUES

BIOMECHANICS OF LIVING TISSUES AND BIOMATERIALS FOR ARTIFICIAL JOINT

Lecturers: Clotilde Minfray, Vincent Fridrici, Thierry Hoc

| Lectures: 20 h | TC: 4 h | PW: 4 h | Autonomy: 18 h | Study: 0 h | Project: 0 h | Language:  

Objectives

For developing artificial joint, it is necessary to know the properties of living materials to choose substitutes. This module proposes a detailed study of the mechanical properties of various living tissues (bone, skin, cell, organ, etc.). The choice of bio-compatible materials for artificial joint will then be discussed in particular the problems generated by the mechanical stresses and the surrounding environment (damage, biocompatibility ...). The aim of the course is to use notions of mechanics and materials science to justify the choices made today in terms of prostheses and bone reconstruction.

Keywords: Biomechanics, Biomaterials, Living tissues (bone), artificial joint

Programme

Biomechanics
The bone: living and anisotropic materials
Soft tissues
From cell to organ
Biomaterials
Family of substitutes materials (Ceramics, metals and polymers)
Properties of biomaterials: biocompatibility, friction and wear, fatigue.
BE: Synthesis of a scientific article on biomaterials

Learning outcomes

◊ Identify mechanical law for living tissues
◊ Know how to explain the process of bone regrowth
◊ Know biocompatibility issues with materials
◊ Know family of materials used in artificial joint

Independent study

Objectives: Case study to increase knowledge on a subject to choose from
Methods: To be done in autonomy by group of two. A written report and an oral presentation are requested.

Core texts


Assessment

Mark = 0.5 x test mark + 0.4 x mark case study + 0.1 x mark BE
Applications concurrentes, mobiles et réparties en Java

Java application programming: Android development, concurrency, distributed applications and graphical user interfaces

Lecturers: Stéphane Derrode - Alexandre Saidi

| Lectures: 20 h | TC: 12 h | PW: 0 h | Autonomy: 0 h | Study: 0 h | Project: 16 h | Language: |

Objectives

Keywords:

Core texts


**Problem Solving Issues**

**Lecturers:** Alexandre Saidi

| Lectures: 8 h | TC: 0 h | PW: 28 h | Autonomy: 12 h | Study: 0 h | Project: 0 h | Language: |

**Objectives**

**Keywords:**

**Core texts**


Data analysis and pattern recognition

Lecturers: Liming Chen, Emmanuel Dellandréa

| Lectures: 14 h | TC: 20 h | PW: 0 h | Autonomy: 14 h | Study: 0 h | Project: 0 h | Language:  |

Objectives

Keywords:

Core texts

INELASTIC BEHAVIOUR OF STRUCTURES

Lecturers: Francesco Froiio, Cécile Nougquier

| Lectures: 12 h | TC: 6 h | PW: 0 h | Autonomy: 20 h | Study: 0 h | Project: 10 h | Language: |

Objectives

To provide a more comprehensive knowledge of the behaviour of elastic and inelastic structures

Keywords: Anisotropy, elastoplasticity, thermoelasticity, viscoelasticity

Programme

Course #1 and #2: Elements of anisotropy and elastoplasticity
Course #3 and #4: Displacement method and its application to the thermoelastic analysis of structures
Course #5 and #6: Structural plasticity

Learning outcomes

◊ Positioning of linear elasticity in a wider theoretical framework
◊ To perform basic viscothermoelastic/elastoplastic analysis of structures
◊ To develop a project-based approach to the resolution of mechanical problems
◊ To deploy either numerical or analytical resolution methods

Independent study

Objectives: Analytical and/or numerical analysis of inelastic structures
Methods: 3 groups of 8 students each will work on as many different projects. The total allocated time for each project is 30 hours (1/3 supervised)

Core texts


Assessment

Closed-book final exam (60% of the final score)
Assessment of the project activity (40% of the final score)
Objectives

Within the framework of General Mechanics and Structural Mechanics, the course is an introduction to the mechanics of vibrations and an opening towards nonlinear phenomena and the stability of mechanical systems.

Keywords: Vibrations, discrete / continuous systems, damping, modal synthesis, nonlinear systems.

Programme

Discrete systems
- Vibration Response
- Isolation and damping of systems
- Modal synthesis

Continuous Systems
- Calculation of beam modes
- Construction of discrete models
- Application of the finite element method

Nonlinear systems
- Stability of mechanical systems

Learning outcomes

◊ Know how to equate a mechanical system in the context of small movements.
◊ Know how to calculate normal eigenmodes and use them in modal synthesis.
◊ Understand the main approximation methods, in particular the finite elements method
◊ Know how to take into account non-linearities in the field of mechanics of vibrations

Independent study

Objectives: To allow the students to assimilate the notions and the concepts seen in course and in design classes
Methods: Formatting of results and writing.

Core texts


Assessment

Knowledge: 0.8 * exam + 0.1 * design classes mark + 0.1 * seminar mark
Know-how: 0.3 * TP mark + 0.35 * design classes mark + 0.35 * TD mark
**Analyse Mathématique des Équations aux Dérivées Partielles**

**Deterministic and Probabilistic Approach for the Heat Equation**

**Lecturers:** Michel Philippe, Grégory Vial

| Lectures: 18 h | TC: 18 h | PW: 0 h | Autonomy: 0 h | Study: 0 h | Project: 0 h | Language: |  |

**Objectives**

The aim of this course is to show diffusive effect from the microscopic point of view (probabilistic) to the macroscopic point of view (PDE and heat equation).

