TEACHING PROGRAMME

SEMESTERS 5, 6 AND 7
Core courses
S7 - 2019-2020
(For incoming students in 2nd year in 2019-2020)
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### Scientific Modules

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Adapted Maths II : Probability
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Numerical Analysis
Probability
Statistics

PHYSICS AND CHEMISTRY OF MATTER

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Physics
Practical works in Physic and chemistry
Tranversal activity

ECONOMICS AND CORPORATE FINANCE

Business Administration
Economics

HUMANITIES AND SOCIAL SCIENCES

Ethics
Individuals and society
Working nowadays

INFORMATION SCIENCE AND TECHNIQUES

Analog to Digital Conversion
Autonomous work
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PROFESSIONAL MODULES

The engineering profession

Blue-collar internship
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**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
- 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
- Partial differential equations
- Power Electronics
- Probability theory and introduction to random processes
- Problem Solving Issues
- Quantum mechanics and applications
- Semiconductor solid-state physics
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LANGUAGES AND CULTURES

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Dean
Marie-Annick GALLAND, Dean of Studies
Ségolène CALLARD, Vice Dean of Studies

Scientific Modules
# Introduction

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Autonomie
Autonomous work

Lecturers: Christian Vollaire

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

Objectives

Keywords:
Lecturers: Christian Vollaire, Thomas AKA

| 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, pursuit 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 behavior from poles position
- To elaborate a mere control law allowing pole placement on frequential properties
- To implement a numerical regulator from his continuous transfer

Core texts

AF ECS tc 3

Régulation et entrainement électrique
Control and electrical drive

Lecturers: Catherine Musy-Bassot

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

Objectives

Keywords:
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.

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.
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.
**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**

- \( N_1 = \text{know-how grade (involvement in the practical work sessions)} \)
- \( N_2 = \text{methodology grade (oral and written report)} \)
- Module grade = 0,3 \( \times \) \( N_1 \) + 0,7 \( \times \) \( N_2 \)
**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.

**Semester**

S6 ou S7

**Department**

Département MSGMGc

**Teaching Staff**

Mécanique des solides, Technologie, Vibrations

**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, to define the tolerated geometry of the functional surfaces, and to present the means to realize them.

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

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**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.

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**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, define its functional tolerancing and implement manufacturing means 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

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**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.

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**Core texts**


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**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: 20 h | Autonomy: 0 h | Study: 10 h | Project: 0 h | Language: Ⓞ |

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

Intermediate exam 1 and 2 (Technology Project) (50%) + technical drawing (25%) + deliverables of practical works (25%)
Lecturers: Olivier Dessombz, Francesco Froiio
| Lectures: 4 h | TC: 4 h | PW: 0 h | Autonomy: 2 h | Study: 10 h | Project: 0 h | Language: FR |

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
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
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.

Semester
S6 ou S7

Department
Département STMS

Teaching Staff
Matériaux-Mécanique-Physique,
Matériaux-Tribologie-Surface

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
IDM tc 3 : Synthesis

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
IDM tc1 : 65 %, IDM tc2 : 25 %, IDM tc3 : 10 %
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.
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.
Objectives

This activity is transverse to the IDM (Materials Engineering) and PCM (Physical Chemistry of Matter) teaching units. Students must be able to solve a problem using their knowledge gained in the two teaching units. The topic is related to the field of materials, radiation and chemistry. The topics addressed are related to technological (nanotechnologies, information, ..) or societal (environment, energy, ..) issues. The pedagogy uses the problem-based learning (PBL) approach and the students work in small groups.

Keywords: Chemical, optical and mechanical properties of materials, nanotechnologies, radiation, science and engineering of materials.

Programme

Session 1: Brainstorming on a scientific topic related to the IDM and PCM teaching units, definition of the problem (in a group of 12 students)
Session 2: Oral presentation by the group

Learning outcomes

◊ To know how to use his knowledge to solve an interdisciplinary problem.
◊ Be able to work in group.
◊ To know how to develop a state of the art from some documents.
◊ Be able to conduct a brainstorming meeting and to present the results in an oral form.

