# Segment Specifics Modules

## *AÉRODYNAMIQUE TRANSSONIQUE*

## TRANSONIC AERODYNAMICS

**Lecturers:** Stéphane AUBERT

| Lecturers : 20.0 | TC : 0.0 | PW : 0.0 | Autonomy : 0.0 | Study : 8.0 | Project : 0.0 | Language : AN

### Objectives

Understanding the physical behaviour of compressible gas at high Mach number is crucial to design transonic and supersonic airplanes as well as modern gas turbines. This course objective is to cover the basic theories of supersonic aerodynamics, then to apply these to external flows (around airfoil and fuselage nose) and to internal flows (in compressors and turbines).

Keywords : compressible flows, supersonic, show wave, expansion wave, interactions, analytical methods

### Programme

1. Toolbox : Reminders of fluid mechanics and thermodynamics
2. One-dimensional flow : Normal shock relations
3. Oblique shock and expansion waves : Prandtl-Meyer function ; waves reflections
4. External flows : Critical Mach number ; sound barrier ; bow shock
5. Quasi-one dimensional flow : nozzles
6. Transonic axial compressor flows

### Learning outcomes

- To elaborate and to apply formulations adapted to compressible and transonic flows
- To understand transonic aerodynamics phenomena in external and internal flows
- To judge the accuracy of models to estimate quantities of interest from a design point of view

### Independent study

Objectifs : This activity is not concerned with framed autonomy activities outside personal work.

Méhodes : This activity is not concerned with framed autonomy activities outside personal work.

### Core texts

N.A. Cumpsty, *COMPRESSOR AERODYNAMICS*, Krieger Publishing Company, 2004
J.D. Anderson *MODERN COMPRESSIBLE FLOW*, Mc Graw Hill, 2021

### Assessment

Final mark = 100% Knowledge
Knowledge = 100% final exam

## *ALGORITHMES POUR LA DÉCISION EN ENTREPRISE*

## GAME THEORY AND ALGORITHMS

**Lecturers:** Philippe MICHEL, Alexandre SAIDI, Joël PERRET LIAUDET

| Lecturers : 14.0 | TC : 4.0 | PW : 0.0 | Autonomy : 0.0 | Study : 10.0 | Project : 0.0 | Language : FR

### Objectives

In this course, we show how to model some complex problems encountered in various domains (biology, politics, economics, design, ... ) by dealing with non-standard optimization algorithms (heuristics, meta-heuristics) and game theory.
On simple cases, we will illustrate these resolution processes.

Keywords : optimization algorithm, heuristics, game theory.

### Programme

Complexity / Heuristics / Simulated annealing / Genetic algorithms / Ant system / Particule swarm optimization
Game Theory

### Learning outcomes

- - solve applied optimization problems - modeling and application viaheuristic method - modeling and application via game theory

### Independent study

Objectifs : This activity is not concerned with framed autonomy activities outside personal work.

Méhodes : This activity is not concerned with framed autonomy activities outside personal work.

### Core texts

J. Dréo, A. Pétrowski, P. Arry, E. Aillard , *MÉTAHEURISTIQUES POUR L'OPTIMISATION DIFFICILE.* , Eyrolles, 2003
Colin et Camerer. *BEHAVIORAL GAME THEORY: EXPERIMENTS IN STRATEGIC INTERACTION.* , The Roundtable Series in Behavioral Economics, 2003

### Assessment

> Final mark = 50% Knowledge + 50% Know-how
> Knowledge = final exam
> Know-how = continuous assessment

## *BRUIT DES TRANSPORTS AÉRIENS ET TERRESTRES*

## AIR AND GROUND TRANSPORTATION NOISE

**Lecturers:** Marc JACOB, Mohammed ICHCHOU

| Lecturers : 16.0 | TC : 0.0 | PW : 8 | Autonomy : 0.0 | Study : 4.0 | Project : 0.0 | Language : AN

### Objectives

Noise is perceived as the highest annoyance by EU citizens and noise induced stress, to which transportation noise is a major contributor, is the 2nd largest cause of pollution related diseases in Europe after air pollution, according to WHO. Therefore, sound levels both inside transportation systems and in the surrounding environment, must be considered already at design: regulatory constraints are increasingly severe; acoustic and vibratory comfort is often a key for customer choices. Transportation noise has multiple origins: propulsion and engine systems, ventilation and air conditioning, unsteady flow around vehicles... This course deals with sound sources due to the different transport modes and their consequences on the perceived noise levels inside

Keywords : Acoustics, noise, vibration, comfort, nuisances, transportation systems, car, train, aeronautics

### Programme

•Transportation noise: General features, regulations and certification.
•Noise sources in air transportation. Legislation and certification. (SAFRAN AE)
•Noise reduction methods for air transportation noise. (SAFRAN AE)
•An overview of ground transportation noise: sources and mitigation
•Localisation and identification of sources. Advanced measurement techniques (SAFRAN AE).
•Analysis of structure-borne noise. Vibroacoustics. Statistical energy analysis (SEA). Basics of numerical vibroacoustics.

### Learning outcomes

- Grasp the noise and vibration issues in transport
- Identify and be able to analyze noise sources in transport
- Solve typical problems in transportation noise

### Independent study

Objectifs : •Apply several approaches used to address transportation noise issues to practical situations.
•Carry out a critical result analysis

Méhodes : •1 Case study
•2 Lab classes
•1 Visit

### Core texts

M. P. Norton, *FUNDAMENTALS OF NOISE AND VIBRATION ANALYSIS FOR ENGINEERS*, Cambridge University Press, 1989
F. Fahy *ENGINEERING ACOUSTICS.*, Academic Press, 2001
T.D. Rossing*SPRINGER HANDBOOK OF ACOUSTICS.*, Springer Verlag, 2007

### Assessment

Score = N1 (50%) knowledge + N2 (50%) know-how
•N1: Written exam
•N2 : Case study and lab class reports

## *CONFORT ET ÉNERGIE DE L'HABITAT*

## HOME COMFORT AND ENERGY

**Lecturers:** Eric VINCENS

| Lecturers : 20 | TC : 0 | PW : 0 | Autonomy : 0.0 | Study : 8 | Project : 0.0 | Language : FR

### Objectives

While Housing represents nearly 40% of total energy consumption in France and contributes 25% to greenhouse gas emissions, controlling the energy performance of buildings is becoming a major issue in building a future. sustainable. This course proposes to provide tools for designing a high-performance envelope and for producing energy for a more frugal habitat, but also tools for diagnosing the existing one.

Keywords : frugality, comfort, air renewal, energy for the building

### Programme

- 2020 Environmental standard (RE2020) and labels
- Home comfort
- Frugal solutions for building energy production
- Photovoltaics for buildings

### Learning outcomes

- - build a static and dynamic model to quantify heat losses - build the process to assess heating needs - choose technical solutions for heating the production of domestic hot water

### Independent study

Objectifs : This activity is not concerned with framed autonomy activities outside personal work.

