FIFTH YEAR INSA TOULOUSE

Autumn semester

EMBEDDED SYSTEM COURSES

Integrated circuit design	7 credits	104h
Technology, fabrication and industrialization of embedded systems	6 credits	74h
Autonomous embedded systems design	5 credits	71h
Sensor network : design and networking	5 credits	
Human Resources Management and Group Work	6 credits	75h

SECURITY COURSES

Embedded Computer Architecture	6 credits	72h
Engineering methods	5 credits	71h
Dependability	7 credits	58h
Human Resources Management and Group Work	6 credits	75h
Projet interdisciplinaire		
Mineure	6 credits	

SYSTEM ENGINEERING COURSES

Dependable systems	5 credits	68,5h
Configuration management and knowledge	3 credits	25h
Multidisciplinary design	4 credits	44h
Thermal engines and systems	4 credits	57h
Systems on chip	4 credits	50h
Industrialization and logistics	5 credits	60h
Human Resources Management and Group Work	6 credits	75h

Spring semester

Training period (4th year)	9 credits	1h
Training period (5th year)	21 credits	2h

Integrated circuit design

ECTS
7 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
104h

Presentation

Description

Programme (detailed contents):

* Starting from a real industrial application, the students will specify an embedded electronic system.
* Using the previous specification, the students will design the system on chip and realize the software/hardware partitioning.
* The students will design HW system architecture (digital and analog blocks, interfaces, power sources) taking into account the performances of the system (robustness, power consumption, frequency). The validation will be done by simulation and integrated circuit implementation (IP block).

Organization:

* Courses and labs
* Project based learning
* Link with English courses. The final report and the oral presentation are given in English.

Objectives

At the end of this module, the student will have understood and be able to explain (main concepts):

* MOS characteristics
* CMOS analog and digital function performances (consumption, efficiency, Signal-to-noise ratio, operating frequency , ...)
* The different simulation modes to characterize analog and digital circuits performances
* Design and optimization of advanced integrated systems
* Co-design of SW/HW complex systems

The student will be able to:

* Specify an advanced electronic system including digital, analog, RF circuits and interfaces
* Set up a design methodology (computer aided design) to respond to a specification
* Design full custom CMOS circuits basis (IP blocks) of SoC.
* Simulate CMOS circuits performances with professional tools (Cadence)

Useful info

Place

Toulouse

Technology, fabrication and industrialization of embedded systems

ECTS
6 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
74h

Presentation

Description

Programme (detailed contents):

* modeling techniques and power circuit components
* integration techniques and design (schematic packages in accordance with standard JDEC, manufacture of PCBs in accordance with the standard norm NFC93-713, reflow process, bonding techniques)
* industrialization constraints (BOM, FMEA, BTF, traceability, components définitions)
* awareness of standards (DBT, TERN, CE, RoHS, WEEE) and qualification processes
* analysis techniques and metrics for monitoring quality of an industrial process

Organization:

This teaching approach based on voluntary industry is made around the design of two prototypes in industrial workshops:

• a prototype electronic board assembled on a line classe4 Industrial CMS

• SoP prototype, produced in a clean room for micro-electronic chip part and then assembled as an MCM (hybrid indirect) consisting of mixed SMD/chips carried and connected on different substrates (ceramic, epoxy FR4, flex)

Objectives

At the end of this module, the student will have understood and be able to explain (main concepts):

• how to write a specification of industrialization of an embedded system (BOM, Gerber files, BTF, FMEA, ..)

• how to define classes technology of a printed circuit board (PCB rigid, flexible, hybrid)

• how to route the signals in terms of constraints in line with the aspects heat dissipation and signal integrity

• how to define the type of mounting card (single / double layer, size Class)

• how to comply with different standards (NF 93-713, RTTE, DBT, RoHS, WEEE)

• how to set up a monitoring process quality (ISO17025)

• How to estimate the reliability of the assembly (standard FIDES)

The student will be able to know all stages of manufacturing, design methods and standards / compliance of an electronic product ready to sell.

