APPRO - In-depth Courses

ELECTRONIQUE DE PUISSANCE

POWER ELECTRONICS

Lecturers: Christian VOLLAIRE, Arnaud BREARD

| Lecturers : 16 | TC : 10 | PW : 6.0 | Autonomy : 12 | Study : 4 | Project : 0.0 | Language : FR

Objectives

At the end of this module, students will:
- understand the interest and role of power electronics;
- know the fundamental concepts which govern this discipline;
- know the main structures of electronic power converters;
- be able to trace the shapes of currents and voltages in an electronic power converter from a block diagram;
- be able to choose the electronic power switches for a given converter and specifications;
- be able to assess the losses in an electronic power switch;

Keywords : Power electronics, static conversion of electrical energy, energy efficiency of systems, passive and active electronic components

Programme

Passive components in power electronics
- Roles and importance
- Inductive components
  - Technology
  - Sizing
- Capacity components
  - Technologies
  - Choice criteria

Thermal problems in power electronics

Learning outcomes

Independent study

Objectifs : Autonomous work consists in sizing a system based on specifications and establishing a model that will validate this sizing. The system will be studied in pairs with a student following the electromechanical conversion module. It will be a converter - electromechanical actuator combination. Each student will therefore be able to take advantage of the teaching of his module and must be

Méhodes : Sizing a device using an analytical approach
Construction of a model and verification of the relevance of the design elements

Core texts

J.-P. Ferrieux, F. Forest, *ALIMENTATIONS À DÉCOUPAGE, CONVERTISSEURS À RÉSONANCE*, Masson
J.-L. Cocquerelle *CEM ET ÉLECTRONIQUE DE PUISSANCE*, Technip
R. W. Erickson, D. Moksimovic*FONDAMENTALS OF POWER ELECTRONICS*, Kluwer Academic Publishers

Assessment

The note of the course will be composed of
- the knowledge score (75%)
- the know-how score (25%)

CONVERSION ÉLECTROMÉCANIQUE

ELECTROMECHANICAL CONVERSION

Lecturers: Eric VAGNON

| Lecturers : 14.0 | TC : 14.0 | PW : 6.0 | Autonomy : 14.0 | Study : 0.0 | Project : 0.0 | Language : FR

Objectives

The objective of this course is to present the electromagnetic phenomena with their energetic aspects and to show how to pass, starting from the fundamental concepts of electromagnetism, to the design of an electric machine. This approach is presented on the example of the synchronous machine and illustrated by the various uses of this machine. This approach will be generalized to other types of electric motors in order to design electrical models that can be used for speed variation.

Keywords : Electromagnetic energy, force and power, actuator, conversion structures, frequency-power, synchronous machine, alternator, network, motor, electrical behaviour models, control

Programme

- Introduction: historical aspects and background of converter design.
- Force and mechanical power in electromagnetic systems
- Conversion structures
- Constitution of a synchronous machine
- Technological aspects
- Electrical models
- Control and command in the main applications.

Learning outcomes

- Adapt the fundamental concepts of electromagnetism into terms of designing an electrical machine.
- Adapt this approach to the synchronous machine.
- Create electromagnetic models of different levels from constructive data.
- Analyse an electrical model of an electromechanical converter in view of its control and or command.

Independent study

Objectifs : Autonomous work consists in sizing a system based on specifications and establishing a model that will validate this sizing. The system will be studied in pairs with a student following the Power electronics module.The evaluation is carried out through an exchange of each pair with a teacher of the discipline in order to demonstrate the relevance of the dimensioning carried out and the

Méhodes : Sizing a device using an analytical approach. Construction of a model and verification of the relevance of the design elements.

Core texts

Marcel JUFER, *ELECTROMÉCANIQUE* , raité d'électrcité de l'EPFL - vol XIV, 1995
Ernest MATAGNE *ELECTROMÉCANIQUE - CONVERTISSEURS D'ÉNERGIE ET ACTIONNEURS*, DUNOD, 2009

Assessment

Final mark = 70% knowledge + 30% know-how
Mark knowledge = 100% final test
Mark know-how = 50% practical work + 50% autonomous work

AUTOMATIQUE ET PHÉNOMÈNES NON-LINÉAIRES

AUTOMATIC CONTROL WITH NONLINEAR PHENOMENA

Lecturers: Gérard SCORLETTI, Giacomo CASADEI

| Lecturers : 12.0 | TC : 18.0 | PW : 4.0 | Autonomy : 14.0 | Study : 0.0 | Project : 0.0 | Language : FR

Objectives

The performance requirements in technological systems have led to the widespread use of feedback control and the emergence of non-linear phenomena. However, the most commonly used correctors are based on linearity. The course present the behaviour of non-linear systems and introduces methods for predicting the occurrence of these non-linear behaviours in closed-loop systems designed under the linearity assumption - it will address how to modify the control architecture to avoid these phenomena. The course will also present how to design a control architecture for a system which is described by a non-linear model. (Prerequisite to the Master "Automatic Control Engineering" and basis for the options "Aeronautics" and "Ground Transportation").

Keywords : Automatic control, Nonlinear Systems, Control, Analysis

Programme

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

Learning outcomes

- Analysis of the dynamical closed loop system behavior in presence of nonlinearities.
- Control of nonlinear systems.
- Pratical application to industrial cases.

Independent study

Objectifs : Develop an engineering design procedure by relying on the knowledge acquired during the AF.

Méhodes : Solve a practical and original control problem in the presence of non-linearities by applying the methods and tools acquired during the AF.

