ISAE-SUPAERO Engineers
Academic program 2019-2020
1st year
ISAE-SUPAERO Engineers
Academic program 2019-2020

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This lecture focuses on basic foundations of algorithms, data structures and imperative programming. Its main objective is to provide to the students the necessary knowledge and know-how to design and implement middle-size software, whatever the application field is. The C programming language will be used in order to illustrate algorithmics and to understand how a program executes on a computer.

OVERALL OBJECTIVES
During the lecture, emphasis will be put on algorithmics skill, structured programming in C, usual data structures and good practices for developing software.

Algorithmics
- design an algorithm and/or a data structure (linear data structures, trees, graphs) given a particular problem;
- evaluate the worst-case complexity of an algorithm;
- write an algorithm in a procedural language.

Programming
- write a program in the C programming language to implement an algorithm or a data structure;
- debug a program written in C;
- understand what happens during the execution of a program: memory model (stack and heap), linking.

Software engineering
- decompose a problem into subproblems;
- understand a specification;
- document code;
- apply coding rules.

ASSESSMENT
There will be 2 marks in the lecture:
- an individual miniproject (40% of overall grade)
- a written exam (60% of overall grade)

BIBLIOGRAPHY
The core course of applied mathematics has a multidisciplinary vocation. It aims at giving the necessary background and mathematical tools for the whole curriculum: aerodynamics, structural mechanic, automatic control, etc.

This course has three main fields of application:

- Modelling and simulation: identification of the model, reformulation and resolution with MATLAB.
- Signal processing: identify the different Fourier transforms, use them for the appropriate equations either in continuous or discrete context, combine them, solve filtering problems.
- Analysis for big data: identification of laws of probability, reformulation of the models, use statistics.

The course is organized as follows:

- Deterministic Mathematics (60h)
  - Optimisation (20h)
  - Functional analysis, Harmonic analysis, Numerical analysis (40h)
- Random Mathematics (30h)
  - Probability (15h)
  - Statistics (15h)
1st year
1st semester

SCIENTIFIC COMMON CORE
FLUID MECHANICS AND THERMODYNAMICS

Program coordinator: Sébastien DUPLAA

This teaching contributes to the acquisition of essential knowledge for any engineer graduated from ISAE. It aims to lay the foundations of the thermodynamics applied to the engineer, to expose physics of the models governing the mechanics of fluids, and to address the concept of propulsion. Students will obtain the fundamentals to understand and analyze the operation of the different types of thermal machines that surround us. They will apprehend the phenomenology of fluid flows in various configurations; they will obtain the keys of the analysis of the forces exerted on an obstacle, a profile. Finally, they will discuss the propulsion systems and their operating characteristics.

BIBLIOGRAPHY

Maurice Bailly, Thermodynamique technique – Tome 1 – Chaleur, principes, gaz et vapeurs, Bordas, 1971
Maurice Bailly, Thermodynamique technique, 2a. production transfert de la chaleur – écoulements, Bordas, 1971
Maurice Bailly, Thermodynamique technique 2b. machines thermiques et frigorifiques – tables numériques, Bordas, 1971
The main objective of this course is to study motion equations for solid bodies, and apply it to model the behaviour and trajectory of space and air vehicles. This ability to derive a model will be used in many other applied mechanics courses like aerodynamics, structure mechanics, air and space vehicles dynamics, engines, robotics, systems identification and control.

The course is built in three sequences: classical mechanics, flight mechanics, and celestial mechanics.

**OVERALL OBJECTIVES AND SKILLS**

Classical mechanics: get a detailed knowledge of and be able to apply classical mechanics theory to find the motion of multiple interacting solid bodies in translation and rotation. Be able to determine equilibrium conditions, as well as static and dynamic stability.

Celestial mechanics: Get a general knowledge of problems and tools for celestial mechanics: two and three bodies problems, Hamiltonian, spin-orbit coupling.

Aircraft flight mechanics: Get a thorough understanding of the balanced flight of an aircraft and study the quantities governing it. This includes the evolution of parameters and state during changes of trajectory (climbing, descending, turning, ...). The role and function of the various parts of the airframe will be known and the students will be able to understand the basics of aircraft design and performance, as well as to analyse accident reports.

**ASSESSMENTS**

Written exams and tutorial reports.

**BIBLIOGRAPHY**

Yves Gourinat, Exercices et problèmes de mécanique des solides et des structures. Application à l’aéronautique et l’aérospatiale, coll. Sciences Sup., Dunod
This teaching aims to give to any graduate engineer of ISAE a multidisciplinary culture in mechanics of materials and structures so that he can interact with expert engineers but also understand the complex cross-functional approaches of structural design.

This course consists of 2 parts. The first one is dedicated to Mechanics of Materials (26h). It presents the families of materials and their properties and introduces the fundamentals of mechanical sizing, in particular the basic concepts of stress and strain as well as constitutive laws that connect them. The second part addresses the first elements of Structural Analysis (20h). Using the basics introduced in the first part, it focuses on the design of beam structures. The additional elements of Structural Analysis will be seen in the 2nd year.

**BIBLIOGRAPHY**

S. Timoshenko, Résistance des matériaux, tome 1 et 2, Librairie polytechnique, 1954.
The aim of the physics lectures is to reinforce the scientific basis of any engineer with fundamental and transversal courses allowing him to address several disciplinary fields. The introduction of modern concepts will also bring a technical clarity to any engineer facing a problem in rupture with classical modeling.

First year will introduce special relativity, quantum physics and statistical physics. The main objective will be:
- to raise awareness among students to high speed physics, to the laws of the microscopic world and to assess problems involving a great number of particles.
- to bring about an awareness of the non-intuitive nature of the laws of physics in these different fields.

The concepts introduced will allow students to have minimum benchmarks necessary to follow current evolutions of both the physics of the infinitely small and the infinitely large…

OVERALL OBJECTIVES AND SKILLS
- to know how to describe the laws of contemporary physics within the limits of high speeds, at microscopic scales and involving a large number of particles;
- to question classical notions of space and time;
- to describe the quantum world and its laws;
- to know the need for a statistical approach to deal with problems with a large number of particles;
- to master the associated orders of magnitudes.

Special relativity (10h)
- Galilean relativity and electromagnetism;
- relativity principle;
- Lorentz transformation and its consequences;
- space-time structure;
- introduction relativistic dynamics;
- Global Positionning System and relativity.

Quantum Physics (20h)
- Introduction to quantum physics
- Schrödinger equation, wave function and its application to wells and barriers of potential
- Postulates of quantum physics
- Quantum harmonic Oscillator
- Spin of a particle
- Introduction to entangled states

Equilibrium statistical physics (20h)
- Introduction to statistical physics , micro and macro-states
- Properties of particles
- Statistical Boltzmann entropy ;
- Study of microcanonical, canonical and grand-canonical systems
- Properties of ideal gas
- Einstein and Debye models for the thermal properties of solids
- Quantum ideal gases of fermions and bosons
- Photon gases and blackbody properties – Bose-Einstein condensation
- Electrons in metals.

