ENSIL-ENSCI

Limoges - FRANCE

Detailed syllabus of

International semester for exchange students

Electrical Engineering and System Control

ensil ÉCOLE NATIONALE SUPÉRIEURE D'INGÉNIEURS DE LIMOGES

Faculté des Sciences & Techniques

Université de Limoges

SCHEDULE

February 4th
Welcome day

February 3rd to 22nd
First teaching period

February 18th to 26th
One week Winter break

March 4th to April 12th
Second teaching period

April 15th to May 1st
Spring break

May 2nd to May 31st
Third teaching period

All students will be aware of any modifications to the schedule or syllabus in advance. It is the student's responsibility to adapt to any changes.

The International Semester at ENSIL-ENSCI is taught completely in English. Most of the courses are illustrated by practical laboratory, in which the students will manipulate the state-of-the-art software, hardware and equipment.

The courses are organized in 3 main categories as presented below.

Category	**General Topics (64h) 6 ECTS**	**Signal, systems and circuits (112h) 10-14 ECTS**	**Control system and perception (64h) 4-8 ECTS**
Topics	- French language - Industrial ecology - Project management - Computer programming (Matlab, Labview)	- Analog Electronics - Digital circuit design (VHDL, SOC) - Antenna from theory to practical design - Digital communication - Digital signal processing - Networks	- Control system - Robotics - Computer vision and image processing - Design and Modelling of Unmanned Aerial Systems

Students have the possibility to choose 9 among the 11 topics of the proposed program of the following training modules :
- SIGNAL, SYSTEM AND CIRCUITS (Minimum 10 ECTS - Maximum 12 ECTS)
- CONTROL SYSTEM AND PERCEPTION (Minimum 4 ECTS - Maximum 8 ECTS)
The total combined ECTS number in these two modules should be 18.
The details of the different courses are given below.

GENERAL TOPICS (64h)
6 ECTS

French language: 24h00

by the centre of French language for foreigners

Contents:
Two levels are available: beginners, intermediate
The aim is to learn or improve French language and discover the French culture.

Industrial ecology: 6h

by Dr. Agnès Smith, Professor at the University of Limoges and researcher at IRCER laboratory

Contents:
Industrial ecology is an integrated production system considering the interdependence of processing operations, such as in biological ecosystems, with the goal of minimizing environmental impacts.
The analysis of a production process, its consumption of raw materials and energy, can be approached through the analysis of its “metabolism” with a representation of the flow of matter and energy. This is the systemic approach. Each of its flow generates an environmental impact. The synergies between the flow of several activities can reduce the overall impact of activities.
Learning Objectives:
Upon completion of this course, you will have knowledge of
(i) An approach of industrial production consistent with sustainable development
(ii) Interactions between environment and production and methods for estimating
(iii) The systemic approach to business or territory

Course Content:
- The approach of industrial ecology: history and issues
- Matter cycle and environmental impact
- Flow analysis, material and energy balance
- Industrial metabolism
- Life Cycle Analysis

Project management: 6h

by Mr. Nicolas Boucharel, Project manager at RADIALL company

These courses deal with key knowledge to manage a project in term of Quality, Cost and Deadline. Objective is to learn about the most useful tools to lead a project at industrial scale.
It is mainly structured as following:

- Project Kick off
- Project team
- Deliverables/Milestones
- Planification
- Project risk analysis
- Case studies

Moreover, during this course, students will have opportunity to learn about "Design of Experiment (DoE)" in order to organize their future test plan with a balance between duration/cost/efficiency and mainly improve results analysis step. It is mainly structured as following:

- Introduction to "DoE"
- Example of complete and screening plan
- Introduction to a useful software to manage DoE (Minitab 17)
- Case studies

Computer programming: 28h

Labview, 14h

by Dr. Clement Hallepee, research engineer at XLIM Research Institute

The objective of the course is to train students to the use of the National Instrument Labview software. Through this course, the basic training as well as exercises using advance functionalities will be done.
Summary:

- What is Labview?
- Presentation of the software and its visual programming language
- Creation of basic virtual instruments
- How to pilot measurement instruments through standard communication protocol (USB, serial, …)?
- Practical exercises

Matlab 14h

by Dr. Aurélien Perigaud, research engineer at XLIM Research Institute

Matlab basis, Signal processing with matlab, GUI interface, Image processing, Interface and control of external boards (Arduino).