Core texts

G. Casadei et G. Scorletti, *AUTOMATIQUE & PHÉNOMÈNES NON LINÉAIRES*, Document de cours ECS a 3, 2021
G. Scorletti *COMMANDE MULTI-ACTIONNEURS MULTI-CAPTEURS.*, Document de cours ECS a 4, 189 pages, 2018
H. Khalil*NONLINEAR SYSTEMS 3D EDITION*, Prentice Hall, 2002

Assessment

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

COMMANDE MULTI-ACTIONNEURS MULTI-CAPTEURS

MULTI-SENSOR, MULTI-ACTIVATOR CONTROL

Lecturers: Gérard SCORLETTI, Catherine MUSY, Eric BLANCO

| Lecturers : 12.0 | TC : 18.0 | PW : 4.0 | Autonomy : 14.0 | Study : 0.0 | Project : 0.0 | Language : FR

Objectives

Performance requirements in technological systems have led to the use of advanced control laws dedicated in the past to high-tech systems for everyday systems (automotive, subway, building or irrigation canal). Actual industrial challenges lead to highly tight specifications, for more and more complex processes, with shorter and shorter conception times. An important issue is therefore to design controllers for systems with several actuators and several sensors, so called multivariable systems (piloting aircraft, space launchers). Prerequisite for the Master "Automatic Control Engineering" and basis for the "Aeronautics", 'Energy" and "Ground Transportation" options.

Keywords : Automatic control, State space representation, State/output feedback, multivariable control, observers

Programme

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

Learning outcomes

- Analyze the static and dynamic behaviour of a system.
- Design a modal controller.
- Design a multivariable control ensuring a set of specifications.
- Design an observer by a modal approach.

Independent study

Objectifs : Develop an engineering design procedure by relying on the knowledge acquired during the AF.

Méhodes : Solve a practical and original control problem in the presence of non-linearities by applying the methods and tools acquired during the AF.

Core texts

G. SCORLETTI, *COMMANDE MULTI-ACTIONNEURS MULTI-CAPTEURS*, Polycop ECL, 2014
R.C. DORF and R.H. BISHOP *MODERN CONTROL SYSTEMS*, Pearson Prentice Hall, 2005
G. F. FRANKLIN, J. D. POWELL and A. EMAMI-NAENI*FEEDBACK CONTROL OF DYNAMIC SYSTEMS*, AddisonWesley, 1986

Assessment

Individual written final test 2 hours (knowledge) and individual oral evaluation of autonomy (know-how). Final AF mark =2/3*K+1/3*KH.

TRANSITION VERS LA TURBULENCE

TURBULENCE AND INSTABILITY

Lecturers: **Christophe BAILLY, Andrea MAFFIOLI**

| Lecturers : 20.0 | TC : 16.0 | PW : 0.0 | Autonomy : 12.0 | Study : 0.0 | Project : 0.0 | Language : FR

Objectives

Keywords :

Programme

Learning outcomes

Independent study

Objectifs :

Méhodes :

Core texts

GODRÈCHE C., MANNEVILLE P., *HYDRODYNAMIC AND NON LINEAR INSTABILITIES*, Cambridge University Press, 1998
SCHMID, P.J., HENNIGSON, D.S. *STABILITY AND TRANSITION IN SHEAR FLOWS*, Springer, 2001
BAILLY, C., COMTE-BELLOT, G.*TURBULENCE*, Springer, 2015

Assessment

ACOUSTIQUE ET ONDES DANS LES FLUIDES

ACOUSTICS AND WAVES IN FLUIDS

Lecturers: Didier DRAGNA, Gilles ROBERT

| Lecturers : 20.0 | TC : 24.0 | PW : 4.0 | Autonomy : 0.0 | Study : 0.0 | Project : 0.0 | Language : FR

Objectives

Have the basic knowledge in acoustics and wave propagation in fluids

Keywords : Acoustics, Sound, Noise, Waves, Dispersion relation, Phase and group velocities

Programme

I Acoustics
1. Sound waves as linear perturbations of fluid mechanics equations.
2. Sourd perception : deciBels, weighting curves.
3. Wave propagation equations ; acoustic energy and intensity. Description in the frequency domain ; Helmholtz equation.
4. Plane and spherical waves ; characteristic impedance; near field, far field.
5. Reflection of waves at interfaces. Notion of impedance,
6. Sound radiation from vibrating structures. Integral formulation.

Learning outcomes

- Basic calculations in acoustics (sound pressure levels, source power, dB, ...)
- Kknowledge of elementary sources (plane and spherical)
- Know the basics about the dB scale, the characterization of noise pollution and its perception
- Master the general techniques to analyse linear propagation of waves in fluids: dispersion relation, high-frequency approximation

Independent study

Objectifs : Analysis and design of a muffler.

Méhodes : Analysis of the problem leading to the formalization of the specifications
Proposal of a design for the muffler based on analytical developments.
Discussion of the limits of the proposed solution and prospects for improvement

Core texts

A. D. Pierce, *ACOUSTICS, AN INTRODUCTION TO ITS PHYSICAL PRINCIPLES AND APPLICATONS*, Springer, 2019
J. Lighthill *WAVES IN FLUIDS*, Cambridge University Press, 1978
G. B. Whitham*LINEAR AND NONLINEAR WAVES*, Wiley, 1974

Assessment

Final mark = 0.6* Exam + 0.4* (BE + TP)
BE = report on the work done on the muffler design
TP = report on the TP on acoustic materials

ECOULEMENTS SUPERSONIQUES

SUPERSONIC FLOW

Lecturers: Didier DRAGNA, Marc JACOB

| Lecturers : 16.0 | TC : 16.0 | PW : 2.0 | Autonomy : 10.0 | Study : 4 | Project : 0.0 | Language : FR

Objectives

This course is devoted to high velocity compressible flows and to the study of pressure waves, expansion waves and shock waves. It is an extension of the core course Fluids and Energy and aims at deepening the knowledge in gas dynamics. Applications mainly concern external aerodynamics around high speed vehicles.

Keywords : Compressible flow, Supersonic flow, Shock waves, Expansion waves

Programme

-Introduction.
- Conservation laws.
- Quasi-one-dimensional flows.
- Normal shock waves.
- Two-dimensional flows.
- Oblique shock waves and expansion waves.
- Interactions and unsteady waves.
- Linearized flows.