ASSESSMENTS
Quizzes, homework and final exams.

BIBLIOGRAPHY
Relativité et Invariance, 2nde édition, J.-P. Pérez, Dunod (2011)
Introduction à la relativité restreinte, J. Hladik & M. Chrysos, Dunod (2006)
Relativité restreinte, bases et applications, 2nde édition, C. Semay & B. Silvestre-Brac, Dunod (2010)
Physique quantique, M. Le Bellac, EDP Sciences (2007)
Quantique, fondements et applications, J.P. Perez, R. Carles et O. Pujol, DeBoeck (2013)
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1st year
1st semester

PHYSICS (END)

- Physique statistique à l’équilibre et hors équilibre, 3e édition, C. Ngô & H. Ngô, 2008, Dunod

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The scientific common core Signals and Systems provides students with the basics to understand the key principles of acquisition systems, controls and information transmission. A wide technical scope is covered such as electrical engineering, electronics (analog and digital), automatics, signal processing and telecommunications.

**ORGANIZATION**
The common core Signals and Systems takes place in the first and second years with a 125h face-to-face training program.

In 1st year, three topics are addressed during a 55h face-to-face training:
- on-board electric systems;
- deterministic signal processing;
- electronics.

Courses are given as lectures, (marked or unmarked) seminars, practicals. Interactive tools may be used during lectures. A project-based learning approach is favored to introduce signal processing tools through three applications (radar, communications, navigation).

**TOPICS AND LEARNING OBJECTIVES**
- use conventional time and frequency representations of deterministic signals;
- understand and use fundamentals processing techniques (filtering, transmission);
- analyze and design electrical and electronic functions and systems

**SCHEDULE**

- On-board electric systems (10h)
  - AC/DC systems;
  - electric power generation;
  - power conversion;
  - electric power consumers in aeronautics.
- Deterministic signal processing (20h)
  - signal representation and analysis in the time and frequency domains (Fourier);
  - filtering: definition (convolution), effects (input-output relations);
  - correlation function (energy/power spectral density).
- Electronics (35h)
  - Digital electronics
    - from transistor to logic gates;
  - binary number memorization, memory organization;
  - sequential logic and finite state machine synthesis;
  - example of digital system (processor).

**Analog electronics**
- electronic functions for acquisition chains;
- electronic components (basic and semi-conductors);
- noise in electronics;
- digitization;
- phase lock loop, frequency synthesis, transposition and tracking.

**PREREQUISITES**
- on-board electric systems: fundamentals on electrokinetics and electricity;
- deterministic signal: TCS1-MA (functional and harmonic analysis);
- electronics: fundamentals on electrokinetics, Boolean algebra, Karnaugh maps, binary code.

**ASSESSMENT**
- on-board electric systems: marked seminar (CAD), short written exam;
- deterministic signal: MCQ, technical report;
- electronics: marked seminar, written exam.

**BIBLIOGRAPHY**
G. Séguier, Électrotechnique - 9e édition: Structures, fonctions de base, principales applications, Dunod, 2011
T. Wildi, Électrotechnique, 4e édition, De Boeck, 2005
Lus Lasne, Electrotechnique et énergie électrique - notions fondamentales - Machines -
Réseaux, 2e édition, Dunod, 2013
School of Computer Science: http://www.edwardbosworth.com/

ENGINEERING & CORPORATION COMMON CORE

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1st year
1st semester

ENGINEERING & CORPORATION COMMON CORE

2.5 ECTS
44 h

IE101

ENGINEERING & CORPORATION COMMON CORE 1

JEU D’ARIANE (24 H)
Program coordinator: M. AMAMI

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ENGINEERING & CORPORATION COMMON CORE

ENGINEERING & CORPORATION COMMON CORE 1

THE FIRM AND ITS ENVIRONMENT (20 H)
Program coordinator: P. ROUSSELOT

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INDUSTRIAL MARKETING (20 H)
Program coordinator: L. GAMBINO

OBJECTIVES OF THE MODULE

- Be able to distinguish between industrial or technological marketing (BtoB) and consumer marketing (BtoC);
- Be able to analyze a relevant industrial or technological market;
- Understand the mechanisms for defining strategies in industrial markets;
- Know the principles of operational implementation of marketing plans on industrial or technological markets.

GLOBAL OBJECTIVES KNOWLEDGE AND SKILLS

Contributions for the engineering career

- for those who will remain in technical careers: Better communication skills with Marketing and sales teams as well as with customers, thanks to an understanding of Marketing culture. Never forget the stakes of marketing, constantly creating value for the customer, in order to stand out more and more competitors! Know that you will need to give an economic and competitive dimension to your scientific and technical approach in business;
- for those who will have mixed careers: A capacity for immediate apprehension of the realities of the market.

MODULE PLAN

Generalities and particularities of the industrial markets
- Introduction and generalities;
- Structure of industrial markets;
- The behavior of industrial purchasing;
- Market studies and monitoring in the industrial world.

The construction of the strategy on B to B markets
- The basics of strategic B to B analysis;
- Strategic analysis tools applied to B to B;
- Development of the marketing plan;
- Examples and precautions to be taken.

Action on B to B markets
- Constraints and specificities of the operational phase in B to B;
- Mix in B to B;
- Control and adjustment of the action (CRM);
- Elements of success in operational matters.

ASSESSMENTS
Test sur table en fin de module (Mini cas et questions de cours).
PROJECT MANAGEMENT (20 H)
Program coordinator: Rob VINGERHOEDS

The objective of this course is to prepare the student for project management, an integral part of the work of an engineer. The goal of the first year is to acquire the basics of project management. This involves:

- Familiarising with the vocabulary of Project Management;
- Understand the stages (milestones) of a project realization;
- Knowing the deliverables expected at each milestone;
- Knowing the planning tools of a project;
- Monitoring of projects.

GLOBAL OBJECTIVES KNOWLEDGE AND SKILLS
The Project Management module is spread over the three years of the engineering cycle with the following objectives:

First year «The engineer in his environment»: The goal of the first year is to acquire the basics of project management. This involves:

- Familiarising with the vocabulary of Project Management;
- Understand the stages (milestones) of a project realization;
- Knowing the deliverables expected at each milestone;
- Knowing the planning tools of a project;
- Monitoring of projects.

Second year «The Dynamics of Engineering»: The goal of the second year is to deepen the knowledge of project management. This results in:

- Deepening the bases for real situations,
- Being aware of the business world, understand the financial and economic mechanisms, know how to build a Business Plan
- Knowing risk management
- Framing projects and making commitments
- Knowing projects controls.

Third year «To be autonomous in his role of engineer»: The goal of the third year is the know-how of project management. This involves:

- Understanding management of complex projects
- Knowing how to identify and control the risks of a project,
- Understanding the importance of a Quality Plan,
- Understanding the human dynamics in a project team.
- Knowing how to motivate a project team.