Méhodes : This activity is not concerned with framed autonomy activities outside personal work.

### Core texts

### Assessment

- knowledge score: final exam without documents
- know-how score: notes from the BE

## *CONTRÔLE ACTIF DU BRUIT ET DES VIBRATIONS*

## ACTIVE NOISE CONTROL AND VIBRATION

**Lecturers:** Marie Annick GALLAND, Marc JACOB, Mohammed ICHCHOU

| Lecturers : 10.0 | TC : 0.0 | PW : 8.0 | Autonomy : 0.0 | Study : 10.0 | Project : 0.0 | Language : MI

### Objectives

Active control systems have been widely developed in the last 20 years. The basic principle is well known : a secondary wave, 180° out of phase, is synthetized to interfere with the primary one. Active noise or vibration control therefore aims to reduce an existing noise or vibration, especially at low frequencies, where passive means are unefficient. The
objective of this course is to introduce the basic principles and the main realizations in mechanics. Other topics are also investigated: active absorption, semi-active control, smart materials...

Keywords : active control, acoustics, vibration, fluid mechanics, adaptive filters, real time, analog filters

### Programme

1- Active Noise Control
2- Adaptive algorithms
3- Energy in active systems. Local control/ global control
4- Semi-active and Active Control of Vibrations
5- LQG control - MIMSC control
6- Smart Structures
7- Vibro-acoustic Control
8- Active Control of Flow Instabilities

### Learning outcomes

- to identify potential applications of active control systems
- to select the suited active control technologies
- to design an active control system
- to discuss about active systems' limitations

### Independent study

Objectifs : The practical activities (12h) reflect the variety of applications :
- active headset
- real time systems for noise control
- active vibration control of a structure

Méhodes : 2 Experimental Work sessions (Lab Work)
1 Practical Work

### Core texts

Stephen Elliott , *SIGNAL PROCESSING FOR ACTIVE CONTROL*, Academic Press, 2001
Leonard Meirovich *DYNAMIC AND CONTROL OF STRUCTURES*, John Wiley and Sons, 1990
P.A. Nelson, S.J. Elliott*ACTIVE CONTROL OF SOUND*, Academic Press, 1992

### Assessment

Final mark = 45% Knowledge + 40% Know-How +15% Methodology
K= 10% final exam + 35% Continuous Assessment
KH=40% Continuous Assessment

## *CHOIX DES MATÉRIAUX ET DES ASSEMBLAGES*

## CHOICE OF MATERIALS AND ASSEMBLAGE

**Lecturers:** **Stephane BENAYOUN, Michelle SALVIA**

| Lecturers : 14.0 | TC : 4.0 | PW : 8.0 | Autonomy : 0.0 | Study : 0.0 | Project : 0.0 | Language : FR

### Objectives

Keywords :

### Programme

### Learning outcomes

### Independent study

Objectifs : This activity is not concerned with framed autonomy activities outside personal work.

Méhodes : This activity is not concerned with framed autonomy activities outside personal work.

### Core texts

M.F. Ashby, Y. Bréchet, L. Salvio, *SÉLECTION DES MATÉRIAUX ET DES PROCÉDÉS DE MISE EN OEUVRE*, Presse Polytechniques et Universitaires Romandes, 2001
J.M. Berthelot *MATÉRIAUX COMPOSITES : COMPORTEMENT MÉCANIQUE ET ANALYSE DES STRUCTURES*, Lavoisier, 2005

### Assessment

# *COMPATIBILITÉ ÉLECTROMAGNÉTIQUE DES SYSTÈMES DE PUISSANCE ET INTERACTION*

# ELECTROMAGNETIC COMPATIBILITY OF POWER SYSTEMS, INTERACTION WITH

**Lecturers:** Christian VOLLAIRE

| Lecturers : 12.0 | TC : 4.0 | PW : 4.0 | Autonomy : 0.0 | Study : 8.0 | Project : 0.0 | Language : FR

## Objectives

The massive use of telecommunications and electrical energy conversion systems leads to having to take into consideration the "electromagnetic pollution" linked to human activity, the objective being safety (electromagnetic cohabitation). With the development of increasingly autonomous devices (renewable energies, cars, drones), electromagnetic access routes (waves, cables, etc.) have become potential inputs for signals aimed at disrupting operation or even taking control of the target. We can also mention the problems of exposure of people to electromagnetic fields from human activities that must be controlled.
The objectives are : presentation of sources of disturbances, couplings, failures of complex systems and

Keywords : Electromagnetic compatibility, natural sources of disturbances and those linked to human activity (intentional or not), couplings, victims, exposure to electromagnetic waves, countermeasures, modeling, measurement techniques, standards

## Programme

1 The issue of EMC
2 Electromagnetic fields and propagation
3 Sources of disturbance (natural origin, human origin, intentional or not)
4 Study of conducted and radiated coupling modes
5 Current studies and testing
6 Methods of prevention and protection
7 Electromagnetic fields and biological systems

## Learning outcomes

• At the end of this course, students will be able to analyze EMC phenomena in complex systems, to propose analysis methods and solutions. They will be able to discuss with experts in the field through knowledge of the EMC vocabulary, the phenomena at work, the normative constraints and the usual solutions.

## Independent study

Objectifs : This activity is not concerned with framed autonomy activities outside personal work.

Méhodes : This activity is not concerned with framed autonomy activities outside personal work.

## Core texts

P. Degauque, J. Hamelin , *COMPATIBILITÉ ELECTROMAGNÉTIQUE* , Dunod, 1990
R. Perez *HANDBOOK OF ELECTROMAGNETIC COMPATIBILITY* , Lavoisier
Yvon Mori*COMPATIBILITÉ ELECTROMAGNÉTIQUE*, Hermes Lavoisier, Paris, 2007

## Assessment

Score = 70% knowledge + 30% practical work
Knowledge score = 100% final exam + 0% continuous evaluation
practical work score = = 100% final exam + 0% continuous evaluation

## *COUCHES ULTRAMINCES ET SURFACES FONCTIONNALISÉES*

## FUNCTIONALIZED THIN LAYERS AND SURFACES

**Lecturers:** Virginie MONNIER-VILLAUME, Stephane BENAYOUN

| Lecturers : 14 | TC : 4.0 | PW : 4 | Autonomy : 6 | Study : 0.0 | Project : 0.0 | Language : FR

### Objectives

The objective is, in a first part, to study the relationship between elaboration conditions of thin films, structure and associated micro/nanostructure, and the desired specific properties in various application fields: mechanics, optics, electronics, chemistry and biology. The search of new performances, the development of nanotechnologies and the need for innovation require a mutifunctional approach for the conception of the objects. On the surface, i.e. at the interface with the external medium, sollicitations, damages, or specific properties are occuring and must be optimized and/or considered to be different from the ones of the bulk material.