Independent study

Objectives: To work in group on a transverse problem, to know how to identify a problem and to propose some solutions.
Methods: The pedagogical method used is the problem/project-based learning (PBL).

Assessment

Participation in the brainstorming session
Oral presentation in the form of a lecture
Introduction

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)
Lecturers: Mohsen Ardabilian, Alexandre Saidi

| Lectures: 8 h | TC: 18 h | PW: 0 h | Autonomy: 6 h | Study: 0 h | Project: 0 h | Language: | 

Objectives

Keywords:

Core texts


Object-Oriented Design and Programming

Lecturers: Emmanuel Dellandréa

| Lectures: 8 h | TC: 18 h | PW: 0 h | Autonomy: 6 h | Study: 0 h | Project: 0 h | Language: fr |

Objectives

Keywords:

Core texts

Projet d’application Web
WebApp Lab (Projet d’Application Web)

Lecturers: René Chalon, Daniel Muller

Lectures: 8 h | TC: 11 h | PW: 0 h | Autonomy: 13 h | Study: 0 h | Project: 0 h | Language: 

Objectives

Keywords:

Core texts


LEONARD RICHARDSON, MIKE AMUNDSEN, SAM RUBY. *RESTful Web APIs*. O’Reilly, 2013.
**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%
Elastic Solid Mechanics

Lecturers: Jean-Jacques Sinou, Fabrice Thouverez, Olivier Bareille, Laurent Blanc, Joël Perret-Liaudet

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, continuous 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.

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 Cécile Nouguier

| 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.
Lecturers: Didier Lacour

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

**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.
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 behavior. 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 mold, 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**

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.

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<tr>
<th>Semester</th>
<th>Programme</th>
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<td>S5</td>
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<td>MTH tc 4 : Statistics</td>
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<td>MTH tc 5 : Adapted Maths I Algebra-Analysis</td>
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<td>MTH tc 6 : Adapted Maths II Probability</td>
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<table>
<thead>
<tr>
<th>Learning Outcomes</th>
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</thead>
<tbody>
<tr>
<td>◊ Use a concept or a mathematical principle to describe a problem</td>
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<tr>
<td>◊ Model a random experiment by means of random variables</td>
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<tr>
<td>◊ Identify the various stages of the numerical simulation of phenomena</td>
</tr>
<tr>
<td>◊ Master the basic tools in mathematical analysis</td>
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<tr>
<td>◊ Use the basic functions of a software for numeral calculation or statistics</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Requirements</th>
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</thead>
<tbody>
<tr>
<td>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</td>
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<table>
<thead>
<tr>
<th>Assessment</th>
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</thead>
<tbody>
<tr>
<td>weighted average: MTH tc1/tc5 : 40%, MTH tc2 : 30%, MTH tc3/tc6 : 15%, MTH tc 4: 15%</td>
</tr>
</tbody>
</table>
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

- Topology and differential calculus
- Integration and weak derivative
- 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

Objectives

Keywords:

Core texts


**Objectives**

This 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.

**Keywords:** Probability laws, Random variables with density, Gaussians vectors, numerical simulations

---

**Programme**

1) Random Variables (Probability, density, distribution function)
   2) Mean, Variance
   3) Random vectors
   4) Asymptotics Theorems

**Learning outcomes**

◊ Modelling a random situation with random variables
◊ Simulations with MATLAB
◊ Doing some calculus with computers

**Core texts**

Lecturers: Elisabeth Mironescu, Christophette Blanchet

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

Objectives

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

Keywords: Estimators, parametric tests, linear regression

Programme

1) Estimators
2) Estimators with confidence intervals
3) Statistical tests
4) Linear Regression

Learning outcomes

◊ Be able to propose statistical hypothesis tests adapted to various engineering situations
◊ Be able to manage hypothesis tests on Excel
◊ Be able to run numeric calculus to solve statistical inference problem
◊ Be able to construct and analyze a linear regression

Core texts


MARIO LEFEBVRE. *Probabilités, statistiques et applications*. Presse Internationales, 2011.