The chosen theme aims to progress from the first year with an acquisition of the foundations, via a deepening in the second year, towards a real know-how in the third year. The subjects will be taught with incremental depth.

The chosen pedagogical approach alternates between classes and small classes to provide students with a certain level of interactivity in their participation. The 60 hours allocated to this training break down as follows:

- First year 20h (8h amphi theatre lectures + 12h small classes);
- Second year 18h (12h amphi theatre lectures + 6h small classes);
- Third year 22h (16h amphi theatre lectures + 6h small classes)

ÉVALUATION
The module in the third year is evaluated by TD’s «Optimization of planning» and «Quality approach».

BIBLIOGRAPHY
Project Management for Engineering, Business and Technology, Nicholas, John M., 2011
Project Management, Kerzner, Harold R., 2013
Conduite de Projets Complexes, Roy, Etienne, et Vermerey, Guy, 2010
HUMANITIES
COMMON CORE

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ISAE-SUPAERO has taken up the challenge of forging well-rounded engineers through its department of Arts and Culture. The variety of courses offered aim at awakening the students' emotional intelligence, thus complementing the rigor of scientific discourse. The students are welcomed in as individuals in the making, and these disciplines will provide space for the growth of their whole persona, both in terms of creativity and reflection. The idea is to encourage interaction between knowing oneself and understanding others. This detour through the humanities and/or creative activities is an opportunity for each student to identify those capacities that represent their uniqueness. It is up to them to find out what they are capable of. The Arts and Culture department offers an a la carte curriculum allowing them to plan their tailor made academic journey based on their own curiosity. Evaluation on this course examines the student's engagement in "thought in motion" rather than concrete performance. To each his own path.
ANGLAIS

After 2 years of « Prepa » for most students, it’s time to look at English with eyes wide open and time to start thinking outside the (old) box. You will finally start using English actively. Our approach is based on both verbal and non-verbal communication with the aim of gaining autonomy and being able to function in an English-speaking environment. We will start with a total immersion Intensive Day of English during which you will get to know each other and start the year with fun and a head start in an international mode.

Your first year of English at Isae-Supaero will then be devoted to improving your communication skills with a Common Core module first, followed by 2 Electives of your choice. Between the Common Core and the first Elective, there will be a focus on CV and letter writing. Classes will meet every Wednesday morning for 2 hours from September to the end of May.

Common Core: 16 hours
The aim of this module is threefold:
- to enhance your speaking, note taking and presentation skills;
- to develop your ability to run and participate in effective meetings;
- to improve your confidence in public speaking.

ASSESSMENT: based on work during and outside class time, active participation, meetings and presentations.

Electives: 16 hours each
You will choose 2 consecutive Electives from the same course catalog, given by native speakers with a wide variety of educational and cultural backgrounds. These electives will give you the opportunity to put your communication skills into practice and learn more about the many facets of native English speakers from around the world. Specific groups will be organized for students who will need extra help if they haven’t reached the mandatory 580 points on the TOEFL.

Some examples: The show must go on (theatre), Debunking Conspiracy Theories, Your very own video documentary, British Multiculturalism, Fair Trade and Beyond, Canada.

ASSESSMENT: based on work during and outside class time, active participation. More details from each Elective teacher.

Preparing for your future (CVs, Letter Writing and Interview)
We will start with a 3 hour Master class, followed by a 4 hour workshop. Nothing will stop you from getting that dream internship/job anywhere in the world. This class will provide you with the necessary know how and tools for completing international application forms, prepare your CV, letter and interview to help you reach your goals.

ASSESSMENT: based on CVs, letters and interviews.

OTHER FOREIGN LANGUAGE OPTIONS
Students who are native speakers of English/ bilingual may, after discussion with the Languages & Communication team, opt for another Foreign Language (Mandatory English): German, Arabic, Chinese, Spanish, Italian, Japanese, Portuguese (Brazilian), Russian, French as a Foreign Language.
ISAE-SUPAERO Engineers
Academic program 2019-2020

1st year
1st & 2nd semester

HUMANITIES COMMON CORE
LV2-100 À 109
LV2-120 À 129

FOREIGN LANGUAGE 2
Program coordinator: R. PEARSON / A. GAMISANS / D. VILAIN

CHOICE OF LANGUAGES
Arabic, Chinese, German, French as a foreign language, Italian, Japanese, Portuguese (Brazilian), Russian, Spanish.

OBJECTIVES
Learning/improving the foreign language of your choice.
After the level of the students has been assessed, specific objectives are decided at the beginning of term.
These are established between the teachers and students.

SKILLS
Language and intercultural skills are assessed according to the CEFR. There is also a strong focus on intercultural skills in the language class.

EVALUATION
All CEFR skills will be evaluated.
OBJECTIVES
Autonomy: acquiring the motor skills and methods required for each activity to ensure safety for oneself and others.

HARMONY: frequent and discerning practice contributing to well-being and health in order to establish the right context conducive to personal as well as professional development.

PLEASURE: engaging your body to learn, share and live an enriching experience

SUPPORTING ACTIVITIES: a wide range, covering all required and essential skills:
- with a focus on:
  - energy: swimming, rowing, body building, fitness
  - one to one: judo, fencing, boxing, table tennis, badminton
  - analyzing information: golf, archery
  - opposition/cooperation: baseball, futsal, rugby
  - unfamiliar environment: scuba diving, climbing
  - artistic expression: hip hop, circus
  - personal development: yoga, self defense

SCHEDULE
One and a half hours/week from mid September to mid May divided into 3 cycles/year (3 different activities, 9 to 10 sessions/cycle)

EVALUATION
Formative assessment (self and peer)
Official evaluation: presence and continuous assessment of skills
ISAE-SUPAERO Engineers
Academic program 2019-2020

1st year
2nd semester

TALKS AND LECTURES

TALKS AND LECTURES: SCIENCE, CULTURE & SOCIETY

OBJECTIVES
This module aims at addressing themes and subjects extending the classical academic fields of engineers as well as making them think about their future role at the heart of the company and the society. It allows them to improve their knowledge of major societal challenges and invite them to question themselves.

Themes addressed in 2017-2018:
- Innovation;
- Diversity management;
- Ethics and science;
- Scientific and technic challenges;
- Arts – Culture and society.

#arts #technologie #politique #éthique #littérature #économie #innovation #actu #histoire…

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CREATIVITY & INNOVATION PROJECTS
CREATIVITY & INNOVATION PROJECTS

An important moment of a student’s first year, PIC is a place for expression and methodological learning. An opportunity to explore new fields not represented in the curriculum and an opportunity for delving deeper into a preferred disciplinary field, using theoretical and/or experimental routes, PIC is more exploratory. It may be an applied process and must be an opportunity to acquire or approach new know-how.

Its theoretical and methodological contributions can be broken down into 5 themes:
- tools, methods and processes of creativity and innovation;
- prior art search;
- design thinking or how to carry out a field study;
- project management;
- communication tools.
In the last few years, possibilities for customizing the curriculum have increased greatly to meet the needs of students and recruiters alike. It appeared necessary to organize activities to assist students in making consistent choices in line with their profiles and their aspirations. The purpose of this system is to provide students with tools and an environment so they can design the curriculum that best meets their needs.