**Keywords:** Partial differential equation, Markov Chains, Mathematical analysis

**Programme**

- Markov chain
- PDE: functional analysis and Fourier

**Learning outcomes**

- study and simulate MC
- use analysis tools to study heat equation
- solve (using Fourier) heat eq

**Independent study**

**Objectives:** solve a complex problem

**Methods:** we avoid the systematic correction of exercises and focus on one chosen (by students) exercise.

**Core texts**


**Assessment**

Note BE*2: 50%
Objectives

This course is a complement of the probability. It focuses on time-depending models. The presented models are the one used in engineering. New corresponding theoretic tools are going to be explained. Models and tools can vary from year to year. We shall consider applications such as filtering, queuing, stochastic models in mechanics. Finally, there will be Matlab simulations.

Keywords: random processes, Markov chains, Gaussian processes, queuing theory

Programme

Probability complements: conditional laws and expectation, Markov chains, Gaussian vectors, Poisson and Gaussian processes.
Applications: Filtering, queuing, ...

Learning outcomes

◊ propose adapted models for time depending random phenomena
◊ master probability technics used to analyse such models.
◊ simulate random processes and use numerical technics for their study.

Independent study

Objectives: 1) Learn to use the new theoretical concept seen during the course. 2) Learn how to model random time-dependent phenomena.
Methods: Preparatory work for solving problems by theoretical and computational means.

Core texts


Assessment

Know-how: practical work with Matlab
Knowledge: 2 hours exam
Objectives

Core texts


Numerical approximation of ordinary and partial differential equations

Lecturers: Laurent Seppecher

| Lectures: 18 h | TC: 18 h | PW: 0 h | Autonomy: 0 h | Study: 0 h | Project: 0 h | Language: FR |

Objectives

Keywords:

Core texts

**Objectives**

Why do some molecules have a therapeutic effect? How to make choices to modify the structure of a molecule, in order to improve its properties for a given application? The course "Molecular and supramolecular chemistry" is a physicochemistry course on the link between the structure of molecules and their physicochemical behavior. This course is not a course in organic chemistry or synthesis of molecules.

The course is based on two main areas of application to illustrate the concepts discussed: pharmaceutical molecules and biomedical analysis.

A significant fraction of the course will be performed as a project by group, using a molecular modeling software to calculate physicochemical properties of molecules of interest.

**Keywords:** Chemistry, Physico-Chemistry, Pharmacochemistry, Molecules, Drugs, Biosensors, Modeling

---

**Programme**

- Introduction to pharmacokinetics and pharmacodynamics.
- Molecular modeling: introduction to molecular mechanics calculations, quantum mechanics.
- Calculations of molecular interactions.
- Application to pharmaceutical molecules:
  - Introduction to supramolecular chemistry.
- Study of physicochemical properties of monomers and polymers by molecular modeling.
- Analysis of experimental data and comparison with modeling results.
- Electrochemical and photoelectrochemical biosensor design from the polymers studied.

---

**Learning outcomes**

- To be able to represent the most stable structure of a complex molecule
- To be able to identify physicochemical properties from a molecular structure
- To know the parameters to control in the development of a drug
- To highlight intermolecular interactions

---

**Independent study**

**Objectives:** Put students in front of concrete problems in the field of molecular and supramolecular chemistry. Discover the design of new drugs, the manufacture of biosensors. Learn how to work in groups in autonomy on a new problem.

**Methods:** Problem Based Learning (PBL); molecular modeling; literature search; Preparation of intermediate reports; oral defense of the work done; Self-assessment exercises on Didactest

---

**Core texts**


---

**Assessment**

Group work (Know-how) + micro-exams & individual examination of 2h without documents (Knowledge)

Rating AF=0.6 *Rating Knowledge+0.4*Rating Know-How
Objectives

Quantum mechanics is one of the most predictive and widespread physical theories we know. It allows us to describe the atoms and constituents of matter, but it also allows to understand the assemblies of molecules, the nature of light and the structure of solids. Quantum mechanics, as a fundamental science, is also at the origin of great applications upon which are based our modern society: most high-tech products are directly derived from quantum concepts (computer, laser, GPS, MRI ...). The objective of this course is to offer an introduction to quantum mechanics and its general principles using the Dirac formalism.

Keywords: Schrödinger Equation, quantum state, Quantum mechanics principles, superposition, Dirac formalism, Hamiltonian, Hilbert space, spin, fermion, boson, indistinguishable particles

Programme

- Back to Wave / Corpuscle Duality - Construction of Quantum Theory
- Measurement / Evolution over time of systems
- The postulates of quantum mechanics
- Two-state systems
- The kinetic moment
- ½ spin
- NMR
- The identical particles
- The fermions, the bosons

Learning outcomes

- Identify the field of application of quantum mechanics and the quantum / classical limit.
- Apply the principles of quantum mechanics
- Use Dirac formalism to solve a problem of quantum mechanics
- Describe the state of several particles and their spin.

Independent study

Objectives: Understand and assimilate the course

Methods: Question and answer sessions, Corrections of forme exams in session, Exercises to be treated

Core texts


Assessment

Final exam 2h (with documents)
Electrochemistry and Chemitronic

Lecturers: Naoufel Haddour

| Lectures: 12 h | TC: 12 h | PW: 8 h | Autonomy: 12 h | Study: 0 h | Project: 0 h | Language: FR |

Objectives

Keywords:

Core texts

**PHYSIQUE DES SEMICONDUCTEURS**

**SEMICONDUCTOR SOLID-STATE PHYSICS**

Lecturers: Christelle Monat

| Lectures: 10 h | TC: 16 h | PW: 0 h | Autonomy: 22 h | Study: 0 h | Project: 0 h | Language:  |

**Objectives**

After a presentation of the basic physics of semiconductors and their related electronic and optical properties, the course will describe some applications of these materials in the areas of microelectronics and optoelectronics.