PIERRE DAGNELIE. *Statistique théorique et appliquée*. Deboeck supérieur, 2011.
AF MTH tc 5

Mathématiques adaptées I : analyse-algèbre
Adapted Maths I : Analysis-Algebra

Lecturers: Abdelmalek Zine

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

Objectives

This AF deals with basic tools used in Algebra and Mathematical Analysis: Vectorial spaces, Polynomials, Matrices and reduction, Integration, Fourier analysis

Keywords: Polynomials, Hilbert spaces, Projection, Matrix reduction, Integration, Fourier analysis, Functional spaces

Programme

A-Algebra
- Polynomials
- Hilbert space, Euclidian space
- Matrix, determinant
- Eigenvalue, eigenvector
- Singular value, condition number

B-Analysis
- Refresher course
- Lebesgue integral
- Basic theorems and basic functional spaces
- Fourier series
- Fourier transform

Learning outcomes

◊ Master the basic concepts of algebra
◊ Justify the integral calculation for multivariate functions
◊ Identify the functional spaces used in Fourier analysis
◊ Compute a Fourier series expansion and a Fourier transform

Core texts

C. GASQUET, P. WITOMSKI. Analyse de Fourier et applications. MASSON, 1990.
Objectives

This course deals with the modelization 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.

Keywords: Probability laws, Random variables with density, Gaussians vectors, numerical simulations

Programme

1) Random Variables (Probability, density, distribution function)
2) Mean, Variance
3) Random vectors
4) Asymptotics Theorems

Learning outcomes

◊ Modeling a random situation with random variables
◊ Simulations with MATLAB
◊ Doing some calculus with computers

Core texts

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
PCM tc 4 : Analysis

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 : 30%, PCM tc4 : 5%
**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**

Microtest 25 min without document.
Final exam 2H with personal manuscript form (2 sheets)
Final mark = 15% microtest + 85% final exam
Objectives

This course aims at introducing basis of materials chemistry & 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
- Weak bonds
- Chemical reactivity and kinetics
- Electronic transfers at interfaces

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 theoretic notions and use them for new concrete cases

Independent study

Objectives: Understand the relationships between different notions of the course; Be able to mobilize concepts of the course in new concrete situations

Methods: Auto-evaluation exercises (plate-form Didactest)
Tutorials to prepare in autonomy and defend orally

Core texts


Assessment

- Final exam (1h) without document: 70% knowledge
Travaux Pratiques de Physique-Chimie
Practical works in Physic and chemistry

Lecturers: Virginie Monnier, José Penuelas

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

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 or Scanning Tunneling Microscopy – Structural analysis of matter
- Infrared thermography/Solar cell
- Spectrophotometry of Optical Fiber – Principle and application to sensors

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)
Work (Know-how, 50%)
Written report (Methodology, 30%)
Objectives

This activity is transverse to the IDM (Materials Engineering) and PCM (Physical Chemistry of Matter) teaching units. Students must be able to solve a problem using their knowledge gained in the two teaching units. The topic is related to the field of materials, radiation and chemistry. The topics addressed are related to technological (nanotechnologies, information, ..) or societal (environment, energy, ..) issues. The pedagogy uses the problem-based learning (PBL) approach and the students work in small groups.

Keywords: Chemical, optical and mechanical properties of materials, nanotechnologies, radiation, science and engineering of materials.

Programme

Session 1: Brainstorming on a scientific topic related to the IDM and PCM teaching units, definition of the problem (in a group of 12 students)
Session 2: Oral presentation by the group

Learning outcomes

◊ To know how to use his knowledge to solve an interdisciplinary problem.
◊ Be able to work in group.
◊ Know how to develop a state of the art from some documents.
◊ Be able to conduct a brainstorming meeting and to present the results in an oral form.

Independent study

Objectives: To work in group on a transverse problem, to know how to identify a problem and to propose some solutions.
Methods: The pedagogical method used is the problem/project-based learning (PBL).

