Major **C**ommunication **S**ystems
and **I**nternet **O**f **T**hings

Track 1

Mobile and Autonomous Electronics
Communicating Systems

Semester 7
Semester 8
Projects
Concentration

Gif Campus

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CentraleSupélec

Semester 7:
Thematic Term (ST5) + General Term (SG6)

Thematic Term: Functional Modelisation and Regulation - Autonomous and Connected Vehicle

- Automatic Control
- System modeling
- Architecture and embedded technologies for the autonomous vehicle
- Interactions of the intelligent vehicle with its environment
- Challenge week

2 or 3 elective courses[2] with at the two following

Integrated MEMS Sensors

In many application fields the development or integration of miniaturized MEMS (Micro-Electro- Mechanical Systems) sensors is now a prerequisite for the deployment of connected applications. These devices are used as sensors or for energy conversion. This course covers theoretical and practical aspects, from the point of view of modelling (multi-physical/multi-domain modelling), physics, technology and economics. It aims at providing a comprehensive overview of the field, which will be of interest to students with a taste for "beautiful physics" and for the design of complex systems, and/or those who wish to understand the large-scale industrialization of integrated devices.

MicroProcessors Architectures Design

The aim of this course is to train architects and designers of digital systems. students will be able to define and design the architecture of a digital processing chain, describe a model of this processing in VHDL language. And finally to design a RISC processor. More than half of this course consist of a project.

Common Core Cursus

- Project[1]
- Economics
- Humanities
- Engineering professional skills
- Languages

[1] the project will be included in the "pôle projet" list below
[2] at least 5 elective courses should be validated during semester 7 and 8

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Semester 8
Thematic Term (ST7) + General Term (SG8)

Thematic Term:
Optimization – Open to student choice

- Optimization
- Specific course depending on the topics
- Exemple: Energy Opmization for embedded system
- Exemple: High Performances Simulation

2 or 3 elective courses[2] with the one following:

Advanced Analog Electronic

The purpose of this course is to provide design methodologies for analog systems based on specification and the basics to be able to analyze an existing circuit. The proposed approach is bottom-up. The student learns the functioning of the transistor, then how to associate blocks based on transistors (amplification, filtering, frequency translation…), then how to associate these blocks to obtain a complex system. Through this approach the student will learn to master transistors models, dimensioning methods and simulation.
Analog electronics needs to practice, this is why this course mixes theoretical approach with tutorials presenting classical practical cases commented by a teacher. This way the student learns the method for problem solving in analog electronics.

Common Core Cursus

- Project[1]
- Humanities
- Engineering professional skills
- Languages

[1] the project will be included in the "pôle projet" list below
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Pôle Projet
Semester 7 + Semester 8

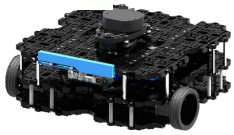
Pôle Autonomous Vehicule:

In order to allow the students of the engineering curriculum CentraleSupélec to deepen on the **technological locks of the autonomous vehicles**, this pole covers the various scientific fields useful for the future of this booming market. In this context, a number of project modalities are proposed to meet the different expectations of students. To achieve this goal, the include a research approach with challenging competition like autonomous racing, autonomous UAV mission or solutions design for the airport of the future.
The action focuses on three major axes:


The vehicle and the interaction with its environment


Architecture and Interfaces


Distributed intelligence



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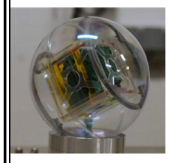
Pôle Projet
Semester 7 + Semester 8

Pôle CubeSat:

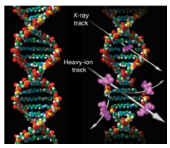
DESIGN AND DEVELOPMENT OF CUBESAT EXPERIMENT MISSIONS

Teamwork and space project management (ESA[1] Standard)



PROJECTS:

- Understand the mechanisms of space debris destruction during atmospheric re-entry
- Qualify autonomous navigation algorithms with high parallelization running on a GPU[2]
  - Evaluate the radiation tolerance of capable Commercial Off-the-Shelf GPU devices
  - Determine their suitability for spaceflight applications
  - Be able to update and reprogram the algorithms tested on the GPU from the ground segment
- Design a spherical air-bearing testing platform to validate CubeSat ADCS[3]
- Design a support system for biological experiments in space
  - Experiment the shielding effectiveness of a material against cosmic rays
  - Studies on Bacillus subtilis spores
- Develop and build a ground station to track CubeSats



[1] European Space Agency
[2] Graphics Processing Unit
[3] Attitude Determination and Control System

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Pôle Projet
Semester 7 + Semester 8

Pôle IOT

Convergence of telecommunications, IT, electronics, signal processing, big data and artificial intelligence, IoT, the future of the internet, is sometimes called Internet 4.0, ambient intelligence, or the internet ubiquitous.
It will bring major changes in daily life and in the industry.
It represents one of the main areas of investment for European science and technology policy, as well as for countries and manufacturers in the rest of the world.