Signal, systems and circuits
(Total 112h)
10-14 ECTS

Analog Electronics: 16h

by Dr. Julien Lintignat, Associate Professor at the University of Limoges and researcher at XLIM Research Institute

Transistor Amplifiers (class A, class B, class AB)

Digital Circuit Design – VHDL : 16h

by Dr. Vahid Meghdadi, Professor at the University of Limoges and researcher at XLIM Research Institute

The objective of the course is to show how to design a digital circuit (combinatory and sequential) at RTL level. The hardware description language used in the course is VHDL.
Contents: combinatory circuits, sequential circuits, synchronous and asynchronous circuits, finite state machines, VHDL programming at RTL abstraction level.
Laboratory: Combinational circuits, Serial port interface, digital signal processing with ADC and DAC (filter), VGA interface, PS2 keyboard interface

Digital Circuit Design – SOC : 16h

by Dr. Vahid Meghdadi, Professor at the University of Limoges and researcher at XLIM Research Institute

A mixed microprocessor/logic circuit will be learnt through this course. The students use Vivado integrated development Environment (IDE) to create their designs. First the architecture of PicoBlaze is presented with its input/output ports. In the lab works, the students will put, using VHDL, all types of interface around the microprocessor. It includes GPIO with LEDs, SWs, serial port (input and output), etc.

Antenna from theory to practical design: 16h

by Dr. Delia Arnaud-Cormos, Associate Professor at the University of Limoges and researcher at XLIM Research Institute

The course aims to give to the students an overview of the fundamental principles associated with electromagnetics propagation and microwave antennas while giving a

grasp of the practical applications. Emphasis will be given to the practical designs of antennas during laboratory demonstrations using state of the art, industrial and academic, 3D electromagnetic simulators such CST Microwave Studio® (CST MWS), Advanced Design System (ADS), ANSYS HFSS. The students will be taught to design, characterize, and measure in an accessible manner simple antennas, considered to give an understanding of their underlying theory, such as dipoles or printed antennas.

Keywords: electromagnetics, wave propagation, microwave antennas, 3D electromagnetic simulators, microwave measurements.

Digital signal processing: 16h

by Dr. Oussama Habachi, Associate Professor at the University of Limoges and researcher at XLIM Research Institute

The course begins by presenting the sampling theorem. Then the discrete time signals will be presented. Discrete time Fourier transform and its relation with continuous time Fourier transform. Discrete time Fourier transform will be explained. Discrete time systems. Linear time-invariant systems and the convolution principles. The Properties of linear systems. The Z transform is defined and its properties will be discussed. The transfer functions of linear systems in Z domain. Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT).
All the principles will be illustrated by Matlab.

Introduction to digital network: 16h

by Wilfrid Petit, lecturer at the University of Limoges

This course provides an introduction to Digital Networks for students without “network past”, with an educational level objective: « To have knowledge on ».
Contents: brief history of communication networks, network architectures (different types and topologies of nodes and links), Ethernet, IP (address classes, routing), TCP/UDP, HTTP protocols. The course is illustrated by 6 hours of practical laboratory.