Assessment

Participation in the brainstorming session
Oral presentation in the form of a lecture
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%
**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

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**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

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**Independent study**

**Objectives:** Understand the class sessions
**Methods:** Readings

---

**Core texts**

**Combe E..** *Précis d’économie.* PUF, 2014.

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**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%
# Humanities and Social Sciences

**Director:** Nicolas Hourcade  
**ECTS:** 64hTD. 5 ECTS

## Introduction

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<td>Department</td>
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<td>CLES</td>
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<tr>
<td>Teaching Staff</td>
<td>Sciences Humaines et Sociales - Economie et Gestion</td>
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</tbody>
</table>

AF SHS tc 1

*Individus et société*
*Individuals and society*

**Lecturers:** Nicolas Hourcade et Jacqueline Vacherand-Revel

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

**Objectives**

**Keywords:**
Lecturers: Nicolas Hourcade et Jacqueline Vacherand-Revel.

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

Objectives

Keywords:
Lecturers: Vincent Beaubois et Laure Flandrin

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

Objectives

Keywords:

Core texts


**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).

**Programme**

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<td>STI tc 0 : Autonomous work</td>
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<tr>
<td>STI tc 1 : Electronic systems</td>
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<tr>
<td>STI tc 2 : Signal processing</td>
</tr>
<tr>
<td>STI tc 3 : A/D conversion for audio systems</td>
</tr>
</tbody>
</table>

**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%
Autonomous work

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)
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

SANGIL PARK. Principles of Sigma-Delta modulation for analog-to-digital converters. Rapport Technique Motorola APR8, 0.


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.
Common Core Courses

Dean
Marie-Annick GALLAND, Dean of Studies
Ségolène CALLARD, Vice Dean of Studies

Professional Modules

Teacher in Charge:
Clotilde MINFRAY
**Introduction**

The engineering profession (UE Pro) offers strong professionalizing 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**
CLES, EEA, MFAE, MI, MSGMGC, STMS

**Teaching Staff**
toutes les équipes d'enseignement de l'Ecole Centrale de Lyon

**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

**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
Lecturers: Elise Contraires, Alexis Giauque, Carole Sanchez, Maria-Isabel de Barros Bouchet

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

**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)
**Discovering engineering**

**Lecturers:** Marie-Annick Galland

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

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**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

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**Programme**

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

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**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

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**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)

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**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**  
**Compagny 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 students 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.
Lecturers: Jean Cotinaud

| Lectures: 0 h | TC: 0 h | PW: 90 h | Autonomy: 0 h | Study: 0 h | Project: 0 h | Language: |

### 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: Laurent Blanc

| Lectures: 2 h | TC: 18 h | PW: 0 h | Autonomy: 0 h | Study: 0 h | Project: 80 h | Language: FR |

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: |

### Objectives

The construction of his own professional project is one of the major objectives that each student-engineer must achieve during his 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 his / her own pace, to conduct his / her personal reflection on his professional project, even his /her 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 his / her reflection and in the construction of his / her professional project, a PCP (Principal Adviser) tutor is awarded to each student at the beginning of the course. This PCP tutor will follow him / her throughout his / her 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 his / her integration into the life of the campus and his / her universitary results.

### Learning outcomes

◊ To set up strategies to build his / her professional project.
◊ To argue his / her choices
◊ To conduct his / her self-assesment

### Independent study

**Objectives:** To build his / her professional project.

To learn to self assess his / her 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 Ecole Centrale de Lyon 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 functional and technical specifications
◊ Write a report and make an oral presentation
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 Ecole Centrale de Lyon, 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
Common Core Courses
Dean
Marie-Annick GALLAND, Dean of Studies
Ségolène CALLARD, Vice Dean of Studies

In-depth Elective Modules
Teacher in Charge:
Emmanuel BOUTLEUX
Introduction

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**Department**
EEA, MFAE, MI, MSGMGC, STMS

**Teaching Staff**
Toutes les équipes d'enseignements scientifiques
Lecturers: Emmanuel Rigaud, Bertrand Houx

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

Objectives

Keywords:

Core texts

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

- GEORGES SPINNLER. *Conception des machines, tomes 1, 2 & 3*. Presses polytechniques et universitaires romandes, 1997.