Learning outcomes

- Determine the behavior of a compressible fluid subjected to thermal or mechanical stresses.
- Design a convergent-divergent nozzle under different downstream conditions.
- Determine the flow structures developing around an obstacle in a supersonic flow.
- Perform a comparative and critical analysis of experimental, numerical and analytical results.

Independent study

Objectifs : Apply the theoretical concepts of the course and compare analytical, numerical and experimental results.

Méhodes : Method 1: design a ramjet and perform a parametric study of its performance.
Method 2: analyze and compare the supersonic flow structures around a diamond profile (test performed in a supersonic wind tunnel).

Core texts

J. D. Anderson, *MODERN COMPRESSIBLE FLOW*, McGraw Hill, 2021
A. H. Shapiro *THE DYNAMICS AND THERMODYNAMICS OF COMPRESSIBLE FLUID FLOW*, Ronald Press Company, 1953

Assessment

Mark = 0.35 * BE + 0.65 * exam
BE = report on the word done during the autonomous work hours
Exam = written test of 2 hours without documents

THERMIQUE ET COMBUSTION

THERMICS AND COMBUSTION

Lecturers: Mathieu CREYSSELS, Andrea MAFFIOLI, Mikhail GOROKHOVSKI

| Lecturers : 20.0 | TC : 18.0 | PW : 10.0 | Autonomy : 0.0 | Study : 0.0 | Project : 0.0 | Language : FR

Objectives

Keywords :

Programme

Learning outcomes

Independent study

Objectifs :

Méhodes :

Core texts

Jean Taine, Franck Enguehard, Estelle Iacona, *TRANSFERTS THERMIQUES*, Dunod, 2021
Theodore L. Bergman, Adrienne S. Lavine, Frank P. Incropera, David P. DeWitt *FUNDAMENTALS OF HEAT AND MASS TRANSFER*, Wiley, 2019
Irvin Glassman, Richard A. Yetter, Nick G. Glumac*COMBUSTION*, Elsevier, 2014

Assessment

SYSTÈMES MÉCANIQUES POLYARTICULÉS

MULTI-BODY MECHANICAL SYSTEMS

Lecturers: Emmanuel RIGAUD, Bertrand HOUX

| Lecturers : 12.0 | TC : 12.0 | PW : 14 | Autonomy : 10 | Study : 0.0 | Project : 0.0 | Language : FR

Objectives

Multibody mechanical systems represent a wide spectrum of practical applications from industrial robots to many mechanisms (connecting rod-crank, automotive suspension, wiper, catenary, etc.).
The course presents and implement the general methods of description, modelling and analysis of multibody mechanical systems, as well as the the tools for the design and synthesis of these systems.
During the design office activities, the behavior of an industrial robot and an automotive wiper system are fully simulated and visualised.

Keywords : Robot, Mechanisms, Geometric model, kinematic model, dynamic model

Programme

Learning outcomes

Independent study

Objectifs :

Méhodes :

Core texts

KHALIL W., DOMBRE E., *MODÉLISATION, IDENTIFICATION ET COMMANDE DES ROBOTS* ., Hermès, 1999

Assessment

INGÉNIERIE MÉCANIQUE

MECHANICAL ENGINEERING

Lecturers: Olivier DESSOMBZ, Jean-Jacques SINOU

| Lecturers : 4.0 | TC : 4.0 | PW : 0.0 | Autonomy : 16.0 | Study : 24.0 | Project : 0.0 | Language : FR

Objectives

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

Keywords : Design, methodology and modelling

Programme

Course / TD program :
- Introduction to the dimensioning issue.
- Dynamic sizing.

Synthesis Studies:
- Two studies make it possible to show the existing links between the different aspects of the dimensioning of a system or a mechanical structure.
- Examples of themes addressed: sizing of a bridge, dimensioning of a lifting clamp, sizing of an automotive clutch.

Learning outcomes

Independent study

Objectifs : Work on BE, formatting of results and writing.

Méhodes : Study of the systems offered in BE, preparation of evaluation presentations.

Core texts

Georges Spinnler, *CONCEPTION DES MACHINES, TOMES 1, 2 & 3*, Presses polytechniques et universitaires romandes, 1997
Daniel Gay & Jacques Gambelin *DIMENSIONNEMENT DES STRUCTURES, UNE INTRODUCTION*, Hermès science publications, 1999
Claude Chèze*DIMENSIONNEMENT DES STRUCTURES*, Ellipses, 2012

Assessment

Score = 50% knowledge + 50% know-how
Knowledge score = 100% terminal exam
Know-how score = 100% continuous assessment

ENDOMMAGEMENT ET RUINE DES MATÉRIAUX

DAMAGE AND RUIN OF MATERIALS

Lecturers: Vincent FRIDRICI, Bruno BERTHEL

| Lecturers : 22 | TC : 14 | PW : 0.0 | Autonomy : 12.0 | Study : 0.0 | Project : 0.0 | Language : FR

Objectives

Keywords :

Programme

Learning outcomes

Independent study

Objectifs :

Méhodes :

Core texts

JP. BAILON, JM DORLOT, *DES MATÉRIAUX*, Presses internationales Polytechnique, 2000
C. BATHIAS, J.-P. BAILON *LA FATIGUE DES MATÉRIAUX ET DES STRUCTURES*, Hermès - Lavoisier, 1997
J.-M. GEORGES*FROTTEMENT, USURE ET LUBRIFICATION*, Eyrolles, 2000

Assessment

MATÉRIAUX ET TRAITEMENTS DE SURFACE INNOVANTS

MATERIALS AND INNOVATIVE SURFACE TREATMENTS

Lecturers: **Stephane BENAYOUN, Stéphane VALETTE**

| Lecturers : 16.0 | TC : 16.0 | PW : 4.0 | Autonomy : 12 | Study : 0.0 | Project : 0.0 | Language : FR

Objectives

Keywords :

Programme

Learning outcomes

Independent study

Objectifs :

Méhodes :

