CENTRALE NANTES

MASTER OF SCIENCE, TECHNOLOGY AND HEALTH

2024-2025

YEAR 1

CONTROL AND ROBOTICS

ADVANCED ROBOTICS

PROGRAMME SUPERVISOR(S):

Elwan HERY

YEAR 1 - Autumn Semester

CORE COURSES

Course code	Title	ECTS Credits
ARPRO	Advanced and Robot Programming	4
ARTIN	Artificial Intelligence	6
CLACO	Classical Linear Control	5
DESRO	Mechanical Design Methods in Robotics	4
MANIP	Modelling of Manipulators	4
SIPRO	Signal Processing	5

LANGUAGE COURSES

Course code	Title	ECTS Credits
CCE1	Cultural and Communication English	2
ESP1	Spanish Language	2
FLE1	French Language	2

YEAR 1 - Spring Semester

CORE COURSES

Course code	Title	ECTS Credits
COVIS	Computer Vision	4
DYBAC	Dynamic Model Based Control	4
MOBRO	Mobile Robots	4
OPTEC	Optimization Techniques	5
PROJECT	Group Project	6
SOFAR	Software Architecture for Robotics	4

LANGUAGE COURSES

Course code	Title	ECTS Credits
CCE2	Cultural and Communication English	2
ESP2	Spanish Language	2
FLE2	French Language	2

Advanced and Robot Programming [ARPRO]

LEAD PROFESSOR(S): Olivier KERMORGANT

Requirements

Objectives

To provide students with the fundamentals of modern programming (with C++) and industrial robot manipulator programming with specialized robot languages.

After completing the course, students will be able to:

- Write a C++ program from scratch or expand an existing project, using external libraries
- Create their own classes and know how to understand a class interface documentation
- Use tools such as Cmake, Qt Creator, a debugger and a profiler
- Use the STL when needed

Course contents

C++
- Basic types, STL useful classes (string, vector, pair, map), struct
- Control blocks: if/then/else, for, while, switch
- Functions: argument passing, overloading
- Classes: attributes and methods, inheritance
- Templates, lambda-functions and STL algorithms
- Code organization
- Compilation with Cmake, using external libraries
- Debugger and profiler

Course material

- Bruce Eckel, Thinking in C++, volumes 1 and 2, 2007.
- Online ressources (CppCon, stack overflow, competitive programming websites)

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	4	10 hrs	0 hrs	20 hrs	0 hrs	2 hrs

Artificial Intelligence [ARTIN]

LEAD PROFESSOR(S): Diana MATEUS LAMUS

Requirements

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. 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
- 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 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	6	16 hrs	2 hrs	12 hrs	0 hrs	2 hrs

Classical Linear Control [CLACO]

LEAD PROFESSOR(S): Guy LEBRET

Requirements

A prerequisite in ordinary differential equations or dynamical systems would facilitate access to this course.

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 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	5	22 hrs	4 hrs	4 hrs	0 hrs	2 hrs

Mechanical Design Methods in Robotics [DESRO]

LEAD PROFESSOR(S): Stéphane CARO

Requirements

Objectives

This course presents an overview of the robot design process: (i) specifications, (ii) conceptual design, (iii) embodiment design and (iv) detailed design. Particular attention will be paid to the conceptual design phase as it is a distinct phase of the design process and 75% of total product life-cycle cost is committed at that stage. The conceptual design deals with the type-synthesis and evaluation of robot architecture. A focus will be placed on the design of serial and parallel robots.

Course contents

Design is an engineering activity that affects almost all areas of human life, using the laws and insights of science, building upon special experience, and providing the prerequisite for the physical realisation of solution ideas.
This course will deal with all the phases of the design process of a product, namely: task definition, conceptual design, embodiment, detailed design.
Particular attention will be paid to the conceptual design phase as stated above.

The following subjects will be discussed:
- Conceptual design: concept generation, concept evaluation.
- Product design: documentation, product generation, evaluation for function and performance, evaluation for cost, ease of assembly and other measures.
- Computer aided design, use of CAD software.
- The design of robotic production cells.
- Fundamentals of integrated design of control and drive systems taking into account measurement, gearing and transmission systems.

After completing this course, the students will be able to:
- Design serial and parallel robotic manipulators.
- Correctly formulate the information required for conceptual design (requirements),
- Use CAD systems on the basic level for the design of a typical mechanism (serial arm),
- Elaborate the design on general level without consideration of material, drive systems and actuators,
- Generate manufacturing drawings.

The course is evaluated with a final exam and a final project that is conducted by groups of two students.
Projects are suggested by the instructor.

Course material

- French, M. J. Conceptual Design for Engineers, 3rd ed., 1999 (Springer)
- Pahl, G. and Beitz, W. Engineering Design: A Systematic Approach, 2nd ed. Wallace, K.M. (editor); Blessing, L., Bauert, F. and Wallace, K.M. (translators), 1996 (Springer-Verlag, London)
- Suh, N.P. The Principles of Design, 1990 (Oxford University Press, Oxford)
- Suh, N.P. Axiomatic Design. Advances and Applications, 2001 (Oxford University Press, Oxford)
- Kong X. and Gosselin, C., Type Synthesis of Parallel Mechanisms, Springer Tracts in Advanced Robotics, 2007.

