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ORLÉANS
Ecole d'ingénieurs de l'université d'Orléans

COURSE SYLLABUS

Polytech Orléans
Course Syllabus

Polytech Orléans
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FRANCE

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FRANCE

Content

Proportion of teaching taught in English

- 🏳 : materials provided in English, course taught in French
- 🏳🏳 : 50% in English
- 🏳🏳🏳 : fully taught in English

Sustainable Development and Social Responsibility (SDRS)

- 🌍 : mentioned
- 🌍🌍 : issues visible in Teaching Unit (TU) competences
- 🌍🌍🌍 : taking into account standards and regulations in the Teaching Unit (TU)

Support for innovation, business creation and takeover

- 🖉 : mentioned
- 🖉🖉 : issues visible in Teaching Unit (TU) competences
- 🖉🖉🖉 : mastery of standards and regulations in the Teaching Unit (TU)

Automotive Engineering for Sustainable Mobility (AESM)

TU Code	Title of the Teaching Unit (TU)	Learning hours	ECTS
	AUTOMOTIVE ENGINEERING for SUSTAINABLE MOBILITY (AESM)	**664**	***60***
	1st year AESM - Semester 1	**347**	***30***
1AE01	Trends in Automotive Transportation and Sustainable Mobility	**10**	***1***
1AE02	Scientific pre-requisite	**50**	***5***
1AE03	Electrical engineering	**50**	***5***
1AE04	IT: programming	**50**	***5***
1AE05	Advanced physics	**50**	***5***
1AE06	French culture and language	**70**	***4***
	One Teaching Unit of your choice according to option ECM or VDIV		
1AE07	Vehicle Dynamics 1	**65**	***5***
1AE08	Internal combustion engines	**65**	***5***
	1st year AESM - Semester 2	**317**	***30***
2AE01	Acquisition systems and signal processing	**50**	***5***
2AE02	Real Time Programming	**50**	***5***
2AE03	Control and simulation of powertrains	**35**	***5***
2AE04	Project	**130**	***10***
	One Teaching Unit of your choice according to option ECM or VDIV		
2AE05	Control and on-board diagnostics applied to internal combustion engines	**50**	***5***
2AE06	Control and on-board diagnostics applied to vehicle dynamics	**50**	***5***

Automotive Engineering and Sustainable Mobility (AESM) **1AE01** **Semester 1**

Trends in Automotive Transportation and sustainable Mobility

Supervisor: Luis LE MOYNE **ECTS: 1**

Skills

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

- Understand transport geo-politics.
- Understand the inventory of resources.
- Recognize operational actors in the transport sector.

Syllabus

- Sustainable mobility.
- Environmental incentives.
- Well-to-wheels CO2 analysis.
- Areas for technology improvements.

Grading

Written exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
10h00	0h00	0h00	1h15	0h00

In person teaching: 10h00

Taught in English: 🏳🏳🏳 **SD/SR:** 🌍🌍🌍 **Innovation:** 🖉🖉🖉

Automotive Engineering and Sustainable Mobility (AESM) **1AE02** **Semester 1**

Scientific pre-requisite

Supervisor: Meryem JABLOUN **ECTS: 5**

Skills

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

- Acquire skills and an understanding of mathematical tools necessary for studying and exploring characteristics of linear systems.

Syllabus

Fourier series decomposition

Perform Fourier Series decomposition on continuous-time periodic signals and understand Gibbs phenomenon

Linear differential equations

Solve linear differential equations: 1st and 2nd order cases: illustration and application to physical systems

Grading

Written exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
28h45	21h15	0h00	1h15	0h00

In person teaching: 50h00

Taught in English:⚐⚐⚐ **SD/SR:** **Innovation:**

Automotive Engineering and Sustainable Mobility (AESM) **1AE03** **Semester 1**

Electrical engineering

Supervisor: Emmanuel BEURUAY **ECTS: 5**

Skills

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

- Understand electrical and magnetism principles occurring in electrical motors divided in two parts: electrical motors and the dedicated converters.
- Understand the inner working of continuous and synchronous motors.
- Quantify the electrical efficiencies using active power, reactive power, apparent power, distortion power and power factor.

Syllabus

- Power: quantifying yields and efficiencies.
- Active, reactive, apparent, distortion power, power factor.
- Three phased system grid.
- Harmonic aspects in power and electromagnetic pollution.
- Magnetism applied to electrical motors. Loss reduction in permanent magnet rotors of synchronous machines.
- Continuous motors and AC/DC, DC/DC converters integrated power electronics. Step down and the step up chopper structures.
- Synchronous motors in servo synchronous machines with Pulse Width Modulator frequency converter.
- Four practical sessions illustrate three kinds of motors and transformer needed in industrial processes.

Grading

Written exam, Oral exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
13h45	10h00	26h15	0h00	0h00

In person teaching: 50h00

Taught in English: ⚐⚐⚐ **SD/SR:** 🌍🌍🌍 **Innovation:** ✎✎

Automotive Engineering and Sustainable Mobility (AESM) **1AE04** **Semester 1**

IT: programming

Supervisor: Rachid JENNANE **ECTS: 5**

Skills

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

- Analyze a problem
- Propose an algorithm
- Develop an architecture for a problem
- Use a development environment and a C/C++ compiler

Syllabus

Basics

- Structure of a program in C language
- Basic elements (character, type, constants, variables, blocs, etc.)
- Instructions and Operators
- Conditional structures, iterative structures and connections, etc.
- Pointers and dynamic variables
- Arrays
- Strings
- Functions, passing parameters: by value, by reference and by address

Object oriented programming

- Structure of a program in C++ language
- Classes
- Member variables and member functions
- Specialized constructors
- Overloaded functions and operators
- Data stream
- Abstract class
- Generic classes

Grading

Written exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
16h15	0h00	33h45	0h00	0h00

In person teaching: 50h00

Taught in English: **SD/SR:** **Innovation:**

Automotive Engineering and Sustainable Mobility (AESM) **1AE05** **Semester 1**

Advanced physics

Supervisor: Azeddine KOURTA **ECTS: 5**

Skills

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

- Understand the inner working of power electronics
- Understand basic automotive aerodynamics
- Solve 1st and 2nd principle based thermodynamic problems

Syllabus

Power electronics

- Semi-conductor physics
- Power MOS
- IGBT

Automotive aerodynamics

- Basics of aerodynamics
- Specificities of automotive aerodynamics
- Wind tunnel experiments

Thermodynamics

- 1st and 2nd principle of thermodynamics
- Ideal gases
- Basic engine cycles

Grading

Written exam, Report

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
32h30	13h45	3h45	0h00	0h00

In person teaching: 50h00

Taught in English: 🏳🏳🏳 **SD/SR:** 🌍🌍 **Innovation:** ✎

Automotive Engineering and Sustainable Mobility (AESM)	**1AE06**	**Semester 1**

French culture and language

Supervisor: Geanina BOUTONNE **ECTS: 4**

Skills

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

- Understand spoken french and speak basic sentences.
- Read and write basic french.
- Hold a basic conversation.

Syllabus

- French language sounds
- French grammar
- French conjugation
- Interactive discussions in French

Grading

Written exam, Oral exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
0h00	70h00	0h00	0h00	0h00

In person teaching: 70h00

Taught in English: **SD/SR:** **Innovation:**

Automotive Engineering and Sustainable Mobility (AESM) **1AE07** **Semester 1**

Vehicle Dynamics 1

Supervisor: Pascal HIGELIN **ECTS: 5**

Skills

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

- Understand vocabulary, technology and general issues and goals of vehicle dynamics applied to passenger cars.
- Choose and model a tire. Design or choose front and rear axles technologies according to an expected behavior. Design suspension systems and anti roll bars.
- Model the behavior of a car using several numerical models, and compare them to real world test measurements.
- Conduct experimental measurements on a real axle or a complete vehicle to obtain the variation of the geometrical characteristics length and angles for roll, pumping and pitching.

Syllabus

- Generalities: SAE Coordinate System. Definition of specific vocabulary. Motion variables. Basic geometry of an Axle (toe, caster, camber, kingpin etc.) and its effect on drivability.
- Tire: Constitution and behavior. Vertical, longitudinal and lateral modelling. Auto- align torque. Pacejka Model and introduction to TM Easy Model.
- Axle: Kinematics modelling of various axle using the theory of the mechanism. Suspension steer and roll properties. Analysis of the design effects on the change of characteristic angles and length (toe, camber etc.) as a function of pumping and rolling. Roll Center of an axle.
- Vertical behavior and suspension design. Spring and shock absorber design for sprung mass, un-sprung mass control in the case of pitching and pumping behavior.
- Transversal Behavior: Ackermann Geometry. Jeantaud's steering system. Bicycle Model. Over steer coefficient, characteristic speed, yaw speed gain. Roll Stiffness of an axle. Roll Flexibility. Lateral Load Transfer. Anti-roll bar design.
- Numerical simulations and comparison to real test results using several models (Simulink, Thesis).
- Practical work 1: Experimental measurements and modeling of the kinematics roll effects on camber and steering angle for the H-Frame axle.
- Practical Work 2: Experimental measurement of suspension steer, roll effect and pitch effect on the geometrical characteristic angles, for a complete car, in case of pure pumping.

Grading

Written exam, Oral exam, Report

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
35h00	22h30	7h30	0h00	0h00

In person teaching: 65h00

Taught in English:⚐⚐⚐ **SD/SR:** 🌍 **Innovation:** ✎✎

Automotive Engineering and Sustainable Mobility (AESM) **1AE08** **Semester 1**

Internal combustion engines

Supervisor: Pascal HIGELIN **ECTS: 5**

Skills

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

- Understand the physical and chemical processes occurring during combustion and scavenging in internal combustion engines. Understand the behavior of an engine when changing its settings using modeling.
- Be able to build an internal combustion engine model. Be able to optimize the size and settings of an engine performance under efficiency, power, emission constraints using modeling.

Syllabus

- Combustion: Thermochemistry and Kinetics applied to combustion. The self-ignition. Premixed flames, flammability limits, flame stability, turbulent combustion. Diffusion flames, biphasic combustion. Internal aerodynamics of an engine. Mixture preparation, requirements of spark ignition and self-ignition, initiation and propagation of combustion (definition of core burning speeds), formation of pollutants. Identification of engine manufacturers needs in terms of fundamentals.
- Thermodynamic models: Classification of thermodynamic models: air cycle models, one and two zone models, multizone models. Combustion chamber walls losses models. Limits of validity.
- Combustion models: semi-empirical combustion models, application to spark ignition engines. Extension to compression ignition engines. Combustion models for spark ignition engines. Combustion models for compression-ignition engines (spray patterns, combustion models in the premix and diffusion phase).
- Scavenging models: filling/emptying models and acoustic 1D intake/exhaust. Boundary conditions: open tubing, closed, partially open junctions. Consideration of thermal losses and friction to the walls. Filling efficiency curves reconstruction.
- Specific Tool: Matlab/Simulink, GTpower, CHEMKIN.

Grading

Written exam, Oral exam, Report

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
16h15	41h15	7h30	0h00	0h00

In person teaching: 65h00

Taught in English: ⚐⚐⚐ **SD/SR:** 🌍🌍🌍 **Innovation:** ✎✎

Automotive Engineering and Sustainable Mobility (AESM) **2AE01** **Semester 2**

Acquisition systems and signal processing

Supervisor: Philippe RAVIER **ECTS: 5**

Skills

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

- Mastering Analog to Digital conversion for digital systems
- Mastering the Fourier Transform for spectral analysis of the data
- Selecting and implementing an FIR or IIR filter on a dedicated hardware or software architecture

Syllabus

Signal processing basics

- Analog and digital representation, Shannon theorem
- Time and frequency representation
- Fourier transform
- Noise processing

Digital filtering

- Z transform for digital signals
- Transverse filters
- Recursive filters

Grading

Written exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
20h00	20h00	10h00	0h00	0h00

In person teaching: 50h00

Taught in English:⚐⚐⚐ **SD/SR:** **Innovation:**

Automotive Engineering and Sustainable Mobility (AESM) **2AE02** **Semester 2**

Real Time Programming

Supervisor: Raphaël CANALS **ECTS: 5**

Skills

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

- Mastering techniques for the implementation of digital systems
- Understanding and implementing hardware and software for real-time systems
- Controlling the CAN and FlexRay communication buses

Syllabus

Digital systems

- Number coding and algebra.
- Analog-to-digital and digital-to-analog conversions.

Electronic components

Microcontrollers: applications in automobile.
Microcontrollers: structure and implementation.
Architecture of a microcontroller board.

Role and place of an OS on a processor board.
Architecture of an OS.
Calls to OS functions.

Automotive communication buses

CAN and FlexRay buses architecture.
Communication protocols.

Grading

Written exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
17h30	10h00	15h00	3h45	7h30

In person teaching: 50h00

Taught in English:⚐⚐⚐ **SD/SR:** **Innovation:**

Automotive Engineering and Sustainable Mobility (AESM) **2AE03** **Semester 2**

Control & Simulation of Powertrains

Supervisor: Alain CHARLET **ECTS: 5**

Skills

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

- Understanding why and how hybridization works
- Understanding where energy is lost in a car vs driving conditions
- Being able to build a simple model of a car and its control

Syllabus

Part 1: Control of powertrains

Anti-lock Bracking System (ABS) & Cruise control. This study is performed in simulation with the software Matlab/Simulink.