Keywords : Thin film, deposition methods, defects, electrical properties, supraconductivity, optical properties, mechanical properties, self-assembled monolayers, sol-gel

### Programme

During this course, we will particularly study the mechanical properties (elasticity, plasticity, damage and adhesion of the films on the substrate), the electrical properties (influence of bidimensionality on the carriers, films of nanometric thickness taking into account the quantum nature of their electronic properties), the optical properties (application to integrated optics and obtention of specific functional properties) of thin films. The last part of the course will be dedicated to the study of self-assembled monolayers and their applications. A practical session will allow the students to take part to a molecular beam epitaxy experiment in the cleanroom.

### Learning outcomes

- Know the mechanism and elaboration systems of a thin film.
- Know the different properties and applications of a thin film.

### Independent study

Objectifs : This activity is not concerned with framed autonomy activities outside personal work.

Méhodes : This activity is not concerned with framed autonomy activities outside personal work.

### Core texts

Bethany R. Hughes, Yaser Dahman *FABRICATION AND SELF-ASSEMBLY OF NANOBIOMATERIALS APPLICATIONS OF NANOBIOMATERIALS, CHAPTER 14*

### Assessment

Final mark = 100% Knowledge
Knowledge = 100% final exam

## *DYNAMIQUE DES MÉCANISMES*

## DYNAMIC MECHANISMS

**Lecturers:** **Joël PERRET LIAUDET, Alain LE BOT**

| Lecturers : 12.0 | TC : 6.0 | PW : 0.0 | Autonomy : 0.0 | Study : 10.0 | Project : 0.0 | Language : FR

### Objectives

Keywords :

### Programme

### Learning outcomes

### Independent study

Objectifs :

Méhodes :

### Core texts

Georges Spinnler, *CONCEPTION DES MACHINES, PRINCIPES ET APPLICATIONS VOL. 2 DYNAMIQUE* , Presses polytechniques et universitaires romandes, 1998

### Assessment

## *ECONOMÉTRIE DES SÉRIES TEMPORELLES*

## TIME SERIES ANALYSIS

**Lecturers:** Christian DE PERETTI, Alexandre SAIDI, Marie-Christophette BLANCHET

| Lecturers : 28 | TC : 0.0 | PW : 0.0 | Autonomy : 0.0 | Study : 0.0 | Project : 0.0 | Language : FR

### Objectives

A time series - or time series - is a sequence of observations indexed by time. The temporal and joint dynamics of time series are modelled by discrete-time stochastic processes. The main applications of time series are the modelling of macroeconomic and financial series. They can also be used in other sciences such as physics, biology, geology (Nile floods, Hurst 1951), health (hormone levels in blood), etc.

The objective of this time series course is to review a large number of econometric models without going into mathematical demonstrations: for univariate stationary (ARMA models, application to short-term interest rates),

Keywords : Discrete-time stochastic processes, econometrics, estimation, testing, economic interpretation, neural networks, Eviews software.

### Programme

Chap 1: Introduction to the concept of time series.
Chap 2. Autoregressive moving average models (ARMA)
Basic model.
+ recurrent neural networks. LSTM.
Chap 3. Autoregressive conditional heteroskedasticity models (ARCH)
Models specific to the returns of financial securities.
They take into account periods of volatility observed in financial markets.
+ Neural volatility models
Chap 4. Notion of unit root and ARIMA models

### Learning outcomes

- Knowledge: time series modelling by stochastic process. Know-how: Applications to macroeconomic and financial problems.

### Independent study

Objectifs : Non.

Méhodes :

### Core texts

Walter Enders, *APPLIED ECONOMETRIC TIME SERIES*, Wiley, 2014

### Assessment

50% one-hour examination.
50% project in pairs.

## *ECOULEMENTS INSTATIONNAIRES EN TURBOMACHINE*

## UNSTEADY FLOW IN TURBOMACHINE

**Lecturers:** Stéphane AUBERT, Alexis GIAUQUE

| Lecturers : 24.0 | TC : 0.0 | PW : 0.0 | Autonomy : 0.0 | Study : 4.0 | Project : 0.0 | Language : AN

### Objectives

Exchanges between the fluid and the structure are involved in turbomachinery either to extract energy from the fluid (turbines), or to transfer energy to the fluid (compressors). While these energy levels may be very large, one part may be diverted to feed unsteady mechanisms, leading some time to the machine blowout. The course objective is to study some of these unsteady mechanisms and to answer basic questions : why and how are they generated, how do they grow, is it possible to control them or to delay their onset, is it possible to simulate them numerically or to measure them experimentally ?

Keywords : turbomachinery, unsteady flows, aeroelasticity, instabilities, coupled phenomena

### Programme

1. Out-of-design performances degradation : operability reduction due to cumulative effects in multi-rows machines; quasi-steady or fully unsteady phenomena
2. Rotor-stator interactions : potential effects in subsonic and supersonic regimes; wakes behaviour through turbines and compressors channels; forced vibration of the structure
3. Aerodynamic instabilities : description, analysis and model of surge; rotating stall; example of recent research in multi-stages axial compressors
4. Fluid-structure coupling and aeroelasticity instabilities : history of failures related to flutter; specificities of flutter in turbomachinary

### Learning outcomes

- To name the main unsteady phenomena in turbomachinery
- To formulate interaction scenarios between these phenomena
- To evaluate the characteristic frequencies of these phenomena
- To split in basic physical phenomena the complex behaviour of a turbomachine from data based on simulations or measurements

### Independent study

Objectifs :

Méhodes :

### Core texts

### Assessment

Final mark = 100% Knowledge
Knowledge = 100% final exam

## *FIABILITÉ DES SYSTÈMES COMPLEXES*

## COMPLEX SYSTEMS FIABILITY

**Lecturers:** Mohammed ICHCHOU, Lyes NECHAK, Olivier BAREILLE

| Lecturers : 0.0 | TC : 28.0 | PW : 0.0 | Autonomy : 0.0 | Study : 0.0 | Project : 0.0 | Language : FR

### Objectives

Keywords :

### Programme

- Partie I : Modes de défaillances et notions de bases
o Notions de sûreté et de qualité
o Normes en vigueurs
o Classification des défaillances
o Notions de probabilités de défaillances
o Lois usuelles
o …
- Partie II : Techniques d'analyse fiabilistes
o Approches probabilistes

### Learning outcomes

### Independent study

Objectifs : This activity is not concerned with framed autonomy activities outside personal work.

Méhodes : This activity is not concerned with framed autonomy activities outside personal work.