Core texts

Assessment

MATÉRIAUX AMORPHES POUR STRUCTURES FONCTIONNELLES INNOVANTES

AMORPHOUS MATERIALS FOR INNOVATIVE FUNCTIONAL STRUCTURES

Lecturers: Michelle SALVIA, Maria-Isabel DE BARROS BOUCHET

| Lecturers : 12.0 | TC : 14.0 | PW : 4.0 | Autonomy : 0.0 | Study : 0.0 | Project : 0.0 | Language : FR

Objectives

Amorphous materials are synthetic or natural materials widely used in a large number of applications. For these materials, the industrial and technological development has often preceded scientific concerns in terms of characterization, structure-property relationship and modelling of the behavior and their life cycle. Currently, the science of glasses is a field rich in developments, with numerous technological impacts in industrial sectors such as the transportation, civil engineering, medical, agri-food... This course offers a deepening of the knowledge on the specificities of these materials and on their applications. External speakers will be present and a visit to a plastic bottle recycling centre will be organised.

Keywords : Glass, vitreous state, oxides, polymers, elastomers, glass transition, semi-crystallinity, rheological behavior, recycling

Programme

- The amorphous state: origins of order and disorder...
- Manufacturing processes.
- Networks and crystallization phenomena.
- Characterization methods: thermal analysis, X-ray, infrared...
- Structure and rheological behavior.
- Functional properties: optics, shape memory, damping, thermal insulation, electrical conduction and innovative applications in various industrial sectors.
- Life cycle, characterization and recyclability of a packaging (example of a soda bottle).

Learning outcomes

- Acquire knowledge on the structure and characterisation techniques of amorphous materials in the objective to better understand their properties.
- Define the characterisation and identification techniques to be used according to the material to be analysed.
- Have notions concerning the recycling of amorphous materials.
- Use acquired knowledge to analyse the issues of their life cycle and make a critical analysis.

Independent study

Objectifs : Control of all the stages of the life of a part made of amorphous material from its manufacturing to its after-use destination.

Méhodes : The autonomous work consists of preparing practical works, writing reports and carrying out a bibliographic project on a problem related to the recyclability of these materials. All these activities are teamwork.

Core texts

Powell, Peter C, *ENGINEERING WITH POLYMERS*, Chapman & Hall, 1992
Jerzy, Zarzycki *GLASSES AND THE VITREOUS STATE*, Cambridge University Press, 1991
Duval, Claude *PRÉSENTATION MATIÈRES PLASTIQUES ET ENVIRONNEMENT - RECYCLAGE, VALORISATION, BIODÉGRADABILITÉ, ÉCO-CONCEPTION*, Dunod, 2009

Assessment

0.5: knowledge (test: quiz + exercises); 0.3: know-how (oral presentation of the project); 0.2: methodology (practical work report).

BIOMÉCANIQUE DES TISSUS VIVANTS ET BIOMATÉRIAUX PROTHÉTIQUES

BIOMECHANICS OF LIVING TISSUE AND PROSTHETIC BIOMATERIALS

Lecturers: Clotilde MINFRAY, Thierry HOC, Vincent FRIDRICI

| Lecturers : 20.0 | TC : 4.0 | PW : 4.0 | Autonomy : 18.0 | Study : 0.0 | Project : 0.0 | Language : FR

Objectives

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

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

Programme

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

Learning outcomes

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

Independent study

Objectifs : Case study to increase knowledge on a subject of your choice related to the course.

Méhodes : To be done in autonomy by group of two. A written report and an oral presentation are requested.

Core texts

B.D. Ratner , *BIOMATERIALS SCIENCE - THIRD EDITION. ACADEMIC PRESS, 2013*

Assessment

Mark = 50% knowledge + 50% know-how.
Mark knowledge = 100% final exam.
Mark know-how = 80% case study + 20% continuous control.

MULTIMÉDIA : CONCEPTS ET TECHNOLOGIES

MULTIMEDIA : CONCEPTS AND TECHNOLOGIES

Lecturers: Emmanuel DELLANDREA, Mohsen ARDABILIAN

| Lecturers : 16.0 | TC : 0.0 | PW : 18.0 | Autonomy : 14.0 | Study : 0.0 | Project : 0.0 | Language : FR

Objectives

This course aims to familiarize students with the fundamental concepts of multimedia and technologies, systems and methods of multimedia analysis. Communication is one of the factors for the development of industry and the individual in modern societies. The rapid change in emerging societies and technologies is testament to the ever-changing nature of media and environments, as well as the messages conveyed. Indeed, today it is increasingly easier to convey an idea through a combination of text, image, audio and video documents than through a simple text document. A multimedia document thus follows a life cycle that undergoes various transformations. This course describes the fundamental concepts by placing them in a global

Keywords : Interactivity, Information, Media, Digital, Video, Audio, Text, Audiovisual, System, Content, Content analysis, Compression, Standard, Standard

Programme

1) Basic terminologies and concepts: Visual and auditory perception. Sampling and quantification. Acquisition of sound, image and video. Acquisition systems.
2) Multimedia analysis and its applications: Multimodal content analysis (visual modality, audio modality, temporal modality). The principles of coding and compression. Automatic indexing. Automatic structuring (summary, chaptering, etc.).
3) Presentation of standards and standards for description, compression and synchronization: H.26x, JPEGs, MPEGs, SMIL and others.

Learning outcomes

- Understand the general principle of the different coding and compression processes applied to images, audio and video.
- To be able to identify the most suitable coding and compression techniques according to the nature of the multimedia data.
- Understand the principle of multimedia analysis methods.
- Know how to implement audio / video analysis methods (segmentation, classification).

Independent study

Objectifs : Allow students to assimilate notions and concepts seen in class and in BE.

Méhodes : Coaching and question-and-answer sessions.