**Keywords:** Semiconductors, dielectrics, devices, microelectronics, optoelectronics

**Programme**

1/ Cristalline properties and fabrication processes of semiconductor materials  
2/ Band diagrams of semiconductor materials  
3/ Electrical conductivity in a semiconductor material  
4/ Processes of charge transfer in semiconductors  
5/ PN junctions and applications  
6/ Metal/ Semiconductor junctions and Metal/ Insulator/ Semiconductor junctions  
7/ Optoelectronic devices for light detection  
8/ Optoelectronic devices for light emission

**Learning outcomes**

◊ to be able to explain the origin of the physical properties of semiconductor materials and dielectrics  
◊ to be able to use the concepts describing the physical properties of semiconductor materials and dielectrics  
◊ to be able to describe the physical processes related to electrical charge transfer and the electron/ photon interaction in semiconductors  
◊ to be able to explain the way basic semiconductor devices work (transistors, photodiode, solar cell, laser diode)

**Independent study**

**Objectives:** Team work to expand the knowledge on a mature or emerging technological area related to semiconductor physics and its application in microelectronics/ optoelectronics  
**Methods:** Various topics will be suggested and distributed across small groups (possible topics include solar cells, spintronic, single electron transitors, blue LED, graphene and 2D semiconductor materials...)  
Attributed grade through an oral presentation

**Core texts**


**Assessment**

Written exam: 80% of the final grade  
Oral presentation: 20% of the final grade
Embedded Systems Architectures

Lecturers: David Navarro, Cédric Marchand

| Lectures: 16 h | TC: 10 h | PW: 8 h | Autonomy: 14 h | Study: 0 h | Project: 0 h | Language: FR |

Objectives

Keywords:

Core texts

AF STI a 2-FH

ESTIMATION ET TRANSMISSION DE L’INFORMATION

OPTIMAL FILTERING AND INFORMATION TRANSMISSION

Lecturers: Eric Blanco - Julien Huillery

| Lectures: 12 h | TC: 18 h | PW: 4 h | Autonomy: 8 h | Study: 0 h | Project: 0 h | Language: 

Objectives

The growth of communication and information processing systems has led to the emergence of new services. This development is based on an ever greater appropriation by the industrial world of information theory and signal processing methods whose theoretical bases have been presented in the first year course STI tc2.

The objective of the proposed course is to complete the presentation of the basics and methods of signal processing in order to acquire a complete set of tools to address the modeling, analysis and filtering of signals, as well as the operation of communication channels. These principles are found in applications such as telecommunications, software sensors or GPS positioning.

Keywords: Stochastic signals, Generator system, Wiener filter, Kalman filter, Information theory, Source entropy, Channel capacity, Coding theorems.

Programme

Part I: Optimal filtering
1- Stochastic signal
2- Wiener filtering
3- Kalman filtering

Part II: Information Transmission
1- Elements of information theory
2- Entropy and source coding
3- Capacity and channel coding

Learning outcomes

◊ Modelling a signal and build a generator process
◊ Design an optimal filter in the time or frequency domains
◊ Implementing an entropic source coding scheme
◊ Calculate the limits of performance of a communication system

Independent study

Objectives: Implementation and evaluation of a complete system of information transmission through a physical channel. The work includes the realization of the coding/decoding, modulation/demodulation and channel equalization steps.

Methods: Definition of specifications, signal / system modeling, implementation under matlab/simulink, implementation of an evaluation protocol of the proposed solutions. The restitution of the work done in pairs takes the form of an oral presentation.

Core texts


Assessment

Knowledge (70%): 2h-final test (56%), two 1h-microtest (14%)
Know-how (30%): autonomy project
Digital computing and information processing architectures

Lecturers: Ian O’Connor

| Lectures: 16 h | TC: 10 h | PW: 8 h | Autonomy: 0 h | Study: 0 h | Project: 0 h | Language: |

Objectives

Keywords:

Core texts


SMART SENSOR NETWORKS: INTERFACE SYSTEMS

Lecturers: Pedro Rojo Romeo, David Navarro

Lectures: 16 h  |  TC: 10 h  |  PW: 8 h  |  Autonomy: 14 h  |  Study: 0 h  |  Project: 0 h  |  Language:

Objectives

Keywords:

Core texts


PROFESSIONAL MODULES

TEACHER IN CHARGE
Clotilde MINFRAY

DEAN
Grégory VIAL, Dean of Studies
Ségolène CALLARD, Vice Dean of Studies
**Introduction**

The engineering profession (UE Pro) offers strong professionalising skills to students in engineering of Ecole Centrale de Lyon in order to make them operational for their future jobs.

The UE Pro objectives are to enable students in engineering:

- to discover the world of business and various jobs possibilities, thanks to conferences, visits of companies, interviews with engineers...
- to acquire professional skills and to practice them through action-learning activities (projects, sports, internships) that will allow students to quickly integrate into a team, adapt to company culture, to animate groups, to negotiate, to communicate, to manage a project, a team ...
- to think and develop their own professional project.

**Semester**

S5, S6 et S7

**Department**

CLE, EEA, MFAE, MI, MSGMGC, STMS

**Teaching Staff**

toutes les équipes d'enseignement de l'ECL

**Programme**

- tc1 : Conferences
- tc2 : Discovering engineering
- tc3 : Company visit
- tc4 : Blue-collar internship
- tc5 : Sport and physical education
- tc6 : Study Project
- tc7 : Career plan tutoring
- tc8 or tc9 : Research or industrial project
- tc32 : CLIC

**Learning Outcomes**

- Manage a project
- Work as a team
- Manage an engineering project
- Develop its own professional project
- Write a report and perform an oral presentation

**Assessment**

Half-year evaluation depending activities
CONFÉRENCES
Conferences

Lecturers: Vincent Clair, Elise Contraire, Alexis Giauque, Maria-Isabel de Barros Bouchet

| Lectures: 0 h | TC: 9 h | PW: 0 h | Autonomy: 0 h | Study: 0 h | Project: 0 h | Language: 
---|---|---|---|---|---|---|---

Objectives
Conducted by invited personalities, experts in their field, they tackle very varied subjects.