### Core texts

A. El Hami et B. Radi, *FIABILITÉ ET OPTIMISATION DES SYSTÈMES : THÉORIE ET APPLICATIONS, COURS ET EXERCICES CORRIGÉS* , TECHNOSUP, 2011
Jean-Louis Bon *FIABILITÉ DES SYSTÈMES. MÉTHODES MATHÉMATIQUES*, MASSON, 1995
Christiane Cocozza-Thivent*PROCESSUS STOCHASTIQUES ET FIABILITÉ DES SYSTÈMES*, Springer, 2018

### Assessment

## *GÉOTECHNIQUE*

## ADVANCED SOIL ENGINEERING

**Lecturers:** **Eric VINCENS**

| Lecturers : 0.0 | TC : 28.0 | PW : 0.0 | Autonomy : 0.0 | Study : 0.0 | Project : 0.0 | Language : FR

### Objectives

This course presents the design of the foundations of structures as well as the techniques for retaining soils in the works or final phase. It is based on knowledge of soil mechanics which should have been
acquired through MOD2.6 or ELC-C6.

Keywords : shallow foundations, deep foundations, retaining wall, reinforcement

### Programme

Shallow foundations
Deep foundations
Retaining walls and soil reinforcement

### Learning outcomes

- - how to analyze the data constraints of a geotechnical project - sizing a geotechnical system (foundation, reinforcement) - how to choose a technological solution

### Independent study

Objectifs : This activity is not concerned with framed autonomy activities outside personal work.

Méhodes : This activity is not concerned with framed autonomy activities outside personal work.

### Core texts

Georges Filliat, *LA PRATIQUE DES SOLS ET FONDATIONS*, EDITIONS DU MONITEUR, 1981
Philippe Mestat *DE LA RHÉOLOGIE DES SOLS À LA MODÉLISATION DES OUVRAGES GÉOTECHNIQUES*, LCPC, 2000

### Assessment

- knowledge score: a final test with part without documents and part with documents
- know-how score: reports from BE

## *HYDROLOGY AND HYDROGEOLOGY*

## HYDROLOGY AND HYDROGEOLOGY

**Lecturers:** Richard PERKINS, Pietro SALIZZONI

| Lecturers : 14 | TC : 0.0 | PW : 6 | Autonomy : 0.0 | Study : 8 | Project : 0.0 | Language : FR

### Objectives

Water is a natural resource essential to life, and although it covers 71% of the earth's surface, only a small fraction of this water is directly usable. Worse, this fraction is distributed very unevenly over the earth's surface, and the ever-increasing demand for water renders its management ever more critical. The engineer has a central role to play in the control and management of water resources.

Hydrology is the science of the water cycle - the exchanges between the atmosphere, the earth's surface and the subsoil. More specifically, hydrogeology is the science of groundwater.

Keywords : Hydrology, hydrogeology, water resources, precipitation, hydrographs, evaporation, evapo-transpiration, Darcy, porous media.

### Programme

1. Introduction
   - the hydrological cycle
   - the distribution of water over the planet
   - a short history of water management and water treatment

2. The hydrological cycle
   - water in the atmosphere: moisture and precipitation
   - evapo-transpiration

### Learning outcomes

- Students should be familiar with the major components of the hydrological cycle, and the interaction between them. They should be able to estimate their importance through order-of-magnitude calculations.
- Students should understand how to develop models which combine physical principles with real data, and should be able to apply these to the laboratory classes.
- Students should have mastered the basic equations for flow in porous media, and should be able to solve them for simple situations. They should be able to develop solutions for more complex situations through the superposition of solutions for simpler

### Independent study

Objectifs : This activity is not concerned with framed autonomy activities outside personal work.

Méhodes : This activity is not concerned with framed autonomy activities outside personal work.

### Core texts

Brutsaert, W., *HYDROLOGY: AN INTRODUCTION*, Cambridge University Press, 2005
Freeze, R.A. & Cherry, J.A. *GROUNDWATER*, Pearson, 1979
Shaw, E.M.*HYDROLOGY IN PRACTICE*, Taylor & Francis, 2010

### Assessment

Knowledge 50% Know-how 50%
Knowledge: 40% Exam + 60% Continuous assessment
Know-how: 40% Exam + 60% Continuous assessment

## *INFORMATIQUE D'ENTREPRISE*

## ENTERPRISE COMPUTING

**Lecturers:** Daniel MULLER, Alexandre SAIDI, Mohsen ARDABILIAN

| Lecturers : 0.0 | TC : 28.0 | PW : 0.0 | Autonomy : 0.0 | Study : 0.0 | Project : 0.0 | Language : FR

### Objectives

Through a series of conferences led by professionals, this course aims to provide a better knowledge of systems, applications, methods, and professions of IT in companies, whose realities are often very different and much richer than the vision that may have students.

Keywords : Business IT, information systems, IT trades.

### Programme

Here are some conferences that have taken place in previous years:

"e-payment services", Cédric Lamarzelle, Atos Worldline
"Service-oriented architecture", Matthieu Girardin, CGI
"Information technology and freedoms", Correspondent for information technology and freedoms, Centrale Lyon
"HPC and Big Data virtualization", Jean-Daniel Bonnetot, OVH,
"Open-Source jobs", Valentin Clavreul, Smile
"Application Outsourcing", Philippe Ihuel, Sopra Group

### Learning outcomes

- Understand the complexity and diversity of IT in business.
- Have an idea of the various IT professions in business.

### Independent study

Objectifs : This activity is not concerned with framed autonomy activities outside personal work.

Méhodes : This activity is not concerned with framed autonomy activities outside personal work.

### Core texts

### Assessment

MCQ covering all the conferences, based on questions submitted by each of the speakers.

## *INFORMATIQUE GRAPHIQUE*

## COMPUTER GRAPHICS

**Lecturers:** Mohsen ARDABILIAN, Alexandre SAIDI

| Lecturers : 0.0 | TC : 28.0 | PW : 0.0 | Autonomy : 0.0 | Study : 0.0 | Project : 0.0 | Language : FR

### Objectives

This course will present notions of computer graphics, and mainly those related to the realistic rendering of 3D images. It notably introduces notions of raytracing/pathtracing and lighting simulation (the rendering equation), textures and representation of materials, representations of 3D geometry, camera models, Monte Carlo simulation and integration, and importance sampling, acceleration structures, surface parametrization and perception. During this course, you will entirely develop in C ++ a realistic image rendering engine (graded) based on a Monte Carlo simulation that you will improve over the course of the lectures.

Keywords : Computer Graphics, 3d rendering, raytracing, Monte Carlo integration, lighting simulation

### Programme

You will start the course with an almost empty code. Over the course of the explanations, you will first add the possibility to render simple diffuse spheres with point lights and direct lighting. You will add gamma correction, anti-aliasing, and the handling of reflective and transparent spheres. After a lecture on Monte Carlo Simulation and the Rendering Equation, you will add indirect lighting, extended light sources to achieve soft shadows, as well as depth of field blur. Finally, you will add support for more complex 3D shapes through textured meshes.

### Learning outcomes

- 3d rendering: At the end of this course, you will be able to implement a simple but realistic 3d rendering engine, and will understand related concepts.
- Monte Carlo integration: At the end of this course, you will understand how to stochatically integrate functions, and know variance reduction techniques.
- Programming: This course will strengthen your programming skills, through the implementation of non-trivial data structures (e.g., Bounding Volumes Hierarchies) and a motivating application.