Part 2: Simulation of powertrains

An overview of electric hybrid powertrains is proposed.
Then, students work on a simulation platform (Simcenter AMESim by Siemens) where they have to build an energy balance of a conventional vehicle.
This study is completed by two practical classes on a rolling test bed where students measure energetic performances of a conventional car vs hybrid car (Toyota Yaris)

Grading

Written exam, Oral exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
5h00	22h30	7h30	0h00	0h00

In person teaching: 35h00

Taught in English: ⚐⚐⚐ **SD/SR:** 🌍🌍 **Innovation:** ✎✎

Automotive Engineering and Sustainable Mobility (AESM) **2AE04** **Semester 2**

Project

Supervisor: Pascal HIGELIN **ECTS: 10**

Skills

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

- Split a complex task into subtasks. Plan and schedule tasks.
- Work as a group. Assign tasks to members of the group taking dependencies into account
- Select the more adequate modeling level and simulation tool
- Present work performed in a concise way focusing on the most important aspects
- Build working powertrain and vehicle dynamics models based on experimental data

Syllabus

- Reformulation of project subject
- Split subject objectives into tasks and sub-tasks
- Schedule tasks and assign them to project members
- Report work performed, current state and upcoming tasks every 2 weeks

Grading

Thesis, Oral exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
0h00	0h00	0h00	3h00	130h00

In person teaching: 130h00

Taught in English:⚐⚐⚐ **SD/SR:** **Innovation:**

Automotive Engineering and Sustainable Mobility (AESM) **2AE05** **Semester 2**

Control and on-board diagnosis applied to ICE

Supervisor: Guillaume COLIN **ECTS: 5**

Skills

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

- Find the good set of parameters for a PID controller on simple systems
- Tune an internal combustion engine control
- Control some simple actuators
- Define, parameterize and implement a simple observer-based diagnosis tool

Syllabus

State of the art of engine control: sensors, actuators

- Gasoline engines
- Diesel engines

Automatic control

- Linear Models (1st order, 2nd order)
- Conventional Linear Control (PID)

Applications to powertrain control: labs

- Experimental engine test benches: tuning and control
- Hardware in the Loop (HIL) & Rapid prototyping for Control: Application on valves

On Board Diagnosis

- Rule based diagnosis
- Observer based diagnosis with numerical simulations on Matlab/Simulink

Grading

Written exam, Oral exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
23h45	10h00	16h15	0h00	0h00

In person teaching: 50h00

Taught in English: 🏳🏳🏳 **SD/SR:** 🌍🌍 **Innovation:** 🖉🖉

Automotive Engineering and Sustainable Mobility (AESM) **2AE06** **Semester 2**

Control and on-board diagnosis applied to vehicle dynamics

Supervisor: Guillaume COLIN **ECTS: 5**

Skills

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

- Find the good set of parameters for a PID controller on simple systems
- Tune a vehicle dynamics control
- Control some simple actuators
- Define, parameterize and implement a simple observer-based diagnosis tool

Syllabus

State of the art

Hardware (sensors, actuators...)
Software

Automatic control

- Linear Models (1st order, 2nd order)
- Conventional Linear Control (PID)

Applications to vehicle dynamics: labs

- Tuning a vehicle dynamics controller
- Hardware in the Loop (HIL) & Rapid prototyping for Control: Application on valves

On Board Diagnosis

- Rule based diagnosis
- Observer based diagnosis with numerical simulations on Matlab/Simulink

Grading

Written exam, Oral exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
31h15	8h45	10h00	0h00	0h00

In person teaching: 50h00

Taught in English:⚐⚐⚐ **SD/SR:** 🌍🌍 **Innovation:** ✎✎

Internet of Things (IoT)

TU Code	Title of the Teaching Unit (TU)	Learning hours	ECTS
Master of Science INTERNET of THINGS (IoT)		**682.0**	***90***
		682.0	***90***
Prerequisites (2 TU among 4)			
IoT01	Mathematics	**40**	***4***
IoT02	IT programming	**40**	***4***
IoT03	Analog and digital electronics	**40**	***4***
IoT04	Web and networks	**40**	***4***
Economy, management and uses			
IoT05	IoT ecosystem	**30**	***4***
Embedded system engineer			
IoT06	Architectures and technologies	**20**	***2***
IoT07	Data transmission	**20**	***2***
IoT08	Design for IoT	**20**	***2***
Full-stack engineer			
IoT09	Servers and frameworks	**20**	***2***
IoT10	Smartphones and tablets	**20**	***2***
IoT11	Cybersecurity	**20**	***2***
Data scientist			
IoT12	Data mining	**20**	***2***
Economy, management and uses			
IoT13	IoT demonstrator	**70**	***6***
Expert approach (1 TU amongst 3)			
IoT14	Embedded systems	**80**	***10***
IoT15	Full-stack integration	**80**	***10***
IoT16	Data Sciences	**80**	***10***
Synthesis project			
IoT17	Final team project	**280**	***18***

Internet of Things **IoT01** **Semester 9**

Mathematics

Supervisor: Carine LUCAS **ECTS: 4**

Skills

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

- Master the different types of signals and their representations
- Master basic transformations and processing of digital signals
- Design filters
- Understand a digital communication chain
- Generate, analyze, process, detect digital signals with Matlabsignal

Syllabus

- Elementary descriptive statistics: bar charts, histograms, quantiles, box plots, conditional diagrams, contingency diagrams.
- Optimization: gradient descent, application to linear regression, projected gradient descent.
- Modeling: Bayes model, variational formulation. Application to reconstruction and regulation.
- Fourier analysis: notes on Hilbert space, complex exponentials, discrete Fourier transform, discrete Fourier series, properties, amplitude and phase spectrum, timefrequency analysis and spectrogram, fast Fourier transform.
- Filtering: time-invariant linear systems, convolution operator, impulse response, frequency response, ideal filters.
- Random signals: random vectors and processes, spectral representation, power spectral density, white noise, ARMA processes.
- The courses will be accompanied by computer works during which we will use the softwares R, Python, Matlab

Grading

Written exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
20h00	0h00	20h00	0h00	0h00

In person teaching: 40h00

Taught in English: ⚐⚐⚐ **SD/SR:** **Innovation:**

Internet of Things **IoT02** **Semester 9**

IT programming

Supervisor: Rachid JENNANE **ECTS: 4**

Skills

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

- Analyze a problem
- Develop programs in the Python language
- Propose an application under the C language

Syllabus

Python

- Basic types and operations
- Control structures
- Functions
- Files
- Classes, inheritance
- Modules

C Language

- Types, variables, control instructions
- Functions, parameter passing
- Dynamic variables
- Single and multi-dimensional automatic/dynamic arrays
- Strings of characters
- Structures
- Stream

Grading

Written exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
10h00	0h00	30h00	0h00	0h00

In person teaching: 40h00

Taught in English:⚐⚐⚐ **SD/SR:** **Innovation:**

Internet of Things **IoT03** **Semester 9**

Analog and digital electronics

Supervisor: Rodolphe WEBER **ECTS: 4**

Skills

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

- Understand the operation of a simple electronic circuit based on passive components
- Analyze a single electrical circuit in DC, AC or transient mode
- Understand the notions of combinatorial and sequential logic in digital electronics
- Build a simple system based on a microcontroller

Syllabus

Analog electronics

- Instrumentation
- Metrology
- Impedance adaptation
- Continuous and transient linear circuits
- Kirchoff's Laws. Theorem of Thevenin, of Norton...
  Operational amplifier, diode, bipolar transistor

Digital electronics

- Combinatorial logic
- Sequential logic

Signal shaping before processing

- Filtering
- Amplification / leveling

Practicum

- Applications

Grading

Written exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
12h30	8h45	18h45	3h45	0h00

In person teaching: 40h00

Taught in English:⚐⚐⚐ **SD/SR:** **Innovation:**

Internet of Things **Iot04** **Semester 9**

Web and networks

Supervisor: Raphaël CANALS **ECTS: 4**

Skills

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

- Understand the basics of Ethernet and TCP/IP networks and the different physical media (fibre, Wifi, Ethernet, PLC, etc.) involved
- Know how to set up and parameterize a network and routes, perform elementary calculations (classes, ranges in IPv4 and IPv6)
- Observe and interpret frames circulating on a network

Syllabus

Networks

- Network fundamentals: OSI layered model, Ethernet and TCP/IP, physical media
  ARP, routes, IPv4, IPv6, DNS
- TCP/UDP, DHCP: TCP reliability (3 Way Hand-Shake, etc.), congestion management
- Headers, Checksums, state diagram, netsat
- UDP: differences and uses
- DHCP - NAT and PAT

Web

- Setup of a static site with HTML5 and CSS
- Dynamic programming with a Python microframework: Flask
- Project structure, templates
- Use of databases
- API Consumption – JavaScript

Grading

Written exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
10h00	17h30	12h30	0h00	0h00

In person teaching: 40h00

Taught in English:⚐⚐⚐ **SD/SR:** **Innovation:**

Internet of Things **IoT05** **Semester 9**

IoT ecosystem

Supervisor: Raphaël CANALS **ECTS: 4**

Skills

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

- Have a global and transversal vision of the social economic aspects related to the development and deployment of an IoT solution
- Understand the design and development of an IoT solution with an iterative approach and a user service-oriented approach

Syllabus

Markets, economic issues and business intelligence

- IoT value chain (actors, positions and issues)
- Objects, data, services and value creation (challenges, barriers, business models)
- Fields of application, market developments and expectations related to mobility

Standards, regulations, industrial property

- Norms and standards: foundations, procedures and organizations
- Intellectual property, industrial property and strategies (secrets vs. patents)
- Social and legal aspects, personal data and digital identities

Design of services, of objects and industrialization

- Functional analysis, life cycle and solution development
- Service design (utility, employability, usability and users paths experiences)
- Scale-up, industrialization, deployment of IoT solutions, supply chains and costs

Management of digital projects, innovative entrepreneurship

- Agile methods for management and business administration
- Innovative entrepreneurship and Lean Startup approach)
- Business plans and fundings of innovative projects

Grading

Written exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
16h15	7h30	6h15	0h00	0h00

In person teaching: 30h00

Taught in English:⚐⚐⚐ **SD/SR:** **Innovation:**

Internet of Things **IoT06** **Semester 9**

Architectures and technologies

Supervisor: Raphaël CANALS **ECTS: 2**

Skills

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

- Understand how a processor architecture works
- Choose a hardware architecture
- Understand the advantages of integration: consumption, dimensions, reliability, ...
- Realize the acquisition of a sensor data
- Manage asynchronous events
  Implement a serial communication

Syllabus

Processor system architectures

- Different processor families
- Architecture of a processor board
- Program memory, data memory and input/output devices

Microcontroller architectures

- ARM processor architecture: RISC architecture, operation, pipeline, operating modes
- Interruption: role, asynchronism, management, multitasking, ...
- Timers, meters and PWM
- Development tools and environments
- Understanding of the high-level language to machine code compilation chain

Communicating systems

- Different types of serial link, implementation

Grading

Written exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
7h30	0h00	12h30	0h00	0h00

In person teaching: 20h00

Taught in English:⚐⚐⚐ **SD/SR:** **Innovation:**

Internet of Things **IoT07** **Semester 9**

Data transmission

Supervisor: Rodolphe WEBER **ECTS: 2**

Skills

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

- Choose a wired or radio transmission protocol depending on the constraints (data rate, latency, power consumption, transmission range, bit error rate, regulations and standards, EMC...)
- Understand the architecture of a digital radio transmission system
- Understand the basics of antenna design and antenna impedance adaptation
- Assess a link budget
- Know the certification procedure for IoT systems

Syllabus

Introduction to digital communication

- The overall architecture and associated parameters (source, channel, bandwidth, data rate, signal to noise ratio, bit error rate) ; Linear and non-linear digital modulations and associated parameters (inter symbol interferences, spectral efficiency, pulse shaping, bit error rate, Eb/No) ; Software defined radio (SDR) architecture and et associated tools (eye diagram, constellation, carrier and symbol synchronization) ; Demultiplexing techniques OFDM, FDMA, TDMA, CDMA ;
- Implementation on a SDR GnuRadio demonstration board

RF considerations

- Antenna characteristics (gain, directivity, VSWR, …) ; Antenna design and antenna adaptation issues ; The certification procedure for IoT systems ; Measurement tools for antenna and EMC studies, Link budget

Standard radio communication protocol

- Short range (WPAN, WLAN): BT, BLE, Wi-Fi, ZigBee, Thread, Z-Wave, RFID, NFC, EnOCEAN, Ant+ ; Long range (WNAN, WWAN, LPWAN): ZigBee-NAN, WirelessHART, Wi-SUN, 4G/5G, LTE-M, Sigfox, Lora, 6LoWPan, NB-IoT, Telensa … ; Standardization, industrial alliances

Grading

Written exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
15h00	2h30	2h30	10h00	0h00

In person teaching: 20h00

Taught in English: **SD/SR:** **Innovation:**

Internet of Things **IoT08** **Semester 9**

Design for IoT

Supervisor: Caroline Zahnd **ECTS: 2**

Skills

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

- Understand the processes for designing connected and interactive objects (methodology, tools, specificities)
- Address the issue interfaces (HMI, UI design, physical interfaces in connected objects, ...)
- Understand the concepts of Interaction design and user experience (UX design)
- Master the bases of a design culture (nature of the business approach, historical perspectives, then more specifically culture and history of the design of technological objects, then of connected objects, references to be known, designers and flagship projects

Syllabus

Introduction to design

- Design of connected and interactive objects (methodology, tools, specificities)
- Interface design (HMI, physical interfaces in connected objects...)
- Interaction design and user experience (UX design, conceiving the nature of interaction as an object of the design process)

Design in practice

- Analysis of the context of use and needs
- Research and contribution of design references and monitoring of the existing and research of visual inspirations
- Usage scenario, user experience reflection (UX)
- Object design concept
- Interaction design concept (GUI, user experience)
- Form, materials and plastic qualities
- Implementation and prototyping

Grading

Written exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
20h00	0h00	0h00	47h30	0h00

In person teaching: 20h00

Taught in English:⚐⚐⚐ **SD/SR:** **Innovation:**

Internet of Things **IoT09** **Semester 9**

Servers and frameworks

Supervisor: Matthieu EXBRAYAT **ECTS: 2**

Skills

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

- Design and implement a REST web service to collect and transmit data in connection with an existing relational or NOSQL database
- Propose a client/server architecture with possibly several services to answer a problem
- Test and secure this API
- Implement a Python framework to develop this type of service

Syllabus

- http protocols - REST architectures
- Client/Server
- Address an API design framework
- Introduction to REST Web Services – Design, request and authentication
- API testing tools
- Notions about microservices

Grading

Written exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
20h00	0h00	0h00	20h00	0h00

In person teaching: 20h00

Taught in English: 🏳🏳🏳 **SD/SR:** **Innovation:** 🖉🖉

Internet of Things **IoT10** **Semester 9**

Smartphones and tablets

Supervisor: Aladine CHETOUANI **ECTS: 2**

Skills

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

- Develop applications on Android and iOS
- Manage the packaging of activities
- Communicate between activities and transmit data
- Use the different existing data sensors (accelerometer, gyroscope, camera, audio, GPS, ...)
- Use communication channels (bluetooth, Wifi)
- Transmit data between smartphones

Syllabus

Java & Swift

- Introduction to JAVA (Android) and SWIFT (iOS) programming ; Program Development

Android

- Interface management (design and XML) ; Basic "Hello Word" application; Multi-activity application ; Control management ; Transfer of information ; Use of sensors ; Communication

iOS

- Interface management (design) ; Basic "Hello Word" application ; Multi-window application ; Control management ; Transfer of information ; Use of sensors ; Communication

Complements

- Cross-platform ; PWA (Progressive Web Apps): nomadic continuous access to information without reliable connection

Grading

Written exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
5h00	0h00	15h00	0h00	0h00

In person teaching: 20h00

Taught in English:⚐⚐⚐ **SD/SR:** **Innovation:**

Internet of Things **IoT11** **Semester 9**

Cybersecurity

Supervisor: Laurent MOULIN **ECTS: 2**

Skills

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

- Understanding the fundamentals of cyber security

Syllabus

- The basics of cyber security
- Implementing secure chat
- Creating ransomware
- Participating in a capture flag

Grading

Written exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
20h00	0h00	0h00	7h30	0h00

In person teaching: 20h00

Taught in English: ⚐⚐⚐ **SD/SR:** 🌍 **Innovation:** ✎✎

Internet of Things **IoT12** **Semester 9**

Data mining

Supervisor: Frédéric ROS **ECTS: 2**

Skills

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

- Use statistical data analysis tools such as linear or logistic regression, PCA and factor analysis
- Use data visualization or representation tools in MATLAB or R languages
- Use tools for pre-processing data and extracting characteristic attributes from the data
- Understand the principes and use basic classification methods such as SVM and neural networks

Syllabus

Analysis tools

- Linear and logistic regression
- Principal Component Analysis (PCA)
- Factor analyses

Time series

Data mining and visualization

- R language (introduction) and descriptive graphs
- Practicum in multimedia data analysis (images and audio) using R and/or Python

Data pre-processing and attribute extraction

- Some data denoising techniques
- Characteristic attributes: audio and image examples
- Attribute selection

Classification methods

- SVM Method
- Classification by neural networks
- Introduction to Deep Learning

Grading

Written exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
11h15	3h45	5h00	0h00	0h00

In person teaching: 20h00

Taught in English:⚐⚐⚐ **SD/SR:** **Innovation:**

Internet of Things **IoT13** **Semester 9**

IoT demonstrator

Supervisor: Rodolphe WEBER **ECTS: 5**

Skills

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

- Better understand and assimilate the entire chain, from the sensor to the Data Sciences
- Realize a functional IoT demonstrator, from end to end of the chain

Syllabus

- Thanks to the System Approach formation, each participant realizes in team an industrial project which consists in:
  - Realizing, testing, developing or optimizing a communicating system around a server base on which a management of data stored in a base is carried out
  - Proposing objectives and a work plan for possible successors.
- During this project, the student benefits from the supervision of a scientific leader or supervisor, whom he or she must meet at least once a week to report on the work carried out and the actions to be implemented. At the end of the project, an oral presentation of the work is organised followed by a demonstration and a written report must be given to the supervisor.