Useful info

Place

Toulouse

Autonomous embedded systems design

ECTS
5 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
71h

Presentation

Description

Programme (detailed contents):

Due to embedded system constraints linked to the application, two applications are detailed:

• complete design an autonomous mobile robot able to move and communicate with other robots.

• design of an automotive application (body control) with sensors, microcontrollers, smart power actuators, communication bus, LCD display, system basis chip, in partnership with NXP.

The themes are:

- Management / Storage / energy recharging.

- Automotive electronics modern power boards, computers communication bus, LCD display, system basis chip

- Architectures and protocols of the various buses (wired and wireless)

- Architectures multi-source voltage (interface and translation of logic levels)

- Motor control

- Instrumentation and reconfigurable architectures for sensor signal conditioning

- components to ensure safety and robustness

Organization:

Mixed between lectures and Project based learning

Lectures are made by different industry stakeholders, each with a special skill and working in order to give students the latest advances in automotive electronics.

Projects allow students to work in a very close conditions that they will find in the industry.

For the design part of a mobile robot, it is ensured by leading researchers in the field of embedded electronics.

Objectives

At the end of this module, the student will have understood and be able to explain (main concepts) main subsystems as follow:

- Energy Management:

  * architectures converters (DC-DC, LDO, Band-Gap ...)

  * Storage and charging architectures (Lipo, Li-ion ...)

* Management of low-power modes of a microcontroller

- Interfacing:

  * between logic levels (strong currents, voltage levels, EMC, thermal protection, ...)

  * between the microcontroller and peripherals based on the waveform of the current• with power actuators (smart MOS)

-Communication:

  * protocols: I2C, SPI, CAN, OneWire

  * RF protocols: XBee, 868MHz, 433MHz RFID

- On board intelligence:

  * Reconfigurable digital and analog architectures (3 bit microcontroller, FPAA)

- Display:

  * Automotive Dashboard

  * Screens / touchscreens

- Safety and robustness:

  * analysis of safety

  * System basis chip, power supply supervision

  * Watchdogs, error and fault diagnosis

  * EMC requirements

The student will be able to devise from specifications all the subsystems architectures and choose components to assume a design complies with the specifications (battery and electronics management, connection of selected cards and constraints for microcontrollers programming).

Note that analog design will be provided on

FPAA.

Useful info

Place

Toulouse

Sensor network : design and networking

ECTS
5 credits

Presentation

Description

Programme (detailed contents):

This course is composed of :

1) lectures :

20 lectures (1.25h each)

2) practical labs :

They consist of :

* *Project 1* : 7 lab sessions (2.75h each)

The students have to implement three different sensors (one accelerometer, one photoresistor, and one pyroelectric infrared sensor). Then, they have to design, size and test an electronic circuit dedicated to process the sensor signal.

* *Project 2* : 7 lab sessions (2.75h each)

On a microcontroller platform : setup transfer protocols through a sensor network to exchange information to a GSM mobile terminal.

Objectives

By the end of this module, the student will have understood and be able to explain (main concepts) :

About the sensors part :

* the way various sensors operate (optronic, thermal, mechanical, acoustic ...),
* the operation of these sensors and the associated signal conditioning.

About the communication between sensors part:

Wireless communication technologies and sensor networks, internet of things (IOT), machine to machine communication (M2M).

Useful info

Contacts

Education manager

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Human Resources Management and Group Work

ECTS
6 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
75h

Presentation

Objectives

At the end of this module, the student will have understood and be able to explain (main concepts) :

Human Resource Management

Aims and organisation of a Human Resources position, job analysis and forecasting, recruiting, work motivation, skills, salary, training, career management, conflict mitigation, work contract

Social Psychology

Groups, what they are, their influences and dynamics

The student will be able to analyse a group situation

Pre-requisites

None

Place

Toulouse

Useful info

Embedded Computer Architecture

ECTS
6 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
72h

Presentation

Description

Programme (detailed contents):

The Learning Unit is composed of three topics related to embedded computer architecture.