Keywords: General knowledge, Industry, Social issues, Research, Engineering trades, Fields of activity, Engineering tools

---

Programme
3 lectures by half-year in S5, S6 and S7
2 lectures in S8

Learning outcomes
◊ Develop a spirit of openness
◊ Know how to find the information you need for your professional project

Independent study
Objectives: To make the engineering student responsible for the development of his own professional project by choosing his lectures.
Methods: Lecture attendance
Follow-up of external lectures validated by writing a report

Assessment
Validation of the activity through the presence at the lectures (or by writing a report for external conferences, at the rate of one per year maximum)
ENQUÊTE DÉCOUVERTE

DISCOVERING ENGINEERING

Lecturers: Gregory Vial

Lectures: 0 h | TC: 2 h | PW: 0 h | Autonomy: 2 h | Study: 0 h | Project: 0 h | Language: 

Objectives

The objective of this training is to discover various aspects of the engineer’s job. Every student is invited to contact two engineers of his choice and to meet them to talk about their career. Analyzing the different interviews will allow the student to build his own professional project.

Keywords: engineer, career, professional project

Programme

- Interviews of two engineers having different careers
- Oral presentation by group of 6 students, in presence of a professor and an engineer

Learning outcomes

- To understand the realities of being an engineer
- To prepare and lead an interview
- To give an oral report in a limited time
- To build his own professional project

Independent study

Objectives: Establish an individualized relationship with at least two active engineers, if possible from "Ecole Centrale de Lyon", with different profiles.

Methods: Preparation of the meetings (contact, questionnaire, ...)

Report and preparation of the restitution (quick presentation of the survey framework, analysis of the information received and conclusions for the construction of the professional project)

Assessment

Validation of the activity by an oral presentation in front of a jury and showing the attestations of visit fulfilled by the engineers met.
AF PRO tc 3

VISITE D’ENTREPRISES

COMPANY VISIT

Lecturers: Philippe Thimonier

Lectures: 0 h | TC: 8 h | PW: 0 h | Autonomy: 0 h | Study: 0 h | Project: 0 h | Language: 🇫🇷 |

Objectives

Discover the world of business (one day tour).
Discover production sites, warehouses, construction sites.
Become aware of the complexity of a business.
Dialogue with engineers and non-engineers.
Discover engineering professions.
Reflection on a theme related to the company.
Learn about the company and study an industrial theme.

Keywords: Production site, logistics platform, environment, organization, infrastructure, construction site

Programme

The following themes are given to student for reflection:
- Organization of production operations
- Organization of logistics (physical flows)
- Management of sustainable development issues (linked to industrial operations, products, etc.)
- Taking the competitive environment into account in the company’s strategy
- Hygiene, Safety & Working Conditions
- Industrial property (patents, confidentiality, ...)
- Quality approach (actions implemented, standards ...)
- Human Resource Management and Social Relations
- Economic situation & performance of the site
- Innovation, launch of new products
- Equality between women and men

Learning outcomes

◊ Be able to conduct a critical analysis
◊ Be able to put into perspective the solutions of the different companies
◊ Search for relevant information
◊ Prepare a visit

Independent study

Objectives: Through one of the previous themes, become aware of the complexity and diversity of the company’s system.
Methods: Working in groups and writing a report related to one of the themes and companies visited

Assessment

Grade: written report + active participation during visits
Objectives

The internship aims at making the students discover the functioning of a company, the nature of the work of execution and the relations between operators and managers. Completed at the end of the first year, this practical activity carried out in a hierarchical position of performer lasts at least four weeks. It must be completed by the next academic year. The objectives of this course are twofold. On the one hand, it often offers a first contact with the world of the company. On the other hand, it allows to carry out a worker's work, by being integrated into a team of operators, and to observe the relationships between this team and the other components of the company. It is thus an enriching experience for the professional and human training of engineering students.

Keywords: Execution work, integration into a team, organization of the company, relationships between workers and engineers.

Programme

The internship must take place in a private or public company. An internship in another structure can only be accepted under certain conditions (it must correspond to the educational objectives defined above).

The internship should preferably be carried out in a structure in which engineers work.

Industrial enterprises of sufficient size (about 50 people) should be privileged.

The student must be in a hierarchical position of worker. He must be engaged in the activities of the company. He is thus an actor and not merely an observer. The student must be integrated into a work team.

Learning outcomes

◊ Work in a team, integrate into a service, adopt a behavior adapted to the situation
◊ Observe safety procedures and instructions, take note of advice
◊ Analyze the organization of a company, identify its key activities and its different entities
◊ Report on this experience in a report and a presentation following the instructions given

Independent study

Objectives: The search for the internship is done in autonomy as well as the preparation of the report and the presentation.

Methods: For their research internship, the students have different resources (proposed in particular by the direction of the relations of companies). Instructions are provided for the preparation of the report and presentation.

Assessment

The course is evaluated by the company (via a form) and a report and an oral presentation are evaluated by a teacher.
Objectives

The main goals of this training scheme are many. The first one is to maintain and develop physical abilities through individual or collective activities, whether competitive or not; The other one is to develop self-confidence and self-fulfillment. It also aims to make work and to strengthen its skills in a team work. Finally, it allows to develop its capacity for autonomy (time management, taking responsibility).

Keywords: Physical life of adults (health, leisure activities), self-knowledge and others, teamwork, standing by your commitments, autonomy and self-sufficiency.

Programme

2 hours courses with 3 trainings a week and university competitions (on Thursday afternoon) according to the discipline selected from a list of about twenty different activities.

Learning outcomes

◊ To be able to develop and manage their physical and emotional potentials
◊ To know how to surpass.
◊ Getting to know each other better (teamwork).