Grading

Oral exam, Report

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
17h30	3h45	18h45	56h15	30h00

In person teaching: 70h00

Taught in English: 🏳🏳🏳 **SD/SR:** **Innovation:** 🖉

Internet of Things **IoT15** **Semester 9**

Full-stack integration

Supervisor: Raphaël CANALS **ECTS: 8**

Skills

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

Knowledge and understanding of:

- Technologies involved in end-to-end IoT solutions. Protocols for local & global connectivity
- The architecture and concept of different cloud models: IaaS, PaaS, SaaS, cloud virtualization, cloud storage, data management
- The decisive factors for the user interaction in the context of the Internet of Things (IoT)

Practical skills:

- The student can design the architecture and technologies needed to implement IoT devices
- Design usable functional prototypes of interactive system
- Create application by utilizing cloud platforms

Syllabus

- **Device hardware:** IoT objects (sensors, actuators, smartphones, gateways)
- **Device software**: Embedded / firmware programming, edge operating systems and applications
- **Communications**: Models, data exchange formats, protocols (MQTT, CoAP, HTTP REST, ...)
- **Cloud Platform & Middleware Programming:** Delivery models – IaaS, PaaS, SaaS, cloud platform ; micro-services using Docker
- **Security and regulations:**
  - IoT security standard: identity, authentication, authorization, confidentiality, integrity, availability, lifecycle management (OTA upgrades)
  - GDPR, ePrivacy regulation, privacy by design. Practical cryptography for the Internet of Things
- **Scalability and Management:** (devices, applications, network): IoT interoperability and scalability.
- **Integration with IT & other systems:** Open data management & API. Aggregations.
- **Laboratory and project:** Case studies: Smart homes/buildings, smart cities, smart industry, smart medical care. Human activity recognition. Air quality analysis, industrial internet (IoT)

Grading

Written exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
20h00	30h00	30h00	21h15	0h00

In person teaching: 80h00

Taught in English:⚐⚐⚐ **SD/SR:** 🌍 **Innovation:**

Internet of Things **IoT16** **Semester 9**

Data Sciences

Supervisor: Bruno GALERNE **ECTS: 8**

Skills

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

- Choose and implement methods adapted to the types of data involved
- Anticipate high-performance and/or distributed computing needs

Syllabus

Classical multivariate analyses: PCA, CFA, ACM

Learning and classification methods

- Classical unsupervised methods (kmeans, CAH) towards model-based classification (= multidim Gaussian/nonparametric and EM mixing) ; Supervised methods: logistic regression, CART, random forest (boosting and bagging), discriminant analysis ; Clustering of symbolic data and search for frequent patterns

Image processing

- Analysis, Segmentation, Denoising, Classification, Local descriptors and texture analysis, Variational methods, convex optimization and neural networks

Big data

- Initiation to the Hadoop/MapReduce paradigm, scaling up statistical tools for distributed data, Rhadoop tool,
- noSQL, Hadoop/MapReduce, HIVE, Hbase, heterogeneous data

HPC

- Parallel calculation with R ; GPGPU (CUDA) ; Open MP, MPI, ...

New technologies under R

- Reproducible and interactive documents: RMarkdown, Shiny, Rdashboard

Grading

Written exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
40h00	0h00	40h00	0h00	0h00

In person teaching: 80h00

Taught in English:⚐⚐⚐ **SD/SR:** **Innovation:**

Internet of Things **IoT17** **Semester 9**

Final team project

Supervisor: Raphaël CANALS **ECTS: 17**

Skills

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

- Design, test a system or develop a process following a quality approach in accordance with industrial standards, favouring both methodological project management (specifications writing, time management by defining the various tasks to be carried out) and the effective completion of the work required

Syllabus

- During a fixed period of eight weeks, each student works in teams on an industrial project consisting of:

  - Designing, testing, developing or optimising an industrial process or a software system which meets precise specifications defined beforehand by the scientific manager or project supervisor in collaboration with the company applying for the project (or the laboratory).
  - Proposing objectives and a work plan for possible successors.

- During this project, the student benefits from the coaching of a scientific manager or project supervisor whom he must meet at least once a week to report on the work carried out and the actions to be implemented. At the end of the project, an oral presentation of the work is organised followed by a demonstration and a written report must be given to the supervisor

Grading

Thesis, Oral exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
1h15	0h00	0h00	17h30	8h00

In person teaching: 9h15

Taught in English: ⚐⚐⚐ **SD/SR:** **Innovation:** ✎✎

Civil and Geo-environmental Engineering (GCGE)

TU Code	Title of the Teaching Unit (TU)	Learning hours	ECTS
Civil and Geo-environmental Engineering (GCGE)		**417,00**	***60***
5th year GC 1st semester - S9		**289**	***30***
1 English Teaching Unit according to validated TOEIC level			
9HC02	Intercultural communication	**22,5**	***2***
9HC03	Intercultural communication debating society	**10**	***2***
9LVA1	German (not for beginners)	**28**	***2****
9LVE1	Spanish (not for beginners)	**28**	***2****
Sustainable Construction Option (COD)			
9CD01	Structures under dynamic and environmental loads	**70**	***8***
9CD03	Building thermal and aeraulic	**40**	***5***
9CD04	Building sites and design offices	**56,25**	***6***
Geo-environment and Sustainable City Option (GVD)			
9GE01	Polluted sites and soils	**52,5**	***6***
9GE02	Water Resource and Environment Management	**65**	***8***
9GE04	Site preparation	**48,75**	***5***
Public Works and Development Option (TPA)			
9TP02	Site preparation	**48,75**	***5***
9TP03	Public works	**61,25**	***7***
9TP04	Design of facilities	**56,25**	***7***
9GC02	Engineer project - phase 1	**100**	***9***
5th year GC 2nd semester - S10		**128,25**	***30***
To be chosen function of S9			
AHC01	Operational management	**36,25**	***2***
AGC03	Engineer project - phase 2	**70**	***3***
Sustainable Construction Option (COD)			
ACD01	Design and rehabilitation	**56,25**	***5***
Geo-environment and Sustainable City Option (GVD)			
AGE01	Design and Depollution Works	**56,25**	***5***
Public Works and Development Option (TPA)			
ATP01	Road design offices	**56,25**	***5***
AGC04	Engineer project	**170**	***10***
ASTC2	Professional engineering experience (student status)	**0**	***20***

Civil and Geo-environmental Engineering (GCGE) **9GC02** **Semester 9**

Engineer project - phase 1

Supervisor: Duc Phi DO **ECTS: 9**

Skills

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

- Conduct a project to respond to a real problem of a company, a design office or a laboratory related to civil engineering, the geo-environment and the sustainable city, respecting specifications
- Optimize an industrial process, a method of calculation or characterization
- Organize a project until the presentation of the results
- Apply project management methods
- Lead a project in the field of building, public works and geo-environment in the different phases: preparation-design, execution-production

Syllabus

- Presentation of the project and definition of the objectives with an academic supervisor who proposes the specifications with a representative of the company/laboratory
- Analysis of documents and considering the constraints and specification of the project
- Definition of the work schedule
- Realization of the different parts of the work
- Presentation of the results during an oral defense
- Linguistic follow-up carried out by an English teacher

Grading

Thesis, Oral exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
0h00	10h00	0h00	1h00	0h00

In person teaching: 10h00

Taught in English: 🏳🏳 **SD/SR:** 🌍🌍 **Innovation:** 🖉🖉

Civil and Geo-environmental Engineering (GCGE) **9GE01** **Semester 9**

Polluted sites and soils

Supervisor: Stefan MOTELICA-HEINO **ECTS: 6**

Skills

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

- Designing remediation strategies
- Diagnosis of polluted sites and soils
- Basics of geochemical modelling and PHREEQ practice
- Knowing the behavior of the main pollutants
- Assess the key concepts of environmental geochemistry

Syllabus

Geochemistry of contaminants

Environmental biogeochemistry
Water geochemistry
Hydrogeochemical modelling
Ecodynamics of contaminants
Basic geochemical calculations
Graphical representations
Hydrogeochemical sequence
Phase equilibrium as a function of pH and temperature
Adsorption of Zn on oxides

Diagnosis and rehabilitation

Decontamination of hydrocarbons, metals and metalloids
Standards
Physico-chemical treatments
Phytoremediation
Bioremediation
Rehabilitation
Visit to BRGM
Laboratory/field work

Grading

Written exam, Thesis, Oral exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
32h30	12h30	7h30	3h45	0h00

In person teaching: 52h30

Taught in English: ⚐⚐ **SD/SR:** 🌍🌍🌍 **Innovation:** ✎✎✎

Civil and Geo-environmental Engineering (GCGE) **9GE02** **Semester 9**

Water Resource and Environment Management

Supervisor: Christian DEFARGE **ECTS: 8**

Skills

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

- Consider risks in land-use planning (floods…) and water management (living organisms…)
- Implement hydrogeological methods in the field (flow, piezometric map, pumping test…)
- Model water and pollutant transfer in surface and underground hydrologic systems
- Size, implement, pilot and evaluate water and wastewater treatment processes and plants

Syllabus

Part 1: Geobiology of resources and processes

- Aquatic organisms, bioindicators, biological water-related diseases, invasive species
- Roles of living organisms in waters, use in water treatment processes

Part 2: Vulnerability, risks

- Risk management chain: uncertainty/issues, security/protection, forecasting, damage repair
- Study of dangers and crisis management

Part3: Field hydrology

- Flow measurement via exploration of the velocity field exploration and chemical gauging
- Drawing up a piezometric map and delimitation of the system
- Well-production test to characterize the hydrodynamic properties

Part 4: Water management

- Notions of hydrological cycle, residence time and groundwater storage volume
- Interaction between reservoirs, mixing, tools for active resource management using hydrodynamic modeling (Modflow software)
- Mass transfer mechanisms, at pore level and at the macroscopic level, pollutant reactivity

Part5: Water and wastewater treatment

- Classroom lessons: Water and wastewater treatment processes, case studies
- On-site lessons: Wastewater treatment plants, drinking water production plants

Grading

Written exam, Oral exam, Report

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
48h45	16h15	0h00	16h15	0h00

In person teaching: 65h00

Taught in English: ⚐⚐ **SD/SR:** 🌍🌍🌍 **Innovation:** ✎

Civil and Geo-environmental Engineering (GCGE) **9TP03** **Semester 9**

Public works

Supervisor: Laurent JOSSERAND **ECTS: 7**

Skills

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

- Define the schedule of quantities for a construction site; optimize its tasks and organization. Through productivity, they will be able to estimate its duration, cost and environmental impact limited to greenhouse gases.
- Choose and optimize quantities of materials necessary to construction sites among which stones, soils, pipes, coated materials... Acquired knowledge about these hydrocarbon coated materials and their bonding agents will allow students to optimize their compositions

Syllabus

This TU is the logical consequence of "Road and building Construction" 8GC02. Many implementation projects allow students to deepen their knowledge and skills while giving them the opportunity to get prepared for their future professional position:

- construction sites, study of economical variants or solutions with a limited environmental impact,
- use of natural stones,
- implementation of networks (wastewater, rainwater, multitubular network, etc.),
- specific coated materials (HiMA, draining and aeronautical asphaltic concrete, etc.),
- road recycling,

Grading

Written exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
30h00	22h30	8h45	6h15	0h00

In person teaching: 61h15

Taught in English: 🏳 **SD/SR:** 🌍🌍 **Innovation:** ✎

Civil and Geo-environmental Engineering (GCGE) **AGC03** **Semester 10**

Engineer project – phase 2

Supervisor: Duc Phi DO **ECTS: 3**

Skills

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

- Conduct a project to respond to a real problem of a company, a design office or a laboratory related to civil engineering, the geo-environment and the sustainable city, respecting specifications
- Optimize an industrial process, a method of calculation or characterization
- Organize a project until the presentation of the results
- Apply project management methods
- Lead a project in the field of building, public works and geo-environment in the different phases: preparation-design, execution-production

Syllabus

- Presentation of the project and definition of the objectives with an academic supervisor who proposes the specifications with a representative of the company/laboratory
- Analysis of documents and considering the constraints and specification of the project
- Definition of the work schedule
- Realization of the different parts of the work
- Presentation of the results during an oral defense
- Linguistic follow-up carried out by an English teacher

Grading

Thesis, Oral exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
0h00	11h00	0h00	0h00	1h00

In person teaching: 12h00

Taught in English: 🏳🏳 **SD/SR:** 🌍🌍 **Innovation:** ✎✎

Civil and Geo-environmental Engineering (GCGE) **AGC04** **Semester 10**

Engineer project

Supervisor: Duc Phi DO **ECTS: 10**

Skills

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

- Conduct a project to respond to a real problem of a company, a design office or a laboratory related to civil engineering, the geo-environment and the sustainable city, respecting specifications
- Carry out or optimize an industrial process, a method of calculation or characterization
- Organize a project until the presentation of the results
- Apply project management methods
- Lead a project in the field of building, public works and geo-environment in the different phases: preparation-design, execution-production

Syllabus

- Presentation of the project and definition of the objectives with an academic supervisor who proposes the specifications with a representative of the company/laboratory
- Analysis of documents and considering the constraints and specification of the project
- Definition of the work schedule
- Realization of the different parts of the work
- Presentation of the results during an oral defense
- Linguistic follow-up carried out by an English teacher

Grading

Thesis, Oral exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
0h00	21h00	0h00	0h00	1h00

In person teaching: 22h00

Taught in English: 🏳🏳 **SD/SR:** 🌍🌍 **Innovation:** ✎✎

Civil and Geo-environmental Engineering (GCGE) **AGE01** **Semester 10**

Design and Depollution Works

Supervisor: Christian DEFARGE **ECTS: 5**

Skills

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

- Conduct an environmental impact assessment
- Realize artificial tracer tests and interpretations
- Integrate ecological engineering into a development project
- Conduct projects and works in soil remediation

Syllabus

Part 1: Environmental impacts

- Impact assessments strictly speaking (geology, water management, public easement, dusts, hazard...)
- Study of an environmental impact assessment for a quarry's operation