Core texts

P. Bellaïche, , *LES SECRETS DE L'IMAGE VIDÉO.*, Eyrolles., 2002
T. Vaughan. *MULTIMEDIA-MAKING IT WORK (5ÈME ÉDITION)*, McGraw-Hill., 2002
N. Chapman & J. Chapman. *DIGITAL MULTIMEDIA.*, Wiley,, 2000

Assessment

Final mark = 63% Knowledge + 37% Know-how
Knowledge = final exam
Know-how = continuous assessment

STRATÉGIES DE RÉSOLUTION DE PROBLÈMES

PROBLEM RESOLUTION STRATEGIES

Lecturers: **Alexandre SAIDI**

| Lecturers : 8.0 | TC : 0.0 | PW : 28.0 | Autonomy : 12.0 | Study : 0.0 | Project : 0.0 | Language : FR

Objectives

Keywords :

Programme

Learning outcomes

Independent study

Objectifs :

Méhodes :

Core texts

D.E. Knuth, The art of Programming, Addison Wesley (réédition), 2000.
R. Neapolitan, K. Naimipour, Foundations of Algorithms, Health & Company, 1996.
P. Dohornoy, Complexité et Décidabilité, SMAI , Springer-Verlag, 1993. , Michel Sakarovitch, Optimisation Combinatoire, Herman Ed., 1984.

Assessment

APPLICATIONS CONCURRENTES, MOBILES ET RÉPARTIES EN JAVA

SOFTWARE ENGINEERING: MODEL AND PROCESS BASED SOFTWARE DEVELOPMENT

Lecturers: Stéphane DERRODE, Alexandre SAIDI

| Lecturers : 16 | TC : 0.0 | PW : 0.0 | Autonomy : 10 | Study : 22 | Project : 0.0 | Language : FR

Objectives

After the discovery of object programming in the core curriculum, this course aims to continue learning object programming by studying : human-computer interfaces, or how to offer the user a nice ergonomic interface ; concurrency, or how to use several cores of a microprocessor to make a parallel calculation; distributed programming, or how to make remote computers work together on a network. This is one of the principles of cloud computing; mobile programming, or how to program on Android. Java is a language widely used in the industry, with vast libraries to facilitate programming and essential to mastering Android programming.

Keywords : Computer science, Java, Android, concurrency, parallelism, distributed programming, HCI, user interface

Programme

- The Java language
- Event-based programming (human-machine interfaces, HMI)
- Concurrent programming (processes, parallel computing)
- Distributed programming (Java RMI)
- Programming for mobile computing devices (Android, Android Studio)

Learning outcomes

- Know how to program in Java an application distributed on several computers linked by a network.
- Know how to develop a concurrent application using several processors.
- Know how to program a user interface (GUI) that is ergonomic and fluid.
- Be able to develop an Android application.

Independent study

Objectifs : Carry out several group tasks aimed at producing a functional application based on the concepts studied in class.

Méhodes : Projects in groups of 2 students, to be carried out in sessions and independently.

Core texts

Luigi Zaffalon, *PROGRAMMATION CONCURRENTE ET TEMPS RÉEL AVEC JAVA*, Presses Polytechniques Romandes, 2007
Reto Meier *DÉVELOPPEMENT D'APPLICATIONS AVANCÉES*, Pearson France, 2012
Serge Ungar, Nazim Benbourahla*DES FONDAMENTAUX DU DÉVELOPPEMENT JAVA À LA MISE EN PRATIQUE D'UNE APPLICATION SOUS ANDROID* , ENI, 2012

Assessment

Grade = 50% knowledge + 50% skills
Knowledge grade = 100% final exam
Know-how mark = 33% for each of the 3 mini-project RCs.

ANALYSE DE DONNÉES ET RECONNAISSANCE DES FORMES

DATA ANALYSIS AND PATTERN RECOGNITION

Lecturers: Emmanuel DELLANDREA, Liming CHEN

| Lecturers : 14.0 | TC : 20.0 | PW : 0.0 | Autonomy : 14.0 | Study : 0.0 | Project : 0.0 | Language : MI

Objectives

The purpose of data analysis and pattern recognition is to analyse and make explicit the concepts embedded in large amounts of data that can come from many sources. These methods have ever-increasing application benefits in fields as diverse and varied as computer vision, signal analysis, robotics, medicine, finance, electronic commerce, or military applications, etc. This course therefore aims to introduce the fundamental principles and techniques of data analysis and pattern recognition, and in particular descriptive approaches (automatic description of the concepts contained in the data), as well as predictive approaches.

Keywords : Data analysis, Pattern recognition, machine learning, classification, regression, neural networks

Programme

- Factor Analysis (PCA, AFC, ACM)
- Discriminant Analysis (LDA)
- Linear models for regression
- Logistic regression for classification
- Problem of over-fitting and regularization
- Neural networks: representation and learning
- Tips and Practices for Applying Machine Learning
- Design of machine learning systems

Learning outcomes

- Understand the principle of the main methods of data analysis and pattern recognition.
- Knowing how to choose the method of data analysis or pattern recognition to be implemented according to the data and the objectives of the study at hand.
- Know how to implement the main methods of data analysis and pattern recognition, and exploit their results.
- Understand the principles of statistical learning for regression and classification.

Independent study

Objectifs : Understand and assimilate the concepts of courses implemented through lab works.

Méhodes : Question / answer sessions with teachers following the tutorials to help with homework assignments.

Core texts

Christopher M.Bishop, *PATTERN RECOGNITION AND MACHINE LEARNING*, Springer, 2006
Richard O.Duda, Peter E.Hart, David G.Stork *PATTERN CLASSIFICATION*, John Wiley & Sons, 2001
Trevor Hastie, Robert Tibshirani, Jerome Friedman*THE ELEMENTS OF STATISTICAL LEARNING*, Springer, 2011

Assessment

N1: knowledge mark (written exam)
N2: skill score (average of the three assignments to be completed)
Score AF = 0.5 * N1 + 0.5 * N2

VIBRATION DES SYSTÈMES MÉCANIQUES

VIBRATION ANALYSIS

Lecturers: Olivier DESSOMBZ

| Lecturers : 12.0 | TC : 16.0 | PW : 4.0 | Autonomy : 12.0 | Study : 4.0 | Project : 0.0 | Language : FR

Objectives

Within the framework of general mechanics and structural mechanics, the course constitutes an introduction to vibration mechanics and an opening towards non-linear phenomena and the stability of mechanical systems.