If with connected objects we are only in the infancy of IoT, just as simple web pages were only the infancy of the internet that we know today, it is in the next years that IoT will be built with all its potential. Today's students - tomorrow's engineers - will be the pioneers.

With the IoT project pole, you will participate in the definition and construction of the IoT of tomorrow with industrial partner.

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Concentration
Semester 9
Mobile and Autonomous Communicating Systems

Objectives: This major aims to train high-level engineers, capable of analyzing complex systems in an interconnected world, and creating disruptive concepts, specify the architecture of these systems from the physical interface to data transmission, while optimizing cost, consumption, performance, and latency. The architectural engineers coming out of this major will have digital tools for specification/sizing, multi-physical modeling, analogue/digital agile design/Software/Hardware.

- **Teaching modalities**: The mention is structured in a top-down pedagogical approach "From system to technology" of the problems encountered when designing autonomous mobile systems.
  - The courses include theoretical inputs, tutorials of immediate application, and laboratories or small projects of application of concepts implementing modelling tools, CAD, or characterization to meet real problems of industrialists.
  - The first sequence (2 months) is common to all specialties. It provides the theoretical, technological, economic and legal foundations of communicating systems and IoT
  - The next sequence is rather reserved for general electronic and radio frequency design methods while the last sequence will focus on technological solutions, integration and new issues and concepts of the future
  - Industry or research project on all three sequences

- **Trained Engineers**: R&D Engineer, Design and Production, Project Manager, Consulting Trades
- **Employment**: high-level R&D centres: (Stmicroelectronics, CEA Leti, IRT Nanoelec, laboratory III-V Lab, XFAB, ONERA), Aeronautics and space (Thales, Airbus Defense and Space, Dassault, Safran, Zodiac), IOT (Gemalto, Start'ups), Operators and telephone manufacturers (Orange, SFR, Bouygues, Nokia, Huawei) Energie (EDF, Schlumberger), Transport (Renault, PSA, Valeo, Safran, SNCF, RATP, Michelin, Alstom), Santé (General Electric), etc.

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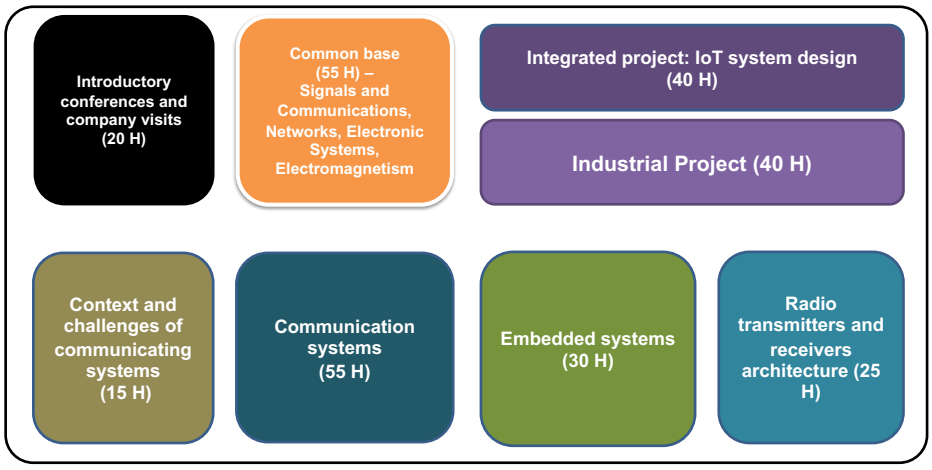
CSIoT Major first sequence – MT9

The major form of architects and designers of complex heterogeneous, flexible, high-tech cooperative and distributed intelligence processing and communication systems.
The first sequence is intended to give an overview of the different disciplines that will be deepened and expanded in the three specialties.



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First sequence syllabus (120h + 48h project)

- Context and issues of interconnected communication systems (9h):
  Strategic, economic, industrial, societal and human issues. Energy and environmental aspects.
  Legal aspects (law, data protection, resource management, etc.). New paradigms.
- Common Base (33h): This course base is intended to provide basic concepts for communicating systems and connected objects by providing reminders and complements in communications and networks, electronics and electromagnetism, adapted to the diversity of students entering the mainstream (ST/elective). The TD will be broken down according to the student's career and the TP according to the chosen mention.
- Communication Systems (33h): This course covers communications techniques, network architectures and processing architecture. It provides the basis for basic processing of a digital communication chain, access methods and data routing for different types of networks and applications. It addresses issues of quality of service, capacity, energy, reliability, security and resilience. It introduces new paradigms (virtualization, massive densification, intelligence, autonomy, etc.).
- Embedded Systems (18h): Communicating objects require a high computing power that can be embedded or distributed in a network. This course addresses major related issues such as processing distribution, embedded OS, cyber security of components and systems while taking into account methodologies for reducing energy consumption. Part of this teaching takes the form of a project to put into practice the various architectural design strategies on "Low Power System-on-Chip" platforms.
- Radio Transmitters and Receivers Architecture (15h): This course addresses the issues of radio transmission (spectrum management, noise and interference, energy and power balance, range of links). It gives a view of the architectures and processing chains of the transmitters/receivers (amplification, frequency transposition, modulation/demodulation, ...). It gives the modelling and analysis tools to design these treatments (microwave circuits) and manage the performance compromises (linearity, efficiency, energy efficiency).
- Project (24h) : A project integrating connected objects for applications such as the factory of the future, transport or health will allow students to work on the design of a communicating object, then to the realization of a functional and operational demonstrator of an object connected to a network at the service of an application. This demonstrator will integrate electronics, communication, and data processing.