Part 2: Artificial tracer tests applied to engineering

- Practice of artificial tracer tests (sizing, installation and implementation, detection on site and in the laboratory, concentration-time curve)
- Synthesis and data interpretation in the karstic environment of the Val d'Orléans
- Case studies in other contexts of application of the method: soil remediation operations, studies of leaks and aging of civil engineering structures (dam, canal)

Part 3: Ecological engineering

- Consideration of ecology in the various phases of project design (study phase, construction phase, operation phase)
- Cases studies of projects for the development or restoration of natural environments involving ecological engineering

Part 4: Soil remediation works

- Alternating between classes and homework around a concrete case for understand: What is a remediation project? The needs of a client? How to build a remediation strategy? How to choose and size a remediation technology?
- Monitoring of a remediation project, elements of remediation project management

Grading

Oral exam, Report

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
47h30	6h15	2h30	1h15	0h00

In person teaching: 56h15

Taught in English: ⚐⚐ **SD/SR:** 🌍🌍🌍 **Innovation:** ✎✎

Innovations in Design and Materials (ICM)

TU Code	Title of the Teaching Unit (TU)	Learning hours	ECTS
INNOVATIONS in DESIGN and MATERIALS (ICM)		**803,75**	***60***
5th year ICM 1er semester - S9		**332,50**	**30**
1 English Teaching Unit according to validated TOEIC level			
9HM02	Intercultural communication	**22,5**	***2***
9HM03	Intercultural communication start up project	**10**	***2***
9LVA1	German (not for beginners)	**28**	***2****
9LVE1	Spanish (not for beginners)	**28**	***2****
Parcours Eco - conception de systèmes mécatroniques (EcoSyM)			
9EC01	Mechatronic systems	**65**	***6***
9EC02	Analysis and design of mechanical systems	**55**	***5***
9EC03	Thematic scientific conferences	**10**	***1***
9EC04	Automatic control and robotics	**80**	***7***
Parcours Modélisation et simulation multiphysiques (MSP)			
9MP01	Nonlinear mechanics	**70**	***6***
9MP02	Composites and processes	**40**	***4***
9MP03	Multiphysics couplings	**40**	***4***
9MP04	Thematic scientific conferences	**10**	***1***
9MP05	Numerical simulation	**50**	***4***
To be chosen according to status			
9IC02	Engineer Project - 1st Phase	**100**	***9***
5th year ICM 2nd semester - S10		**471,25**	**30**
To be chosen function of S9			
AHM01	Operational management	**36,25**	***2***
AIC02	Engineer project - Phase 2	**70**	***3***
Parcours Matériaux de structures (MS)			
AMS01	Ceramics	**65**	***5***
Parcours Eco - conception de systèmes mécatroniques (EcoSyM)			
AEC01	Transversal projects	**65**	***5***
Parcours Modélisation et simulation multiphysiques (MSP)			
AMP01	Industrial Applications	**65**	***5***
To be chosen according to status			
ASTM1	Professional engineering experience	**0**	***20***

Innovations in Design and Materials (ICM) **9HM02** **Semester 9**

Intercultural communication

Supervisor: Catherine MOREAU **ECTS 7**

Skills

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

- Improve language skills to get closer to the required score of 785 TOEIC score

Syllabus

TOEIC practice
Oral presentations
Reading and listening comprehension training

Grading

Written exam, Oral exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs
0h00	0h00	22h30	0h00

In person teaching: 22h30

Taught in English:⚐⚐⚐ **SD/SR:**

Innovations in Design and Materials (ICM) **9HM03** **Semester 9**

Intercultural communication start up project

Supervisor: Catherine MOREAU **ECTS: 2**

Skills

At the end of this course, engineering students will be able to:
Research and creation of a virtual company to set up abroad
Independent teamwork
Regular progress reviews
Debates and presentations

Syllabus

Research and creation of a virtual company to set up abroad
Independent teamwork
Regular progress reviews
Debates and presentations

Grading

Oral exam, Report

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
0h00	0h00	10h00	12h30	0h00

In person teaching: 10h00

Taught in English: 🏳🏳🏳 **SD/SR:** 🌍🌍 **Innovation:** ✏✏✏

Innovations in Design and Materials (ICM) **9MS10** **Semester 9**

Advanced Materials, coupling and processes

Supervisor: Leire DEL CAMPO **ECTS: 6**

Skills

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

- Select a suitable process for a composite application, dimension and optimize the process to anticipate the induced properties
- Model and simulate composite shaping and injection processes
- Select a thermal control unit

Syllabus

Composite materials and processes

- Processing of structural composites for industrial applications
- Modeling and simulation of composite forming processes using EF approaches (Abaqus and PAM FORM)
- Process-and residual stress induced properties

Multi-physics simulation

- Heat transfer: heat equation and Fourier's law
- Charge transfer: current continuity equation and Ohm's law
- Electrothermal coupling: heat generated by the Joule effect in a DC conductor
- Electro-thermal-mechanical coupling: Thermal expansion
- Mass diffusion: Fick's laws

Grading

Written exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
6h15	43h45	0h00	0h00	0h00

In person teaching: 50h00

Taught in English: **SD/SR:** **Innovation:**

Innovations in Design and Materials (ICM) **9EC01** **Semester 9**

Mechatronic systems

Supervisor: Emmanuel BEURUAY **ECTS: 6**

Skills

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

- Analyze, model and set-up mecatronics systems
- Analyze the performance of a system from measurements and the limits of modeling
- Measure the necessary signals and then model and set-up a control law for concrete mechatronic system
- Set up a speed control system from the industrial documentation

Syllabus

Theorical parts

- This teaching unit is intended to illustrate the last courses in a Mechatronics context under environmental sustainability constraints. This translates into the use of components and/or systems, as close as possible to industrial applications, with the will to model, analyze and control them. Most of the teaching will be done through practical work on mechatronic systems.

Pratical parts

- Sizing of a motorization in a mechatronic system; harmonic disturbances; design principles and sizing of a photovoltaic system; continuous servo motorization; lifting system; speed variation on asynchronous motorization; energy reversibility on continuous and synchronous motorization
- Steward platform (modeling and experimentation); Renault welding clamp; screwed assembly; parametric optimization of part geometry; study of a tripod joint; Torsen differential. Exhaust gas recirculation valve in internal combustion engines, gasoline engine throttle valve, train catenary

Grading

Written exam, Oral exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
7h30	2h30	55h00	7h30	0h00

In person teaching: 65h00

Taught in English: **SD/SR:** **Innovation:**

Innovations in Design and Materials (ICM) **9EC02** **Semester 9**

Analysis and design of mechanical systems

Supervisor: Jean-Marc AUFRERE **ECTS: 5**

Skills

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

- Apply hydrostatic laws to analyze and operation of a circuit, study the functioning and design of the hydrostatic power transmission.
- Identify the parameters needed to select a pneumatic components for the design of a circuit
- Establish criteria and strategies for optimizing and sizing of a cylindrical gear of industrial gearboxes.

Syllabus

1. Dimensionning component

- Material fatigue (Whöler, Goodman, Haigh). Sizing bearing and shaft. Using Kiss-Soft and Kiss-sys software

2. Power transmissions by fluids

- Application of the law of hydrostatics
- Overall assessment and sizing approach of a circuit
- Specificities of pneumatic power transmission

3. Gear power transmissions

- Kinematics; interference; geometrical dimensioning in preliminary design.
- Operating laws, achievable ratios, energy transit, efficiency and irreversibility of single gear planetary gears

4. Functional tolerancing as a tool increasing energy gain

- Functional tolerancing as a tool guaranteeing the performances listed in the bill of specifications (reliability, life span); converting the geometric criteria of the specifications into tolerancing conditions.

5. Lubrication

- Different lubrication modes (hydrodynamic, hydrostatic, elastohydrodynamic); permanent, critical and lubricating regimes; lubrication dimensioning and performances

Grading

Written exam, Oral exam, Report

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
32h30	22h30	0h00	3h45	0h00

In person teaching: 55h00

Taught in English: 🏳🏳 **SD/SR:** 🌍🌍 **Innovation:** ✎

Innovations in Design and Materials (ICM) **9EC04** **Semester 9**

Automatic control and robotics

Supervisor: Estelle COURTIAL **ECTS: 7**

Skills

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

- Model and identify a process in the state space
- Design state feedback control laws (pole placement, decoupling)
- Synthesize state observers (software sensors)
- Implement different control laws (optimal control law, predictive control, visual servoing)
- Use tools and techniques to simulate, plan and control the motion of robotic systems

Syllabus

- Modeling processes as state space representations
- Study of system properties (controllability, observability, stability)
- Design of state feedback control laws (pole placement, decoupling control, linearizing control)
- State observers (soft sensor): Luenberger, Kalman
- Model simplification methods (Shur, Padé)
- Introduction to robotic system modeling
- Advanced control laws: predictive control, optimal control, linear quadratic control (LQC), robustness of a linear quadratic regulator (LQR), visual servoing
- Identification (nonlinear programming)
- Various applications will be studied in class using the following tools: Matlab, Simulink and Control toolbox.

Grading

Written exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
36h15	32h30	11h15	0h00	0h00

In person teaching: 80h00

Taught in English: **SD/SR:** **Innovation:**

Innovations in Design and Materials (ICM) **9MP01** **Semester 9**

Nonlinear mechanics

Supervisor: Alain GASSER **ECTS: 6**

Skills

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

- Study the non-linear aspects of structural mechanics.
- Recognise the type of non-linear behaviour and choose an associated law. Identify the coefficients of this law.
- Use the most common nonlinear behaviour laws.
- Treat a problem in large transformations (geometrical nonlinearities).
- Use contact processing techniques.

Syllabus

Non-linear behaviour of materials

Thermodynamic approach for the construction of material behaviour laws.
Study of different non-linear behaviours: plasticity, damage, failure, viscoelasticity, hyperelasticity.
Identification of the coefficients of non-linear behaviour laws.
Examples of use of these laws in problems of mechanics of continuous media.

Contact, large transformations

Analysis and calculation of structures with non-linear behaviour of material, geometric and contact type:
- Origin of non-linearities.
- Mechanics in large transformations.
- Taking into account non-linearities of behaviour.
- Treatment of contact.

Finite element applications

Beams, contact, large transformations, rigid solids, plasticity, hyperelasticity, viscoelasticity, buckling, topological optimisation

Grading

Written exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
20h00	50h00	0h00	0h00	0h00

In person teaching: 70h00

Taught in English: **SD/SR:** **Innovation:**

Innovations in Design and Materials (ICM) **9MP02** **Semester 9**

Composites and processes

Supervisor: Lukas JAKABCIN **ECTS: 4**

Skills

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

- Select a suitable process for a composite application, dimension and optimize the process to anticipate the properties induced
- Model and simulate composite forming processes

Syllabus

- Processing of structural composites for industrial applications. Criteria for a given application
- Formability and mechanical behavior of reinforcements. Modeling and simulation of forming processes using FE approaches (Abaqus and PAM FORM)
- Process- and residual stress induced properties
- Application to industrial case studies

Grading

Written exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
3h45	36h15	0h00	6h15	0h00

In person teaching: 40h00

Taught in English: **SD/SR:** **Innovation:**

Innovations in Design and Materials (ICM) **9MP03** **Semester 9**

Multiphysics couplings

Supervisor: Thomas SAYET **ECTS: 4**

Skills

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

- write properly a multi-physics problem
- Analyse and comment multiphysics simulations results
- Use of a commercial finite element software to solve a multi-physics problem

Syllabus

Lecture

- Thermo-mechanics
- Thermo-poro-mechanics
- Numerical resolution of the transport equation, space/time coupling
- Basis of the thermodynamics of the irreversible processes

Numerical methods and tools

- Heat and charge exchange
- Steady state and transient thermo-mechanics
- Thermo-electro-mechanics
- transient thermo-poro-elastic

Grading

Written exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
8h45	31h15	0h00	13h45	0h00

In person teaching: 40h00

Taught in English: 🏳🏳 **SD/SR:** 🌍🌍 **Innovation:** 🖉🖉

Innovations in Design and Materials (ICM) **9MP04** **Semester 9**

Thematic scientific conferences

Supervisor: Alain GASSER **ECTS: 1**

Skills

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

- Understanding industrial issues
- Understand how they have been addressed and solved
- Knowing the means implemented

Syllabus

Ingineers will present the problems encountered in their companies. They will explain how they were treated and solved. The experimental and numerical tools used will be described and analysed.

Grading

Written exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
10h00	0h00	0h00	0h00	0h00

In person teaching: 10h00

Taught in English:⚐⚐ **SD/SR:** 🌍 **Innovation:** ✎✎

Innovations in Design and Materials (ICM) **9MP05** **Semester 9**

Numerical simulation

Supervisor: Thomas SAYET **ECTS: 4**

Skills

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

- Understand the various hypotheses involved in beam, plate and shell models
- Understand the key finite elements used in these models
- Defining the framework for their use
- Be able to carry out FE calculations for the simulation of forming processes

Syllabus

- Study of simplified beam, plate and shell models
- Elastic thin shells
- Finite elements for plates and shells
- Large-scale transformations

Grading

Written exam, Report

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
16h15	33h45	0h00	6h15	0h00

In person teaching: 50h00

Taught in English: **SD/SR:** **Innovation:**

Innovations in Design and Materials (ICM) **9IC02** **Semester 9**

Engineer Project - 1st Phase

Supervisor: Anwar SHANWAN **ECTS : 9**

Skills

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

- Develop a project and analysis methodology
- Work independently in a multidisciplinary group
- Write a project report
- Present and format acquired results

Syllabus

Structure

- The student's autonomy as part of a project team is the main rule in this subject. Weekly meetings are scheduled to manage project progress. The project will be the subject of a written report with a summary in English, and an oral presentation.

Scientific content

- Project management and mechatronics and robotics design: project team management risk analysis, sizing and selection of mechanical components, study of control laws and correctors, robot programming, etc.
- Simulation: shaping of metal or composite parts, modeling and simulation of multiphysics impact simulation, multi-scale modeling and simulation, design and calculation of composite parts, topological optimization, modeling of living materials, etc.
- Materials: characterization of materials and structures, durability and corrosion of materials, setting up a knowledge base on materials, studying physico-chemical stability, aging studies, material/structure relationships,
process/material/use properties, etc.

Technical content

- SysML tool for integrating the description of the temporal or event-based operation of systems

Grading

Oral exam, Report

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
0h00	1h00	0h00	168h45	0h00

In person teaching: 1h00

Taught in English:⚐⚐ **SD/SR:** **Innovation:** ✎✎✎

Innovations in Design and Materials (ICM) **AHM01** **Semester 10**

Operational management

Supervisor: Jean-François KRAUSE **ECTS: 2**

Skills

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

- Apply team building and negotiation methods. Understand the driving forces of motivation
- Use quality tools to solve a problem. Identify workplace risks and analyze the company's safety policy
- Apply professional ethics to your work
- Understand the steps involved in designing, drafting and filing an industrial patent. Know how to search and read an industrial patent efficiently.
- Enhance your CV and interview to ensure an interesting internship

Syllabus

Operational management

- Debrief management cases encountered during 4th year internship, create management cases
  Understand the role and responsibility of the engineer within management
  Handling difficult situations and conflicts, conducting interviews and leading meetings
  Methodically negotiate a purchase or sale

Quality & Safety Management

Solve problems methodically, use Lean Management tools.
Integrate professional ethics into management. Prevent and combat psychosocial risks. Analyze and diagnose workplace risks in order to control them.