- The first one is about network and middleware used for embedded systems. This part introduces the main concepts on fieldbus and middlewares with CAN (Controller Area Network), industrial Ethernet Industrial, AFDX (Avionic Full DupleX Switched Ethernet) as examples and expose network architecture for connected devices (based on IPv6 and IEEE 802.15.4).

- The second part deals with operating systems used for embedded systems and the constraints induced (portability, memory management, cross-compiler, drivers, scheduling, etc.). Linux and FreeRTOS are used during labwork to illustrate these concepts.

- The objective of the third part is to bring skills to size and evaluate an embedded computer architecture. An overview of different computer architectures for embedded systems (micro-controller, multi-processors, many-core, fpga, gpu, etc) is given, then methods and metrics to evaluate performances (energy consumption, computation capacity, etc.) are presented. A labwork is conducted to confront students with problematics to size an embedded computer architecture in order to fit the needs of an embedded system.

Organisation:

Each topic is introduced by lectures to tackle theoretical aspects. The practical application is done during lab works and illustrates each topic on a shared embedded computer architecture.

An integrated project is coordinated with other Learning Units of SEC to bring into use the skills and knowledges of students on embedded computer architectures to implement a complete embedded system.

Objectives

At the end of this module, the student will have understood and be able to explain:

- Main concepts and specificities of networks used in embedded systems for automotive, avionic and connected devices.

- Specificities of embedded operating systems and main services (scheduling, memory management, privileges, etc.).

- Advantages and drawbacks of different embedded computer architecture (micro-controller, multi-processors, many-core, fpga, gpu, etc.).

- Which components impact the performances of an embedded computer architecture and which methods can optimize them.

The student will be able:

- To choose a networking technology to fit the needs of an embedded system.

- To set up a network for an embedded system.

- To deploy an operating system for embedded systems.

- To implement operating-system-specific drivers.

- To compare performances of embedded computer architectures.

- To choose an embedded computer architecture to fit the needs of embedded applications.

Useful info

Contacts

Education manager

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Place

Toulouse

Engineering methods

ECTS
5 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
71h

Presentation

Description

The goal of this UF is to introduce the main principles of systems engineering and software engineering. A first course introduces the concepts, methods and tools, to define and control the process development of a critical embedded system.

A second course focuses on the agile management of engineering processes in a project of development of a critical embedded system.

A MOOC allows the student to synthetize all the notions of this UF and to reinforce some.

All method, tools and good practices presented in the UF will be used in a transversal project of development of a critical embedded system.

Organisation

4 parts with lectures, on line lectures, paper work and lab works, a transversal project.

Objectives

At the end of this module, the student will have understood and be able to explain (main concepts):

Main principles of systems engineering and software engineering: concepts, methods and tools, to define and control the process development of a critical embedded system.

The student will be able to:

- apply these general competences to computer based embedded systems

explain different methods and chose the best adapted to develop a specific application.

Useful info

Contacts

Education manager
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Place

Toulouse

Dependability

ECTS
7 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
58h

Presentation

Description

Programme (detailed contents):

The purpose of this UF is to introduce the main principles of dependability (SDF): the basic concepts and the main methods and techniques to get it

A first course gives a general introduction to the Dependability specifying terminology, attributes, resources, ...

Specific courses allow you to go a little further in this panorama mainly illustrating the means - Prevention through modeling -

following the timed synchronous and asynchronous paradigms - Elimination of faults through the static verification of sequential programs and diagnostics.

Organisation:

5 parts, each including lectures, tutorials and lab work

Introduction to dependability

Program Verification

Synchronous programming

Temporal models

Diagnostic

A MOOC allows the student to synthetise all the notions of this UF and to reinforce some.

All methods, tools and good practices presented in the UF will be used during a transversal project of development of a critical embedded system.

Objectives

At the end of this module, the student will have understood and be able to explain (main concepts):

the basic concepts of dependability and main methods and techniques for obtaining and validation of the safety.