Assessment

Knowledge: 0.8 * test + 0.1 * DC1 + 0.1 * DC2
know how: average ratings of design classes marks
Lecturers: Florent Morel, Christian Vollaire

| Lectures: 12 h | TC: 12 h | PW: 6 h | Autonomy: 10 h | Study: 2 h | Project: 0 h | Language:  |

### 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

**Objectives:** Basic sizing of a system including an electromechanical actuator and a power electronic converter. Choice of power electronic converter structure. Sizing of components. Control loop design.

**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 * independent study mark + 0.10 * practical work mark
Lecturers: François Buret, Thomas Aka

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

Objectives

Keywords:

Core texts


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

- Modeling 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 behavior 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

Turbulences et instabilité
Turbulences and instability

Lecturers: Julian Scott, Daniel Juve

| 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: Daniel Juve, Christophe Bailly

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

Objectives

Keywords:

Core texts


Lecturers: Isabelle Trébinjac

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

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

Objectives

Keywords:

Core texts

AF IDM a 3-EG

Matériaux amorphes pour structures fonctionnelles innovantes
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: 🇫🇷 |

Objectives

Keywords:
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


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


**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: Charles-Edmond Bichot

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

Objectives

Keywords:

Core texts

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


Comportement anélastique des structures
Inelastic behaviour of structures

Lecturers: Francesco Froio, Cécile Nouguier

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

Objectives

To provide a more comprehensive knowledge of the behavior 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
Lecturers: Martine Marion

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

Objectives

Keywords:

Core texts


**Serre D.**. *Systèmes de lois de conservation 1*. Diderot, 1996.
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, queing 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 technical used to analyze such models.
◊ simulate random processes and use numerical techniques 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
Lecturers: Christian de Peretti

| Lectures: 32 h | TC: 4 h | PW: 0 h | Autonomy: 12 h | Study: 0 h | Project: 0 h | Language: FR |

Objectives

Keywords:

Core texts


Approximation numérique d’équations différentielles et aux dérivées partielles
Numerical approximation of ordinary and partial differential equations

Lecturers: Grégory Vial

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

Objectives

Keywords:

Core texts

AF PCM a 2-FH

Chimie Moléculaire et Supramoléculaire
Molecular and Supramolecular Chemistry

Lecturers: Jean-Pierre Cloarec, Naoufel Haddour, Virginie Monnier-Villaume

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

Objectives

Keywords:

Core texts

Lecturers: Ségolène Callard, José Pénuélas

| Lectures: 18 h | TC: 18 h | PW: 0 h | Autonomy: 12 h | Study: 0 h | Project: 0 h | Language: {fr}

Objectives

Keywords:

Core texts

Electrochimie et Chimitronique
Electrochemistry and Chemitronic

Lecturers: Guy stremsdoerfer, Naoufel Haddour

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

Objectives

Keywords:

Core texts

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

- Cristalline properties and synthesis of semiconductor materials
- Band diagrams of semiconductor materials
- Electrical conductivity in a semiconductor material
- Phenomena of charge transfer in semiconductors
- Dielectrics: properties and applications
- Examples of electronic devices
- Optoelectronic devices: detection and 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 strengthen a specific or emerging 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, spintronics, 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
Lecturers: David Navarro, Cédric Marchand

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

Objectives

Keywords:

Core texts

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

◊ Modeling 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


Capteurs intelligents communicants : systèmes d’interface
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


Languages and Cultures

Teacher in Charge:
Florence MILLON
## Introduction

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## Department

- CLES

## Teaching Staff

- 8 enseignants titulaires, 3 contractuels et une trentaine de vacataires.

◊
Lecturers: MILON Florence

Objectives

Keywords:
Lecturers: MILON Florence

Objectives

Keywords:
Lecturers: NOIROT Jérôme

Objectives

Keywords:
Lecturers: WUNDER Waltraut

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Keywords:
Lecturers: COGNET Anne

Objectives

Keywords:
Lecturers: PASTOR Nathalie

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Keywords:
Lecturers: MILON Florence

Objectives

Keywords:
Lecturers: AKUTSU Mariko

Objectives

Keywords:
Lecturers: MILON Florence

Objectives

Keywords:

Core texts

M.ZELTCHENKO. *Je parle russe. Niveau 1*. ellipses, 0.
Lecturers: SUN Cheng

Objectives

Keywords: