CENTRALE NANTES

Integrated Master-PhD Track

2025-2026

YEAR 1

CONTROL AND ROBOTICS

DATA SCIENCE, SIGNAL AND IMAGE PROCESSING

PROGRAMME SUPERVISOR:

Pierre-Emmanuel HLADIK

YEAR 1 - Autumn Semester

CORE COURSES

Course code	Title	ECTS Credits	Page number
ALPRO	Algorithmics and programming	4	4
ARTIN	Artificial Intelligence	6	5
CLACO	Classical Linear Control	5	6
MATOSS	Mathematicals Tools for Signals and Systems	4	7
MICRO	Embedded Computing	4	9
SIPRO	Signal Processing	5	10

In addition to the courses, students will attend scientific seminars to gain an overview of research activities in the field of control and robotics. This will enable them to identify the areas in which they wish to focus their research activities for the remainder of the programme.

LANGUAGE COURSES (one module from a choice of three) *

Course code	Title	ECTS Credits	Page number
CCE1	Cultural and Communication English	2	11
ESP1	Spanish Language	2	13
FLE1	French Language	2	14

** 'French as Foreign Language' except for French native speakers who will study 'Cultural and Communicational English' or Spanish (depending on sufficient demand).*

YEAR 1 - Spring Semester

CORE COURSES

Course code	Title	ECTS Credits	Page number
REPRO	Research Project	6	16
COVIS	Computer Vision	4	17
IMPRO	Image Processing	5	18
OPTEC	Optimization Techniques	5	19
SISIF	Systems Identification and Signal Filtering	4	20
STFAS	Spectral and Time Frequency Analysis	4	21

LANGUAGE COURSES (one module from a choice of three) *

Course code	Title	ECTS Credits	Page number
CCE2	Cultural and Communication English	2	22
ESP2	Spanish Language	2	23
FLE2	French Language	2	24

** 'French as Foreign Language' except for French native speakers who will study 'Cultural and Communicational English' or Spanish (depending on sufficient demand).*

YEAR 1 - Autumn Semester

Algorithmics and programming [ALPRO]

LEAD PROFESSOR(S): Mira RIZKALLAH

Objectives

To provide students with the fundamentals of algorithmic and programming (with C language). Starting with the general concepts of algorithm and efficiency, to understand basic algorithms for simple programs.

Course contents

Algorithmic:

- Pseudocode
- Variables and constants
- Boolean and logical operators
- Conditional branches and loops: if, while, for, switch cases
- Algorithm efficiency, basic complexity
- Sorting algorithms C language:
- Basics of C language
- Pointers and call by reference
- Basic memory management
- Read and write to a file
- Data structure: (doubly-)linked list, binary-search tree
- Recursive functions
- Bitwise operators
- Floating point arithmetic, rounding problem, integer overflow
- Write programs using well-chosen separation between files and header files, according to the usage of functions and data structures.
- Debugging

Course material

- The C Programming Language, Brian Kernighan and Dennis Ritchie, Prentice Hall, 1978
- Introduction to Algorithms (3rd ed.), T.H. Cormen, C.E. Leiserson, R.L. Rivest, C. Stein, Dunod, MIT Press, 2009

Assessment

Individual assessment: EVI 1 (coefficient 1)

Language of instruction	ECTS Credits	Lectures	Tutorials	Lab	Project	Exam
English	4	10 hrs	4 hrs	16 hrs	0 hrs	2 hrs

YEAR 1 - Autumn Semester

Artificial Intelligence [ARTIN]

LEAD PROFESSOR(S): Diana MATEUS LAMUS

Objectives

This course introduces the key notions of artificial intelligence and machine learning, essential today in dealing with the ubiquitous collection of increasing amounts of data. Starting from general theoretical concepts, we will review the most influential methods for unsupervised and supervised learning, and link them to applications. The sessions will alternate between lectures and practical exercises in Python. Although the techniques will be presented from a broad and general perspective, the applications will focus on image and signal processing

Course contents

- General concepts of machine learning
- Unsupervised methods for clustering and dimensionality reduction
- From linear classification to Support Vector Machines (SVM)
- Decision trees and ensemble methods
- Neural networks and introduction to deep learning
- Evaluation measurements

Course material

[1] Bishop C. : Pattern Recognition and Machine Learning. Springer, 2006.