Keywords : Vibrations, discrete / continuous systems, damping, modal synthesis, non-linear systems

Programme

- Discrete Systems Program : Vibration response of systems. Insulation and damping of systems. Modal synthesis.
- Continuous systems : Calculation of beam modes. Building discrete models. Application of the finite element method.
- Non-linear systems.
- Stability of mechanical systems.

Learning outcomes

- To know how to put into equations a mechanical system within the framework of small movements.
- Know how to calculate normal eigenmodes and use them in modal synthesis.
- Understand the major approximation methods, in particular the finite elements method.
- Know how to take into account non-linearities in vibratory mechanics.

Independent study

Objectifs : Allow students to assimilate notions and concepts seen in class and in BE.

Méhodes : Formatting of results and writing.

Core texts

J-F. Imbert, *ANALYSE DES STRUCTURES PAR ÉLÉMENTS FINIS (3ÈME ED)*, Cépaduès éditions, 1991
M. Géradin & D. Rixen *THÉORIE DES VIBRATIONS. APPLICATION À LA DYNAMIQUE DES STRUCTURES*, Masson, 1993
P. Pahut & M. Del Pedro*MÉCANIQUE VIBRATOIRE. SYSTÈMES DISCRETS LINÉAIRES*, Presses polytechniques et universitaires romandes, 2003

Assessment

Score = 50% knowledge + 50% know-how
Knowledge score = 100% terminal exam
Know-how score = 100% continuous assessment

COMPORTEMENT ANÉLASTIQUE DES STRUCTURES

INELASTIC BEHAVIOUR OF STRUCTURES

Lecturers: Cécile NOUGUIER, Francesco FROIIO

| Lecturers : 12.0 | TC : 6.0 | PW : 0.0 | Autonomy : 20.0 | Study : 0.0 | Project : 10.0 | Language : FR

Objectives

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

Keywords : Anisotropy, elastoplasticity, thermoelasticity, viscoelasticity

Programme

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

Learning outcomes

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

Independent study

Objectifs : Analytical and/or numerical analysis of inelastic structures.

Méhodes : 3 groups of 8 students each will work on as many different projects. The total allocated time for each project is 30 hours (1/3 supervised).

Core texts

J. Lemaitre, J-L. Chaboche, *MÉCANIQUE DES MATÉRIAUX SOLIDES*, Dunod, 2001
Albiges, Coin, Journet *ETUDE DES STRUCTURES PAR LES MÉTHODES MATRICIELLES*, Eyrolles, 1969
S. Timoshenko*RÉSISTANCE DES MATÉRIAUX*, Dunod, 1968

Assessment

Mark = 60% knowledge + 40% know-how.
Knowledge mark = 100% final exam.
Know-how mark = 100% student project.

OUTILS MATHÉMATIQUES AVANCÉS POUR LES PROBABILITÉS ET L'APPRENTISSAGE

PROBABILITY THEORY AND INTRODUCTION TO RANDOM PROCESSES

Lecturers: **Elisabeth MIRONESCU, Philippe MICHEL**

| Lecturers : 18.0 | TC : 14 | PW : 0.0 | Autonomy : 12 | Study : 4 | Project : 0.0 | Language : FR

Objectives

Keywords :

Programme

Learning outcomes

Independent study

Objectifs :

Méhodes :

Core texts

N. imnios, V. Girardin, *PROBABILITÉS EN VUE DES APPLICATIONS*, Vuibert, 2008
H. Brézis *ANALYSE FONCTIONNELLE*, Dunod, 2020
P. Bilingsley*PROBABILITY AND MEASURE*, Wiley, 1995

Assessment

OUTILS MATHÉMATIQUES AVANCÉS POUR L'ANALYSE DES ÉQUATIONS AUX DÉRIVÉES

NUMERICAL APPROXIMATION FOR ODES AND PDES

Lecturers: Laurent SEPPECHER, Hélène HIVERT

| Lecturers : 18 | TC : 18 | PW : 0 | Autonomy : 12 | Study : 0.0 | Project : 0.0 | Language : FR

Objectives

Keywords :

Programme

Learning outcomes

Independent study

Objectifs :

Méhodes :

Core texts

N. Limnios, V. Girardin, *PROBABILITÉS EN VUE DES APPLICATIONS*, Vuibert, 2008
H. Brezis *ANALYSE FONCTIONNELLE - THÉORIE ET APPLICATIONS*, Dunod, 2005
G. Allaire*ANALYSE NUMÉRIQUE ET OPTIMISATION*, Editions de l'Ecole polytechnique, 2005

Assessment

MÉCANIQUE QUANTIQUE ET APPLICATIONS

QUANTUM MECHANICS AND APPLICATIONS

Lecturers: Anne-Segolene CALLARD, José PENUELAS

| Lecturers : 18.0 | TC : 18.0 | PW : 0.0 | Autonomy : 12.0 | Study : 0.0 | Project : 0.0 | Language : FR

Objectives

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

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

Programme

- Back to wave / particle duality - Construction of quantum theory.
- Measurement / Time evolution of systems.
- The postulates of quantum mechanics.
- Two-state systems.
- The angular momentum.
- ½ spin.
- NMR.
- The identical particles.
- The fermions, the bosons.

Learning outcomes

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

Independent study

Objectifs : Understand and assimilate the course.

Méhodes : Questions and answers sessions, corrections of former exams in session, exercises to be treated in autonomy.