Beyond activities aimed at helping students in designing their training curriculum, workshops are organized on defining skills, writing résumés and designing a LinkedIn page.

Knowing yourself
- the MBTI Myers Briggs Type Indicator test. This test defines 16 profiles that can help in professional orientation or in communicating with and understanding others (often used by Human Resources in companies).

Understanding the curriculum:
- a game session for a different look at the curriculum’s possibilities; a gateway forum with students and alumni to share experiences; people available to provide you with individual support needed.
- gateway sheet, skills sheet. The people who employers recruit come with their aptitudes, their backgrounds, their qualities, their character traits, their cultures, etc. They need to know who they are dealing with and to have a detailed understanding of their skills and know-how.
- Learning to communicate:
  - writing a résumé, the importance of social media – a focus on LinkedIn, résumés and cover letters in English.
  - presenting your training background.
EXPERIMENTAL PRACTICE
The objective of this course is to develop experimental skills in order to be able - with a certain degree of autonomy - to design experiments, make measurements, analyse experimental results and present them.

**KNOWLEDGE AND COMPETENCIES EXPECTED AT THE END OF THE COURSE**

- To know how to design an experiment to answer objectives
  - Identify and rank pertinent parameters and physical quantities
  - Design an experimental configuration
  - Specify a measurement range
- To have a critical look on measurement techniques:
  - Measurement system analysis
  - Sensor performances and limits
  - Uncertainties evaluative
- To know how to analyse experimental results and extract conclusions in order to present them:
  - Post-processing and analysis of experimental data
  - Comparison between experimental results and models (theoretical or numerical)
  - Presentation of results and analysis with adapted media.

**COURSE SEQUENCE AND EVALUATIONS**

- 6 laboratory periods (for a total of 20h) in partial autonomy within one of the ISAE-Supaero training and research labs
- 6 lecture hours (design of experiment, metrology, measurement chain)
- Evaluation based on an oral presentation and the work done during lab sessions
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The objective of this class is to provide the basics for high performance computing, from the main principles of parallel programming to its application on local many cores supercomputers. Although we give the course a fluid dynamic color, the major principles are applicable to many fields, including astrophysics, financial science or weather forecast.

MAIN OBJECTIVES AND SKILLS

In this class, the student will have to develop several skills, going from the understanding of the architecture of a supercomputer to its usage for science purposes. This skills are mandatory for engineers involved in various scientific fields in which large computing resources are required, being at the CPU level or in the amount of data produced.

The application case is based on the numerical resolution of the Navier Stokes equations based on the Boltzmann equation (Lattice Boltzmann method). This kind of method is very popular in CFD, but also in the movie industry.

Various concept will be introduced such as performance of an application, parallelization technics and philosophy. The final goal will be to maximize the performances obtained with a simple solver partially developed during the course. Visualisation technics will also be introduced. Most of the class will be dedicated to practice on workstations and on our local cluster.

EVALUATIONS

The understanding and autonomy of the student will be evaluated through the completion of the project, from the development of a parallel application (C++) work to the clear presentation of the algorithm and the results. Bonus points will be attributed to students who obtain the best performances with their applications.

PREREQUISITE

Basis of C++ or other compiled programming language (e.g. fortran, C).
The objective of this course is to present both formal and conceptual alternative tools for the analysis of fluid dynamics: advance fluid kinematics, rheology of complex non-Newtonian fluids, vortex dynamics and an introduction to stability analysis.

BIBLIOGRAPHY
The kinematics of vorticity, C. Truesdell, IUP, 1954.
Instabilités hydrodynamiques, F. Charru, EDP Sciences, 2007.
ACOUSTICS AND SHOCK WAVES
Program coordinator: F. SIMON / Jérémie GRESSIER

The objective of this course is to assess two particular fields of fluid mechanics: acoustics whose field of application is today mandatory, and unsteady phenomena associated with more severe wave such as shock waves (detonation).

MAIN OBJECTIVES AND SKILLS
The objective is to understand the physics of unsteady fluid mechanics. Starting from the perfect fluid model, the equations for acoustics will be developed to describe the canonical cases of wave propagation. In parallel, the practical aspects of test facilities, metrology and application to noise reduction will be illustrated. Then, the small pressure disturbances assumption will then be transcended to describe the physics of unsteady shock waves. This theoretical analysis will be kept simple and limited to the monodimensional cases. Illustrations on test bench (shock tube), and numerical simulations will be proposed in practical session.

ASSESSMENT
Report and Multiple Choice Exam.

BIBLIOGRAPHY
The objective of this course is to present, through concrete applications, the place and challenges of the aerodynamics applied to production vehicles and race cars. This introduction to road vehicles aerodynamics complements the common core aerodynamics course, more centered on aircraft applications.

**OVERALL OBJECTIVES**

The first part of the module (13h) is consecrated to production vehicles. The main sources of aerodynamic forces (lift / drag), their impact on vehicle performances and the ways to reduce/optimize their effects are discussed. Numerical and experimental tools widely used in vehicle research and design are presented as well.

The second part (6h) presents the specific objectives of race cars aerodynamics and the associated design strategies.

The third part (11h) is dedicated to wind tunnels demonstrations and numerical simulations analyses on simplified car models. This last part leads to a mini-project.

**EVALUATION**

Part 1 is evaluated through a written quiz (1h), part 2 through a report on wind tunnel measurements on a formula 1 model and part 3 through a summary sheet on the simplified body mini-project.

**BIBLIOGRAPHY**

PHASE INTERFACE PHENOMENA IN TWO-PHASE FLOWS (UNDERSTANDING LIQUID SHEET ATOMIZATION)

Program coordinator: Nicolas GARCIA ROSA

BIBLIOGRAPHY
WIND PROPULSION
Program coordinator: Vincent CHAPIN

The objective of this course is to extend the knowledge in aerodynamics to the domain of wind propulsion, a domain of innovation oriented toward high performances and sustainability. Concepts presented are applied to America’s Cup Yachts, foiling boats and/or Kite propulsion. The content of this course may be applied to contribute to the development of sustainable maritime transport to tackle the challenges of a low carbon human activity.

OVERALL OBJECTIVES
A first part of the module is devoted to the history of wind propulsion and basic concepts in aerodynamics and hydrodynamics. It will focus on the succession of disruptive innovations that have punctuated the long history of sailing boats. Elements of modeling aero-hydrodynamic forces (lift, drag) will be given. The performances of a sailing boat will be characterized. A Velocity Prediction Program (VPP) will be used to illustrate the force equilibrium and how it changes with design choice and constraints.

In a second part, the Kite propulsion will be presented as a new propulsion system for sustainable maritime transport. A significant part of the course will be devoted to a team project dedicated to applying the knowledge learnt to contribute to new development in a field of innovation. This part will lead to a written report and a presentation of the work done.