Independent study

Objectives: The course is organized in such a way as to place the student in a variety of situations requiring a good degree of autonomy.
Methods: Teamwork - situations of self or co-supervision. Sessions completely supervised by the students.

Assessment

Attendance 40%
Level, progress and commitment 60%
Lecturers: Thierry Fargère, Laurent Blanc

| Lectures: 2 h | TC: 18 h | PW: 0 h | Autonomy: 0 h | Study: 0 h | Project: 72 h | Language:  |

**Objectives**

Confronting a complex problem without a single solution
Team project management
The search for skills and information,
The setting up of resources
The achievement of results without achieving the obligation of success, taking into account the formative nature of the approach
Self-assessment of acquired skills
Mastery of written and oral communication.

**Keywords:** Project mode, teamwork, autonomy

**Programme**

Every Wednesday afternoon in autonomy supervised by a scientific tutor.
The Expression and Organization Advisor (EO) helps students to develop communication skills to effectively present and value the work accomplished. It also helps students to organize collaboration among team members. This assistance is provided at the project follow-up meetings and at seven TD "Methods of expression and organization" (TD EO).
The project management consultant (GP) is responsible for training students in project management, ensuring that these rules are applied in the context of their project, and facilitating contacts between the various partners. For that, it supervises 3 sessions of TD GP.
Finally, 2 hours of training in bibliographic research are proposed.

**Learning outcomes**

◊ Draw up specifications, Identify the physical phenomena, the main parameters, the disciplines and skills to be mobilized
◊ Research and synthesize existing solutions (state of the art), Propose an approach adapted to the problem
◊ Structure a project (tasks, responsibilities, planning), Lead a project, Working collaboratively, facilitating a meeting
◊ Write a written document (report, report), Conduct an oral presentation, Accurately represent results

**Assessment**

The evaluation is based:
- on the written report (25%)
- oral defense (25%)
- work done (50%)
ACCOMPAGNEMENT AU PROJET PROFESSIONNEL

CAREER PLAN - TUTORING

Lecturers: Catherine Musy-Bassot, Philippe Thimonier

| Lectures: 0 h | TC: 3 h | PW: 0 h | Autonomy: 0 h | Study: 0 h | Project: 0 h | Language: | F |

Objectives

The construction of his own professional project is one of the major objectives that each student-engineer must achieve during their time at the Ecole Centrale de Lyon. The main objective of this activity is to allow the student to reflect on himself to advance in the construction of his short-term engineer training project and his longer-term professional career project. The accompanying activity to the professional project must allow each student, at their own pace, to conduct their personal reflection on his professional project, even their life plan. The professional project of each student is obviously bound to evolve and deepen during the course of schooling, and well beyond...

Keywords: professional career project

Programme

In order to support the student in their reflection and in the construction of their professional project, a PCP (Principal Adviser) tutor is awarded to each student at the beginning of the course. This PCP tutor will follow their throughout their schooling, at least through 6 Bilateral Meetings (BM) scheduled during the common core. On the occasion of these BM, discussions will take place between the student and the PCP tutor on the progress of the reflection on the professional project and appraisal will be made at certain key moments of the cursus. On these occasions, the PCP tutor will also be able to discuss with the student their integration into the life of the campus and their univertisary results.

Learning outcomes

◊ To set up strategies to build their professional project.
◊ To argue their choices
◊ To conduct their self-assessment

Independent study

Objectives: To build their professional project.
To learn to self assess their professional skills
Methods: Professional skills sheet
CV
Progress report

Assessment

All meetings must occur
All expected reports must be submitted
Objectives

PAi are designed for second-year students who wish to acquire a real experience of project management in an operational situation as part of an engineering problem proposed by an ECL partner. Within a team of 6 students and accompanied by a Project Advisor, the students use the S5 and S6 lessons to offer the Project Sponsor a process that ensures the success of the project, both in terms of quality, cost and time. The PAi is also a space for experimentation or confirmation of the professional choices that students will have to finalize during their second year and which will be the main axes of their third year.

Keywords: Engineering, working in project mode, teamwork.

Programme

The project runs on S7 and S8 for one afternoon per week. Pilotage meetings are organized by the students to report on the progress of the project.

Learning outcomes

◊ Structuring and piloting a project
◊ Putting in place an engineer approach
◊ Define fonctionnal and technical specifications
◊ Write a report and make an oral presentation
**Research Project**

**Objectives**

Research projects are intended for students who wish to acquire a first research experience as part of their curriculum or for those who are simply curious to discover the research.

In a research laboratory of the ECL, all of them internationally renowned, students are initiated, alone or in pairs, in the research activity.

Most often integrated into a research group and sometimes into an existing project, students have the opportunity to meet the various research stakeholders, to discover the many facets of the profession of researcher and the context of academic research in France. They may also be offered the opportunity to participate in the life of the research laboratory hosting them, for example by attending seminars or other events.

**Keywords:** Research, project work

---

**Programme**

The project takes place on S7 and S8 for one afternoon a week.

Supervised by a scientific tutor and accompanied by a project management adviser, students search for and exploit bibliographic data, formulate hypotheses, experiment, simulate or model, face often unexpected results, interpret results, Emit, validate or refute hypotheses, propose new ideas to explore, ...

Project reviews are organized by the students to report on the progress of the project.

---

**Learning outcomes**

- Structuring and managing a project
- Implementing a research approach
- Searching and citing bibliographic references
- Writing a report and making an oral presentation

---

**Independent study**

**Objectives:** Manage a project

Carry out a research work

**Methods:** Bibliographic search: after 4 hour formation, using of online bibliographic databases

Project management using appropriate methods and tools, under the supervision of a project management adviser.