### Independent study

Objectifs : This activity is not concerned with framed autonomy activities outside personal work.

Méhodes : This activity is not concerned with framed autonomy activities outside personal work.

### Core texts

Matt Pharr, Wenzel Jakob, Greg Humphreys, *PHYSICALLY BASED RENDERING: FROM THEORY TO IMPLEMENTATION. HTTPS://PBRT.ORG/*, Elsevier, 2016
Peter Shirley *RAY TRACING IN ONE WEEKEND. HTTPS://RAYTRACING.GITHUB.IO/* , 2016

### Assessment

Note = 33% savoir + 67% savoir-faire
Note de savoir = 100% examen terminal
Note de savoir-faire = 100% contrôle continu.

## *INGÉNIERIE TISSULAIRE ET BIOMATÉRIAUX*

## TISSUE ENGINEERING AND BIOMATERIALS

**Lecturers:** Emmanuelle LAURENCEAU, Vincent FRIDRICI

| Lecturers : 24.0 | TC : 0.0 | PW : 0.0 | Autonomy : 4.0 | Study : 0.0 | Project : 0.0 | Language : FR

### Objectives

The objective of this course is to address the problems of repair and replacement of biological tissues, as well as to give the bases and principles of tissue engineering through different examples (orthopedics, vascular, dental, skin)

Keywords : Material-living interactions, biomaterials, tissue reconstruction, prostheses

### Programme

Cells and extracellular matrix
Biocompatibility and biomaterials
Biomaterials in dentistry
Bone tissue engineering and mechanical behavior
Vascular prostheses, orthopedic ...
Skin tissue engineering and tribology

### Learning outcomes

- - Know the basics of cellular functioning - Explain the principles of tissue engineering - Select a biomaterial for a given application - Evaluate a scientific publication

### Independent study

Objectifs : This activity is not concerned with framed autonomy activities outside personal work.

Méhodes : This activity is not concerned with framed autonomy activities outside personal work.

### Core texts

### Assessment

Final mark = 100% final written exam

## *MACRO ENERGIE*

## MACRO ENERGY

**Lecturers:** Jean-Pierre CLOAREC

| Lecturers : 28.0 | TC : 0.0 | PW : 0.0 | Autonomy : 0.0 | Study : 0.0 | Project : 0.0 | Language : FR

### Objectives

The development model of today's societies is based on energy consumption that is not sustainable in the long term. This course therefore aims to enable engineers to acquire a global vision of the energy system, which is indispensable both to the understanding of the current context and the challenges that future generations will have to face. The course provides fundamental knowledge on geopolitical, economic and technical aspects of various energy sectors and their deployment or shutdown at the international and local level.

Keywords : Geopolitics of energy; primary, secondary and final energy, energy balance, energy chains; energy-climate; energy-development; international, national, local scales

### Programme

### Learning outcomes

### Independent study

Objectifs :

Méhodes :

### Core texts

### Assessment

## *MICROSYSTÈMES, MICROCAPTEURS, MICROFLUIDIQUE*

## MICROSYSTEMS, MICROSENSORS, MICROFLUIDIC

**Lecturers:** Emmanuelle LAURENCEAU, Ian O CONNOR

| Lecturers : 16.0 | TC : 0.0 | PW : 0.0 | Autonomy : 0.0 | Study : 12.0 | Project : 0.0 | Language : FR

### Objectives

Starting from the example of a lab-on-chip for biological analysis, the issues related to the integration of different components and functions on a miniaturized system will be developed and clarified. An introduction to microfluidics (physics at the microfluidic scale, influence of the laws of scale on the miniaturization of systems, hydrodynamics of microfluidic systems, diffusion, mixing and separation in microsystems) as well as the notions necessary for understanding the problems of Acquisition of the very low amplitude signal will be presented. The cases of chemical and biological sensors will be particularly developed.

Keywords : Miniaturized system, sensor and biosensor, integration, microfluidics

### Programme

Chemical, biological and physical microsensors
Electrokinetics, diffusion and mixing in microsystems
Electronic detection, noise level, electronic control of sample movement
BE1: Bibliographic study of a biosensor
BE2: Microfluidics
BE3: Electronic signal processing

### Learning outcomes

- Know the basics of how a microsensor works
- Know how to develop a microsystem for a given application
- Extract data
- Analyze a scientific publication

### Independent study

Objectifs : This activity is not concerned with framed autonomy activities outside personal work.

Méhodes : This activity is not concerned with framed autonomy activities outside personal work.

### Core texts

Cooper Jonathan M., *BIOSENSORS*, Oxford University Press, 2004
Folch Albert *INTRODUCTION TO BIOMEMS*, CRC Press, 2013
Tabeling Patrick*INTRODUCTION À LA MICROFLUIDIQUE*, Belin, 2003

### Assessment

Final mark= 33%  mark BE1 + 33% mark BE2 + 33% mark BE3

# *NOUVELLES TECHNOLOGIES DE L'INFORMATION ET DE LA COMMUNICATION*

# NEW TECHNOLOGIES OF INFORMATION AND COMMUNICATION

**Lecturers:** Daniel MULLER, Alexandre SAIDI, Mohsen ARDABILIAN

| Lecturers : 0.0 | TC : 28.0 | PW : 0.0 | Autonomy : 0.0 | Study : 0.0 | Project : 0.0 | Language : FR

## Objectives

At the convergence of IT, telecommunications, corporate networks, and multimedia, the world of Information and Communication Technologies is constantly changing and therefore requires active monitoring by stakeholders. involved. This training action aims to introduce students to technological watch, both theoretically and practically. In coordination with the teaching team, the students will put technological watch into practice by carrying out their own study on a freely chosen subject. Each student will be asked to present his results to all his peers during workshops organized for this purpose.

Keywords : Technological watch, information and communication technologies, innovation.

## Programme

Introduction to technological and strategic watch
The challenges - The tools
The main areas of technology watch - choice of an issue
Individual presentations by the students of the selected subjects

## Learning outcomes

- To be able to carry out a technological watch.
- Knowing how to identify innovations in your sector of activity.
- Be able to report to peers.

## Independent study

Objectifs : This activity is not concerned with framed autonomy activities outside personal work.

Méhodes : This activity is not concerned with framed autonomy activities outside personal work.