Core texts

J-L Basdevant, J. Dalibard., *MÉCANIQUE QUANTIQUE*, Ed. de l'Ecole Polytechnique, 2002
C. Cohen-Tannoudj i. et al. *MÉCANIQUE QUANTIQUE I*, Hermann, 1973
C. Cohen-Tannoudj i. et al.*MÉCANIQUE QUANTIQUE II*, Hermann, 1973

Assessment

CHIMIE MOLÉCULAIRE ET SUPRAMOLÉCULAIRE

MOLECULAR AND SUPRAMOLECULAR CHEMISTRY

Lecturers: Christelle YEROMONAHOS, Naoufel HADDOUR

| Lecturers : 12.0 | TC : 18.0 | PW : 0.0 | Autonomy : 18.0 | Study : 0.0 | Project : 0.0 | Language : FR

Objectives

Metabolites are low molecular weigth species, present in blood, among an abundant background of high molecular weight species. Metabolites are the biomarkers of a large range of pathologies. However their detection, for clinical use, is still a global challenge. Chemical functionalization of porous silicon surfaces, by using specific molecules, could allow the selective trapping of metabolites. Such a trapping could allow to improve the sensitivity of the detection tools, classically used in hospitals (mass spectrometry).
Objectives of this course is to study the effects of the physico-chemical properties of molecules (structure, hydrophile-liphophile balance, charges) on the intermolecular interactions. A large part of the course will be

Keywords : Intermolecular interactions, Molecular Dynamics simulations, innovative clinical diagnostic tools

Programme

This course will be presented in the form of a case study.

First, the physicochemical properties of single molecules will be presented (structure, hydrophilic hydrophobic balance, charges).
Secondly, the physicochemical properties of supramolecular structures will be analyzed from the properties of the single molecules that constitute them by molecular modeling (energy of interactions...).
The results of this analysis will be used to design a biomedical analysis tool.

Learning outcomes

- C2N1: Define a system and its boundaries, identifie the phenomena involved and propose a simple model. Formulate the hypotheses.
- C2N3: Characterize the complexity of a system, identifie interactions and sources of uncertainty.
- C1I1: Carrie out a state of the art and implement creative methods, on a problem open to technical-scientific-economic questions, and formalize the result.

Independent study

Objectifs : Molecular modeling on computer

Méhodes :

Core texts

Franck, *CHIMIE PHARMACEUTIQUE*, De Boeck, 2005
J.-M. Lehn *LA CHIMIE SUPRAMOLÉCULAIRE, CONCEPTS ET PERSPECTIVES*, De Boeck, 1997
Trong Anh*INTRODUCTION À LA CHIMIE MOLÉCULAIRE*, Ellipses, 1994

Assessment

Score = 50% knowledge + 50% know-how
Knowledge score = 50% final exam + 50% continuous assessment
Know-how score = = 50% final exam + 50% continuous assessment

ELECTROCHIMIE ET CHIMITRONIQUE.

ELECTROCHEMISTRY AND CHEMITRONICS

Lecturers: Naoufel HADDOUR

| Lecturers : 12.0 | TC : 12.0 | PW : 8.0 | Autonomy : 12.0 | Study : 4 | Project : 0.0 | Language : FR

Objectives

Objectives of this course is to study the physicochemistry of electronic transfers at electrode/ electrolyte interfaces and concepts of electrochemical engineering. A large part of the course will be based on a concrete example of an industrial effluent treatment process. This course is mainly conducted in the form of problem-based learning, in group work, with individual evaluation at the end of the project.

Keywords : Butler-Volmer model, fuel cells, corrosion, electrolysis, battery

Programme

This course will be presented in the form of a case study to address the following concepts:
1) Electrochemical thermodynamics: Spontaneous and non-spontaneous redox reactions. Maximum and minumum voltages for galvanic and electrolytic systems.
2) Electrochemical kinetics: Butler-Volmer model with and without transport limitations. Tafel plot analysis. Linear and cyclic voltammetry.
3) Transport / Fluidic: Diffusion, migration, and convection of electroactive species in different systems.
4) Electrochemical reactors: Architecture, characterization and scaling.

Learning outcomes

- Differentiate between galvanic and electrolytic reactions.
- Determine electrochemical thermodynamic efficiency and voltage of a redox system.
- Determine key kinetic models used to characterize electrochemical devices.
- Design electrodes and operating conditions with favorable performance for specific applications.

Independent study

Objectifs :

Méhodes :

Core texts

Fabien MIOMANDRE, Saïd SADKI, Pierre AUDEBERT, *ÉLECTROCHIMIE DES CONCEPTS AUX APPLICATIONS*, Dunod, 2011
Hartmut WENDT, Gerhard KREYSA *GÉNIE ÉLECTROCHIMIQUE*, Dunod, 2001
François COEURET, Alain STORCK*ÉLÉMENTS DE GÉNIE ÉLECTROCHIMIQUE*, ParisTec et doc, 1993

Assessment

PHYSIQUE DES SEMICONDUCTEURS ET DES DIÉLECTRIQUES

DIELECTRIC AND SEMICONDUCTOR PHYSICS

Lecturers: Christelle MONAT

| Lecturers : 13 | TC : 16.0 | PW : 0.0 | Autonomy : 13 | Study : 6 | Project : 0.0 | Language : FR

Objectives

Semiconductor materials are part of our modern life and sustain our technologies for computers, communications, lightning or energy conversion. After a presentation of the main physics processes in semiconductors and the resulting electronic and optical properties of these materials, the course will describe various device applications of semiconductors in microelectronics and optoelectronics.

