CENTRALE NANTES

FOUNDATION MASTER

2023-2024

YEAR 1

SIGNAL CONTROL AND ROBOTICS

PROGRAMME SUPERVISOR(S):
Eric LE CARPENTIER

YEAR 1 - Autumn Semester

CORE COURSES

Course code	Title	ECTS Credits
CPD	Computer Programming and Data Analysis	3
CTR1	Control Systems	3
EAE	Energetics and Environment	3
ENL1	English, Cultural and Business Environment	3
FRL1	French language	3
MAT1	Mathematics	3
PROJ1	Project	9
ROB1	Robotics	3

YEAR 1 - Spring Semester

CORE COURSES

Course code	Title	ECTS Credits
CTR2	Control Systems	3
DIP	Digital Image Processing	3
ENL2	English, Cultural and Business Environment	3
FRL2	French language	3
IAS	Industrial Automation Systems	3
MAT2	Mathematics	3
PROJ2	Project	9
ROB2	Robotics	3

Computer Programming and Data Analysis [CPD]

LEAD PROFESSOR(S): Hugues DIGONNET

Objectives

This course aims to provide students with basic knowledge of computer programming with Matlab, and to introduce more advanced tools for data analysis (visualization, statistical analysis, numerical methods).

Course contents

This course includes an introduction to the Matlab programming environment, the use of matrix variables and matrix manipulations. Scripts and functions are introduced, together with basic programming structures, conditions and loops. Graphics manipulation and statistical tools for data analysis are presented, and general programming rules and tips for efficient computations are provided.

Course material

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	3	0 hrs	0 hrs	18 hrs	0 hrs	2 hrs

Control Systems [CTR1]

LEAD PROFESSOR(S): Ina TARALOVA

Objectives

This course is designed for students looking to develop their skills in electrical/electronic and control systems engineering, with the emphasis on applying the key principles to practical situations. It includes the fundamentals of control theory and the use of Simulink (the mathWorks graphical programming environment for modeling, simulating and analyzing multidomain dynamic systems).

Course contents

Basics of Control Theory.
Part I: First semester - First and second order systems time responses, characteristics, canonical form.
LTI (Linear Time invariant Systems)
Part II: Second semester - Frequency responses, Magnitude and phase, Bode diagram. Nyquist plot. Stability criteria, stability margins. Design of control laws.

Course material

R. C. Dorf and R. H. Bishop, Modern Control Systems, Pearson Education, Upper Saddle River, NJ, twelfth edition, 2011, ISBN-13:978-0-13-602458-3

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
null	3	18 hrs	0 hrs	0 hrs	0 hrs	2 hrs

Energetics and Environment [EAE]

LEAD PROFESSOR(S): Georges SALAMEH

Objectives

Understand and master the major energy, climate and environmental challenges of this century. The students will have to master the fundamental concepts and the large orders of magnitude, know how to make "back of an envelope" calculations in order to quickly analyze a solution while developing finely-tuned critical thinking skills.

Course contents

Energy issues
Climate issues
Environmental Issues
Introduction, factfulness, energy-climate exercises, carbon footprint calculation
Mini simulation of energy transition scenarios
"Climate fresk" workshop.

Course material

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	3	14 hrs	4 hrs	0 hrs	0 hrs	2 hrs

English, Cultural and Business Environment [ENL1]

LEAD PROFESSOR(S): David TROYA

Objectives

In this course, you will learn how to:
- Develop an understanding of inter-cultural communication
- Develop oral and written communication adapted to different contexts (mainly inter-cultural situations)
- Organize, lead and participate in a meeting
- Strengthen self-confidence and level of conviction
- Work on professional documents in English
- Acquire presentation skills
- Express feelings and practice assertiveness
- Develop active listening and understanding to reformulate, explain and argue
- Develop well-being at work and a sense of responsibility
- Negotiate, innovate and propose innovative solutions
- Enhance teamwork

Course contents

Those objectives will be achieved by doing:
- English: full range of practical communication language exercises (reading comprehension, listening comprehension, written expression, oral expression)
- Business English: introduction to marketing and business practices
Educational projects are adapted to the level of the group (scenarios, role plays, simulations).
Analysis of a short story or an extract of a novel in order to explain the cultural components of the text.

Course material

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	3	0 hrs	30 hrs	0 hrs	0 hrs	0 hrs

French language [FRL1]

LEAD PROFESSOR(S): Astrid DE BRUYN

Objectives

Students will learn general French and develop language skills in oral and written comprehension and expression. After completing this course, 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 provide an introduction to French culture. At the end of course (60 hours), complete beginners can expect to achieve A1 level and some aspects of A2 of The Common European Framework of Reference for Languages. More advanced students may aim for B1/B2 levels.

Course contents

Being able to speak about oneself.
Speaking about daily life in France.
Speaking about projects during the year in France.
Speaking about French festivals, traditions and comparing with one's home country.