## Core texts

F. Jakobiak, *L'INTELLIGENCE ÉCONOMIQUE, TECHNIQUES ET OUTILS.* , Dunod,, 2009

## Assessment

Final Mark Score = 20% knowledge + 70% know-how + 10% interpersonal skills
Knowledge score = 100% methodological report
Interpersonal skills score = attendance

## *OUVRAGES DE PRODUCTION D'ENERGIE*

## CONSTRUCTION OF ENERGY PRODUCTION

**Lecturers:** Eric VINCENS, Pierre BRUN

| Lecturers : 20.0 | TC : 0.0 | PW : 0.0 | Autonomy : 0.0 | Study : 8.0 | Project : 0.0 | Language : FR

### Objectives

- Know the installations associated with the production of nuclear, hydroelectric and wind energy.
- Know how to apply the basic concepts of design and safety

Keywords : Power systems, nuclear power plant, dams, safety, design, wind power

### Programme

Nuclear works
1. Presentation of general site plans (relative locations and role of structures)
2. The texts governing the design and operation of nuc structures, having an impact on the design
3. Safety requirements and general civil engineering installation
4. Design of structures: from basic texts to sizing criteria
5. Introduction to simplified reliability studies applied to civil engineering
6. Containment enclosures

### Learning outcomes

- - Layout design - Safety Assessment

### Independent study

Objectifs : This activity is not concerned with framed autonomy activities outside personal work.

Méhodes : This activity is not concerned with framed autonomy activities outside personal work.

### Core texts

### Assessment

- knowledge score: final exam without documents
- know-how score: BE study by group of 2

## *PHÉNOMÈNES COMPLEXES EN DYNAMIQUE DES STRUCTURES*

## COMPLEX PHENOMENA IN STRUCTURAL DYNAMICS

**Lecturers:** Olivier DESSOMBZ, Jean-Jacques SINOU

| Lecturers : 4.0 | TC : 24.0 | PW : 0.0 | Autonomy : 0.0 | Study : 0.0 | Project : 0.0 | Language : FR

### Objectives

The behavior of real structures often exceeds the basic mechanics framework for various reasons. The non-deterministic nature of the structures, the presence of nonlinearities are taken into account to better understand the behavior of these structures in real cases operating in engineering.
We propose here to give tools and address the conventional methods of engineering for introducing randomness and non-linearities in the systems, and to describe and more realistically the behavior of real structures and their optimization. Particular attention will also be paid to the engineer's process of defining a relevant mathematical model with regard to the experimental observations. These tools will be

Keywords : Solid Mechanics, Structural Dynamics Engineering of complex systems, Uncertainty, Optimization, Stability, Nonlinear Systems

### Programme

1) Introduction
2) Instability
3) Nonlinear behavior and methodology
4) Dispersions
5) Structural optimization

### Learning outcomes

- Formulate a complex problem in structural dynamics
- Explain physical phenomena in structural dynamics
- Evaluate according to the dynamic operating criteria of an object
- Knowing the sources of uncertainties and nonlinearities and how to model them

### Independent study

Objectifs :

Méhodes :

### Core texts

A.H. Nayfeh and D.T. Mook, *NONLINEAR OSCILLATIONS*, John Wiley & Sons, 1979
A. Preumont *VIBRATIONS ALÉATOIRES ET ANALYSE SPECTRALE*, Presses Polytechniques Romandes, 1990
D.-J. Ewins*MODAL TESTING: THEORY, PRACTICE AND APPLICATION*, Study Press,, 1984

### Assessment

Final mark = 30% Knowledge + 70% Know-how
Knowledge = 100% final exam
Know-how = 100% continuous assessment

***ENTREPRENEUR***

## ENTREPRENEURIAL COACHING

**Lecturers:** **Thierry FARGERE, Sylvie MIRA**

| Lecturers : 0.0 | TC : 28.0 | PW : 0.0 | Autonomy : 0.0 | Study : 0.0 | Project : 0.0 | Language : FR

### Objectives

Develop entrepreneurial competencies and create a startup

Keywords : business creation - entrepreneurial finance - entrepreneurial law

### Programme

Legal aspects of business creation
Financial dimensions of business creation
Startup management

### Learning outcomes

- Implement a business creation process
- Know how to finance a business creation
- Know the different legal status of a startup

### Independent study

Objectifs : Implementation of a startup creation process

Méhodes : Practical work with potential customes, competitors, financial plan

### Core texts

Alexander Osterwalder, Yves Pigneur, Alan Smith. , *BUSINESS MODEL GENERATION*, WILEY, 2010
Eric Ries. *THE LEAN STARTUP.*, CURRENCY,, 2017

### Assessment

Continuous monitoring of project progress

## *INTRAPRENEUR*

## BUSINESS DEVELOPMENT

**Lecturers:** **Marie GOYON**

| Lecturers : 0.0 | TC : 28.0 | PW : 0.0 | Autonomy : 0.0 | Study : 0.0 | Project : 0.0 | Language : FR

### Objectives

Faced with the challenges of the call for innovation in the companies and in the public sector, this training aims to allow engineering students to train in the issues and practices of innovation, the design of innovative projects and their strategic support (intrapreneurship). Theoretical training (innovation management, project management, open innovation, innnovate with labs, agile methods, ecosystems and labs, companies social responsibilities) and project-driven training with one or more partner companies. A case study can also be realized.
OPEN to all Students

Keywords : innovation, strategy, management, design, agility, intrapreneurship, project

### Programme

Courses, workshops, coaching, autonomy
Themes: Design thinking and agile methods, prototyping, communication, negotiation, open innovation, innovation strategies,actors, field surveys, buisness models, patent monitoring

### Learning outcomes

- conduct an innovation process: design, manage, realize
- lead an innovation strategy: actors and stakeholders, strategy development and planning, negotiation and communication
- federate and manage a project team
- adopt a transversal and agile project practice

### Independent study

Objectifs : Realization of a project (design, communication and strategy)

Méhodes : Project, coaching, fieldwork

### Core texts

### Assessment

Oral presentations and report

## *POLLUTION ATMOSPHÉRIQUE*

## ATMOSPHERIC POLLUTION

**Lecturers:** **Lionel SOULHAC, Didier DRAGNA, Pietro SALIZZONI**

| Lecturers : 16.0 | TC : 4.0 | PW : 0.0 | Autonomy : 0.0 | Study : 8.0 | Project : 0.0 | Language : FR

### Objectives

Keywords :

### Programme

### Learning outcomes

### Independent study

Objectifs : This activity is not concerned with framed autonomy activities outside personal work.

Méhodes : This activity is not concerned with framed autonomy activities outside personal work.

### Core texts

### Assessment

## *PROBLÈMES EN DOMAINES NON BORNÉS : ANALYSE MATHÉMATIQUE ET SIMULATION*

## PHYSICAL PROBLEMS IN UNBOUNDED MEDIA : MATHEMATICAL ANALYSIS AND NUMERICS

**Lecturers:** Laurent SEPPECHER, Alexandre SAIDI, Grégory VIAL, Marc JACOB

| Lecturers : 10.0 | TC : 6.0 | PW : 0.0 | Autonomy : 0.0 | Study : 12.0 | Project : 0.0 | Language : MI

### Objectives

This course aims at giving the mathematical foundations for the study of partial differential equations posed in an unbounded domain. We will focus on model equations (Laplace, Helmholtz, wave equation) to present the mathematical framework and the main ideas for the design of numerical methods.