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	4	18 hrs	0 hrs	12 hrs	0 hrs	2 hrs

Modelling of Manipulators [MANIP]

LEAD PROFESSOR(S): Olivier KERMORGANT

Requirements

Objectives

This course introduces the modelling and basic control of serial robot arms. The topics include robot architecture and modeling conventions, forward and inverse kinematic model, differential kinematic modelling and the basics of trajectory planning and tracking.

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

- Have a clear view of 3D geometry, including rotation parametrization and velocity screws
- Define a table of modified Denavit-Hartenberg parameters to model a robot from a sketch
- Compute (manually or with software) the direct and differential kinematic models
- Derive the inverse kinematic model for standard manipulators (6R / 3P3R)
- Understand position and velocity control modes
- Know how to generate a trajectory from a sequence of 3D waypoints
- Know various symbolic or numeric software tools that can be used to model and control robots

Course contents

- Robot architecture, joint and operational spaces
- Homogeneous transformation matrices, 3D geometry, velocity screw
- Modified Denavit-Hartenberg parametrization and direct kinematics
- Definition and computation of the robot Jacobian
- Inverse kinematics in exact and iterative forms
- Trajectory generation
- Basic position and velocity control modes (trajectory / velocity tracking)

Exercises will involve modelling and simulating various serial manipulators.

Course material

- Slides and labs are available online.
- W. Khalil, and E. Dombre, Modeling, identification and control of robots, Hermes Penton, 2002.

Further reading:

- C. Canudas, B. Siciliano, G. Bastin (editors), Theory of Robot Control, Springer-Verlag, 1996
- J. Angeles, Fundamentals of Robotic Mechanical Systems, Springer-Verlag, New York, 2002.

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	4	16 hrs	0 hrs	14 hrs	0 hrs	2 hrs

Signal Processing [SIPRO]

LEAD PROFESSOR(S): Eric LE CARPENTIER

Requirements

Objectives

Keeping a floating wind turbine afloat, optimising its energy production, ensuring the autonomous behaviour of a robot, regulating the blood sugar level of a diabetic patient - these are just some of the applications that require automated action. The wind turbine, the robot and the patient are the systems. The action, or control law, is based on the processing of information collected over time, the signals, and on the formalisation of the behaviour of these systems.
This course covers the fundamental principles of automatic control and signal processing, i.e. mathematical analysis and representation followed by the development of the control law, prior to computer implementation.
It is a benchmark for the essential knowledge covered in any international course of this type.
At the end of this teaching, the student will be able:
- 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
  - o Sample, hold, quantization, Shannon theorem
- Modelling of continuous-time and discrete-time linear time invariant (LTI) systems
  - o Transfer function, state space representation
  - o Poles, zeros, stability
  - o Time response, frequency response
  - o Sampling
  - o Simulation (Matlab Simulink)
  - o First-order and second-order systems
- Design of an actual digital control implementation
  - o Analog to Digital Converter, Digital to Analog converter
  - o Sample and hold
- Lab work
  - o A codec based on the Fourier transform
  - o 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
- Lecture notes on hippocampus

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	5	16 hrs	0 hrs	14 hrs	0 hrs	2 hrs

Cultural and Communication English [CCE1]

LEAD PROFESSOR(S): David TROYA

Requirements

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, we will brainstorm potential topics for debate, and follow the British Parliamentary model to sharpen your research, critical thinking, 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 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	2	0 hrs	32 hrs	0 hrs	0 hrs	0 hrs

Spanish Language [ESP1]

LEAD PROFESSOR(S): Marta HERRERA

Requirements

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

French Language [FLE1]

LEAD PROFESSOR(S): Silvia ERTL

Requirements

N/A

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 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	2	0 hrs	48 hrs	0 hrs	0 hrs	0 hrs

Computer Vision [COVIS]

LEAD PROFESSOR(S): Elwan HERY

Requirements

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
▪ 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 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	4	20 hrs	0 hrs	10 hrs	0 hrs	2 hrs

Dynamic Model Based Control [DYBAC]

LEAD PROFESSOR(S): Guy LEBRET / Sebastien BRIOT

Requirements

A first course in control (classical control) and on mechanical systems are prerequisites to this course

Objectives

To show that using in a control law "a dynamic model" of a dynamical system can be the base of a fruitful control methodology. This course is an extension of two courses: Classical Linear Control and Modelling of Manipulators.
In the first part (16h), for linear multivariable systems, the model is used, first of all, to obtain observer-based controllers (state space approach of linear multivariable systems) as the feedback part of the control law, and secondly, in a possible feedforward part.
In the second part (16h), it is shown how the dynamic model of mechanisms or, more specifically, serial robots can be obtained, as this model is the basis of the so-called "computed torque control law". Different formalisms for the computation of the dynamic model will be explored (Newton-Euler, Lagrange equations).