ASSESSMENT
☞ The module will be evaluated by practical session reports and the team project.

BIBLIOGRAPHY
CONTINUUM SOLID AND FLUID MECHANICS

Program coordinator: Grégoire CASALIS

The objective of this module is to lay the theoretical foundations of the mechanics of continuous media, the basis of the mechanics of deformable solids and fluid mechanics:

- Introduce the different tensors of stresses and deformations;
- Introduce the Principle of Virtual Powers;
- Show the links between the mechanics of solids and the mechanics of fluids;
- Introduce the laws of behavior in mechanics of solids and fluids;
- Apply the mechanics of continuous media and fluids to concrete cases.

OVERALL OBJECTIVES KNOWLEDGE AND SKILLS

To meet the main goal, the course will:

- Introduce the different tensors of stresses and deformation strains;
- Introduce the Principle of Virtual Powers;
- Show the links between the mechanics of solids and the mechanics of fluids;
- Introduce the laws of behavior in mechanics of solids and fluids;
- Apply continuous media mechanics to concrete cases.

This course gives the theoretical foundations of the first year of the Mechanics of Materials course, and then proposes more complex applications of Continuum Mechanics.

Expected skills, learning outcomes

At the end of the module, the student will have understood the fundamentals of deformable media mechanics and fluid mechanics. In addition, this course introduces the tensors and makes the connection between the weak formulation of a mechanical problem and the duality as it is seen in mathematics (functional analysis course in 1st year and scientific calculation in 2nd year).

Contents

- Notions of stress and deformation strains
- Principle of virtual powers
- Laws of behavior in mechanics of solids and fluids
- Applications to cases of mechanics of solids and fluids

EVALUATION

- 1 written test and 2 practical Design sessions.

BIBLIOGRAPHY

ELECTIVE MODULES

ISAE-SUPAERO Engineers
Academic program 2019-2020

1st year
2nd semester

MODELING OF MECHANICAL SYSTEMS
(TRIBOLOGY)

Program coordinator: Rémy CHIERAGATTI

The objective of this module is to provide tools for the design and analysis of complex mechanical systems whatever their overall mobility: from clamping to robots.

OVERALL OBJECTIVES – KNOWLEDGE AND SKILLS
- Flux of forces in the links of an aeronautical turbomachine mast;
- Operation of a turbomachine starter free wheel;
- Motorization of a treadmill;
- Device for opening a commercial aircraft door;
- Operation of a capstan;
- Genesis of new kinematic links, robots application.

Here are some of the topics for which the theory of mechanisms and models of link sizing (close contact fatigue, tribology, matting ...) will be applied. The mastery of these models, combined with those of general mechanics, makes it possible to design, analyze and modify complex mechanical systems regardless of their overall mobility:
- From the lowest mobility: classic aeronautical embedding;
- To the greatest mobility: articulated arms for robotics.

EVALUATION
One technical design session (50%) and one written examination (50%)

BIBLIOGRAPHY
ISAE-SUPAERO Engineers
Academic program 2019-2020

1st year
2nd semester

ECO-DESIGN
Program coordinator: Catherine MABRU

The objective of this module is, on the one hand, to present the challenges, the different approaches and the tools to eco-design and on the other hand to study the energies and to identify the renewable ones with their exploitations or transformations.

OVERALL OBJECTIVES

- The course is an introduction to eco-design: choosing materials from an environmental perspective.
- In the face of current and future ecological and economic issues, the directives and the demand of society, it is necessary to minimize the impact on the environment from the design phase of the products, whether it is good, Services...
- The objective of this course is on the one hand to present the issues, the different approaches and tools to eco-design and on the other hand to study the energies and identify those renewable with their farms or transformations.

- After having seen the basics of eco-design and the life cycle strategy we will study the methods and tools of eco-design with their specificities related to different sectors of activity. In a design process we will use a software of choice of material and process to minimize the environmental impact. As part of the life cycle analysis we will also use computer software such as Simapro and Bilan Carbone to assess the environmental impact of a product.

EVALUATION
Technical design session + project
### DYNAMICAL SYSTEMS: HOW DOES IT WORK?

Program coordinator: Daniel ALAZARD / Miguel CHARLOTTE

From basic physical phenomena which can be experimentally highlighted (flutter, stick-slip, gyroscopic effect of a spinning top, Segway, energy exchanges, vibrations, ...), the objective of this course is to drive students in using engineering methods and tools in order to:

- Derive a mathematical model of the phenomenon,
- Analyze it quantitatively using a judiciously selected method from applied Mathematics (simulation, ..)
- Analyze it qualitatively and be able to size it in a preliminary design phase,
- Control it,
- Assess the limits of engineering methods and the still-open problems.

This interdisciplinary course aims to develop student skills rather than academic knowledges. The various methods will be taught in other courses in a more general way but they will be combine here to solve a particular problem governed by equations without analytical solution, thus requiring the use of applied Mathematics.

### EVALUATION

Through a report and an oral presentation on a team project. A team is composed of 4/5 students. The report is web page edited using Matlab Publish.

### SYNOPSIS

- 6 hours of course on general concepts: Mechanical model (Lagrange), Equilibrium point and linearization, numerical integration, stabilization by feedback, non-linear behavior analysis,
- 7 hours of tutorial classes on a study case (pendulum on a cart) allowing the various course topics to be highlighted,
- 2 hours of scientific conferences,
- 1 hour: project presentation,
- 12 hours on the project supervised by lecturers. Examples of project: Control Moment Gyros (CMGs), Vibration propagation in spacecraft and control, Liquid sloshing, Segway, Flutter...
- 2 hours of oral presentation and questions (30mn by project).

### BIBLIOGRAPHY

System Dynamics, Palm III, Mc Graw Hill.
This module deals with the study of the operational performances of transport aircraft in cruise, during takeoff and landing, in steady turn, etc., in relation to aerodynamic, structures and propulsion.

OBJECTIVES
This course focuses on the definition and calculation of operational performance taking into account all the aspects involved in this performance calculation: flight dynamics, aerodynamics and propulsion. We discuss the definition of the flight domain and the analysis of the different phases of flight will be completed by the search for optimum. The models developed will then be used to highlight these performance optima and their parametric sensitivity. Optimal cruises will be presented in a synthetic way for the different types of aircraft. This will justify the solutions currently being chosen.

The aerodynamics of the subsonic transport aircraft are presented using theoretical and empirical preliminary design methods applied to the aerodynamic design of profiles, wings and aerodynamic airfoil-interactions. The course is illustrated with many examples and leads the student, during practical sessions, to perform the aerodynamic performance analysis of a complete aircraft.

The propulsive aspect is approached through the propulsion of aircraft by turbojet and turbo-propeller with modeling of the thrust and traction according to the flight speed and altitude. Models that will be used in the estimation of performances are presented in detail.

BIBLIOGRAPHY
Introduction to flight – John D. Anderson Jr.
INTRODUCTION
The main objective of this module is to get in touch with the social perception of various aspects of aviation, so that students get convinced that being technically right is not sufficient for a project to be accepted by a population.