Patents and intellectual property

Understand the links between innovation and industrial property
Understand the criteria for filing a patent application, read a patent text in its various sections of a patent, search a patent database to find the relevant information

Recruitment

Grading

Written exam, Oral exam, Report

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
0h00	31h15	5h00	0h00	0h00

In person teaching: 36h15

Taught in English: ⚐⚐ **SD/SR:** 🌍 **Innovation:** ✎✎

Innovations in Design and Materials (ICM) **AIC02** **Semester 10**

Engineer project - Phase 2

Supervisor: Anwar SHANWAN **ECTS: 3**

Skills

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

- Develop a project and analysis methodology.
- Work independently in a multidisciplinary group.
- Write a project report.
- Analyze and present the obtained results.

Syllabus

Structure

- The student's autonomy as part of the project team is the main rule in this subject. Weekly meetings are scheduled to manage project progress. The project should be finished by a written report and an oral presentation.

Scientific content

Project management, mechatronics and robotics design: project team management, risk analysis, sizing and selection of mechanical components, study of control laws and correctors, robot programming, etc.
Simulation: shaping of metal or composite parts, modeling and simulation of multiphysics impact simulation, multi-scale modeling and simulation, design and calculation of composite parts, topological optimization, modeling of living materials, etc.
Materials: characterization of materials and structures, durability and corrosion of materials, setting up a knowledge base on materials, studying physico-chemical stability, aging studies, material/structure relationships,
process/material/use properties, etc.

Technical content

SysML tool for integrating the description of the temporal or event-based operation of systems.

Grading

Oral exam, Report

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
0h00	0h00	0h00	135h00	0h00

In person teaching: 0h00

Taught in English: ⚐ **SD/SR:** **Innovation:** 🖉🖉🖉

Innovations in Design and Materials (ICM) **AMS01** **Semester 10**

Ceramics

Supervisor: Marie-Laure BOUCHETOU **ECTS: 5**

Skills

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

- Master the processes used to engineer ceramic materials
- Know the main properties of ceramic uses
- Understand concepts necessary for engineering and forming ceramic materials, their properties and limitations of use
- Tackle practical applications (energy, automotive and aeronautical engineering, mechanical construction, civil engineering, etc.)
- Know the main methods of characterization of advanced materials

Syllabus

Ceramics: production and high temperature applications

- Recap of the fundamentals in ceramic
- Ternary phase diagrams
- Methods to produce ceramics, practical case study: silicate ceramics, refractory ceramics, techniques
- High-temperature heat treatment of ceramics. Sintering in ceramics
- Industrial case studies: engineering, characteristics, properties of use. Ceramics for energy, environment application…

Method of characterization of advanced materials

- Microstructure (optical microscope, SEM, TEM)
- Thermal analysis
- Raman spectroscopy
- Infrared spectroscopy
- NMR
- Pore size distribution, XRays tomography, BET

Grading

Written exam, Oral exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
32h30	15h00	17h30	0h00	0h00

In person teaching: 65h00

Taught in English: **SD/SR:** **Innovation:**

Innovations in Design and Materials (ICM) **AEC01** **Semester 10**

Transversal projects

Supervisor: Jean GILLIBERT **ECTS: 5**

Skills

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

- Use the knowledge and analysis methods seen in the training, to deal with concrete industrial cases
- Develop a project and analysis methodology
- Work independently in a multidisciplinary group
- Write a project report
- Present the results acquired

Syllabus

During this teaching unit, students work on a technical project supervised by a scientific tutor (s).

Organization

The autonomy of the student associated with a project team is the main rule that prevails in this UE.
Weekly meetings are planned to manage the progress of projects.
The project will be the subject of a written report with a summary in English, and an oral presentation.

Scientific content

Project management and design of mechatronics and robotics systems: project team management, risk analysis, sizing and selection of mechanical components, study of control laws and correctors in servo control, programming of robots, etc.
The work of each student varies according to the project in which he will be involved, as well as his role within each project team.
This teaching Unit is part of a process of individualization of the training of students to allow them different learning paths according to their professional and personal projects

Grading

Written exam, Oral exam, Report

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
22h30	42h30	0h00	55h15	0h00

In person teaching: 65h00

Taught in English: **SD/SR:** **Innovation:**

Innovations in Design and Materials (ICM) **AMP01** **Semester 10**

Industrial Applications

Supervisor: Anwar SHANWAN **ECTS: 5**

Skills

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

- Use the knowledge and analysis methods seen in the training, to deal with concrete industrial cases
- Develop a project and analysis methodology
- Work independently in a multidisciplinary group
- Write a project report
- Present the results acquired

Syllabus

During this teaching unit, students work on a technical project supervised by a scientific tutor (s).

Organization:

The autonomy of the student associated with a project team is the main rule that prevails in this UE.
Weekly meetings are planned to manage the progress of projects.
The project will be the subject of a written report with a summary in English, and an oral presentation.

Scientific content:

- The content will focus on real case studies, from our industrial partners, focusing on material, structure and process simulation issues
- Problems dealt with in this project framework: shaping of metal parts or composites, modeling and simulation of multi-physical behaviors, (thermal, mechanical, chemical, hygrometric, etc.), impact simulation, multi-scale modeling and simulation, design and calculation of composite parts, topological optimization, modeling of living materials, etc.
- The work of each student varies according to the project in which he will be involved, as well as his role within each project team.
  This Teaching Unit is part of a process of individualization of the training of students to allow them different learning paths according to their professional and personal projects.

Grading

Thesis, Oral exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
36h15	28h45	0h00	15h00	0h00

In person teaching: 65h00

Taught in English: 🏳 **SD/SR:** **Innovation:** ✎✎

Innovations in Design and Materials (ICM) **ASTM1** **Semester 10**

Professional engineering experience

Supervisor: Thomas SAYET **ECTS: 20**

Skills

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

- Apply the scientific and technical knowledges in a professional projet.
- Master the methods and tools required for engineering work.
- Acquire an independent methodology.
- Integrate into an organization and a team.
- Respect the company's societal, social and environmental values.

Syllabus

- A student engineer should have, at least, one project engineering in a company, with a minimal duration of 33 to 44 weeks, spread overall the three years of the engineering cycle. The project engineering can be:

- An internship with agreement.
- Employment contract of defined or indefinite duration
  WWOOFings with or without contract (1st year, 2nd year or 3rd year).
- Work-study contract (3rd year apprenticeship, FISA status, specialties of GI, PROD, and SB).

  An internship in a research laboratory could be substituted by a 4th or 5th year internship in a company.

  The 5th year internship duration should be 20 weeks at least and couldn't be more than 6 months.

  International work experience can take the form of subsidized internships, work contracts or WWOOFings.
  An Internship may be financed by Erasmus+ or Mobicentre grants.

  The internship agreement of 3rd and 4th years should be finished on August 31 of the academic year. For the 5th students. The internship agreement could continue until the 30 of September.

Grading

Thesis, Oral exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
0h00	3h45	0h00	0h00	0h00

In person teaching: 3h45

Taught in English: **SD/SR:** **Innovation:**

Technologies for Energy, Aerospace and Motoring sciences (TEAM)

4th year courses

TU Code	Title of the Teaching Unit (TU)	Learning hours	*ECTS*
TECHNOLOGIES for ENERGY, AEROSPACE and MOTORING SCIENCES (TEAM)		**616,5**	***60***
4th year TEAM 1st semester - S7		**377**	**30**
7HT02	English and science	**40**	***3***
7LVA1	Optional language (german)	**28**	***2****
7LVE1	Optional language (spanish)	**28**	***2****
7TE01	Energy Management	**117,5**	***9***
7TE02	Fluid dynamics	**117,5**	***9***
7TE03	Electrical engineering and automatic control	**67,5**	***6***
4th year TEAM 2nd semester - S8		**239,5**	**30**
8HT01	Business English	**40**	***4***
8HT02	Human resource management	**27,5**	***2***
8TE01	Assistant Engineer Project	**5**	***4***
8TE02	Engine and propulsion systems	**120**	***9***
8TE03	Numerical and experimental tools for the engineer	**45**	***4***
8STT1	Professional experience	**0**	***7***

Technologies for Energy, Aerospace and Motoring Sciences (TEAM) **7HT02** **Semester 7**

English and science

Supervisor: Sybilla DUBOIS **ECTS: 3**

Skills

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

- Practise communicating in English on a scientific or technical subject, orally, in writing and by visual means

Syllabus

- Learn how to write a CV and cover letter in English by studying documents, the work of young engineers, as well as the websites of various companies in the field.
- Discuss an invention and how it works and its potential evolution
- Discuss and promote a product or gadget related to your field of activity and/or write technical documentation corresponding to the project
- Study and understand audio and visual scientific documents related to their field of engineering;
  Express themselves orally and in writing: writing exercises and oral expression activities using technical and scientific structures and vocabulary
- Take part in discussions and/or debates on science, environment, climate, policy, etc.
- Final project: participate in a shared virtual project using your area of expertise

Grading

Written exam, Oral exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
0h00	0h00	40h00	0h00	0h00

In person teaching: 40h00

Taught in English:⚐⚐⚐ **SD/SR:** **Innovation:** ✎

Technologies for Energy, Aerospace and Motoring Sciences (TEAM) **7TE01** **Semester 7**

Energy Management

Supervisor: Christian CAILLOL **ECTS: 9**

Skills

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

- Use the essential tools to assess the different potential energy sources (from conventional or renewable resources), whether for energy production (thermal or motor systems) or energy-saving strategies in buildings.
- Apply the main principles of acoustic treatment to building interiors or noisy devices.

Syllabus

The main challenges for tomorrow's energy and renewable energies

Primary resources, final energy consumption in France and worldwide and its impact on the climate. Solar thermal energy: sizing of collectors. Wind energy. Eco-design: principles of life cycle analysis. Bio-fuels.

Thermal design of buildings

Thermal optimization of buildings, thermal regulation RE2020. Introduction to HVAC engineering: air exchange, air conditioning.

Vibration and acoustics

Determining the vibration modes of simple elements, the reflection and transmission coefficients of acoustic waves. Determining the resonance modes in a room and identifying solutions to dampen them.

Industrial combustion

Definition and determination of characteristic combustion parameters. Fuels and oxidizers: stoichiometric combustion equation, equivalence ratio. Analysis of pollutant emissions. Combustion heat and temperature.

Labs in energetics

Measurement of flame front velocity and stability diagram. Calorimetry: measurement of the heat of combustion. Study of the efficiency of a solar collector. ThermOptim software: study of a heat pump.

Grading

Written exam, Oral exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
55h00	25h00	37h30	5h00	0h00

In person teaching: 117h30

Taught in English: ⚐⚐ **SD/SR:** 🌍🌍🌍 **Innovation:** ✎✎

Technologies for Energy, Aerospace and Motoring Sciences (TEAM) **7TE02** **Semester 7**

Fluid dynamics

Supervisor: Nicolas MAZELLIER **ECTS: 9**

Skills

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

- Understand the physical principles of fluid dynamics and heat transfer in different regimes. Being able to apply them in simple configurations.
- Identify and classify the main types of flows encountered in aerodynamics and understand their effects on aerodynamic performance.
- Learn about digital and experimental tools in academic or industrial configurations. Being able to choose the most suitable physical models. Know how to carry out an experiment/simulation and criticize the results.

Syllabus

1. Gas dynamics
Reminder of the equations of motion and energy. Highlighting dimensionless numbers and the notion of similarity. Introduction to compressible flows in perfect fluid; isentropic relationships; shock waves; study of the Laval nozzle.
2. Boundary layer
Dynamic and thermal boundary layer theory, self-similar solutions and scaling laws. Dimensionless numbers characteristic of heat transfers. Reynolds analogy.
3. External aerodynamics
The main phenomena: attached and separated, 2D and 3D, subsonic and supersonic flows. Case of the profile and the wing in incompressible. Linearized potential in compressible; 2D sub and supersonic applications. Application to vehicles and energy systems.
4. Turbulence
Introduction to turbulence. Statistical approach through the Reynolds formalism (RANS).
Highlighting the closure problem and introducing the turbulent viscosity model.
5. Experimental practical work
Getting started with measuring instruments in fluid dynamics. Development of a boundary layer.
Laminar/turbulent transition. Simple body aerodynamics. Laval nozzle.
6. Numerical practical work
Simulation of turbulent flows on the ANSYS software suite. Getting started with simple cases. Wing profile from Mach 0.3 to Mach 3. Laval nozzle.

Grading

Written exam, Oral exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
50h00	32h30	35h00	8h45	0h00

In person teaching: 117h30

Taught in English: 🏳🏳 **SD/SR:** 🌍 **Innovation:** ✏✏

Technologies for Energy, Aerospace and Motoring Sciences (TEAM) **7TE03** **Semester 7**

Electrical engineering and automatic control

Supervisor: Guillaume COLIN **ECTS: 6**

Skills

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

- Modeling 4 electrical machines by their equivalent schemes; associating loads to rotating machines by their mechanical characteristics; measuring electrical powers on networks with linear or non-linear loads; understanding the risks at low voltage below 500 V; implementing the 4 electrical machines; recording the mechanical characteristics of two rotating machines associated with their converter or scalar inverter
- Study of continuous linear dynamic systems and synthesizing equalizers; modeling and identifying a linear system from data; identifying the inputs and limitations of a closed-loop control system; adjusting and operating a PID, introduction to advanced industrial controls

Syllabus

Electrical Engineering

Active, reactive and deforming apparent powers on linear and non-linear loads; elements of magnetism applied to current transformers, linear inductances and no-load current of a voltage transformer; ferromagnetic losses and technological solutions. 4 electrical energy conversion machines. Transformer. DC machine, AC machines, synchronous and asynchronous.

Automatic control

Introduction and recaps: definitions, synthesis of a control system. Basic models and responses. Dynamic performance of corrected systems.
Continuous control: principles, role, effects and use. Synthesis of PID correctors: tuning, industrial structure. Delayed process, internal model control.

Labs

Three-phase power measurements and protection of persons; Three-phase transformer; Direct current machine; Asynchronous machine; Speed variation on an asynchronous machine; Synchronous machine and alternator starter test bench; PID regulation of the thermal behavior of a building.