Digital communications: 16h

by Dr. Anne Julien-Vergonjanne Professor at the University of Limoges and researcher at XLIM Research Institute

and

by Dr. Stéphanie Sahuguede Associate Professor at the University of Limoges and researcher at XLIM Research Institute

This course is illustrated by numerous Matlab simulations done by students.
It provides an introduction to digital communication principles. The main goal is to study how to translate information into digital signals to be transmitted, and how to retrieve the information back from the received signal in the presence of Gaussian noise and Inter-Symbol Interference (ISI).
Digital base-band and band-pass modulation and demodulation schemes are covered in detail and illustrated using MATLAB and Simulink to design and test digital modems and communication systems.
Prerequisites: signals and systems course, basis of MATLAB. Familiarity with Simulink is not required.
Keywords: base-band communication; Pulse Amplitude Modulation, PAM; band-pass communication; digital modulation using phase, frequency and amplitude, PSK, FSK, ASK, quadrature amplitude modulation QAM; additive white Gaussian noise (AWGN); model for communication channel; detection using a matched filter/correlation; inter symbol interference (ISI); raised cosine filter; bit-error probability for a communication system; simulation of a communication system
Note: this is a laboratory oriented course.

CONTROL SYSTEM AND PERCEPTION
(Total 64h00)
4-8 ECTS

Control systems: 16h

by Dr. Joanny Stéphant, Associate Professor at the University of Limoges and researcher at XLIM Research Institute

After introducing the fundamentals of linear dynamic systems, the state space representation of these systems will be approached. A didactic and practical case study (for example, a mechanical system) will be used as a recurrent theme to present all the different notions. These ones are commandability, observability, state feedback, linear observer and state feedback based on observed state. All the notions will be treated using Matlab-Simulink software.
Keywords: linear control systems, case study

Robotics: 16h

by Dr. Ouiddad Labbani, Professor at the University of Limoges and researcher at XLIM Research Institute

Objective: Overview of the robot mechanisms, kinematics and control. Gaining own experience through practical robot modelling and trajectory planning.

Contents: This course provides an overview of robot mechanisms, basics of modeling, design, planning, and control of robot systems. After a brief survey of relevant results from geometry, kinematics, statics, dynamics, and control, the course is mainly presented of problem sets and laboratory work. The latter includes spatial kinematics and will help to design and evaluate motion planning algorithms on simulated robots.

Keywords: Robot manipulators, Modelling, Forward and inverse kinematics, Trajectory planning

Computer vision and image processing: 16h

by Dr. Ouiddad Labbani, Professor at the University of Limoges and researcher at XLIM Research Institute

Objectives: Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience through practical computer and programming exercises.

Contents: The lecture provides an introduction to basic methods of digital image processing and computer vision. It starts from the necessary steps to arrive at the discrete images that serve as input to algorithms. It describes necessary preprocessing steps of image analysis, which enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course continues by analyzing procedures allowing extracting additional types of basic information and implementation of laboratory examples.

Keywords: Computer vision, Image processing, Linear and non-linear filtering, Image filtering in the spatial and frequency domains

Design and Modelling of Unmanned Aerial Systems: 16h

by Dr. Juan Antonio Escareno, Associate Professor at the University of Limoges and researcher at XLIM Research Institute

Objectives/outcomes: The goal of the course is twofold, (i) the study of most-used modeling techniques applied to unmanned aerial vehicles (UAV) and (ii) the underlying synthesis of navigation control strategies. Regarding the course's outcomes, enrolled students will possess a wider perspective on the UAVs application scope.

Contents: The course details the equations of motion of aerial robots, considering classical configurations and the multi-robot cases. We are particularly interested on a energy-based formalism due to its natural link to the control techniques addressed within the actual course. Specifically, in terms of control, we will focus on robust navigation. Moreover, a simulation stage will be conducted considering close-to-reality models. Finally, an experimental implementation on a homemade drone-based benchmark is envisioned.

Keywords: Energy-based modeling, flight dynamics, aerial robots, navigation, robust controllers, simulation, experimental platforms

TECHNICAL PROJECT (60h)
6 ECTS

A project is to be accomplished by the student. The number of hours that the students are supposed to work on is at least 60h. It can be a practical implementation, research theoretical studies, modelling and simulation, etc. The subject of project can be proposed by professors or by students themselves. The home university is also encouraged to propose project subject.