Course material

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	3	0 hrs	30 hrs	0 hrs	0 hrs	0 hrs

Mathematics [MAT1]

LEAD PROFESSOR(S): Françoise FOUCHER

Objectives

The objective is to supplement students' knowledge of both the theoretical and practical use of mathematical tools required in advanced engineering. This course focuses on linear algebra, and vector differential and integral calculus.

Course contents

1- Vector spaces, linear mappings, matrices, linear systems, real and complex inner products, orthogonal projection, Gram-Schmidt orthogonalization
2- Eigenvalues and eigenvectors, eigenbases, diagonalization, triangulation, spectral radius, matrix norms, application to quadratic forms, application to the study of the stationary points of a multivariate function
3- Functions of several variables, differential operators, Taylor formulas, line integrals, multiple integrals

Course material

References: Erwin Kreyszig, Advanced Engineering Mathematics, 10th edition, John Wiley & Sons, 2010

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	3	18 hrs	0 hrs	0 hrs	0 hrs	2 hrs

Project [PROJ1]

LEAD PROFESSOR(S): Loic MICHEL / Tugdual LE NÉEL

Objectives

Option mécanique:
The objective of the course is to prototype autonomously a mecatronics object, with a notion of corporate social responsibility.

Course contents

Project management
Computer aided design
Manual and computerized manufacturing
Prototyping
Industrialization

Course material

Monk, Simon. Programming Arduino: Getting Started with Sketches. New York: McGraw-Hill Education, 2016.
Olwen Wolfe, Paris, J!innove comme on respire ou Comment faire vivre notre capacite d'innovation, 2007.
Kalani Kirk Hausman, Richard Horne,3D Printing For Dummies, 2014

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	9	0 hrs	0 hrs	0 hrs	60 hrs	0 hrs

Robotics [ROB1]

LEAD PROFESSOR(S): Juan SANDOVAL AREVALO

Objectives

The aim of this course is to provide an overview of robotics. First, we present the different robot architectures and their main characteristics. We also introduce robot properties, workspace and singularities. Next, we present the basics of robot kinematics for robotic manipulators. This course provides students with the tools they need to choose a robot for a given application.

Course contents

* Introduction to robotics
- Historical facts
- Types of robots
- Main properties of a robot
* Introduction to robot kinematics
- Joint ant task spaces
- Direct and inverse kinematics

Course material

[1] Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani, and Giuseppe Oriolo, Robotics: Modelling, planning and control, 1st ed., Springer Publishing Company, Incorporated, 2008.
[2] Siciliano, B. & Khatib, O. (eds.) (2008). Springer Handbook of Robotics. Berlin, Heidelberg: Springer. ISBN: 978-3-540-23957-4
[3] W Khalil and E Dombre, "Robot: Modeling, Identification and Control", Butterworth-Heinemann 2004.

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
null	3	18 hrs	0 hrs	0 hrs	0 hrs	2 hrs

Control Systems [CTR2]

LEAD PROFESSOR(S): Ina TARALOVA

Objectives

This course is designed for students looking to develop their skills in electrical/electronic and control systems engineering, with the emphasis on applying the key principles to practical situations. It includes the fundamentals of control theory and the use of Simulink (the mathWorks graphical programming environment for modeling, simulating and analyzing multidomain dynamic systems).

Course contents

Basics of Control Theory.
Part I: First semester - First and second order systems time responses, characteristics, canonical form.
LTI (Linear Time invariant Systems)

FM_CTR2 takes place the second semester

Part II: Second semester - Frequency responses, Magnitude and phase, Bode diagram. Nyquist plot. Stability criteria, stability margins. Design of control laws.

Course material

[1] R. C. Dorf and R. H. Bishop, Modern Control Systems, Pearson Education, Upper Saddle River, NJ, twelfth edition, 2011, ISBN-13:978-0-13-602458-3

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
null	3	18 hrs	0 hrs	0 hrs	0 hrs	2 hrs

Digital Image Processing [DIP]

LEAD PROFESSOR(S): Diana MATEUS LAMUS

Objectives

This course is an introduction to digital image processing techniques. It covers how images are created, stored, processed, and used. We will review various methods of image processing, including image enhancement, filtering, and noise reduction techniques. The course consists of a series of lectures, accompanied by hands-on practice through the implementation of image analysis techniques in Python.

Course contents

Content:
-Introduction
-Quality measurements
-Intensity transformations
- Morphological operators
- Spatial filtering
- Spectral representations and filtering

Course material

[1] Digital Image Processing, 4th Ed. Gonzalez and Woods © 2018, ISBN: 9780133356724
[2] Computer Vision: Algorithms and Applications (Texts in Computer Science). 2011th Edition. by Richard Szeliski

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
null	3	12 hrs	0 hrs	6 hrs	0 hrs	2 hrs

English, Cultural and Business Environment [ENL2]

LEAD PROFESSOR(S): David TROYA

Objectives

- Understand the general concepts of business English and marketing principles
- Build a professional project and explore international opportunities
- Develop strategies for inter-cultural practice
- Develop oral and written communication adapted to different contexts
- Organize, lead and participate in a meeting
- Work on professional documents in English
- Acquire a professional lexicon
- Understand the principles of corporate business models
- Acquire notions of corporate culture and values
- Develop well-being at work and a sense of responsibility
- Negotiate, innovate and propose innovative solutions

Course contents

- English: full range of practical communication language exercises
- Business English: exercises to explore in practice the areas of management and marketing

Educational projects adapted to the level of the group (scenarios, role plays, simulations).
Analysis of a short story or an extract of a novel in order to explain the cultural components of the text.
Projects in a professional context "Start-up simulation", "marketing assignment", "advertising assignment", etc.