Keywords : Semiconductors, dielectric materials, devices, microelectronics, optoelectronics

Programme

1/ Cristalline properties and fabrication of semiconductor materials
2/ Electronic band structures in semiconductors
3/ Electrical conduction of semiconductors
4/ Charge transport mechanisms in semiconductors
5/ PN junctions and applications
6/ Metal/ semiconductor junctions and applications
7/ Optoelectronic devices for light detection
8/ Optoelectronic devices for light emission

Learning outcomes

- Being able to explain the distinction between the properties of metals, insulators, and semiconductors and the origin of these differences
- Being able to use the concepts that describe the properties of semiconductor materials
- Being able to describe the processes responsible for electron transport and photon/ electron interactions in semiconductors
- Being able to describe how various classes of semiconductor devices work (transistors, photodiode, solar cells, laser diode)

Independent study

Objectifs : Group assignment to learn more about a particular topic in link with semiconductor physics and its applications in microelectronics/ optoelectronics

Méhodes : Various topics will be suggested (photovoltaics, blue LEDs, graphene and 2D materials, silicon photonics...)
Oral presentations will be prepared by each group and delivered at the final BE

Core texts

Henry Mathieu, *PHYSIQUE DES SEMICONDUCTEURS ET DES COMPOSANTS ÉLECTRONIQUES*, 5ème édition, Dunod,, 2009
Emmanuel ROSENCHER *OPTOÉLECTRONIQUE*, Masson, 1998

Assessment

ARCHITECTURES EMBARQUÉES ET INFORMATIQUE INDUSTRIELLE

EMBEDDED SYSTEMS ARCHITECTURES

Lecturers: David NAVARRO, Cédric MARCHAND

| Lecturers : 16.0 | TC : 10.0 | PW : 8.0 | Autonomy : 14.0 | Study : 0.0 | Project : 0.0 | Language : FR

Objectives

Keywords :

Programme

Learning outcomes

Independent study

Objectifs :

Méhodes :

Core texts

C. Tavernier, Dunod, 978-2-10-049978-6, *MICROCONTRÔLEURS PIC - DESCRIPTION ET MISE EN ŒUVRE*

Assessment

ESTIMATION ET TRANSMISSION DE L'INFORMATION

OPTIMAL FILTERING AND INFORMATION TRANSMISSION

Lecturers: Eric BLANCO, Julien HUILLERY, Laurent BAKO

| Lecturers : 12.0 | TC : 18.0 | PW : 4.0 | Autonomy : 14.0 | Study : 0.0 | Project : 0.0 | Language : FR

Objectives

The growth of communication and information processing systems has led to the emergence of new services. This development is based on an ever greater appropriation by the industrial world of information theory and signal processing methods whose theoretical bases have been presented in the first year course STI tc2. The objective of the course is to complete the presentation of the basics and methods of signal processing in order to acquire a complete set of tools to address the modeling, analysis and filtering of signals, as well as the operation of communication channels. These principles are found in applications such as telecommunications, software sensors or GPS positioning.

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

Programme

Part I: Optimal filtering
1- Stochastic signal
2- Wiener filtering
3- Kalman filtering
Part II: Information Transmission
1- Elements of information theory
2- Entropy and source coding
3- Capacity and channel coding

Learning outcomes

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

Independent study

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

Méhodes : Definition of specifications, signal / system modelling, implementation under matlab/simulink, implementation of an evaluation protocol of the proposed solutions.

Core texts

T. Assefi, *STOCHASTIC PROCESSES AND ESTIMATION THEORY WITH APPLICATIONS*, John Wiley & Sons, 1979
T. Cover, J. Thomas *ELEMENTS OF INFORMATION THEORY*, John Wiley & Sons, 2006
O. Rioul*THÉORIE DE L'INFORMATION ET DU CODAGE*, Hermes Sciences, 2007

Assessment

Final mark = 70% knowledge + 30% know-how
Knowledge = 80% final exam + 20% continuous assessment
Know-how = 100% final exam (oral)

ARCHITECTURES NUMÉRIQUES DE TRAITEMENT DE L'INFORMATION

DIGITAL ARCHITECTURES FOR COMPUTING AND INFORMATION PROCESSING

Lecturers: Ian O CONNOR

| Lecturers : 18 | TC : 10.0 | PW : 8.0 | Autonomy : 12 | Study : 0.0 | Project : 0.0 | Language : FR

Objectives

SOMMAIRE :

Contenu des cours :
- Analyse électrique des portes de base de l'électronique numérique : consommation (dynamique, statique, court-circuit), vitesse, surface. Alternatives (logique dynamique, logique à porte de passage)
- Principes des architectures : von Neumann et Harvard (modifié), RISC, CISC.
- Jeux d'instructions, mémoire et types d'adressage.

Keywords : BIBLIOGRAPHIE :

"Computer Architecture: A Quantitative Approach, 4th Edition", John L. Hennessy, David A. Patterson, Morgan Kaufmann, 2006

Programme

Learning outcomes

Independent study

Objectifs :

Méhodes :

Core texts

Assessment

CAPTEURS INTELLIGENTS COMMUNICANTS : SYSTÈMES D'INTERFACE

COMMUNICANT AND INTELLIGENT SENSORS

Lecturers: Cédric MARCHAND, David NAVARRO

| Lecturers : 16.0 | TC : 10.0 | PW : 8.0 | Autonomy : 14.0 | Study : 0.0 | Project : 0.0 | Language : FR

Objectives

The objective of this course is to describe the different part of the acquisition chain in electronics systems (sensors, actuators, microcontroler). This course take example from modern sensing and communicating systems.

Keywords : Sensor, acquisition chain, microcontroler

Programme

0 - Introduction
1 - Sensors
2 - Filtering
3 - Conversion
4 - Modulation
5 - Microcontrolers

Learning outcomes

Independent study

Objectifs : Apply knowledge from lecture and exercises sessions to prepare lab sessions. Final report writing.

Méhodes : Exercise given before the Lab session.

Core texts

B.P. Lathi, *MODERN ANALOG AND DIGITAL COMMUNICATION SYSTEMS.*, Oxford university press, 1998
F. Cottet. *TRAITEMENT DU SIGNAL ET ACQUISITION DE DONNÉES*, Dunod, 2009
H. Mathieu, H. Fanet.*PHYSIQUE DES SEMICONDUCTEURS ET DES COMPOSANTS ÉLECTRONIQUES*, Dunod, 2009

Assessment

Grade = 50 % knowledge + 50% practice.
Practice grade = 50% Lab 1 + 50% Lab 2.