---

**Assessment**

S7: evaluation after a project review and a short report

S8: evaluation of the work and results, of a written report and of an oral presentation
CLIC - CENTRALE LYON INNOVATION CAMP

CLIC - Centrale Lyon Innovation Camp

Lecturers: David Lenoir

| Lectures: 0 h | TC: 2 h | PW: 0 h | Autonomy: 16 h | Study: 0 h | Project: 0 h | Language: 🇫🇷 |

Objectives

- Awareness of all first year student to creativity
- Appropriation and deployment of a methodological tool of creativity (C-K method)

Keywords: Innovation challenge, work in group (x5), C-K method

Programme

Pedagogical process put in place to respond by team of 5 students to an innovation challenge proposed by an industrial partner of Ecole Centrale de Lyon.

2h tutorial: appropriation of C-K method
1h tutorial: how to do a good pitch?
Autonomous work by student teams on 4 days

Learning outcomes

◊ Make ideas emerge
◊ Dare
◊ Realize and create value
◊ Generate individual and collective performance

Independent study

Objectives: Make ideas emerge, present them and convince a jury
Methods: The autonomous work is organized in 3 phases: appropriation of the subject, phase of creativity, restitution.
At the end of the work in autonomy, the students must submit three deliverables and present a pitch of 3 min in front of a jury.

Core texts

STIM. Stim décrypte : LES MÉTHODES D’INNOVATION À l’aide de la théorie C-K. Licence Creative Commons, 2014.

Assessment

The activity is validated by the presence at the tutorial, at the different pitches and by the quality of the work done.
COMMON CORE COURSES

DEAN
Grégory VIAL, Dean of Studies
Ségolène CALLARD, Vice Dean of Studies

LANGUAGES AND CULTURE

TEACHER IN CHARGE
Florence MILLON

DEAN
Grégory VIAL, Dean of Studies
Ségolène CALLARD, Vice Dean of Studies
Introduction
Mastery of the English language is a must. Mastery of several foreign languages is a prized asset. Ecole Centrale de Lyon requires all students to reach a threshold level in English (590 ITP/PBT TOEFL, 825 TOEIC, 7 IELTS) to graduate and offers the opportunity to learn two languages over the first two years of the curriculum. There is a wide choice of languages: Arabic, Chinese, English, French as a Foreign Language, German, Italian, Japanese, Portuguese, Spanish, Russian. Levels range from Beginner (A1) to Advanced (C2). The purpose of the Department is to open our students to linguistic, cultural, geographical, and social diversity, to prepare them for studies with our partner universities or internships abroad. The broader aim is to provide them with the tools to work in international teams, to widen their skills and their ability to adjust professionally and socially.

Programme
1st and 2nd Year: students have to take two language courses (unless their level is low in English or French). Classroom activities vary with languages and levels.
3rd Year: students have to take one language course, a second one is optional.

Learning Outcomes
- Understanding and communicating orally and interactively.
- Reading and writing in one or more languages.
- Being aware of the cultural and intercultural factors in a particular linguistic situation.
- Team-working with one or more languages.
- Analysing, interacting, reporting, summarising in a foreign language.

Assessment
Mean value of language scores. Each language score: 50% continuous assessment, 50% final exam.
Lecturers: WUNDER Waltraut

| Lectures: 0 h | TC: 0 h | PW: 0 h | Autonomy: 0 h | Study: 0 h | Project: 0 h | Language:  

Objectives

First and second year: 2 hours weekly, except for beginners (3 hours)
A1: acquiring basic lexical and grammatical skills. Understanding and using familiar everyday expressions.
A2: widening basic lexical and grammatical skills. Understanding and using language at home and at work.
B1/B2: widening basic lexical and grammatical skills. Learning about the culture of German-speaking countries.
B2+: developing oral skills and learning about culture in general.
C1/C2 (2nd-year course): extending cultural knowledge and becoming aware of cross-cultural issues.

Keywords: cross-cultural - Franco-German relations - project work - news - cross-disciplinary approach - culture - company life

Programme

Subjects are consistent with course levels.
- During S5 and S6, the focus is on social and topical issues: everyday life, campus life, politics, Franco-German relations, the environment, history, the media, cultural specificities, the cinema, literature; CV writing.
- During S7 and S8, the focus is on professional life (company life, job-seeking, the economy, German industry, industrial challenges (energy, sustainable development, auto-making, new technologies).
3rd-year of Double-Degree students can prepare for the Goethe Institut examinations (levels: B1 or B2/C1).
Annual study trip to Freiburg.

Learning outcomes

◊ CEFRL (from A1 to C2), acquiring all competences of expression and understanding
◊ Being able to interact in personal and professional situations
◊ Developing cultural and cross-cultural skills
◊ Acquiring learning and memorising skills

Assessment

Continuous assessment (50%) and final exam (50%)
Objectives

The course focuses on classical Arabic, the language of the press and of the media and on Modern Standard Arabic. It provides an introduction to writing and to communication in Arabic.

Keywords:

Programme

There are two levels: a beginner's course and an intermediate course (both two hours per week).

Learning outcomes

◊ Oral understanding and expression (dialogues and expression in Modern Standard Arabic).
◊ Learning vocabulary through games.
◊ Learning to write (calligraphy).
◊ Learning about culture (discovering the socio-cultural environment, ethnic groups, religions, civilisation, music, and arts).

Assessment

Continuous assessment (50%) and final exam (50%).
Spanish

Lecturers: PASTOR Nathalie

| Lectures: 0 h | TC: 0 h | PW: 0 h | Autonomy: 0 h | Study: 0 h | Project: 0 h | Language:  

Objectives

A1-A2: acquiring basic linguistic and cultural skills in everyday, academic and professional situations.
A2+-B1: widening skills in everyday, academic and professional situations.
B1+-B2: learning skills and acquiring knowledge in wider contexts and more complex situations.
B2+-C1: improving oral skills in cross-cultural situations.
C1+-C2: advanced vocabulary and grammar; exploring cultural, geopolitical and socio-economic background. Quasi-bilingual competence.