The student will be able to:

- apply these general competences to computer based embedded systems

explain different methods and chose the best adapted to develop a specific application.

Pre-requisites

Discrete event systems - linear continuous systems (modelling and control) - System design : software design and programming - fuzzy logic - neural networks

Useful info

Contacts

Education manager

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Place

Toulouse

Projet interdisciplinaire

Useful info

Mineure

ECTS
6 credits

Useful info

Dependable systems

ECTS
5 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
68,5h

Presentation

Objectives

At the end of this module, the student will have understood and be able to explain the notions associated with the concepts of risk, dependability and quality as well as the tasks of the associated Management process and their implementations. The student will have to perceive the importance of the continuous improvement of the management activities (Management System).The student will be able to identify the hindrances to safety and quality, to evaluate them and to select the adequate methods to handle these issues.

Useful info

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Place

Toulouse

Configuration management and knowledge

ECTS
3 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
25h

Presentation

Objectives

Based on ISO 10007 norm, the aim of Configuration Management training is to explain the process applied to an aircraft manufacturer.From customer requirements, the courses explain step by step the methods used to ensure product conformity in compliance with customer requirements and certification authorities requirements.The steps correspond to the product development cycle (contract, specify, define, produce, attest, certify and deliver).Understand the concepts of industrial property and copyright, know the conditions and formalities required for filing a patent.Knowing the practices of knowledge management in industry: knowledge engineering, acquisition and accumulation of knowledge.

Useful info

Place

Toulouse

Multidisciplinary design

Level
BAC +4

ECTS
4 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
44h

Presentation

Description

Design of Experiment (DoE)

Accounts.- Practical exercices.- Practical work using Explaser, an interactive simulator of industrial process : to solve a multi parameter problem of laser soldering. In a first stage, all calculations are made by hand without any helps of softwares, in order to understand the mechanic of the calculations and the manner of establishing effect graphisms of factors and of their interactions.- Application of the method to the improvement of a catapult : the Statapult.

Surrogate models and sizing of mechatronic systems

The lectures take the forms of videos (moodle SPOC) and interactive quiz.

Program: design drivers, sizing scenarios, surrogate models, estimation models with scaling laws, life time evaluation, profil mission simulation, optimization, sizing procedure definition, numerical solver.

Projects examples: Optimal preliminary design of thrust vector control actuation system (Ariane, Vega), supercapacitor charge converter (chopper), flight control actuator (spoiler, aileron), last mile delivery electric vehicle...

Objectives

Design of experiments

To know the global concepts of DoE and understand the interest of the tool.

Surrogate models and sizing of mechatronic systems

To explain the process and the different models usefull for the optimal sizing of mechatronic systems.

The student will be able to:

Design of experiments

- To be able to define and set into work some tests allowing to get an optimistic process.
- To carry out one's own design of experiments.

Surrogate models and sizing of mechatronic systems

- To define the sizing scenarios of a technical system

- To establish the estimation models and simulation modes of the set of components

- To set a design procedure and to define the optimization problem

- To Implement the calculations in a numerical environment

Pre-requisites

Probability (basic), statistics (basic), notions of system architecture (mechanical, hydraulic, electric, etc.)

Useful info

Contacts

Education manager
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Place

Toulouse

Thermal engines and systems

ECTS
4 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
57h

Presentation

Description

Thermal engines : First, a reminder of the principles of thermodynamics, fluid modeling, thermodynamic transformations (isobar, isoenthalp, adiabatic, etc.). Secondly, analysis of the thermodynamic cycles of steam engines, gas turbines and heat pumps.

Thermal systems : Lumped parameter modeling of components involved in thermal engines and systems such as heat exchangers, compressors, turbines, valves. Case study on an air conditioning and pressurization system for an aircraft.

Computational fluid mechanics : Initiation to the CFD code Fluent. Numerical simulation of one of the components of a thermal system, in the framework of a project done by groups of 2 students.

Objectives

At the end of this module, the student should have understood and be able to analyze thermal and mechanical energy production systems and their associated components.