Students will first find a (reasonably) controversial issue (like night opening of a runway, settlement of a new airfield, ...). With experts in the field, they will then analyse the more challenging subjects and design a survey they will actually conduct in the Toulouse area. Eventually, they will present the results and major findings.

ASSESSMENTS
Each group of five students defines its subject and conduct a mini-survey. A small report and a group oral presentation will be evaluated.

BIBLIOGRAPHY
Utiliser le logiciel Limesurvey:
http://quant.hypotheses.org/18/comment-page-1/.
The aim of this elective course is to show the application of dynamical systems and optimal control to celestial mechanics and space missions, including an introduction to specific numerical methods.

OVERALL OBJECTIVES KNOWLEDGE AND SKILLS

Optimal control, with application to space rendez-vous (15h): optimisation of a quadratic energy functional, under linear dynamical system seen as a constraint; in continuous time or in discrete time; including a final state constraint or not. A lab is devoted to the space rendez-vous application.

Symplectic numerical integrators (6h): an introduction to those numerical methods specifically designed for the simulation of Hamiltonian dynamical systems. One lesson and one lab for application.

The Three Body Problem and Manifolds (19h): complementing the space mechanics course of the scientif common core, it consists of the precise description of the stable and unstable manifolds of the CR3BP. Applications to trajectory planning and parametrization, and mission analysis for space applications.

EVALUATION
3 labs: optimal control, symplectic integrators, TBP and manifolds.
1 written exam on Nonlinear dynamical systems.
Introduction to those numerical methods specifically designed for the simulation of Hamiltonian dynamical systems.

BIBLIOGRAPHY
ELECTIVE MODULES

AN INTRODUCTION TO ARTIFICIAL INTELLIGENCE THROUGH GAMES PROGRAMMING

Program coordinator: Fabrice FRANCES

OVERALL OBJECTIVES

This course focuses on « intelligent » zero-sum games, i.e. games where the capability of an artificial (computer) player to perform better than a human player might qualify it as an « Artificial Intelligence ». This is the case of many classic games: board games like chess or othello, card games, etc. Actually, a software program that plays such games must often use the highest processing power available, and the most efficient algorithms for the determination of the best move. The course gradually introduces these algorithms, starting with the base Minimax for solving finales of simple games, and then studying the case of standard games where the full tree of moves cannot be computed, and thus introducing several optimizations to the Alpha-beta algorithms (heuristic evaluation functions, transposition tables, iterative deepening, quiescent search, etc.). The case of games for which it is difficult to design a good evaluation function is also mentioned in order to introduce alternative approaches like the Monte Carlo Tree Search.

Instead of only presenting the theory, the course focuses on acquiring a real know-how of these algorithms which are often hard to debug, so the students will develop their own “Artificial Intelligence” for the game of their choice during the course.

EVALUATION

The game project will evaluate how much the students master the different algorithms.

BIBLIOGRAPHY

Intelligence Artificielle et Informatique Théorique, Jean-Marc Alliot, Thomas Schiex, Pascal Brisset, F. Garcia, éditions Cépaduès.
ELECTIVE MODULES

DISC / EISC-101

2 ECTS
30 h

FUNCTIONAL AND LOGIC PROGRAMMING LANGUAGES

Program coordinator: Christophe GARION

This lecture aims at giving students new ways to think computationally. Imperative programming is classically seen during the basic curriculum of each student and leads them to use solutions based on state changes. Yet, some categories of problems can be solved more naturally with different paradigms, for instance by manipulating functions as first-class citizens or by using automated reasoning with logic languages. When attending this lecture, students will not only learn three new programming languages (Racket, Scala and Prolog), but also two new paradigms to model and solve problems that are more and more often used in fields like Big Data, machine learning, Artificial Intelligence, etc.

OVERALL OBJECTIVES
Two paradigms will be presented during the lecture: functional programming and logic programming. Three languages will be used to illustrate these paradigms:

- Racket, a language of the Lisp family, to define the foundation of functional programming
- Scala, a statically typed functional language, to show the interest of this kind of language to implement complex datatypes for instance
- Prolog, a logic programming language

The sessions will mainly be based on languages manipulation through simple exercises and problem resolution.

BIBLIOGRAPHY


http://www.racket-lang.org
http://www.scala-lang.org
http://gprolog.org
Graphs are massively present in the 21st century. Social networks, communication networks, interaction networks in biology or in molecular chemistry are at the heart of important scientific, technologic and societal issues. The goal of this course is to present the mathematical tools to think and describe these complex structures.

Each class will develop an independent theme, like graph coloring or random trees. The proof of a famous result will be presented and developed around exercises.

**BIBLIOGRAPHY**

ELECTIVE MODULES

DISC / EISC-105

2 ECTS
30 h

INTRODUCTION TO DISTRIBUTIONS AND OPERATOR THEORY, SEMIGROUP THEORY AND APPLICATION TO PDE’S

Program coordinator: Ghislain HAINÉ / Denis MATIGNON / Michel SALAUN

The aim of this elective course is to give some insight to a part of theoretical mathematics, which prove most useful in the applications to engineering sciences. It is composed of three parts: distributions, operators and semigroups, which are a powerful generalisation of functions, matrices and exponential of matrices respectively.

OVERALL OBJECTIVES KNOWLEDGE AND SKILLS

- **Distributions (10h)** are generalized functions. Indeed, the weak solutions of PDEs are some particular distributions, the Dirac measure or the Dirac comb known in signal processing are some other ones. In this course, definitions and main properties of distributions will be given, while concrete examples will be taken from the engineering sciences. The Fourier transform will be defined on tempered distributions, and will enable the definition of Sobolev spaces of any index, which prove most useful for the solution of PDEs.

- **Operators (10h)** are generalized matrices acting on Hilbert spaces. These operators can be bounded, like the shift of sequences, or unbounded, like the derivative of functions. We will provide some reduction theorems, which prove similar to those known for the diagonalisation of real-valued symmetric matrices. The spectrum of an operator happens to be a surprising generalisation of the eigenvalues of a matrix: the latter definitions will be fully illustrated on simple examples which are most useful in practice.

- **Semigroups (10h)** of operators are the exact analogue of exponential of matrices. They help writing the solution of linear evolution PDEs, like the heat or the wave equation, on some Hilbert spaces (which can be Sobolev spaces).

When the geometry of the physical domain is simple, one can compute the spectrum of the operator explicitly; in this latter case, the associated semigroup enjoys a nice analytic expression, as a series, which makes things quite easy to handle: some worked-out examples will come as a useful illustration of the concept.

EVALUATION

- 6 written short tests, 1h each, 2 in each part of the elective module.