Grading

Written exam, Oral exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
16h15	13h45	37h30	13h45	0h00

In person teaching: 67h30

Taught in English: **SD/SR:** **Innovation:**

Technologies for Energy, Aerospace and Motoring Sciences (TEAM) **8HT01** **Semester 8**

Business English

Supervisor: Isabelle BEN CHAABANE **ECTS: 4**

Skills

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

- Use English in the corporate world
- Reach the B2+ level

Syllabus

1 - Business English

Various activities involving the use of corporate vocabulary and skills:
- Job interview simulations
- Study of company organigrams, portraits of CEOs, management styles and corporate cultures
- Meetings and telephoning
- "Project": Reading and study of a book in English dealing with societal and economic stakes

2 - TOEIC Preparation

2 mock TOEICs. Revision of key grammatical and lexical points

Grading

Written exam, Oral exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
0h00	0h00	40h00	0h00	0h00

In person teaching: 40h00

Taught in English:⚐⚐⚐ **SD/SR:** **Innovation:**

Technologies for Energy, Aerospace and Motoring Sciences (TEAM) **8TE01** **Semester 8**

Assistant Engineer Project

Supervisor: Ivan FEDIOUN **ECTS: 4**

Skills

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

- Apply for an assistant engineer position (CV, cover letter, interview)
- Analyze a customer's needs and expectations and propose a suitable cost-effective solution
- Build on and consolidate the disciplinary skills acquired during the first two years of training to respond technically to the needs of the project
- Plan and optimize work (independently and as part of a team) in order to meet performance and meet deadlines

Syllabus

Project team recruitment

- Consult offers submitted by project managers
- Build your CV and cover letter accordingly
- Applying for jobs and preparing for interviews

Project Management

- Introduction to the information retrieval tools required for project management
- Introduction to drawing up quotations and scientific technical appendices
- Introduction to audit principles

Technical implementation support in collaboration with project managers
Design and production of experimental and/or digital databases
Contribute to writing technical reports
Attendance at progress meetings
Assessment of acquired skills (written + oral)

Grading

Thesis, Oral exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
0h30	3h45	0h45	86h15	0h00

In person teaching: 5h00

Taught in English: ⚐ **SD/SR:** 🌍🌍 **Innovation:** 🖉🖉

Technologies for Energy, Aerospace and Motoring Sciences (TEAM) **8TE02** **Semester 8**

Engine and propulsion systems

Supervisor: Pierre BREQUIGNY **ECTS: 9**

Skills

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

- Understand the main parameters impacting the operation of an internal combustion engine (ICE)
- Carry out an analysis of the cimbustion process in an ICE
- Carry out the pre-sizing of an air breating or rocket propulsion system

Syllabus

Internal Combustion Engine

Thermodynamic cycles, efficiencies, energy calculation
Study of the compression phase, assess wall heat losses, wall temperature, hypothesis & limits
Heat Realease and Heat Release rate (HRR) calculation growth and net, wall heat losses, energy model closure
HRR Wiebe model, premixed and diffusion combustion. Adjusting the model to fit experimental data
Lab session on engine test benches

Aircraft and Rocket Propulsion

Main components, architecture, principles
Thermodynamic and mechanical sizing of a turbojet/fan
Performances calculation of rocket and aircraft engines
Projetcts on a virtual engine test bench: control and thermodynamics

Grading

Written exam, Oral exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
61h15	6h15	52h30	18h45	0h00

In person teaching: 120h00

Taught in English: 🏳🏳🏳 **SD/SR:** 🌍🌍🌍 **Innovation:** ✎✎

Technologies for Energy, Aerospace and Motoring Sciences (TEAM) **8TE03** **Semester 8**

Numerical and experimental tools for the engineer

Supervisor: Pierre-Yves PASSAGGIA **ECTS: 4**

Skills

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

- Select a particular type of sensor to measure a specific type of physical phenomenon.
  Perform the acquisition and visualisation of a signal from an experiment. Numerical analysis of different signals (statistics, spectral analysis, filtering)
  Interpolate, approximate and integrate multivariate functions.
  Perform optimisation methods to determine local and global minima using simplex and Lagrange multipliers methods.

Syllabus

Signal acquisition and processing

- Signal processing: Fourier analysis, auto- and cross-correlations, Parseval and Wiener theorem, introduction to wavelets.
- Lab sessions using Matlab: Acquisition, and visualisation of a signal using a microphone. Processing and analysis from acoustics, engines, and fluid mechanics.
- Sensor technology and acquisition methods.

Interpolation and filtering

- Interpolation, nodal approximation, polynomial expansions, spline methods.
- Numerical integration.
- Least-squares methods.

Optimisation

- Local and global minima analysis of multivariate functions.
- Constrained optimisation.
- Lagrange multipliers method.

Grading

Written exam, Oral exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
16h15	0h00	28h45	6h15	0h00

In person teaching: 45h00

Taught in English:⚐⚐ **SD/SR:** **Innovation:**

5th year courses

TU Code	Title of the Teaching Unit (TU)	Learning hours	ECTS
TECHNOLOGIES for ENERGY, AEROSPACE and MOTORING SCIENCES (TEAM)		**732,50**	***60***
5th year TEAM 1st semester - S9		**282,50**	**30**
1 English Teaching Unit according to validated TOEIC level			
9HT02	Intercultural communication	**22,5**	***2***
9HT03	Intercultural communication debating society	**10**	***2***
9LVA1	German (not for beginners)	**28**	***2****
9LVE1	Spanish (not for beginners)	**28**	***2****
2 Teaching Unit amongst 5			
9TE11	Turbulence and advanced CFD	**70**	***8***
9TE12	Multiphysics coupling in aerodynamics	**70**	***8***
9TE13	Combustion and applications	**70**	***8***
9TE14	Control of Energetic System	**70**	***8***
9TE15	Energetic systems	**70**	***8***
To be chosen according to status			
9TE16	Engineer project - phase 1	**100**	***9***
5th year TEAM 2nd semester - S10		**450**	**30**
To be chosen function of S9			
AHT01	Operational management	**36,25**	***2***
ATE05	Engineer project - phase 2	**70**	***3***
1 Teaching Unit amongst 3			
ATE02	Gas dynamics	**70**	***5***
ATE03	Powertrain	**70**	***5***
ATE04	Buildings energy	**70**	***5***
ATE06	Engineer project	**170**	***10***
ASTE1	Engineer intership	**0**	***20***

Technologies for Energy, Aerospace and Motoring Sciences (TEAM)	9TE11	Semester 9

Turbulence and advanced CFD

Supervisor: Ivan FEDIOUN **ECTS : 8**

Skills

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

- Describe, understand, and analyse turbulent flow phenomena.
- Use the necessary tools for the analysis of experimental databases and numerical simulations.
- Select and perform different levels of descriptions/physical modelling (ILES, LES, DES, RANS) upon available computing resources.
- Use the ANSYS/FLUENT software suite for the simulation of turbulent flows and their optimisation.

Syllabus

Experimental labs and signal analysis

Grid and jet turbulence, hot-wire measurements - Signal analysis of experimental data (spectral analysis, first-to-fouth order statistical moments). Analysis of PIV databases (provided by the professor).

Statistical modelling of turbulence (RANS)

Statistical tools - Reynolds- Averaged Navier-Stokes equations - Closure problem and solutions - Transport equations of turbulent quantities - Newtonian closure and its consequences - Turbulent viscosity models - Wall laws.

Physics of turbulence

One-point/two-point statistics - Eulerian microscales integral lengthscales - Energy and enstrophy spectra in homogeneous and isotropic turbulence - Kolmogorov theory (K41).

Large-eddy simulation

Explicit and implicit filtering - Filtering induced by the numerical scheme - Sub-grid scale modelling for large-eddy simulations.

CFD Labs

RANS and LES simulations, shape and turbulence model optimisation.

Grading

Written exam, Oral exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
28h45	0h00	31h15	0h00	10h00

In person teaching: 70h00

Taught in English:⚐⚐⚐ **SD/SR:** 🌍🌍 **Innovation:** ✎

Technologies for Energy, Aerospace and Motoring Sciences (TEAM) **9TE12** **Semester 9**

Multiphysics coupling in aerodynamics

Supervisor: Pierre-Yves PASSAGGIA **ECTS: 8**

Skills

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

- Describe fundamental physical phenomena associated with aeroacoustics (aerodynamic noise), aeroelasticity (fluid-structure interaction), and high-speed flows (where high enthalpies are reached).

Syllabus

Aeroacoustics

General concepts of aerodynamic noise, fields of application, sound propagation in the presence of flow in an inhomogeneous medium, methods for calculating radiated noise, noise sources, interaction between flow and acoustics

Aeroelasticity

Description and analysis of steady and unsteady aerodynamics coupled to deformable structures, key physical characteristics of the statics and dynamics of objects (airfoils, wings, building), subject to elastic, inertial, and aerodynamic forces, at the origin of static divergence and aerodynamic flutter:

High-speed aerodynamics

Description, analysis, and simulation of very high-speed flows where heating effects dominate aerodynamics, for instance, during reentry flight phases and hypersonic flight regimes.

Adjoint-based sensitivity analysis

Mathematical techniques for Lagrangian-based sensitivity analysis of physical models towards optimisation and flow control. Mathematical analysis of sensitivity equations for optimisation and physical analysis. Application to static, dynamic, nonlinear and 3D unsteady problems. Shape and turbulence models optimisation.

Grading

Written exam, Oral exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
27h30	42h30	0h00	6h15	0h00

In person teaching: 70h00

Taught in English: ⚐⚐⚐ **SD/SR:** 🌍🌍🌍 **Innovation:** ✎✎✎

Technologies for Energy, Aerospace and Motoring Sciences (TEAM) **9TE13** **Semester 9**

Combustion and applications²

Supervisor: Christine MOUNAIM-ROUSSELLE **ECTS : 8**

Skills

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

- Acquire the requisite knowledge to describe, understand and analyze laminar and turbulent combustion phenomena involving in industrial applications
- Know the basic mechanisms determining the formation and reduction of pollutant emissions
- Identify parameters influencing heat release and the formation of the main pollutants (soot, NOx) for applications such as internal combustion engines, thermal power plants (coal, gas, biofuels) and turbines. Know how to vary parameters to optimize the working of the energy system
- Use CFD software to simulate a complex system
- Acquire an overview of the tools allowing characterizing a reactive or non-reactive turbulent flow (measurement techniques and post-processing tools).

Syllabus

Theory

Combustion chemistry (thermodynamics applied to chemistry, chemical kinetics) ; Self-ignition (theory, measurement methods, examples of detailed modeling) ; Premixed and diffusion flames (flammability limit, flame stabilization, extinction parameters, propagation velocity, flame thickness, …) ; Flame/turbulence interactions ; Models for premixed and diffusion turbulent flames ; Combustion high-energy materials and explosives ; Pollutant formation and post-treatment systems ; Examples of combustion phenomena and pollutant formation with recent technologies ; Introduction to experimental techniques allowing to characterize a reactive or non-reactive turbulent eddy flow

Practice

Use of Image processing (Matlab); Use of CHEMKIN software (chemical kinetic) ; Application of notions tackled through 3D calculation codes (FLUENT or CONVERGE)

Autonomous supervised project

Students will work by group on a project dedicated to the description and the understanding of an accidental combustion phenomenon ; A guided project devoted to the characterization of acoustically perturbed flames using post-processing tools will be proposed.

Grading

Written exam, Oral exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
37h30	3h45	28h45	2h30	0h00

In person teaching: 70h00

Taught in English: ⚐⚐ **SD/SR:** 🌍🌍 **Innovation:** ✎

Technologies for Energy, Aerospace and Motoring Sciences (TEAM) **9TE14** **Semester 9**

Control of Energetic System

Supervisor: Guillaume COLIN **ECTS: 8**

Skills

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

- Master engine control systems, control strategies and the associated control devices (sensors, actuators, controllers);
- Implement control strategies for internal combustion engines;
- Apply the knowledge acquired in class to the tuning and control of internal combustion engines on a test bench, an actuator bench or via simulation;
- Perform energy balance on a hybrid vehicle and generate an energy management strategy (heuristic, optimal).

Syllabus

Theory

- History of engine control: carburetor, mechanical injection
- State of the art: sensors, actuators, hardware and software, strategies...
- Spark ignition engine control: basic strategies, pollution, knock, idle, start, cold start, drivability...
- Diesel engine control: history, high pressure pumps and injectors, common rail control
- Control Development methods. Embedded networks. Embedded models
- Automatic control: PID control and advanced control. Control based on physical or heuristic models, torque control.
- Hybrid vehicles: definitions, issues, energy management (heuristic, optimal, Equivalent Consumption Minimization Strategy)

Practice

- Tuning an internal combustion engine: 3 labs including 2 on a real engine test bench
- Engine control: 3 labs, 1 of which on an actuator bench system and 1 on a real engine test bench
- Energy management of an hybrid vehicle (1 lab on a roller bench)

Mini-project

Pre-sizing the technical elements of an Hybrid Electric Vehicle and designing the energy management with the softwares Amesim and Simulink.

Grading

Written exam, Oral exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
17h30	0h00	52h30	28h45	0h00

In person teaching: 70h00

Taught in English: 🏳🏳🏳 **SD/SR:** 🌍 **Innovation:** 🖉🖉

Technologies for Energy, Aerospace and Motoring Sciences (TEAM) **9TE15** **Semester 9**

Energetic systems

Supervisor: Camille HESPEL **ECTS: 8**

Skills

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

- Size of power generation systems
- Apply the concepts of security and nuclear safety
- Use business software to perform a life cycle analysis

Syllabus

Energy geopolitics

- Situation and issues: primary energy, eqCO2 emissions, standard, 1.5°C objective
- Energy mix: nuclear, renewable energy, other
- Role of new energy carriers: hydrogen, ammonia

Renewable energies

- Photovoltaics: technology and sizing
- Wind power: technology and sizing
- Solar thermal: technology, sizing and return on investment

Advanced thermodynamics

- Joule cycle and cogeneration
- Rankine cycle with or without superheat

Life cycle analysis

- Introduction to software (Gabi, simapro or greet)
- Compare different scenarios

Visit to a plant or company

Sites already visited: nuclear and thermal power plant, wood-fired heating plant, Artenay sugar refinery, La Renardière site (EDF), photovoltaic plant, POWIDIAN company

Grading

Written exam, Oral exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
50h00	20h00	0h00	11h15	0h00

In person teaching: 70h00

Taught in English: ⚐⚐ **SD/SR:** 🌍🌍🌍 **Innovation:** ✎✎

Technologies for Energy, Aerospace and Motoring Sciences (TEAM) **9TE16** **Semester 9**

Engineer project - phase 1

Supervisor: Ivan FEDIOUN **ECTS : 9**

Skills

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

- Conduct an engineering project to answer an industrial or research problem.
- Develop, consolidate, and apply the skills developed during the engineering curriculum.
- Establish technical specifications, and management plans, and work autonomously.
- Regular follow-up meeting organisation with the industrial/academic partners.
- Syntethise work progress and deliver both presentations and written reports.

Syllabus

Project Phase 1

- Project selection.
- Contact the industrial or academic partner and establish the technical specifications of the study.
- Tasks and meeting planning.
- Tools and resource identifications that are required to accomplish the tasks.
- Risk and alternative solutions planning.
- Technical work realisation for each task.
- Update on work advancement, providing backup solutions when necessary.

Grading

Thesis, Oral exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
0h00	12h00	0h00	1h15	0h00

In person teaching: 12h00

Taught in English:🏳🏳🏳 **SD/SR:** 🌍🌍🌍 **Innovation:** 🖉🖉🖉

Technologies for Energy, Aerospace and Motoring Sciences (TEAM) **ATE02** **Semester 10**

Gas dynamics

Supervisor: Azeddine KOURTA **ECTS: 5**

Skills

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

- Have acquired a comprehensive understanding of the physical phenomena present in flows at speeds ranging from high subsonic to hypersonic.
- Understand the mathematical properties of Euler's equations (hyperbolicity, characteristics) in numerical shock-capture schemes (FVS, FDS). The main schemes. Initiation into FORTRAN programming.