Course material

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	3	0 hrs	30 hrs	0 hrs	0 hrs	0 hrs

French language [FRL2]

LEAD PROFESSOR(S): Astrid DE BRUYN

Objectives

Students will learn general French and develop language skills in oral and written comprehension and expression. After completing this course, 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 provide an introduction to French culture. At the end of course (50 hours), complete beginners can expect to achieve A1 level and some aspects of A2 of The Common European Framework of Reference for Languages. More advanced students may aim for B1/B2 levels.

Course contents

Speaking about stereotypes
Speaking about French icons and introducing one from one's home country
Speaking about media (press, social networks)

Course material

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	3	0 hrs	30 hrs	0 hrs	0 hrs	0 hrs

Industrial Automation Systems [IAS]

LEAD PROFESSOR(S): Abdelhamid CHRIETTE

Objectives

After completing this lecture, students should be able to:
▪ Know the hardware organization of PLCs (Programmable Logic Con-trollers), its input-output and communication peripherals.
▪ Able to recognize the structure and components of automated sys-tems.
▪ Able to analyze automation problems using combinatorial and se-quential logic.
▪ Be able to represent solutions by logic circuits and their translation into programmed logic: Ladder, GRAFCET.
▪ Be able to program the control of simple processes using PLCs, sen-sors and actuators.

Course contents

▪ History
▪ Automatic system
▪ Programmable Logic Controllers (PLC)
▪ Basics of the language
▪ Basic structures
▪ Particular structures

Course material

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	3	4 hrs	6 hrs	8 hrs	0 hrs	2 hrs

Mathematics [MAT2]

LEAD PROFESSOR(S): Françoise FOUCHER

Objectives

The objective is to supplement students' knowledge of both the theoretical and practical use of mathematical tools required in advanced engineering. This course focuses on ordinary differential equations, probability and statistics.

Course contents

1- First-order ODEs: Euler's method, equations with separate variables, linear ODEs
2- Second order linear ODEs: homogeneous case, homogeneous case with constant coefficients, non homogeneous case, solution by variation of parameters
3- Higher order linear ODEs
4- Systems of first-order ODEs, constant coefficient systems
5- Probability, random variables, probability distributions
6- Vectors and sequences of random variables, independance, convergence in distribution, almost sure convergence
7- Statistics: point estimation and confidence interval

Course material

References: Erwin Kreyszig, Advanced Engineering Mathematics, 10th edition, John Wiley & Sons, 2010

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	3	18 hrs	0 hrs	0 hrs	0 hrs	2 hrs

Project [PROJ2]

LEAD PROFESSOR(S): Loic MICHEL / Tugdual LE NÉEL

Objectives

The objective of the course is to prototype autonomous

Course contents

Project management
Computer aided design
Manual and computerized manufacturing
Prototyping
Industrialization

Course material

Monk, Simon. Programming Arduino: Getting Started with Sketches. New York: McGraw-Hill Education, 2016.
Olwen Wolfe, Paris, J!innove comme on respire ou Comment faire vivre notre capacite d'innovation, 2007.
Kalani Kirk Hausman, Richard Horne,3D Printing For Dummies, 2014

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	9	0 hrs	0 hrs	0 hrs	60 hrs	0 hrs

Robotics [ROB2]

LEAD PROFESSOR(S): Juan SANDOVAL AREVALO

Objectives

The objective of this course is to discover industrial robots. In the first step, we present the different robot architectures and their main characteristics. We will do kinematic modeling to discover the properties of robots, the workspace, and the singularities. We will discuss after the generation of trajectories in the joint space and Cartesian space. We will introduce the different types of trajectory of the robots and their link with the industrial processes. The concept of optimal placement will be discussed as well as the simple methods that can be used in robotic CAD software. With this course, students will have tools to choose a robot for an industrial application.
The different stages of the course will be illustrated using the DELMIA software to create
- a robot
- a tool
- a robotic cell with pick-and-place operations
- a robotic cell with welding operations

Course contents

- Introduction of industrial robots
- Modeling of robots
- Workspace and singularities
- Trajectory planning

Course material

[1] W Khalil and E Dombre, "Robot: Modeling, Identification and Control", Butterworth-Heinemann 2004.
[2] E. Dombre, P. Chemdail, P. Wenger, "La CAO en robotique", Hermès Science Publications, 1998.
[3] J. Angeles, "Fundamentals of Robotic Mechanical Systems ", Springer, 2014

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	3	6 hrs	0 hrs	12 hrs	0 hrs	2 hrs