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CSIoT Major Second sequence – CT10

Second sequence (Nov – Jan)

This sequence focuses on the fundamentals for the realization of autonomous communication systems: design of analog, digital, HF electronic functions on the one hand and transmission and propagation of waves on the other hand

Qualification Introductory Seminars (12h H) – Economy / Business visit

Industrial Project (60h) or Research Project

Electronic functions (48h) - from physics to integration, from specifications to synthesis

RF functions (48h) - guidance, processing and transmission

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Second sequence syllabus (108h + 60h project)

- **Teaching modules:**
  - Introductory seminars of the specialty (12h): Introduction of the content of the specialty, illustrating it on one or more cases proposed by industrial partners (AIRBUS, THALES, XFAB), with particular emphasis on the economics of electronic systems and the semiconductor market.

  - Electronic Functions (48 h):

Analogue electronics : Knowledge of basic principles of electronic circuit manufacturing and design. Physics and models of MOS transistors. Design of analog electronic circuits and analysis of performance.
Digital electronics : Methods of designing digital systems in HDL language, Mastery of the design flow: description, simulation, logical synthesis. Power analysis and low power design.

  - Communication and remote sensing functions (48 h):

Radio frequency systems,
transmission, radiation and diffraction
guided propagation,
MMIC,
integrated antennas and filters

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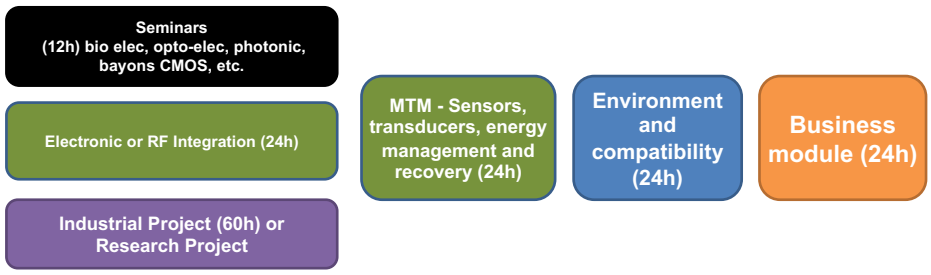
CSIoT Major Third sequence – CT11

Third sequence (Feb – April)

This sequence focuses on technological solutions for the integration of electronic functions, energy management, consideration of the environment (EM disturbance and sensitivity to disturbances), new issues and concepts of the future.



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Third sequence syllabus (108h + 60h project)

- Seminars (12h): Seminars given by external, industrial or academic speakers (ST, CEA-LETI, C2N, etc.) will provide a portrait of the state of the art and perspectives of modern electronics (More Moore, More-than-Moore and Beyond CMOS) from a technical, integrative (new design predicates) and economic point of view.
- Integration (24h): The objective of this course is to provide students with methods for producing mixed low-frequency integrated circuits or monolithic microwave integrated circuits (MMIC). After a general course on integration techniques, students will work on an integrated circuit project by specializing in one of the two technologies (BF or HF Mixed).
- More than Moore (24h): Functional diversification of micro-electronic systems now allows them to interact with their environment using multi-physical devices (imagers, sensors or MEMS actuators, neural interfaces, energy pickers, etc.). The integration of these transducers within systems raises many practical and theoretical challenges (co-integration, co-simulation) to meet application and economic constraints. This course allows, through a bottom-up approach, the understanding of these challenges and issues, as well as the mastery of the tools to meet them.
- Communicating Systems Compatibility (24h): Mobile and Standalone Communicating Systems, like all electronic systems, will need to meet the requirements arising from electromagnetic compatibility issues. The communicating aspect of these systems also requires compliance with radio compatibility requirements. This course, through iconic examples of communicating systems, will clarify the challenges and challenges associated with these compatibility issues.
- Business Module (24h): one of the following 2 courses:
  - **Embedded Space Systems**: At the end of this module, students will have a global knowledge of space systems to intervene in the design of an on-board system operating in a hostile environment. (mechanical, thermal, radiative and electromagnetic stresses). Emphasis will also be placed on the variety of on-board activities and related occupations, from silicon to the complete system, software, validation and telecoms.
  - **Navigation Systems:** This course aims to give an overview of navigation systems in a wide range of applications: introduction to inertial navigation, radio navigation and hybridization techniques of various means of navigation. It presents the basic technical knowledge to understand the main problems raised by the design and implementation of navigation systems, and the solutions adopted to solve them.

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