BIBLIOGRAPHY

Markov chains are stochastic dynamical systems of the form $X(n+1) = F(X(n), U(n+1))$ where the $U(n)$'s are random variables inducing randomness in the trajectory $X(n)$. They are widely used in other scientific fields (such as physics, chemistry, biology, economics or finance), in modeling of real-world systems (communication networks, supply chains, plane trajectories, ...) and also in the design of algorithms: for instance, Google’s PageRank algorithm is based on Markov Chains theory and state-of-the-art simulation and optimization techniques use are based on Markov Chains (Markov Chains Monte-Carlo methods).

In this course the mathematical foundation of the theory of discrete time Markov Chains on a countable state space is presented. We will consider classical questions related to dynamical systems (convergence, equilibrium, speed of convergence) in this stochastic context. The emphasis is put on the stochastic behavior and links are made with linear algebra (e.g., via Perron-Frobenius theory) and analysis.

**BIBLIOGRAPHY**


1st year

2nd semester

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**MARKOV CHAINS**

Program coordinator: Florian SIMATOS

In this course the mathematical foundation of the theory of discrete time Markov Chains on a countable state space is presented. We will consider classical questions related to dynamical systems (convergence, equilibrium, speed of convergence) in this stochastic context. The emphasis is put on the stochastic behavior and links are made with linear algebra (e.g., via Perron-Frobenius theory) and analysis.

**BIBLIOGRAPHY**

In this course, we present basic concepts and applications of information theory which allows to measure the amount of information contained in a file or transmitted over a communication link plagued with noise.

Applications of information theory can be found in data compression, in error correction coding, and in security which are the main building blocks of current communication networks.

**OVERALL OBJECTIVES AND SKILLS**

Information theory consists in a set of tools which allow to measure the information content of a file (in bits) or the maximum achievable communication rate (in bits/sec). These concepts are essential to networks, communications and computer science, and can be also very useful in other fields such as molecular biology and chemistry. In this course, we introduce basic concepts and applications of information theory, namely:

- Data compression, which allows to reduce the size of data in storage or during transmission

- Information security which enables to secure information and data with respect to unintended users

- Other fancy applications: statistical learning, network flows, molecular biology, chemistry, alien sounding

**EVALUATION**

The course is evaluated through:

- Written exam
- Graded Lab sessions
- Seminar-like presentations

**BIBLIOGRAPHY**


Voyage dans le monde de la Théorie de l’Information: https://fr.khanacademy.org/computing/computer-science/information-theory
This module has three major aims, firstly, it gives a detailed description of the basic theory of mathematical programming and the resulting algorithms for unconstrained optimization. Secondly, this module includes many laboratory works allowing to test different implementations within the computational details. Finally, this module aims to give a substantive material on less well-known advanced topics, including trust-region methods, derivative-free methods, and nonsmooth problems.

BIBLIOGRAPHY
EMBEDDED CONTROL/COMMAND SYSTEMS

Program coordinator: Fabrice FRANCES

OVERALL OBJECTIVES
The objective of this course is to give a first practical experience on the development of simple Embedded Systems, based on a control/command loop. The course consists in a sequence of very small projects, using a micro-controller kit, sensors, and motors. Each simple project introduces a set of practical concepts (pulse width modulation, analog/digital conversion, etc.). The students will thus gain a first understanding of Embedded Systems.

KNOWLEDGE AND SKILLS
After this course, the students will be able to develop Embedded Systems on a small platform (AVR micro-controller family) and to adapt to other similar platforms.

Through a sequence of small projects, the students will have the opportunity to first control basic discrete inputs and outputs (LEDs, switches) before using more evolved sensors that can be found in IoT objects or Micro Air Vehicles, etc.

The essential capability of an Embedded System to compute a command, in order to interact with its environment through sensors and actuators, links this course to basic notions of Electronics, Signal Processing, Command and Control, Computer Architecture, and Algorithms that will be gradually taught throughout the small projects. A final Robotics project will group all the previous small experiments, giving the students a first understanding of Embedded Systems and a small practical know-how, allowing them to create their own developments.

EVALUATION
The acquired knowledge and practical know-how are evaluated by the final project.

BIBLIOGRAPHY
The objective of this course is to introduce two closely related disciplines of Astrophysics: general relativity and cosmology. It will give the fundamental principles, make an inventory of the understanding of the structure and the evolution of the universe as well as providing an overview of current research on the subject.

**OVERALL OBJECTIVES**

The following topics will be introduced:

- **Introduction to general relativity**: Following the course of special relativity, it will be necessary now to take into account the gravitational forces in the application of the principle of relativity. It will be mainly done through the equivalence principle and its consequences on the structure of space-time.

- **Introduction to cosmology**: This subject studies the structure and evolution of the universe. It will introduce the standard model for the composition of the universe (baryonic matter, dark matter and dark energy) as well as the evolution models of the universe issued from the equations of general relativity.

**EVALUATION**

Final exams

**BIBLIOGRAPHY**


ISAE-SUPAERO Engineers
Academic program 2019-2020

1st year
2nd semester

ELECTIVE MODULES
DEOS / EEOS-102

2
ECTS
30 h

STELLAR PHYSICS AND PLANETOLOGY
Program coordinator: David MIMOUN

BIBLIOGRAPHY
Quantum engineering is a recent research field with a promising future, especially in the field of information processing. This discipline concerns the realization of various functionalities (logic gates, calculators, engines for example) by using the quantum properties of individual nano-objects. The targeted applications of this discipline concern the quantum processing of information with the possibility of developing high-speed computers, teleportation or quantum cryptography.

OVERALL OBJECTIVES
The following topics will be introduced:
- Quantum / classical frontiers
- Molecular engines
- Nanometric mechanics
- Quantum Calculators
- Quantum information processing: teleportation and cryptography.

La compétence principale visée par ce module sera l’utilisation des propriétés du monde quantique pour la réalisation de fonctionnalités mécaniques, électroniques ou de traitement de l’information à l’échelle nanométrique.

EVALUATION
The acquired knowledge is evaluated by a final exam

BIBLIOGRAPHY
M. LeBellac, Introduction à l’information quantique, Belin, 2005
E.G. Riefel, W.H. Polak, Quantum computing, a gentle introduction, MIT Press, 2014
LASER PHYSICS
Program coordinator: Sébastien MASSENOT

A laser is a multiphysics system directly issued from theoretical physics and having many applications either in general use products, industry or fundamental research: CD players, optical fiber telecommunications, materials processing, telemetry, velocimetry, atomic clocks, nuclear fusion, gravitational waves ... This course will present the general operation of lasers while presenting the main applications.

OVERALL OBJECTIVES
The following topics will be introduced:
- Laser operation: optical oscillator
- Light / Matter interaction, semi-classical model
- Light amplification by stimulated emission
- Optical cavities and gaussian beams
- Continuous and pulsed operation for a laser
- Different types of lasers and their applications

By the end of this course, students will be able to describe the general operation of a laser, its main applications and to identify the role played by each components while keeping in mind the area of validity of physical models that will be presented.

EVALUATION
Quizz + final exam

BIBLIOGRAPHY
Particle physics is the branch of physics that studies the elementary constituents of matter, radiation, and their interactions, and attempts to answer the question «what are we made of?» This is also a topical subject with the recent experimental proof of the Higgs boson. The aim of this course is to present an introduction to modern particle physics.