Clearly, the objective of the course is to present a unified methodology to obtain control laws. In this methodology, once the dynamic model has been obtained, then the non-linear coupled MIMO systems can be linearized and decoupled, and finally the linear methodology of the first part can be applied.

Course contents

Part 1 state space approach of linear multivariable systems:
- Time domain state response, modal decomposition of the response
- Controllability, observability
- Observer-based controllers
- Possible two degrees of freedom controllers.

Part 2, mechanisms or more specifically, serial robots:
- Recalls of classical mechanics
- Newton-Euler equations
- Euler-Lagrange equations
- Optimal computation of dynamic models for serial robots (recursive formalisms)

Skills: After completing this course the students will be able to
- Use all classical tools of the linear state space approach to analyse (mode, controllability, etc) and design observer-based controllers.
- Compute the dynamic model of open-loop mechanisms and robots
- Evaluate the benefit of the use of a dynamical model in a control law.

Course material

Recommended texts: Course notes will be provided by the lecturers.

Further reading:

- "Control system design", G.C. Goodwin, S.F. Graebe and M.E. Salgado, Prentice Hall, 2001.
- "Linear Multivariable Control, A Geometric Approach", W.M.Wonham. Springer Verlag, New York, 1985.
- "Linear Systems", T. Kailath, Prentice-Hall, New Jersey, 1980.
- "Modelling, Identification and Control of Robots" W. Khalil and E. Dombre, Hermes Penton, Ltd, 2002

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	4	22 hrs	4 hrs	4 hrs	0 hrs	2 hrs

Mobile Robots [MOBRO]

LEAD PROFESSOR(S): Gaëtan GARCIA / Olivier KERMORGANT / Vincent FRÉMONT

Requirements

- 2D and 3D Geometry
- Linear Algebra
- Probability Theory
- Control Theory
- Linear and Non linear Optimization

Objectives

The objective of the course is to provide students with the necessary tools to model, localize and control conventional wheeled mobile robots, along with tools to plan their path.

Course contents

The following subjects will be addressed:

▪ Modelling of wheeled Robots: Constraint equations, Classification of robots using degrees of mobility and steerability, Posture kinematic model, Configuration kinematic model, Motorisation of wheels.
▪ Localization: Relative localization using odometry, Absolute localisation, Localization sensors, Localization using extended Kalman filtering. Observability analysis of localization problems.
▪ trajectories planing : maps et navigable space, global and local trajectories planing.
▪ Control: Controllability and stabilization, static and dynamic feedback linearization, non-linear control based on Lyapunov functions.

Practical Work:

▪ The students implement a Kalman filter-based localization algorithm using data recorded with a real robot.
▪ Trajectories tracking with various control laws.

Course material

▪ “Theory of robot control”, Carlos Canudas de Wit, Bruno Siciliano, Georges Bastin, Springer Science & Business Media, 2012 - 392 pages.
▪ "Wheeled Mobile Robots—Kinematic Modelling", G. Garcia, Class material in book form.
▪ "Mobile robots—Localization", G. Garcia, Class material in book form.
▪ "Principles of robot motion", H. Choset et. al., Bradford books, MIT Pres.

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	0 hrs	2 hrs

Optimization Techniques [OPTEC]

LEAD PROFESSOR(S): Alexandre GOLDSZTEJN

Requirements

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
- Basic concepts of optimization
- Unconstrained optimization
  - First and second order optimality conditions
  - The steepest descent method
  - Advanced descent methods
- Constrained optimization
  - First and second order optimality conditions
  - Extension of unconstrained methods
  - Methods with penalization
- 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 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	5	14 hrs	0 hrs	16 hrs	0 hrs	2 hrs

Group Project [PROJECT]

LEAD PROFESSOR(S): Elwan HERY / Gaëtan GARCIA / Olivier KERMORGANT / Pierre-Emmanuel HLADIK

Requirements

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.

Course material

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

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	6	0 hrs	0 hrs	0 hrs	32 hrs	0 hrs

Software Architecture for Robotics [SOFAR]

LEAD PROFESSOR(S): Elwan HERY

Requirements

Objectives

The main objective of this course is to master the use of ROS (Robot Operating System), a framework for developing modular programs for robotics.

Course contents

The course covers the following aspects:

- Lectures on ROS
- Labs tutorials on ROS
- Group project on ROS

Course material

https://docs.ros.org/en/humble/index.html

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	4	4 hrs	0 hrs	28 hrs	0 hrs	0 hrs

Cultural and Communication English [CCE2]

LEAD PROFESSOR(S): David TROYA

Requirements

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 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	2	0 hrs	32 hrs	0 hrs	0 hrs	0 hrs

Spanish Language [ESP2]

LEAD PROFESSOR(S): Marta HERRERA

Requirements

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

French Language [FLE2]

LEAD PROFESSOR(S): Silvia ERTL

Requirements

N/A

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. 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.)

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 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	2	0 hrs	48 hrs	0 hrs	0 hrs	0 hrs