Syllabus

Part 1: Dynamics of high-speed

- Recap of the 4th year course on thermodynamics, the Euler system, straight shocks
- 1D instationary flows: characteristics, Riemann invariants, shock tube; solution to the Riemann problem
- 2D stationary flows: oblique shocks, intersection of shocks, Mach disc. Expansion fan, Prandtl-Mayer equation, Linearized supersonic theory, Characteristics, Cauchy problem

Part 2: Numerical methods to solve Euler's equations

- Scalar hyperbolic conservation equations: characteristics and compatibility relation, monotone conservative schemes. Weak solutions and Rankine-Hugoniot condition. Entropy solutions
- Recap on the Euler 1D system: conservative variables, primitives, characteristics, transition matrices, Riemann invariants
- First-order 'upwind' finite-volume schemes based on flow decomposition (FVS) and approximate Riemann solvers (FDS)
- Second-order extension: MUSCL approach, TVD schemes and flow limiters

Part 3: Machine applications in FORTRAN

- Linear convection: programming, management of the boundary conditions
- Burgers' equation: Riemann problem with compressive or expansive initial conditions. Programming Lax-Friedrichs schemes and CIR with a constant time-step
- The Sod shock tube with fixed boundary conditions. Non-reflective, reflective , mixed boundary conditions. Roe scheme with Harten's entropy correction, adaptive time-step

Grading

Written exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
25h00	45h00	0h00	12h30	0h00

In person teaching: 70h00

Taught in English:⚐⚐⚐ **SD/SR:** 🌍🌍 **Innovation:** ✏✏

Technologies for Energy, Aerospace and Motoring Sciences (TEAM) **ATE03** **Semester 10**

Powertrain

Supervisor: Pascal HIGELIN **ECTS: 5**

Skills

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

- Understand physical and chemical processes during combustion and scavenging in internal combustion engines.
- Understand the reactions of a powertrain when changing its operating parameters using modeling.
- Build an internal combustion engine model. Optimise powertrain sizing and settings under efficiency, power output and emission constraints.
- Understand electrified powertrain energy management

Syllabus

Combustion

Thermochemistry and chemistry kinetics applied to combustion. Internal combustion engines aerodynamics. Air/fuel mixture preparation. Auto ignition. Premixed and diffusion flames.

Thermodynamic models

Classification of thermodynamic models. Validity limits. One zone, 2 zones and multizone models. Heat losses to the walls.

Combustion models

Semi-empiric Vibé model. Physical combustion models in spark ignition engines. Physical combustion models in compression ignition engines.

Turbocharging

Static and dynamic turbocharger models. Compressor / turbine adaptation. Pumping limit.

Electrification

Global characteristics of electric machines. Series, parallel, power split hybridization. Batteries and energy management. CAN network and powertrain supervision.

Grading

Written exam, Oral exam, Report

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
22h30	42h30	0h00	0h00	5h00

In person teaching: 70h00

Taught in English: 🏳🏳🏳 **SD/SR:** 🌍🌍🌍 **Innovation:** ✏✏

Technologies for Energy, Aerospace and Motoring Sciences (TEAM) **ATE04** **Semester 10**

Buildings energy

Supervisor: Jean-Michel FAVIE **ECTS : 5**

Skills

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

- Identify the professional elements (human, technical) linked to the work of a project manager specialized in renewable energy and building heat transfer.
- Manage the different norms, state of the art of technology (current and sustainable), innovative production techniques, and environmentally friendly practices.

Syllabus

Environnemental norms, reglementations and requirements

Thermal control, durable architecture, agenda XXI. Project management. Environmental footprint and life cycle analysis.

Audit and thermal diagnostics

Environmental audit, energy-performance diagnostics, carbon footprint budget. Project management assistant and eco-friendly improvements

Passive energy

Classical and bio-sourced materials. Architecture, screens, waterspout wall.

Renewable energies

Solar-thermal heating, wind turbines, geothermal and bio-mass, energy mix.

Heat exchangers

Wood energy and heat pumps.

Grading

Written exam, Oral exam, Report

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
40h00	26h15	3h45	29h00	0h00

In person teaching: 70h00

Taught in English: ⚐⚐⚐ **SD/SR:** 🌍🌍🌍 **Innovation:** ✎✎✎

Technologies for Energy, Aerospace and Motoring Sciences (TEAM) **ATE05** **Semester 10**

Engineer project - phase 2

Supervisor: Ivan FEDIOUN **ECTS : 3**

Skills

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

- Conduct an engineering project to answer an industrial or research problem.
- Develop, consolidate, and apply the skills developed during the engineering curriculum.
- Establish technical specifications, and management plans, and work autonomously.
- Regular follow-up meeting organisation with the industrial/academic partners.
- Synthethise work progress and deliver both presentations and written reports.

Syllabus

First part : corresponds to "Phase 1"

Second part : Tasks completion, presentations and deliverables

- Team selection (with 4th year students), presentation of the previous work done and tasks allocation.
- Technical work realisation.
- Update on the advancement of the project with backup solutions if necessary.
- Deliverables including the final report and oral presentation of the final product/results.

Grading

Thesis, Oral exam

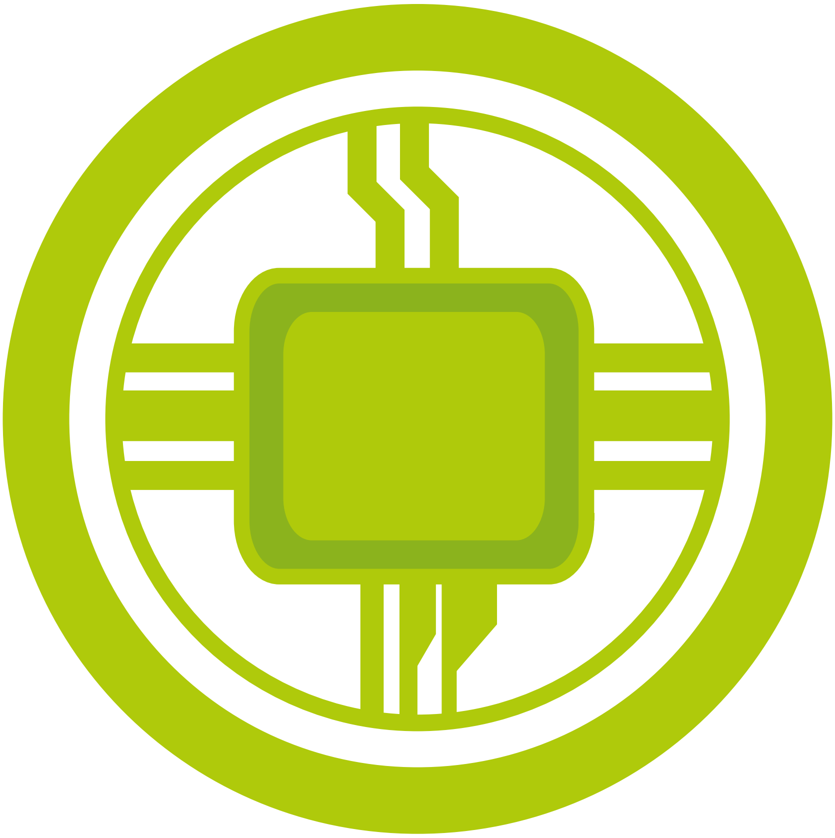
Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
0h00	10h00	0h00	3h45	0h00

In person teaching: 10h00

Taught in English:⚐⚐⚐ **SD/SR:** 🌍🌍🌍 **Innovation:** ✎✎✎

Physical Engineering and Embedded Systems (GPSE)



4th year courses

TU Code	Title of the Teaching Unit (TU)	Learning hours	ECTS
PHYSICAL ENGINEERING and EMBEDDED SYSTEMS (GPSE)		**594**	***60***
4th year GPSE 1st semester - S7		**339,5**	**30**
7HP01	Engineer's tools and personal and professional project	**32,5**	***3***
7HP02	English and science	**40**	***3***
7LVA1	Optional language (german)	**28**	***2****
7LVE1	Optional language (spanish)	**28**	***2****
7GP04	Microcontrollers	**100**	***8***
7GP05	Micro and nanotechnologies	**100**	***8***
7GP06	Environmental issues and technological innovations	**10**	***2***
7GP07	Engineering project - phase I	**55**	***6***
4th year GPSE 2nd semester - S8		**254,5**	***30***
8HP01	Business English	**40**	***4***
8HP02	Human resources management	**27,5**	***2***
8GP04	Internet of Things	**80**	***6***
8GP05	Laser - optronics - spectroscopy	**80**	***6***
8GP06	Engineering project - phase II	**25**	***5***
8STP2	Professional experience	**0**	***7***

Physical Engineering and Embedded Systems (GPSE) **7GP04** **Semester 7**

Microcontrollers

Supervisor: Rodolphe WEBER **ECTS: 8**

Skills

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

- To code a digital processing board, based on microcontrollers and peripherals with or without dedicated libraries
- To design an electronic board starting from the functional, power and mechanical constraints up to the validating tests
- To implement an automatic system in the hardware based on FSM or PID

Syllabus

Reminders on the prerequisites

- Digital number coding
- Analog and Digital electronics

Implementation of embedded systems

- Microprocessor and microcontroller architectures
- The cross-compilation process: from C code to microcontroller execution
- Implementations on Atmega and STM8 (interrupts, serial communications modes (UART, SPI, I2C), timers, ADC and other peripherals
- Software versioning through Git

System control

- finite State Machine (FSM)
- Implement a PID

Design an electronic board

- Design the architecture of the board according to the specifications and the component datasheets
- Design the electronic board with a CAD tool
- Make the board and test it

Grading

Written exam, Oral exam, Report

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
43h45	16h15	40h00	56h15	0h00

In person teaching: 100h00

Taught in English: 🏳🏳🏳 **SD/SR:** 🌍🌍 **Innovation:** 🖉🖉🖉

Physical Engineering and Embedded Systems (GPSE) **7GP05** **Semester 7**

Micro and nanotechnologies

Supervisor: Arnaud STOLZ **ECTS: 8**

Skills

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

- Propose a set of manufacturing steps for an integrated circuit or MEMS micro-device and implement it in a cleanroom environment using high-tech equipment
- Implement basic low pressure plasma processes in microelectronics
- Identify the most suitable materials or components for a given application

Syllabus

Microelectronics Technologies

Size definitions, vacuum generation, low pressure measurements for plasma reactors [Practical work: vacuum system management, reactor opening]
Clean room environment and processes: lithographs, thermal oxidation, annealing, diffusion. SEM, EDX and ellipsometry analyses [Practical work: mask design, process flow, cleanroom design and SEM]
Introduction to low pressure plasmas and interaction with a deposition and etching surface [Practical work: plasmas processes]
Introduction to lasers and interaction with matter for deposition and structuring

Physics and processes for components

Physics of components from the polarized PN junction to the CMOS transistor. Strengths and weaknesses of modern technologies (FinFET, FD-SOI), manufacturing
Schottky diode study from ST Microelectronics engineers
Components for power, photonics and quantum electronics [Practical work: process-flow]
Industrial seminars and company visits

Grading

Written exam, Oral exam, Report

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
56h30	20h00	23h30	17h30	0h00

In person teaching: 100h00

Taught in English: 🏳🏳 **SD/SR:** 🌍🌍 **Innovation:** 🖉🖉

Physical Engineering and Embedded Systems (GPSE) **7GP06** **Semester 7**

Environmental issues and technological innovations

Supervisor: Arnaud STOLZ **ECTS: 2**

Skills

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

- List the types of environmental impacts of a product, process, technology
- Identify local and global environmental issues
- Extract important issues from a complex digital issue
- Know the quantitative and qualitative approaches that reduce impacts

Syllabus

Planetary limits, bio-physico-chemical processes

Their definitions, follow-ups, global and local limits

Climate impact, carbon footprint

Greenhouse gases, emissions and sinks
Concept of functional unit

Life cycle, analysis of environmental impacts and their reductions

Environmental impacts of digital technologies: materials and energy
Eco-design methods

CSR, corporate social responsibility

The content, the practices

Mapping of controversies

The principle of studies of technical problems, of society by synthesizing what all the actors say and publish
Case studies of a digital technology, cross-presentations (practical work)

Grading

Written exam, Oral exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
1h00	5h00	4h00	15h00	0h00

In person teaching: 10h00

Taught in English: **SD/SR:** **Innovation:**

Physical Engineering and Embedded Systems (GPSE) **7GP07** **Semester 7**

Engineering project - phase I

Supervisor: Rodolphe WEBER **ECTS: 6**

Skills

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

- To write specifications, a functional analysis and a risk analysis within a system and/or project engineering approach
- To respond effectively to problems encountered during a pre-implementation phase
- To promote their work through a prototype, technical writing and presentation

Syllabus

Project management

- Take charge of a team project, dispatch the work according to team member skills, elaborate specifications and set up a planning
- Know the key points to carry out a good functional analysis - specification of the need, the validation plan and the risk analysis (courses and practical work carried out by an active project engineer). First steps towards a MBSE approach
- Preliminary Project Requirements: Audit by two professionals on the project set-up

Project Implementation

- Team work: bill of materials, orders, proof of concepts on technical key points
- Technical self-training if necessary (bibliography, software, experiments). Become autonomous
- AGILE approaches to assess the problems encountered and provide solutions quickly
- System Definition Review: Validation of the technical solutions

Prototype validation

- Writing an architecture document

Grading

Written exam, Oral exam, Report

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
8h45	7h30	7h30	61h15	32h15

In person teaching: 56h00

Taught in English:⚐⚐⚐ **SD/SR:** 🌍🌍 **Innovation:** ✎✎✎

Physical Engineering and Embedded Systems (GPSE) **8HP01** **Semester 8**

Business English

Supervisor: Isabelle BEN CHAABANE **ECTS: 4**

Skills

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

- Use English in the corporate world
- Reach the B2+ level

Syllabus

1 - Business English

Various activities involving the use of corporate vocabulary and skills:

- Job interview simulations
- Study of company organigrams, portraits of CEOs, management styles and corporate cultures
- Meetings and telephoning
- "Project": reading and study of a book in English dealing with societal and economic stakes

2 - TOEIC Preparation

2 mock TOEICs. Revision of key grammatical and lexical points

Grading

Written exam, Oral exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
0h00	0h00	40h00	0h00	0h00

In person teaching: 40h00

Taught in English:⚐⚐⚐ **SD/SR:** **Innovation:**

Physical Engineering and Embedded Systems (GPSE) **8GP04** **Semester 8**

Internet of Things

Supervisor: Rodolphe WEBER **ECTS: 6**

Skills

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

- To specify an IoT chain: from the embedded sensor to the server and from server to client
- To choose a radiocommunication protocol according to the constraints (bit rate, regulations, autonomy, range, quality, etc.)
- To analyze multidimensional data to extract valuable information (prediction, classification)

Syllabus

The challenges and technological elements of the IOT

- Introduction to Linux
- Introduction to Internet Network Management
- Introduction to Web service management
- Implementation on ESP32

IOT Communication protocols

- Principles and performances of digital modulations (source coding, channel coding, BPSK, QPSK, QAM, GFSK, TDMA, FDAM, CDMA, ...)
- Radio transmission (antennas, propagation, link budget)
- Radio communication protocols for IoT (WIFI, BLE, LORA, NB-IOT, ZigBee...) and implementation on ESP32

Multidimensional data processing and analysis

- The concepts and their implementation (ACP, ACF, SVM, supervised or unsupervised methods, CNN)

Grading

Written exam, Oral exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
41h15	17h30	21h15	37h30	0h00

In person teaching: 80h00

Taught in English: 🏳🏳🏳 **SD/SR:** 🌍 **Innovation:** 🖉🖉🖉

Physical Engineering and Embedded Systems (GPSE) **8GP05** **Semester 8**

Laser - optronics - spectroscopy

Supervisor: Titaina GIBERT **ECTS: 6**

Skills

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

- Use the most appropriate laser tool for the problem and the context
- Understand and choose an optical detector
- Implement optical spectroscopy
- Analyze and build a diode - fiber link

Syllabus

- The fundamentals of laser physics will lead the student to knowingly use the laser tool thanks in particular to a support of practical work.
- Addressing the different lasers as well as their specific properties gives a precise vision of the consequences on the beam which then allows to use it and also to define the choice of a tool to integrate on an experiment for example.
- The fiber optic diode system is a current case where it is important to understand the source and propagation of the guide. This makes it possible to implement the system whatever the application, from telecommunications to different sensors of all types.
- The keys for implementation and analysis of spectroscopic methods will be given from the reading of the tables to the understanding of the spectral lines. Examples of passive or active methods will be used as a basis for illustrating applications and their limitations.