**OVERALL OBJECTIVES**
The following topics will be introduced:
- The different elementary constituents of matter and description of fundamental forces
- Particles classification
- Quantum physics of particles: spin / isospin
- Special relativity and particle physics
- Nuclear Physics, accelerators, collisions et desintegrations of particles

**EVALUATION**
The acquired knowledge is evaluated by a final exam.

**BIBLIOGRAPHY**
R. Zitoun, Introduction à la physique des particules, Dunod, 2nde édition, 2004
B. Clément, Physique des particules : cours et exercices corrigés, Dunod, 2013
MINIATURIZATION LIMITS: FROM NANOTECHNOLOGIES TO NANO-OBJECTS

Program coordinator: Sébastien MASSENOT

The miniaturization of devices and machines (telecommunications, chips, instrumentation, mechanical systems…) involves the use of quantum properties inherent to atomic and molecular systems. The objective of this course is to address the limits of miniaturization for the realization of electronic and optical components / machines both from a technological and a conceptual point of view, taking into account quantum effects.

OVERALL OBJECTIVES
The following topics will be introduced:
- Issues related to miniaturization
- Top-down and bottom-up methods for nano-fabrication
- Optical nano-components: single photon sources and their applications in quantum information, photonic crystals and circuits
- Electronical nano-components: problems associated to chips miniaturization, electron transport at the nanoscale.

The main skills targeted by this course will be the use of the properties of the quantum world and the knowledge of the frontier between the macroscopic world and the quantum world in order to design electronic and optical nano-components.

ASSESSMENT
The acquired knowledge is evaluated by a final exam.

BIBLIOGRAPHY
Collection : Les nanosciences, Tomes 1 à 5, Belin
C. Joachim et L. Plévert, Nanosciences: La révolution invisible, Seuil, 2008
The Engineering sciences, such as Mechanics, Automatism, Electronics, Physics or Mathematics train multidisciplinary skills in good agreement with the challenges of biomedical. The Biological engineering, covers both biomolecular and genomic engineering, pharmacology and biomedical instrumentation.

OVERALL OBJECTIVES
The aim of this module is to use the knowledge acquired in engineering training in the biological framework. After giving additional knowledge on basic biological processes, the courses will provide the bases necessary for an opening to life sciences based on four major themes of biological engineering through courses, conferences and experimental work.

DNA: knowledge of basic biological processes involving DNA, understanding current research issues, exploring technological tools for development, the issues of high speed sequencing.

Personalized medicine: the medicine of the 21st century. Nanomedicine: explore on a nano scale, treat with nano-tools, Nanostructures inspired by life

Ethics: what are the limits of bioengineering? Each theme will include several sessions dedicated to experimentation.

ASSESSMENT
Each student will do a report and an oral presentation on a selected topic.

BIBLIOGRAPHY
Jean-François Allemand et Pierre Desbiolles, Physique et Biologie : de la molécule au vivant éditions EDP sciences
ISAE-SUPAERO Engineers
Academic program 2019-2020

1st year
2nd semester

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ELECTIVE MODULES
LACS / EACS-101

QUANTITATIVE APPROACHES IN SOCIAL SCIENCES
Program coordinator: Marie-Pierre BÈS

OBJECTIVES
The aim is to present to engineering students some quantitative approaches of the social sciences (statistics, probabilities, graph theory) and how obtain, collect and process data in relation with a sociological question. We will prove that the social sciences are sciences «almost» like the others, with the same steps: problem, methodology, data collection, analysis and conclusion. The secondary objective will be to query the existing social categorizations (social class, group, profession, community, network of people) and their construction, in order to master some keys to read the social world.

ORGANIZATION
The sessions will allow to alternate researcher’s interventions of social science and direct applications made by students using specific statistical software (SPSS, R, Ucinet). In particular, the following themes will be addressed: socioprofessional categories and personal networks. It will also be necessary to present some recent results in Social Networks Analysis and Sociology in Education. The sessions will mainly take place in a computer room in the form of a Design Office and in a «project management» mode that will require the collaboration of all the students.

BIBLIOGRAPHY
The Aerospace Engineering curriculum is strongly focused on the development in students of technical knowledge and skills. More and more, employers are increasingly pointing out that this preparation of engineering students is lacking the wide range of written and spoken communication skills required to engage with members of other professional groups, other cultural backgrounds and with the broader community. The need for engineering students to acquire professional and soft skills, in addition to technical skills, in order to enhance both community engagement and career success has therefore been increasingly underlined by industry professionals.

OVERALL OBJECTIVES
In this module we will emphasize the importance and enhancement of soft skills for engineering graduates. There will be three main parts. We will give weight to self-awareness, teamwork, adaptability, confident promotion of a message, oral and personal presentation skills and negotiations. Firstly this workshop takes you on a journey of self-discovery. By focusing on your self-esteem, and looking at ways to improve your confidence through role-play and observation, you will be confronted with professional situations & given the tools to modify your behavior assertively. Secondly we will look at you and your place in a team, you will discover what you can contribute and how to improve your adaptation abilities. The third part of our elective will focus on the techniques necessary to effectively transmit a strong & convincing professional message and negotiate in a professional context.

ASSESSMENT
Each student will take part in a Professional Presentation delivered for Professionals from different sectors of the corporate world. This presentation/ negotiation may take place in companies or in school depending on the availability of our partners. There will therefore be both a written and oral mark as well as continuous assessment throughout the classes for this elective.

BIBLIOGRAPHY
ELECTIVE MODULES

LACS / EACS-104

FIRM ORGANIZATION AND GOVERNANCE STRUCTURE

Program coordinator: Marie-Pierre BÈS

OBJECTIVES

The aim is the understanding who is leading the companies, what are the social and professional characteristics and the social resources of the managers. The students will understand the composition of this social world, its codes and the ways to become managers (to train, consume, behave, decide, direct). The course will include presentations of the latest results in economics and sociology on corporate governance and illustrations in contemporary business life.

Skills:

At the end of this module you will be able to:

- explain the composition of the socio-professional world of top managers,
- to describe the training trajectories of managers,
- to analyze the reproductive trend of the elites and to study the relations between managers,
- to understand the importance of social resources in management,
- to build and collect relevant data.

ORGANISATION

The courses will follow a series of interventions by the authors mentioned in the bibliography, describing the different aspects of managers and business leaders, based on research on elites, international mobility, social resources, circles of decision-makers, networks personal, the media world and multinational firms. Trainers will take care to bibliographical and methodological contributions specific to the social sciences, particularly with regard to data sources. Most of the sessions will be devoted to a case study chosen by each group of students. They will follow a precise methodology of collecting and processing information.

EVALUATION

The students will choose a famous manager and collect information in order to present the characteristics: an oral presentation by group of two or three students will be organized at the end of the module. It may be completed by the submission of a summary document on the chosen topic.

BIBLIOGRAPHY