Keywords : Propagation phenomena. Partial differential equations. Unbounded domains.

### Programme

Part I : Basic facts for stationary and harmonic problems

Part II : Time dependent problems

Part III : Focus on the Helmholtz problem in the free space

### Learning outcomes

- To be able to identify conditions for closing a problem in an unbounded domain.
- To be able to design a numerical method for PDEs in unbounded domains.
- To be able to quantify the accuracy of such a numerical method.

### Independent study

Objectifs : Basics on finite elements softwares.
Practice on methods developed during lectures.

Méhodes : Application exercises.

### Core texts

J.-C. Nédelec, *ACOUSTIC AND ELECTROMAGNETIC EQUATIONS*, Springer, 2001
D. Givoli *NUMERICAL METHODS FOR PROBLEMS IN INFINITE DOMAINS*, Elsevier, 1992
L. Lehmann*WAVE PROPAGATION IN INFINITE DOMAINS*, Springer, 2007

### Assessment

Grade = 50% knowledge + 50% knowhow
Knowledge grade = 100% final exam
Knowhow grade = 100% continuous assessment

## *PROCÉDÉS GÉNÉRAUX DE CONSTRUCTION*

## TECHNIQUES FOR CONSTRUCTION

**Lecturers:** **Eric VINCENS**

| Lecturers : 0.0 | TC : 28.0 | PW : 0.0 | Autonomy : 0.0 | Study : 0.0 | Project : 0.0 | Language : FR

### Objectives

Construction techniques in the construction industry
Discovery of work in public works and construction companies

Keywords : Public Works, Civil Engineering, Methods, Construction, Site works

### Programme

Recent activity report for conventional and alternative sectors
BIM for construction
The methods for building
Facades in construction
LCA in the construction industry
Building differently: participatory housing
Building differently: earth-straw construction
Price studies

### Learning outcomes

- - Understand the context and the work environment - Know how to choose construction methods - Technical culture

### Independent study

Objectifs : This activity is not concerned with framed autonomy activities outside personal work.

Méhodes : This activity is not concerned with framed autonomy activities outside personal work.

### Core texts

### Assessment

- knowledge score: final test without documents in the form of multiple choice questions
- know-how score: reports of site visits
MOS7.3 final score= 1/2 * knowledge + 1/2 * know-how

## *RESSOURCES, ÉNERGIE, CLIMAT, SOCIÉTÉS*

## RESSOURCES, ENERGY, CLIMATE, SOCIETIES

**Lecturers:** Pietro SALIZZONI, Jean-Pierre CLOAREC, Mathieu CREYSSELS

| Lecturers : 16 | TC : 0.0 | PW : 0.0 | Autonomy : 0.0 | Study : 12 | Project : 0.0 | Language : FR

### Objectives

The objective of this course is to provide basic knowledge to enable students to understand 1) the distribution, availability and exploitation of natural resources, and the impact of the use of natural resources on the biosphere and the quality of life; 2) a basic culture and examples of tools and methods on energy & climate issues

Keywords : Natural resources, environment, climate, energy, economic growth

### Programme

Lectures
1- Historical perspective on resources, energy and climate issues (Pietro Salizzoni)
2- Mitigation of climate change impacts (Jean-Pierre Cloarec)
3- Energy and natural resources (Mathieu Creyssels)
4- Renewable energy: legislative aspects (Isabelle Michalet, Lyon 3)
5- Current natural resources and conflicts (Alberto Christina, Doctors Without Borders)

BE
3 BE sessions: Energy – Climate negotiation simulations (Jean-Pierre Cloarec)

### Learning outcomes

- Familiarize with the major classes of natural resources and their distribution on Earth
- Be aware of the impact of resource development on the environment and society
- Develop a basic understanding of the links between resource development and the growth or collapse of society.
- Become familiar with the complexity of solutions to climate issues and their social and economic acceptance.

### Independent study

Objectifs :

Méhodes :

### Core texts

J. Diamond, *GUNS GERMS AND STEEL*, WW Norton, 1997
V. Smil *ENERGY AND CIVILIZATION: A HISTORY*, The MIT Press, 2018
D. MacKay*SUSTAINABLE ENERGY – WITHOUT THE HOT AIR*, UIT Cambridge, 2008

### Assessment

Mark = 50% knowledge + 50% know-how
Knowledge mark = 100% terminal exam
Know-how mark = 100% terminal exam

## *STABILITÉ DES MACHINES TOURNANTES*

## STABILITY OF ROTATING MACHINES

**Lecturers:** Laurent BLANC, Fabrice THOUVEREZ

| Lecturers : 16.0 | TC : 0.0 | PW : 8.0 | Autonomy : 0.0 | Study : 4.0 | Project : 0.0 | Language : AN

### Objectives

Rotating machines as systems for propulsion (turbojet engines...), energy production (windmills, alternators...) or ay system needing to rotate a shaft (pump, gyroscope, centrifuges...) hold an important place in everyday life. These machines obey the laws of dynamics and often evolve in a multiphysical context: fluid-structure interaction, mechatronics. This lesson's purpose is to provide the key elements for such systems modelling, concentrating on stability aspects. Indeed this point is essential because a lot of energy is concentrated in these machines and their stability is major concern for their good functionning as well as for safety.

Keywords : Rotating machine. Stability. Vibration

### Programme

I/ Reminder of rotating elastic structure equations, modal characterictics in fixed and rotating frame.
II/ Linear systems stability analysis: equations with constants coefficients, equations with periodic coefficients. Introduction to non-linear systems stability
III/ Rotors stability problems: phenomenological analysis, analysis of structural elements leading to instabilities:
• Symmetry, dissipation, buckling in rotating parts • Bearings characteristics
• Rotor / stator coupling • Fluid-structure coupling • Non - linear phenomena causing instability (bifurcation...)

### Learning outcomes

- To understand rotordynamics specific points
- To know how to put into equations rotordynamics problems
- To know how to assess for a rotating machine dynamics and stability
- To know the different organs of a turbomachine

### Independent study

Objectifs : To get informed of rotating machines state of the art

Méhodes : Research papers analysis, by binoms + presentation to the group

### Core texts

R. Bigret, *STABILITÉ DES MACHINES TOURNANTES ET DES SYSTÈMES*, Publication CETIM, 1997
F. F. Ehrich *HANDBOOK OF ROTORDYNAMICS*, Krieger Publishing Company, 2004
M. I. Friswell, J. E. T. Penny, S. D. Garvey and A. W. Lees*DYNAMICS OF ROTATING MACHINES*, Cambridge Aerospace series, 2010

### Assessment

Lab mark
Paper comment mark
Written exam mark

## *STRATÉGIE D'ENTREPRISE*

## STRATEGIC MANAGEMENT

**Lecturers:** Sylvie MIRA, ELISABETH COUZINEAU-ZEGWAARD

| Lecturers : 0.0 | TC : 28.0 | PW : 0.0 | Autonomy : 0.0 | Study : 0.0 | Project : 0.0 | Language : FR