Keywords: Spain - Latin America - Europe/Latin America relations - cross-culturalism - diversity - immensity - cross-disciplinary studies - cinema - news - societies - immersion - simulations - projects - Cervantes Institute - doing business in Spanish

Programme

5 levels are offered with both linguistic and sociocultural objectives. The courses focus on oral skills and interaction based on authentic audio and video documents, but writing skills are also targeted. Oral expression is encouraged through custom-made simulations, roleplays, improvisations and projects. The variety of media and topics aims at mirroring the diversity of the Spanish-speaking world. Students can prepare for the DELE test of the Cervantes Institute (levels A2 through C2).

Learning outcomes

◊ CEFRL (from A1 to C2), with special focus on interaction and on cultural or cross-cultural competences.
◊ Mastering language skills for academic and/or professional immersion.
◊ Learning about the various realities of the Spanish-speaking world.
◊ Understanding the cultural and cross-cultural features of the international scene.

Independent study

Objectives: Follow-up work and teamworking

Methods: Autonomous work on articles, novels, novel extracts, film extracts, TV reports. Use of the teaching platform. Fact-finding. Project work.

Assessment

Continuous assessment (50%) and final exam (50%)
Objectives

- Bringing all the students to the level required for validation (590 IPT TOEFL, 825 TOEIC, 7 IELTS). This level is the B2 level of CEFRL ("Independent User - Vantage").

IMPORTANT: the English course is compulsory for students below the threshold level.

- Bringing as many students as possible up to the C1 level of CEFRL ("Proficient User - Effective Operational Proficiency")
- Extending knowledge of the Anglo-Saxon world and of its diversity.
- Improving methodological and rhetorical skills to achieve structured thinking and precise expression.

Keywords: TOEFL, grammatical consolidation, expanding vocabulary, basic linguistic competences, interactivity, debating, civilisation, Anglo-Saxon, United States, United Kingdom, methodology, rhetoric, adjustment, efficiency, credibility, excellence.

Programme

Intensive oral-comprehension exercises (long and demanding material)

Speaking in small student groups: mini-dialogues, simulations, debates, presentations.

Depending on levels:

- revising grammar, expanding vocabulary and idioms, and improving pronunciation.
- studying the civilisation of Anglo-Saxon countries. Notably, acquiring the knowledge and using the interpretative tools to understand the American society from a political, economic, social, societal, geopolitical, and cultural angle.

Learning outcomes

◊ Understanding oral and written English.
◊ Interacting and expressing oneself in English whatever the context.
◊ Comprehending the cultural and civilisational features of the Anglo-Saxon world.
◊ Participating to and leading a debate.

Assessment

Continuous assessment (50%) and final exam (50%)
AF it

ITALIEN
ITALIAN

Lecturers: MILON Florence

| Lectures: 0 h | TC: 0 h | PW: 0 h | Autonomy: 0 h | Study: 0 h | Project: 0 h | Language:  

Objectives

Level 1 (A2+: beginners): acquiring basic skills to understand and be understood at an elementary level.
Level 2 (B1+: students from first year or students with low competence acquired in secondary school): reaching the threshold level required for an academic or professional experience in Italy (Double degree, semester 8, internships).
Level 3 (B2+: third-year students or students with medium competence acquired in secondary school) and 4 (C1+: students from European or international secondary-school programmes): understanding (all media), note-taking, drawing up summaries, speaking individually or in groups, debating.
Preparation for the CELI (Certificato di conoscenza della lingua italiana 2, 3 and 4)

Keywords: Communication, immersion, interaction, simulation, multimedia, culture, arts, task-based approach, projects, exchanges, international, cross-cultural communication and comprehension

Programme

Courses are taught in Italian right from the beginning to acquire immersive comprehension skills. Classes are interactive to enable students to express themselves and speak with each other. The media used in class are varied. Level-1 material is based on practical everyday situations. For level 2 and above, material falls into three categories: the news, culture, and professional life.

Learning outcomes

◊ Communicating with Italians. Getting ready for a stay in Italy. Learning about Italian culture.

CEFRL: L1: A2+, L2: B1+, L3&4: B2+/C
Objectsives

The main objective is to enable students to follow the courses given at École Centrale de Lyon, to be self-reliant in everyday situations and to make the most of their stay in France. The course provides the tools for understanding and communicating about topical and social issues, for interacting with French people on the campus and at work. Foreign double-degree students who have not graduated from secondary school in France have to take a French-as-a-Foreign-Language exam during their stay at Centrale Lyon and obtain at least a DELF B2 level to validate their degree.

Keywords: integration, autonomy, curiosity, interaction, cross-cultural communication, cultural practices, social issues, academic life, working life, oral expression, written expression, oral comprehension, written comprehension

Programme

French is taught through 4 levels with linguistic and sociocultural objectives. During semesters 5 and 6, the focus is on the skills required for oral and written expression and on social and topical issues with a preference for authentic audio and video material. During semesters 7 and 8, the focus is on professional life, on social issues broached through cross-cultural presentations, and on preparation for DELF and DALF tests.

Learning outcomes

◊ CEFRL (from A2 to C2), with special focus on interaction and on cultural or cross-cultural competences.
◊ written expression : letters, CVs, essays, abstracts
◊ oral expression : pair-work, group-work (roleplays, simulations, exposés, debates...)
◊ oral comprehension (mainly through authentic audio and video material : radio, TV, films...)

Independent study

Objectives: Follow-up work, alone or through pair-work to develop learning and memorising techniques.

Methods: Autonomous work on articles, novels, novel extracts, film extracts, TV reports or dedicated language exercises. Presentations, individual or group projects.