The student should be able to:

- Analyze the thermodynamic cycle associated with a power plant.
- Size a thermal engine to meet specifications in terms of requested power.
- Specify the components of a thermal engine or system.
- Calculate the air conditioning flow requirements to

perform various functions (pressurization, fresh air renewal, heating, cooling) in an aircraft and adjust the recirculation and the flow distribution between the different cabin zones.

Pre-requisites

Basics of thermodynamics and heat transfer.

Useful info

Contacts

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Place

Toulouse

Systems on chip

ECTS
4 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
50h

Presentation

Objectives

At the end of this module, the student will have understood and be able to explain (main concepts):-the design and optimisation of advanced digital systems-the life cycle of a software-hardware system (specifications, design, implementation)-co-design of software hardware complex systems upon the application requests-co-verification of new software ¿ hardware complex systemsThe student will be able to:-design and implement advanced digital systems on FPGA using VHDL and optimise their performances in power consumption and functioning frequency upon the application requests-design and implement hardware and software systems on programmable chips (SoPC) and systems on chip (SoC)

Pre-requisites

Computer engineering

Exigencies engineering

Place

Toulouse

Useful info

Industrialization and logistics

Level
BAC +4

ECTS
5 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
60h

Presentation

Description

Industrialization :

Through two types of industrialization : The automotive and aerospace ; we detail :

- The different types of production management organizations

- Industrial measures implemented

- Piloting of industrialization : PLM , ERP, PDM , MES, lean management

- Design and simulation of the system of industrialization

- Introduction to CAD and CAM Catia V5

Labwork of optimization of production and organization and production management

Visits to factories and conference on lean management

Organization : 5 hours of lectures, 10.25h of Tutorials , 8h of Labwork, 3h conference, examen: 1.25 MCT

Production management, planning, scheduling :

Production management and logistics

linear programming applied to planning

Graphs and scheduling application

Scheduling and combinatorial optimization

Production Planning

Labwork : Introduction to AMPL and Excel

Organization : 12.5 hours of lectures, 2.5h of Tutorials , 2.5h of Labwork, examen: 1.25h

Configuration Management :

1 – Airbus world (Aircraft families, industrial roles accros Europe, all different maturity steps of a program)

2 – Configuration management generalities (first look and presentation of modules that will be detailed afterwards)

3 – Product structure (What is product structure, how it is built and what are the main rules)

4 – The change process (all different steps of a change request during the full process, data and deliverables requiered pending on progress in the process)

5 – Offer management (what is offer management and what are the associated deliverables)

6 – Attestation and control of conformity (Delta managements)

Organization: 6 x 2h30 of course + 2 x 2h30 of labwork + 2h of exam

Objectives

At the end of this module, the student will have understood and be able to explain (main concepts) :

The organization , management and control of a system of industrialization

The challenges of production management (PM) and supply chain (SCM) as well as issues of scheduling

What is configuration management, what are the enablers and what is the purpose

The student will be able to :

- Define the industrial means used and the type of production management organization associated with the system of industrialization
- Define the tools to control it : PLM , ERP, PDM , MES, the lean management
- Use tools for design and simulation of industrialization : CAD and CAM CATIA
- Use of models, methods and tools GP , SCM, and scheduling
- Roughly describe airbus world (A/Cs family, industrial sharing across the Europe)
- Define a hierarchical & appropriated breakdown of a complex product
- Apply the change process and identify required data to allow decision
- Identify mechanisms that enable management of product offer and its customisation
- Demonstrate that final product manufactured is conform to expectations

Pre-requisites

Reading of plans, current metallic materials, various types of machining.

Basic elements on : probabilities – Linear programming.

Useful info

Contacts

Education manager
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Place

Toulouse

Training period (4th year)

ECTS
9 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
1h

In brief

Teaching language(s): Français, Anglais

Useful info

Place

Toulouse

Training period (5th year)

ECTS
21 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
2h

In brief

Teaching language(s): Français, Anglais

Useful info

Place

Toulouse