Grading

Written exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
43h45	16h15	20h00	17h45	0h00

In person teaching: 80h00

Taught in English: ⚐ **SD/SR:** 🌍 **Innovation:** ✎✎

Physical Engineering and Embedded Systems (GPSE) **8GP06** **Semester 8**

Engineering project - phase II

Supervisor: Arnaud STOLZ **ECTS: 5**

Skills

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

- To produce a finalized prototype based on specifications, a functional analysis, a compliance matrix and a risk analysis,
- Develop a system and/or project engineering approach
- To promote their work through a a successful prototype, a technical writing and some presentations

Syllabus

Project management

- Establish the technical specifications and the distribution of work to achieve a finalized prototype
- Develop a business plan
- Critical design review: Audit by two professionals on the technical and organizational management of the project, analysis of the business plan

Project Implementation

- Team work: bill of materials, orders,
- Technical self-training if necessary (bibliography, software, experiments). Become autonomous
- AGILE approaches to assess the problems encountered and provide solutions quickly

Prototype validation

- Updating of the architecture documentation and drafting of a technical-commercial document
- Final Design Review: Technical-commercial defense in English
- Production of a video (making-of and marketing) and a poster, in English

Grading

Written exam, Oral exam, Report

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
2h30	0h00	7h30	81h15	15h00

In person teaching: 25h00

Taught in English: 🏳🏳 **SD/SR:** 🌍🌍 **Innovation:** ✏✏✏

Physical Engineering and Embedded Systems (GPSE) **8STP2** **Semester 8**

Professional experience

Supervisor: Arnaud STOLZ **ECTS: 7**

Skills

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

- Apply for a job offer with a company, community or lab
- Integrate into a work team and adopt business rules
- Working independently and being a force for proposal
- Participate in advancement meetings, if applicable, in a foreign language
- Communicate about your work synthetically in the form of a report and oral presentations

Syllabus

- Prior to the internship, the engineer-student initiates an autonomous process of research of internship adapted to his level of study and to these skills
- The engineer-student applies on internship offers by sending CVs/motivation letters and participates in job interviews
- The trainee integrates into a work team by appropriating and/or adapting the codes and methods recommended within the reception structure
- The trainee shall perform work at a level at least equivalent to that of an engineering assistant in the establishment which recruited him. He interacts with his pedagogical tutor on a regular basis by sending him short summary reports on the progress of his professional experience
- Candidate’s ability to meet expectations is assessed in oral and written form

Grading

Thesis, Oral exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
0h00	1h30	0h00	0h00	0h00

In person teaching: 1h30

Taught in English: **SD/SR:** **Innovation:**

Physical Engineering and Embedded Systems (GPSE) **8STP2** **Semester 8**

Professional experience

Supervisor: Rodolphe WEBER **ECTS : 7**

Skills

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

- Apply for a job offer with a company, community or lab
- Integrate into a work team and adopt business rules
- Working independently and being a force for proposal
- Participate in advancement meetings, if applicable, in a foreign language
- Communicate about your work synthetically in the form of a report and oral presentations

Syllabus

- Prior to the internship, the engineer-student initiates an autonomous process of research of internship adapted to his level of study and to these skills
- The engineer-student applies on internship offers by sending CVs/motivation letters and participates in job interviews
- The trainee integrates into a work team by appropriating and/or adapting the codes and methods recommended within the reception structure
- The trainee shall perform work at a level at least equivalent to that of an engineering assistant in the establishment which recruited him. He interacts with his pedagogical tutor on a regular basis by sending him short summary reports on the progress of his professional experience
- Candidate's ability to meet expectations is assessed in oral and written form

Grading

Thesis, Oral exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
0h00	1h30	0h00	0h00	0h00

In person teaching: 1h30

Taught in English: **SD/SR:** **Innovation:**

5th year courses

TU Code	Title of the Teaching Unit (TU)	Learning hours	ECTS
PHYSICAL ENGINEERING and EMBEDDED SYSTEMS (GPSE)		**440,75**	***60***
5th year GPSE 1st semester - S9		**273,75**	**30**
1 English Teaching Unit according to validated TOEIC level			
9HP02	Intercultural communication	**22,5**	***2***
9HP03	Intercultural communication debating society	**10**	***2***
9LVA1	German (not for beginners)	**28**	***2****
9LVE1	Spanish (not for beginners)	**28**	***2****
9GP05	Computer Vision & Lighting	**56,25**	***7***
9GP06	Specialisation in photonics, plasma or embedded systems I	**95**	***12***
9GP07	Engineer project - Phase 1	**100**	***9***
5th year GPSE 2nd semester - S10		**167**	**30**
To be chosen function of S9			
AHP01	Operational management	**36,25**	***2***
AGP02	Engineer project - Phase 2	**70**	***3***
AGP04	Specialisation in photonics, plasma or embedded systems II	**58,75**	***5***
AGP03	Engineer project	**170**	***10***
ASTP1	Professional engineering internship	**0**	***20***

Physical Engineering and Embedded Systems (GPSE) **9GP05** **Semester 9**

Computer Vision & Lighting

Supervisor: Sylvie TREUILLET **ECTS: 7**

Skills

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

- Compute the threshold contrast of visibility (Adrian model) and design a public lighting optic respecting the EN 13201 standard
- Evaluate a vision problem of medium complexity and find solutions through existing libraries (OpenCV, MATLAB, ImageJ, etc.)

Syllabus

Discover an application through practice and learn how to solve it by using existing software (ImageJ, MATLAB, TracePro, DIALux evo, OpenCV, etc.), develop self-learning through a list of questions and points to look for, tests to perform, and report the results with comments on the acquired knowledge

Lighting

- Threshold contrast and visibility of an object
- Public lighting standards 13201
- Lighting project: R factor method
- Design of a public lighting optic

Computer Vision

- Basics in image processing (histogram, contrast enhancement, thresholding, filtering, segmentation, mathematical morphology)
- Basics in geometric and embedded vision (calibration, 3D localization)
- Basics in shape analysis

Grading

Written exam, Oral exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
13h45	1h15	41h15	13h45	0h00

In person teaching: 56h15

Taught in English: 🏳🏳 **SD/SR:** 🌍 **Innovation:** ✎

Physical Engineering and Embedded Systems (GPSE) **9GP06** **Semester 9**

Specialisation in photonics, plasma or embedded systems I

Supervisor: Rémi DUSSART **ECTS: 12**

Skills

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

- Specialization in Engineering Physics (GP): Analyze the physical mechanisms in low pressure DC and RF plasmas. Use and control lasers and optical systems for material processing or optoelectronics
- Specialization in Embedded Systems (SE): Implement automatic vision and machine learning techniques. Manipulate threads. Choosing encryption techniques
- Develop technical and scientific expertise on a topic proposed by the teaching team
  Develop self-training strategies

Syllabus

Plasma and Photonic Engineering (GP)

- General properties of plasmas (distribution function, collisions, waves in plasmas)
  DC discharge, DC and RF sheaths, diffusion, global model, Langmuir probe
  Yag laser, frequency modulation and doubling, fiber lasers and femtoseconds
  Optical spectroscopy, optoelectronics and optical detectors
- 2 topics to choose from: Impulsive nitrogen laser/ DC discharge/ RF discharge/ Laser induced fluorescence/ Plasma jets/ Microdischarges/ Plasma deposition and engraving

Embedded Systems (SE)

- Specific Hardware Architecture (FPGA, GPU)
- Computer vision and machine learning
- Multithreading
- Introduction to encryption techniques
- 1 topic to choose: Linux system on a microcontroller with YOCTO/ Digital filtering on a Xilinx FPGA (Zybo 7020 board)/ image processing techniques on PC or GPU (OpenCV)/ machine learning techniques on PC or GPU/ cybersecurity techniques on a microprocessor (TrustZonz, SecureBoot)

Grading

Written exam, Oral exam, Report

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
2h30	0h00	150h00	161h15	36h00

In person teaching: 188h30

Taught in English: 🏳🏳🏳 **SD/SR:** 🌍 **Innovation:** 🖉🖉🖉

Physical Engineering and Embedded Systems (GPSE) **9GP07** **Semester 9**

Engineer project - Phase 1

Supervisor: Aladine CHETOUANI **ECTS: 9**

Skills

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

- Manage a project to address a concrete problem of a company, a design office or a laboratory in the field of engineering physics or embedded systems
- Lead a project in different phases: preparation-design, execution-production
- Mastering project management methods
- Know how to organize the time of a project until the presentation of results
- Perform or optimize an industrial process, calculation or characterization method

Syllabus

- Presentation of the project and definition of the objectives with a teacher who proposes the specifications with a representative of the company/laboratory
- Document analysis and consideration of project constraints and specification
  Language monitoring by an English teacher
- Definition of a work schedule
  Implementation of different parts of the work
  Presentation of results during an oral defense

Grading

Thesis, Oral exam, Report

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
1h15	0h00	0h00	7h30	17h15

In person teaching: 18h30

Taught in English: 🏳🏳 **SD/SR:** 🌍🌍 **Innovation:** 🖉🖉🖉

Physical Engineering and Embedded Systems (GPSE) **AGP02** **Semester 10**

Engineer project - Phase 2

Supervisor: Aladine CHETOUANI **ECTS: 3**

Skills

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

- Manage a project to address a concrete problem of a company, a design office or a laboratory in the field of engineering physics or embedded systems
- Lead a project in different phases: preparation-design, execution-production
- Mastering project management methods
- Know how to organize the time of a project until the presentation of results
- Perform or optimize an industrial process, calculation or characterization method

Syllabus

- Presentation of the project and definition of the objectives with a teacher who proposes the specifications with a representative of the company/laboratory
- Document analysis and consideration of project constraints and specification
  Language monitoring by an English teacher
- Definition of a work schedule
  Implementation of different parts of the work
  Presentation of results during an oral defence

Grading

Thesis, Oral exam, Report

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
0h00	0h00	0h00	15h00	1h00

In person teaching: 1h00

Taught in English:🏳🏳 **SD/SR:** 🌍🌍 **Innovation:** ✏✏✏

Physical Engineering and Embedded Systems (GPSE) **AGP04** **Semester 10**

Specialisation in photonics, plasma or embedded systems II

Supervisor: Sylvie TREUILLET **ECTS: 5**

Skills

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

- Evaluate a vision problem of medium complexity and find solutions through existing libraries (OpenCV, MATLAB, ImageJ, etc.)
- Develop technical and scientific expertise on a topic proposed by the teaching team
- Adopt an Agile method in dialogue with the tutor to adapt to the problems encountered and provide answers
- Develop self-training strategies
- Deliver an operational version that meets the needs

Syllabus

Discover an application through practice and learn how to solve it by using existing software (imageJ, MATLAB, TracePro, Dialux EVO, OpenCV, etc.), develop self-learning through a list of questions and points to look for, tests to perform, and report the results with comments on the knowledge acquired

Computer vision

Basics in shape analysis

Practical work in Engineering Physics

2 topics to choose from: Impulsive nitrogen laser/ DC discharge/ RF discharge/ Laser induced fluorescence/ Plasma jets/ Microdischarges/ Plasma deposition and engraving

Practical work in Embedded Systems

1 topic to choose: Linux system on a microcontroller with YOCTO/ Digital filtering on a Xilinx FPGA (Zybo 7020 board)/ image processing techniques on PC or GPU (OpenCV)/ machine learning techniques on PC or GPU/ cybersecurity techniques on a microprocessor (TrustZonz, SecureBoot)

Grading

Written exam, Oral exam, Report

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
0h00	0h00	18h45	131h15	41h00

In person teaching: 59h45

Taught in English: 🏳🏳🏳 **SD/SR:** 🌍 **Innovation:** ✎✎

Physical Engineering and Embedded Systems (GPSE) **AGP03** **Semester 10**

Engineer project

Supervisor: Aladine CHETOUANI **ECTS: 10**

Skills

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

- Manage a project to address a concrete problem of a company, a design office or a laboratory in the field of engineering physics or embedded systems
- Lead a project in different phases: preparation-design, execution-production
- Mastering project management methods
- Know how to organize the time of a project until the presentation of results
- Perform or optimize an industrial process, calculation or characterization method

Syllabus

- Presentation of the project and definition of the objectives with a teacher who proposes the specifications with a representative of the company/laboratory
- Document analysis and consideration of project constraints and specification
  Language monitoring by an English teacher
- Definition of a work schedule
  Implementation of different parts of the work
  Presentation of results during an oral defense

Grading

Thesis, Oral exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
0h00	0h00	0h00	15h00	16h00

In person teaching: 16h00

Taught in English: ⚐⚐⚐ **SD/SR:** 🌍🌍 **Innovation:** 🖉🖉

Physical Engineering and Embedded Systems (GPSE) **ASTP1** **Semester 10**

Professional engineering internship

Supervisor: Sylvie TREUILLET **ECTS: 20**

Skills

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

- Apply for a job offer with a company, community or lab
- Integrate into a work team and adopt business rules
- Working independently and being a force for proposal
- Participate in advancement meetings, if applicable, in a foreign language
- Communicate about your work synthetically in the form of a report and oral presentations

Syllabus

- Prior to the internship, the engineer-student initiates an autonomous process of research of internship adapted to his level of study and to these skills
- The engineer-student applies on internship offers by sending CVs/motivation letters and participates in job interviews
- The trainee integrates into a work team by appropriating and/or adapting the codes and methods recommended within the reception structure
- The trainee shall perform work at a level at least equivalent to that of an engineer in the company. He interacts with his pedagogical tutor on a regular basis by sending him short summary reports on the progress of his professional experience
- Candidate's ability to meet expectations is assessed in oral and written form

Grading

Thesis, Oral exam

Learning hours

Lectures	Tutorials	Lab sessions	Free labs	Project
0h00	3h00	0h00	0h00	0h00

In person teaching: 3h00

Taught in English: 🏳 **SD/SR:** 🌍 **Innovation:** ✎✎

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