[2] Kevin Patrick Murphy. Probabilistic Machine Learning: An Introduction. 2022

Assessment

Individual assessment: EVI 1 (coefficient 1)

Language of instruction	ECTS Credits	Lectures	Tutorials	Lab	Project	Exam
English	6	16 hrs	2 hrs	12 hrs	0 hrs	2 hrs

YEAR 1 - Autumn Semester

Classical Linear Control [CLACO]

LEAD PROFESSOR(S): Guy LEBRET

Objectives

Review the fundamentals of classical control for linear systems and provide a control methodology starting from the open loop analysis of the system to be controlled to the synthesis of a closed loop using classical PID type controllers (one degree of freedom controllers) which can be combined with a feedforward part (two degrees of freedom controllers).

Course contents

- Description of SISO linear systems through the transfer function
- Analysis of behaviour (poles/zeros, first/second/more general systems, time domain/frequency domain responses etc)
- Definition the Control objectives (stability/performance, tracking/regulation)
- Nominal/robust stability (Routh, Nyquist criteria, stability margins).
- Nominal/robust performance and the unavoidable trades off between stability and performance.
- Synthesis of PID type controllers, using frequency approach tunings, in a classical closed loop (one degree of freedom controller strategy).
- Possibility of introducing a feedforward contribution which tries to "invert" the first closed loop obtained (two degrees of freedom controllers).

After completing this course, the students will be able to:

- Analysis of the dynamic behaviour of a SISO linear system
- Design a PID type controller as an example of a feedback controller
- Design a feedforward controller to increase tracking performance

Course material

Recommended texts: course notes will be provided by the lecturer. Further reading:

- "Modern Control Systems", R.C. Dorf and R.H. Bishop, Prentice Hall, 2011.
- "Control Systems Engineering", N. S. Nise, John Wiley & Sons, 2011.
- "Control system design", G.C. Goodwin, S.F. Graebe and M.E. Salgado, Prentice Hall, 2001.
- "Multivariable Feedback Control Analysis and Design", D.S. Skogestad and I. Postlethwaite, Wiley, 2005.

Assessment

Individual assessment: EVI 1 (coefficient 1)

Language of instruction	ECTS Credits	Lectures	Tutorials	Lab	Project	Exam
English	5	22 hrs	4 hrs	4 hrs	0 hrs	2 hrs

YEAR 1 - Autumn Semester

Mathematicals Tools for Signals and Systems [MATOSS]

LEAD PROFESSOR(S): Sébastien Bourguignon

Objectives

This course provides basic mathematical knowledge required for understanding theory and developing relevant methods for the analysis of signals and systems.

One part is dedicated to probability and statistics. It addresses the characterization and the processing of random signals by means of statistical tools. It thus provides the theoretical foundations used in the development of signal modelling methods for the resolution of numerous problems: biomedical signal and image processing (diagnosis, tools to assist the disabled), music signal processing (restoration of old recordings, reconstruction of the score, coding and compression), positioning systems (fusion of GPS and odometry), etc.

Another part is dedicated to understanding and modeling linear operators by means of matrix representations, and exploit the corresponding formalism with standard linear algebra tools such as matrix rank, determinant, matrix inversion, vector spaces, particular matrix properties and, most of all, eigenvalue problems. Such tools are widely used for establishing and understanding state-space representations in control, solving multivariate differential equations, manipulating linear transforms such as the Discrete Fourier Transform or wavelet transforms.