Assessment

Continuous assessment (50%) : homework and classroom tests. One end-of-semester test (50%)
PORTUGUES

Lecturers: MILON Florence

| Lectures: 0 h | TC: 0 h | PW: 0 h | Autonomy: 0 h | Study: 0 h | Project: 0 h | Language: |

Objectives

Brazilian Portuguese classes are for beginners and false beginners. They will learn a new language, discover the various features of a continent-scale country and move beyond classic stereotypes.

Portuguese is easy for Romance-language speakers.

Mastery of the language opens the door to a double degree or an internship in Brazil.

Keywords: Brazil - Portugal - Angola - Macao - Portuguese-speaking countries - Latin America - Mercosur

Programme

Courses focus on communication and oral and written comprehension. Classroom activities (roleplays, simulations, presentations, debates, pronunciation) are based on varied authentic material.

A1-A2: immersive acquisition of language and cultural skills in familiar situations, to meet immediate needs in everyday contexts.

A2+-B1: expanding skills to communicate easily in familiar, academic and professional situations. Successfully exchanging information on familiar topics.

For both levels: studying the main historical, political and sociocultural features of Brazil.

Learning outcomes

◊ CEFRL (from A1 to B1), with special focus on interaction and on cultural or cross-cultural competences.

◊ Learning enough skills for academic and/or professional immersion.

◊ Apprehending the various realities of modern Brazil.

Assessment

Continuous assessment (50%) and final exam (50%)
Lecturers: AKUTSU Mariko

| Lectures: 0 h | TC: 0 h | PW: 0 h | Autonomy: 0 h | Study: 0 h | Project: 0 h | Language: |  |

Objectives

Japanese courses are meant principally for beginners, but not exclusively. The aim of the courses is to learn about Japanese culture, acquire basic grammatical skills and widen knowledge of the language and civilisation, both for personal enrichment and for a potential professional experience in the country of the Rising Sun (semester 8, double degree, internship). Teaching is based on everyday and professional situations. Students are encouraged to prepare for the JLPT (Japanese-language test administered by the Japan Foundation.)

Keywords: Hiragana, Katakana, Kanji, culture, business Japanese

Programme

3 levels are proposed with varied material (coursebook, vocabulary and ideogram lists, audio files, etc...)
A1-A2 : 4 weekly hours (grammar 2h, conversation 2h) : learning the Japanese alphabets (Hiragana, Katakana), acquiring basic vocabulary and grammar.
A2-B1 : 6 weekly hours (grammar 4h, conversation 2h) : learning more vocabulary and grammar, learning Chinese characters.
B1-B2 : 4 weekly hours (grammar 2h, conversation 2h)

Learning outcomes

◊ Expressing oneself fluently both orally and in writing on current subjects.
◊ JLPT level 3

Assessment

Continuous assessment (50%) and final exam (50%)
RUSSIAN

Lecturers: MILON Florence
| Lectures: 0 h | TC: 0 h | PW: 0 h | Autonomy: 0 h | Study: 0 h | Project: 0 h | Language: Ⓞ |

Objectives

Russian courses are meant for beginners and non-beginners. Language learning may pave the way for a double degree with a Russian university or for a first-year or second-year internship in Russia. Learning about Russia will help discover the country and move beyond classic stereotypes.

Keywords: international mobility in Russia - Russian-language courses

Programme

First year:
A1-A2: 3 weekly hours
Learning the Cyrillic alphabet
Learning basic grammar
Learning basic vocabulary
Assimilating the main language structures
Discovering the cultural background

Second year:
A2-B1: 2 weekly hours
Expanding basic vocabulary
Expanding basic grammar
Discovering the cultural background

First & second year:
B1-B2: 2 weekly hours
Learning about the sociocultural environment, with a focus on social issues and the news (everyday life, the economy, cultural features...)

Learning outcomes

◊ Developing oral and written comprehension on topics related to everyday life and campus life.
◊ Learning to speak and write on topical issues.
◊ Using language skills in specific situations.
◊ Learning about culture.

Assessment

Continuous assessment (50%) and final exam (50%)
CHINOIS

CHINESE

Lecturers: SUN Cheng

| Lectures: 0 h | TC: 0 h | PW: 0 h | Autonomy: 0 h | Study: 0 h | Project: 0 h | Language: |

Objectives

The Chinese course is for those who wish to discover the Chinese language, culture and civilisation and/or who want to prepare for a stay in China (semester 8, internship, 3rd year or double degree).
There are 4 weekly hours over 3 years.
The course aims at developing oral skills, oral comprehension, written expression and at discovering the various feature of Chinese culture.
Students may prepare for the HSK (Chinese-language proficiency test).

Keywords: Chinese characters, Pinyin, business Chinese, cultural immersion, interaction, international mobility

Programme

First year :
A1-A2 : acquiring basic skills to understand and be understood (Pinyin pronunciation, basic vocabulary, main linguistic structures, most common Chinese characters)
B1-B2 (non beginners) : expanding language skills (in everyday and professional situations), oral and written comprehension, oral expression, note-taking, summaries...
Second year :
A2-B1 : learning more vocabulary and grammar, expanding oral skill through cross-cultural situations.
B2-C1 : expanding language skills (in various fields and more complex situations), learning about the cultural and socio-economic background.
Preparing for HSK level 2, 3 or 4.

Learning outcomes

◊ developing oral expression
◊ developing oral comprehension
◊ developing written expression
◊ Learning about culture

Assessment

Continuous assessment (50%) and final exam (50%)
Ecole Centrale de Lyon
36, avenue Guy de Collongue
69130 Ecully
+33 (0)4 72 18 60 00

www.ec-lyon.fr

Ecole Centrale de Lyon is a member of the Ecoles Centrale group.

@CentraleLyon