### Objectives

Understand how to design a corporate strategy
Implement a business analysis aligned with a resources based view and the competitive dynamics
Understand how to finance the company's growth

Keywords : Business strategy - competitive advantage - resources based view - growth

### Programme

The fundamentals of strategy
Strategy and marketing
International strategy and operations management
Growth strategy and finance

### Learning outcomes

- Understand value creation mecanism
- Know how to evaluate a company's set of resources and processes
- Know how to evaluate competitors' strategy
- Understand financial growth leverages

### Independent study

Objectifs : Implement kowledge on case studies

Méhodes : Group work on case studies

### Core texts

Frery F., *STRATÉGIQUE*, Pearson, 2014
Meier O. *STRATÉGIES ET CHANGEMENT - INNOVATIONS ET TRANSFORMATIONS DES ORGANISATIONS*, Dunod, 2013
Garette B., Lehman L.*STRATÉGOR - TOUTE LA STRATÉGIE DE LA START-UP À LA MULTINATIONALE*, Dunod, 2020

### Assessment

Case study

## *SÛRETÉ DE FONCTIONNEMENT DES SYSTÈMES ET DES STRUCTURES*

## HEALTH MONITORING

**Lecturers:** Olivier BAREILLE, Michelle SALVIA

| Lecturers : 0.0 | TC : 28.0 | PW : 0.0 | Autonomy : 0.0 | Study : 0.0 | Project : 0.0 | Language : AN

### Objectives

In the transportation and the energy-supply industry, a rigorous and reliable maintenance strategy shall be applied.
In this course, the methods of control and health-monitoring will be described. Their advantages and limitations will be addressed and discussed.
Some specific materials and technique dedicated to the structural health monitoring will be reviewed. The topic will be

Keywords : structures surveillance
ageing, material damages for structures
signal processing
wear and damage index

### Programme

The SHM steps
Measurement and sensor systems
Composite material in aeronautics : application of the SHM
Smart materials
Damage models and predictive models

### Learning outcomes

- establishing a monitoring strategy
- identification of damage phenoma
- data analysis and compared studies

### Independent study

Objectifs :

Méhodes : The 8 lectures are completed by 3 sequences of lab (1 experimental + 2 numerical).

### Core texts

J. Lemaître, *A COURSE ON DAMAGE MECHANICS*, Springer Verlag, New York, 1996
Adams Douglas E. *HEALTH MONITORING OF STRUCTURAL MATERIALS AND COMPONENTS*, Wiley, 2007
Karbhari Vistasp M. and Ansari Farhad*STRUCTURAL HEALTH MONITORING OF CIVIL INFRASTRUCTURE SYSTEMS*, Woodhead Publishing CRC Press, 2009

### Assessment

Final exam (knowledge - coeff. 0,3)
Document analysis and practical exercises (know-how - coeff. 0,6)
Practice (methodology - coeff. 0,1)

# *VÉHICULES HYBRIDES : MODÉLISATION ET GESTION DE L'ÉNERGIE*

# HYBRID ELECTRIC VEHICLES : MODELLING AND ENERGY MANAGEMENT

**Lecturers:** Arnaud BREARD

| Lecturers : 16.0 | TC : 0.0 | PW : 0.0 | Autonomy : 0.0 | Study : 12.0 | Project : 0.0 | Language : FR

## Objectives

The aim of this course is to present electric and hybrid vehicles. Modeling, sizing and energy management of hybrid vehicles and their components are studied. Twelve hours will be spent for practical works to develop and simulate vehicle models. These sessions mainly deal with the developement of a model of electric vehicle, the modelling and the energy management of Toyota Prius, and the energy management of serial hybrid vehicles.

Keywords : Hybrid vehicle, electric vehicle, cybernetic model, battery, engine, electrical machine, pollutant, energy management, emission standards, environnemental impact

## Programme

The teachers in charge of this session are researchers of IFSTTAR working on Electric and Hybrid Vehicles.
1) Hybrid electric vehicle : generalities, definitions, classification and cybernetic modelling.
2) The batteries for electric and hybrid vehicles : introduction, modelling, uses, sizing, security and ageing.
3) Engines and electrical machines : presentation, different types of electrical machines and their controls, different types of engines, anti-pollution norms, application for electric and conventional vehicles.

## Learning outcomes

- Understand the operation principles of the main components of hybrid vehicles (engine, battery, electronic converter,...)
- Modelling of a hybrid vehicle
- Sizing the components of a hybrid vehicle
- Simulate the energy management in a hybrid vehicle

## Independent study

Objectifs : This activity is not concerned with framed autonomy activities outside personal work.

Méhodes : This activity is not concerned with framed autonomy activities outside personal work.

## Core texts

Lino Guzzella, Antonio Sciarretta, *VEHICLE PROPULSION SYSTEMS - INTRODUCTION TO MODELING AND OPTIMIZATION.*, Springer, 2013
Chris Mi, M. Abul Masrur, David Wenzhong Gao *HYBRID ELECTRIC VEHICLES: PRINCIPLES AND APPLICATIONS WITH PRACTICAL PERSPECTIVES.*, Wiley, 2011

## Assessment

Final mark = 60% Knowledge + 40% Know-how
Knowledge N1 = 100% final exam
Know-how N2 = 100% continuous assessment

## *VISUALISATION INTERACTIVE DE DONNÉES*

## INTERACTIVE DATA VISUALIZATION

**Lecturers:** **Romain VUILLEMOT**

| Lecturers : 0.0 | TC : 28.0 | PW : 0.0 | Autonomy : 0.0 | Study : 0.0 | Project : 0.0 | Language : FR

### Objectives

This course aims at presenting the tools and methods located at the ends of the Big Data processing chain: visually exploring data before modeling them, visually communicating analysis results. This step is crucial for data analysts, but also for decision makers who need to understand complex results without being experts, through intuitive graphical interfaces and dashboards.

Keywords : Data visualization, multidimensional projection methods, graph layout algorithms, benchmark and visualization software development, testing methodology, JavaScript, Observable Notebooks.

### Programme

- Introduction to data visualization;
- Principles of visual encoding, perception, cognitive principles and design;
- Typology of graphics, interaction and animation techniques;
- Case studies, paper prototyping;
- Algorithmic aspects and software architectures of visualization;
- Case studies and use of industry standard tools (Tableau, Raw, Google Fusion Table);
- Introduction and advanced JavaScript;
- Web visualization project.

### Learning outcomes

### Independent study

Objectifs : This activity is not concerned with framed autonomy activities outside personal work.

Méhodes : This activity is not concerned with framed autonomy activities outside personal work.

### Core texts

Tamara Munzner, *VISUALIZATION ANALYSIS AND DESIGN*, CRC Press, 2014

### Assessment

Written exam and web project (+ defense)