At the end of the course, the students will be able to:

- Provide a statistical description of a random process
- Solve a statistical estimation problem in a practical situation
- Develop a numerical algorithm to calculate and to characterize the solution
- Characterize solutions to linear systems
- Formulate a linear operation applied on vectors by means of a matrix and study its main properties
- Solve eigenvalue problems, exploit diagonalization and reduce quadratic forms

Course contents

Probability and statistics :

- Probability theory: random vectors, density, mean, variance.
- Time analysis, frequency analysis: random signals, autocorrelation, power spectral density.
- Classical estimation Theory, Bayesian estimation: maximum likelihood (ML) estimation, minimum mean square error (MMSE) estimator, maximum a posteriori (MAP) estimator, linear minimum mean square error (LMMSE).
- Markov chains, Markov processes
- Statistical filtering: Kalman

Linear algebra :

- Vectors and matrices, basic operations
- Solutions to Linear systems: existence, uniqueness, resolution; linear independence and matrix rank
- Determinants. Matrix inversion
- Inner product spaces, linear transformations
- Matrix eigenvalue problems, eigenbases and diagonalization
- Quadratic forms, transformation into principal axes

Course material

[1] Probability, Random Variables and Stochastic Processes. A. Papoulis, S.U. Pillai. Mcgraw Hill.

Assessment

Individual assessment: EVI 1 (coefficient 1)

Language of instruction	ECTS Credits	Lectures	Tutorials	Lab	Project	Exam
English	4	16 hrs	10 hrs	4 hrs	0 hrs	2 hrs

YEAR 1 - Autumn Semester

Embedded Computing [MICRO]

LEAD PROFESSOR(S): Mickael HILAIRET

Objectives

At the end of the course the students will be able to:

- Understand the architecture of a microcontroller;
- Design a low-level driver to access a peripheral of a microcontroller and deal with microcontroller interrupts;
- Design a bare metal application, i.e. without any real time operating system.

Course contents

The first part of the course deals with the software environment for deeply embedded systems:

- Data representation
- Cross compiler: bit operations, memory model, common C design rules, low level C and assembly specific attributes
- Debugging with a JTAG probe (breakpoints, memory watch, etc)

The second part introduces some basic hardware peripherals of a microcontroller to interact with the environment:

- Standard GPIO
- Timers and PWM
- Interrupts
- Serial communication peripherals

The third part of the module focuses on the design of both bare metal applications and driver, including concurrent execution of both software and hardware parts.

Course material

- Philip Koopman, Better Embedded Software Systems, Drumnadrochit Education LLC, 2010
- D. Patterson & J. Hennessy, Computer Organization and Design – ARM Edition, Morgan Kaufmann, 2017

Assessment

Individual assessment: EVI 1 (coefficient 1)

Language of instruction	ECTS Credits	Lectures	Tutorials	Lab	Project	Exam
English	4	12 hrs	2 hrs	16 hrs	0 hrs	2 hrs

YEAR 1 - Autumn Semester

Signal Processing [SIPRO]

LEAD PROFESSOR(S): Eric LE CARPENTIER

Objectives

- To interpret the spectral representations of signals
- To understand the time sampling of signals (sample rate, anti-aliasing filter etc.)
- To model a system using the transfer functions language
- To model a system using the state space language
- To switch from one representation to the other
- To link the physical phenomena to the parameters of these representations (stability, response velocity etc.)
- To simulate these mathematical representations with adapted scientific software tools (Matlab, Simulink)

Course contents

- Analysis of continuous-time and discrete-time signals o Fourier, Laplace and z transforms
- Sample, hold, quantization, Shannon theorem
- Modelling of continuous-time and discrete-time linear time invariant (LTI) systems
- Transfer function, state space representation
- Poles, zeros, stability
- Time response, frequency response
- Sampling
- Simulation (Matlab Simulink)
- First-order and second-order systems
- Design of an actual digital control implementation
- Analog to Digital Converter, Digital to Analog converter
- Sample and hold
- Link with the previous mathematical representations
- Lab work
- A simple encoder
- Spacecraft control simulation

Course material

- Modern Signals and Systems, H. Kwakernaak, R. Sivan, Prentice Hall.
- Signals and Systems, R. Baraniuk, http://www.eng.ucy.ac.cy/cpitris/courses/ece623/notes/SignalsAndSystems.pdf
- Signal processing. Introduction to signals and systems theory, E. Le Carpentier, https://hippocampus.ec-nantes. fr/mod/resource/view.php?id=9179

Assessment Individual assessment: EVI 1 (coefficient 1)

Language of instruction	ECTS Credits	Lectures	Tutorials	Lab	Project	Exam
English	5	16 hrs	0 hrs	14 hrs	0 hrs	2 hrs

YEAR 1 - Autumn Semester

Cultural and Communication English [CCE1]

LEAD PROFESSOR(S): David TROYA

Objectives

This course aims at improving your critical thinking and persuasion skills in English. Using documentaries, we will explore, discuss and debate a range of cultural, political, social, and environmental issues relevant to current world events.

Speaking and understanding English as a second or third language is a great achievement, but does it mean you are an effective communicator? The next step involves, among other things, critical thinking and persuasive skills, both of crucial importance in the modern professional environment. We will address these issues by analyzing documentaries that will lead to formal debates.

Several competencies will be developed through class exercises. Oral presentations will be an opportunity put your verbal as well as your non-verbal communication skills into practice. During debate, you will be able to sharpen your analytical skills, provide constructive feedback, defend an argument, and prove a point.

Course objectives :

- Improving your communication skills
- Becoming an active listener
- Enhancing your non-verbal communication skills
- Developing critical thinking toward media
- Boosting leadership skills through moderating
- Organizing evidence and arguments

Course contents

Each session will be dedicated to a particular cultural, political, social or environmental topic of relevance in the wider anglophone world. Each topic will include multimedia material in the form of a short documentary or documentary excerpt. During class, students will lead a primer presentation, a moderated discussion and a formal debate.

Primer Presentation:

In pairs, you will hold a short talk to prime us on the topic of that week's documentary: you will introduce us to the topic by setting it in a wider context and establishing what's at stake.

Moderated Discussion :

In pairs, you will moderate a discussion related to the themes explored by the documentary. Moderators will come prepared with open-ended questions pertaining to the strengths and weakness of the documentary. They will distinguish between content and form and encourage critical, constructive opinions.

Formal Debate:

What's the difference between an opinion and an argument? You will soon find out. After the moderated discussion, and persuasive skills.

During the debate, each speaker will be assigned an audience member who evaluates their individual performance and provides a short debrief. A panel of two judges will determine which side wins.

Course material

Written and televised press, information and digital tools, general documents, business environment and company strategies. Internet conferences (Ted Talks, etc.), our own educational materials on Hippocampus (Moodle).

Assessment

Individual assessment: EVI 1 (coefficient 1)

Language of instruction	ECTS Credits	Lectures	Tutorials	Lab	Project	Exam
English	2	0 hrs	32hrs	0 hrs	0 hrs	0 hrs

YEAR 1 - Autumn Semester

Spanish Language [ESP1]

LEAD PROFESSOR(S): Marta HERRERA

Objectives

For beginners:

- Practice and reinforcement of the five skills (oral and written expression and comprehension as well as interaction) Acquisition of vocabulary and linguistic structures
- Be able to talk about yourself and those around you Be able to express oneself during daily activities Know how to give your opinion

For advanced students:

- Practice and reinforcement of the five skills (oral and written expression and comprehension as well as interaction) Acquisition of specialised vocabulary
- Be able to understand the essential content of concrete or abstract subjects including a technical discussion Be able to communicate spontaneously and fluently
- Be able to express oneself in a clear and detailed manner, to express an opinion on a topical subject

Course contents

For beginners:

- Personal environment (introduce yourself, express yourself, your tastes, your character, your hobbies, etc.), your surroundings (friends, family, location, climate), your interests (sports, leisure)
- Present tense (regular and irregular)
- Language patterns to express habit, obligation, "gustar" and its equivalents, Possessive adjectives
- Differences between "es", "está", "hay" Use of "por" and "para"
- Adverbs and frequency patterns Numeral adjectives

For advanced students:

- Knowledge of the Hispanic world (economic, technical, cultural and social environment) Present tense (regular and irregular)
- Imperative Past tenses
- Direct / indirect style Future tense Conditional tense
- Present and past subjunctive moods

Course material

Preparation manuals, our own tailor-made documents, written and internet press, general civilization documents, digital tools

Assessment

Individual assessment: EVI 1 (coefficient 1)

Language of instruction	ECTS Credits	Lectures	Tutorials	Lab	Project	Exam
Spanish	2	0 hrs	32hrs	0 hrs	0 hrs	0 hrs

YEAR 1 - Autumn Semester

French Language [FLE1]

LEAD PROFESSOR(S): Silvia ERTL

Objectives

The objective is to familiarize the learner with the French language and French culture through an entertaining task-based communicative language teaching, focused on speaking combined with:

- Phonetics
- Self-correcting exercises on our learning platform
- Learning Lab activities
- Project work
- Tutoring

Course objectives include the acquisition and reinforcement of vocabulary, syntax, and pronunciation by both traditional means and through the use of digital resources.

Students will learn general French, develop language skills of oral and written comprehension and expression.

After completing this course (32 hours + personal work), the students will be able to communicate in spoken and written French, in a simple, but clear manner, on familiar topics in the context of study, hobbies etc. Another important goal of this course is to introduce the student to French culture. At the end of the course (2 semesters), complete beginners can achieve an A1 level and some aspects of the A2 of The Common European Framework of Reference for Languages. More advanced students may aim for B1/B2 levels.

Course contents

Full range of practical communication language exercises: reading comprehension, listening comprehension, written expression, oral expression.

Learners will be able to use the foreign language in a simple way for the following purposes:

1. Gving and obtaining factual information:

- personal information (e.g. name, address, place of origin, date of birth, education, occupation)
- non-personal information (e.g. about places and how to get there, time of day, various facilities and services, rules and regulations, opening hours, where and what to eat, etc.)

2. Establishing and maintaining social and professional contacts, particularly:

- meeting people and making acquaintances
- extending invitations and reacting to being invited

- proposing/arranging a course of action
- exchanging information, views, feelings, wishes, concerning matters of common interest, particularly those relating to personal life and circumstances, living conditions and environment, educational/occupational activities and interests, leisure activities and social life

3. Carrying out certain transactions:

- making arrangements (planning, tickets, reservations, etc.) for travel, accommodation, appointments, leisure activities
- making purchases
- ordering food and drink

Course material

Preparation manuals, our own tailor-made documents, written and televised press, internet, general civilization documents, digital tools, our own educational materials on Hippocampus (Moodle).

Assessment

Individual assessment: EVI 1 (coefficient 1)

Language of instruction	ECTS Credits	Lectures	Tutorials	Lab	Project	Exam
French	2	0 hrs	48 hrs	0 hrs	0 hrs	0 hrs

YEAR 1 - Spring Semester

Research Project [REPRO]

LEAD PROFESSOR(S): Pierre-Emmanuel HLADIK

Objectives

To contribute to solving a scientific, technological or theoretical problem proposed by any of the instructors of the master (professors, assistant professors, researchers etc.) or industrial partners.

Course contents

The students (individually or often as a group of two) organize the project. Depending on the subject, a bibliography may be necessary, an original methodology or solution can be proposed or it can involve purely the application of techniques learned throughout the courses.

32 hours are set aside for the project in the timetable, but additional personal work will be required.

Course material

To be provided by the supervisor(s) if necessary.

Assessment

Collective assessment: EVI 1 (coefficient 1)

Language of instruction	ECTS Credits	Lectures	Tutorials	Lab	Project	Exam
English	6	0 hrs	0 hrs	0 hrs	32hrs	0 hrs

YEAR 1 - Spring Semester

Computer Vision [COVIS]

LEAD PROFESSOR(S): Elwan HERY

Objectives

- To acquire knowledge and skills in computer vision and image processing to understand and to master methods for artificial perception and scene understanding.
- To learn to implement current visual odometry pipelines used in mobile robots and to understand and how to tune Deep Learning algorithms for semantic segmentation.

Course contents

- Introduction
- Image Formation 1: perspective projection and camera models
- Image Formation 2: camera calibration algorithms
- Filtering and Edge detection
- Feature Point Detection
- Multiple-view Geometry and Robust Estimation
- Optical Flow and Feature Tracking
- Visual SLAM Frameworks
- Deep Learning and Semantic Segmentation

Practical Work: Sessions on camera calibration, template tracking and object detection will be proposed.

Course material

Recommended textbooks:

- Digital Image Processing, by Rafael C. Gonzalez and Richard E. Woods, 2018
- Computer Vision: Algorithms and Applications, by Richard Szeliski, 2009.
- Multiple view Geometry, by R. Hartley and A. Zisserman, 2003.
- An Invitation to 3D Vision, by Y. Ma, S. Soatto, J. Kosecka, S.S. Sastry, 2004.
- Robotics, Vision and Control: Fundamental Algorithms, by Peter Corke, 2011.

Online courses:

- Course by Davide Scaramuzza: http://rpg.ifi.uzh.ch/teaching.html
- Course by James Hays at Brown University: https://www.cc.gatech.edu/~hays/
- Course by Andrea Vedaldi: http://www.robots.ox.ac.uk/~vedaldi/teach.html Further reading: will be provided by lecturer

Assessment

Individual assessment: EVI 1 (coefficient 1)

Language of instruction	ECTS Credits	Lectures	Tutorials	Lab	Project	Exam
English	4	20 hrs	0 hrs	10 hrs	0hrs	2 hrs

YEAR 1 - Spring Semester

Image Processing [IMPRO]

LEAD PROFESSOR(S): Diana MATEUS LAMUS

Objectives

This course provides an introduction to the basic concepts and tools of Digital Image Processing. Starting from how images are formed and stored, the lecture will progress towards the elementary techniques to measure and transform different image properties. The lecture will be accompanied by examples on selected applications and by programming lab courses (on python)

Course contents

The following subjects will be addressed:

- Acquiring images and characterising their properties
- Image histograms and intensity transformations
- Spatial Filtering
- Representing and transforming images in the frequency space
- Image segmentation
- Project

Course material

- Digital Image Processing, 4th Ed. Gonzalez and Woods 2018, ISBN: 9780133356724

Assessment

Individual assessment: EVI 1 (coefficient 1)

Language of instruction	ECTS Credits	Lectures	Tutorials	Lab	Project	Exam
English	5	8 hrs	10 hrs	12 hrs	0 hrs	2 hrs

YEAR 1 - Spring Semester

Optimization Techniques [OPTEC]

LEAD PROFESSOR(S): Alexandre GOLDSZTEJN

Objectives

The course presents different theoretical and computational aspects of a wide range of optimization methods for solving a variety of problems in different fields related to the Master's program. The main objective of this course is to give the students the ability to formalise, select the appropriate method, implement the optimisation problem and then analyse the results in order to take the best decision regarding the objectives, variables and constraints. The students will be able to understand different theoretical and computational aspects of a wide range of optimization methods.

Course contents

- Basic concepts of optimization
- The steepest descent method
- Advanced descent methods
- Linear programming
- Multi objective optimization
- Robust optimization methods
- Use of optimization toolboxes

Course material

Jorge Nocedal, Stephen J. Wright: Numerical Optimization, Springer New York, NY. Dimitri P. Bertsekas: Nonlinear Programming, Athena Scientific.

Assessment

Individual assessment: EVI 1 (coefficient 1)

Language of instruction	ECTS Credits	Lectures	Tutorials	Lab	Project	Exam
English	5	14 hrs	0 hrs	16 hrs	0 hrs	2 hrs

YEAR 1 - Spring Semester

Systems Identification and Signal Filtering [SISIF]

LEAD PROFESSOR(S): Mira RIZKALLAH

Objectives

Signal filtering is a basic operation in signal processing which allows, for instance, undesired content to be deleted. The first part of this course deals with methods to design analog and digital filters and their application for the processing of real signals. The second part of the course focuses on experimental modeling of time series. It provides a detailed description of the time series forecasting and modeling chain from data acquisition to model validation.

After completing this course, the students will be able to:

- Specify all the desired properties of a linear filter
- Design a linear filter fulfilling the specifications and apply it to a real signal
- Model time series and estimate model parameters
- Undertake times series forecasting, estimate future values of a time series.

Course contents

1. Signal filtering

- Principles of linear filtering, filter characterization in the frequency domain
- Analog filter synthesis
- Digital filter synthesis (FIR, IIR)

2. Time series analysis

- Time series basics: important features on a time series plot, Auto-regressive(AR) model, Autocorrelation function (ACF)
- Moving Average (MA) models, partial autocorrelation, useful notations (backshift operators etc)
- Identifying and estimating ARMA, ARIMA models; using ARIMA models to forecast future values.

3. Applications

- Audio signal filtering
- Time series 1: fMRI BOLD signals, time series analysis from plotting, correlation
- Time series 2: Forecasting the pandemic trend of Covid 19 (based on past values and models)

Course material

- H. Kwakernaak and R. Sivan, Modern signals and systems, Prentice Hall, Englewood Cliffs, 1991
- C. Chatfield and H. Xing, The Analysis of Time Series: An Introduction with R, 2019

Assessment

Individual assessment: EVI 1 (coefficient 1)

Language of instruction	ECTS Credits	Lectures	Tutorials	Lab	Project	Exam
English	4	12 hrs	10 hrs	8 hrs	0 hrs	2 hrs

YEAR 1 - Spring Semester

Spectral and Time Frequency Analysis [STFAS]

LEAD PROFESSOR(S): Sébastien BOURGUIGNON

Objectives

Spectral analysis concerns the estimation of the frequency content of a given signal, which is the fundamental tool for detecting and characterizing harmonic components or wideband phenomena in stationary signals. This course first provides an overview of most frequently used spectral analysis tools, from standard methods based on Fourier analysis to high- resolution methods. Then, time-frequency analysis is considered, which extends spectral analysis to non-stationary signals (that is, when the frequency content changes with time). A last part is dedicate to time-scale analysis of nonstationary signals and wavelet transforms.
All methods are presented both in their mathematical and informational foundations and in their practical numerical implementation, through application examples taken from real-life data analysis problems.

Course contents

1. Spectral analysis. Fourier-Transform-based methods: advantages and limitations, windowing, periodograms. High- resolution methods: linear prediction models, subspace methods, regularized methods. Labs/projects: detection of multiple oscillating components in noise; exoplanet detection from time series; Fourier-based image compression.

2. Time-frequency representation. Linear models based on the Short-Term Fourier Transform. Quadratic representations: Wigner-Ville distributions, Cohen's class. Labs/projects: comparison of time-frequency representations; application to automatic music transcription; use of time-frequency representations for automatic classification (speaker recognition).

3. Toward time-scale representations: continuous and discrete wavelet transforms.

Course material

- A.V. Oppenheim and R.W. Schafer. Discrete-time signal processing, Prentice Hall, 2010.
- P. Stoica and R. Moses. Spectral Analysis of Signals, TBS, 2005.
- S. Kay. Modern Spectral Estimation, Prentice -Hall, Englewood Cliffs, 1988.
- L. Cohen, Time-Frequency analysis, Prentice-Hall, 1995.
- S. Mallat, A Wavelet Tour of Signal Processing: The Sparse Way, Academic Press, 2008.

Assessment

Individual assessment: EVI 1 (coefficient 1)

Language of instruction	ECTS Credits	Lectures	Tutorials	Lab	Project	Exam
English	4	12 hrs	8 hrs	10 hrs	0 hrs	2 hrs

YEAR 1 - Spring Semester

Cultural and Communication English [CCE2]

LEAD PROFESSOR(S): David TROYA

Objectives

Interview techniques and communicational English:

- Understand the general concepts of interactive communication
- Build a media project
- Acquire interview techniques
- Understand the process of sourcing and checking facts and figures
- Understand issues related to plagiarism
- Create a bibliography
- Behavioral skills in an inter-cultural environment:
- Strengthen self-confidence and capacity for interaction
- Develop active listening and reformulation skills
- Develop networking skills

Course contents

- Cultural and Communicational English: exercises to explore in practice the areas of culture and communication.
- Media project (for example: prepare, conduct and promote interviews for a radio programme: L'Heure Centralienne (http:
- //www.euradionantes.eu/emission/l-heure-centralienne), with the contribution of professors, PhD students, industrial partners, industry players at fairs, etc.

Course material

Written and televised press, information and digital tools, general documents business environment and company strategies. Internet conferences (Ted Talks, etc.), our own educational materials on Hippocampus (Moodle).

Assessment

Individual assessment: EVI 1 (coefficient 1)

Language of instruction	ECTS Credits	Lectures	Tutorials	Lab	Project	Exam
English	2	0 hrs	32 hrs	0 hrs	0 hrs	0 hrs

YEAR 1 - Spring Semester

Spanish Language [ESP2]

LEAD PROFESSOR(S): Marta HERRERA

Objectives

For beginners:

- Practice and reinforcement of the five skills (oral and written expression and comprehension as well as interaction) Acquisition of vocabulary and linguistic structures
- Be able to talk about yourself and those around you Be able to express oneself during daily activities Know how to give your opinion

For advanced students:

- Practice and reinforcement of the five skills (oral and written expression and comprehension as well as interaction) Acquisition of specialised vocabulary
- Be able to understand the essential content of concrete or abstract subjects including a technical discussion Be able to communicate spontaneously and fluently
- Be able to express oneself in a clear and detailed manner, to express an opinion on a topical subject

Course contents

For beginners:

- Personal environment (introduce yourself, express yourself, your tastes, your character, your hobbies, etc.), your surroundings (friends, family, location, climate), your interests (sports, leisure)
- Present tense (regular and irregular)
- Language patterns to express habit, obligation, "gustar" and its equivalents, Possessive adjectives
- Differences between "es", "está", "hay" Use of "por" and "para"
- Adverbs and frequency patterns Numeral adjectives

For advanced students:

- Knowledge of the Hispanic world (economic, technical, cultural and social environment) Present tense (regular and irregular)
- Imperative Past tenses
- Direct / indirect style Future tense Conditional tense
- Present and past subjunctive moods

Course material

Preparation manuals, our own tailor-made documents, written and internet press, general civilization documents, digital tools

Assessment

Individual assessment: EVI 1 (coefficient 1)

Language of instruction	ECTS Credits	Lectures	Tutorials	Lab	Project	Exam
Spanish	2	0 hrs	32 hrs	0 hrs	0 hrs	0 hrs

YEAR 1 - Spring Semester

French Language [FLE2]

LEAD PROFESSOR(S): Silvia ERTL

Objectives

The objective is to familiarize the learner with the French language and French culture through an entertaining task-based communicative language teaching, focused on speaking combined with:

- Phonetics
- Self-correcting exercises on our learning platform
- Learning Lab activities
- Project work
- Tutoring

Course objectives include the acquisition and reinforcement of vocabulary, syntax, and pronunciation by both traditional means and through the use of digital resources.

Students will learn general French, develop language skills of oral and written comprehension and expression.

After completing this course (32 hours + personal work), the students will be able to communicate in spoken and written French, in a simple, but clear manner, on familiar topics in the context of study, hobbies etc. Another important goal of this course is to introduce the student to French culture. At the end of the course (2 semesters), complete beginners can achieve an A1 level and some aspects of the A2 of The Common European Framework of Reference for Languages. More advanced students may aim for B1/B2 levels.

Course contents

Full range of practical communication language exercises: reading comprehension, listening comprehension, written expression, oral expression. Learners will be able to use the foreign language in a simple way for the following purposes:

Giving and obtaining factual information:

- Personal information (e.g. name, address, place of origin, date of birth, education, occupation)
- Non-personal information (e.g. about places and how to get there, time of day, various facilities and services, rules and regulations, opening hours, where and what to eat, etc.)

Establishing and maintaining social and professional contacts, particularly:

- Meeting people and making acquaintances
- Extending invitations and reacting to being invited

- Proposing/arranging a course of action
- Exchanging information, views, feelings, wishes, concerning matters of common interest, particularly those relating to personal life and circumstances, living conditions and environment, educational/occupational activities and interests, leisure activities and social life

Carrying out certain transactions:

- Making arrangements (planning, tickets, reservations, etc.) for travel, accommodation, aMpointments, leisure activities
- Making purchases
- Ordering food and drink+-

Course material

Preparation manuals, our own tailor-made documents, written and televised press, internet, general civilization documents, digital tools, our own educational materials on Hippocampus (Moodle).

Assessment

Individual assessment: EVI 1 (coefficient 1)

Language of instruction	ECTS Credits	Lectures	Tutorials	Lab	Project	Exam
French	2	0 hrs	48 hrs	0 hrs	0 hrs	0 hrs