Semesters

Semester 5				
TEACHING UNIT	**ECTS**	**TEACHING UNIT COMPONENT**	**Content**	**TEACHING HOURS**
Electrical Engineering S5	3	**Electrical Machines**	Description : This course provides engineering students with in-depth knowledge of electrical machines theories. It teaches the students the necessary techniques of solving problems. The concept of magnetic field and the principle of operation of machines are covered. DC machines, their construction, their operation and their equivalent model are studied in depth. The principle of rotating magnetic field and AC machinery are underlined. AC machines including three-phase Synchronous machines and three-phase induction machines are explained. Analysis and calculations to find the voltage regulation and efficiency of a machine at a certain load are included. The different applications of each machine are studied as well. o Introduction to Machinery Principles: Rotational Notions, The Magnetic Field, Magnetic Circuit, Voltage & Torque Equations, Magnetic Losses o DC Machines Construction : Simplest DC Machine (1 loop), Armature Construction, Commutation in a 4 Loop DC Machine, Lap & Wave Windings, Problems & Solutions in Real DC Machines, Voltage & Torque Equations, Losses in DC Machines o DC Motors: Separately Excited & Shunt (Parallel) DC Motor, Series DC Motor & Compounded DC Motor, DC Motors Starting, DC Motors Applications & Test Procedures, DC Generators o Principle of Rotating Magnetic Field: Rotating Magnetic Field, Electrical & Mechanical Quantities, Magnetomotive Force and Flux Distribution, Induced Voltage & Torque in AC Machines, Winding Insulation & AC Machine Losses, Voltage Regulation & Speed Regulation o Synchronous Machines: Synchronous Generator Model, Synchronous Generator Operating Alone, Parallel Operation of Synchronous Generators, Control of Parallel Generators, Synchronous Motor Model, Synchronous Motor: Load and Field Effects, Starting Synchronous Motors o Induction Machines: Induction Motor Construction, Induction Motor Concepts & Model, IM Torque Speed Characteristic, IM Rotor Design, IM Starting, Induction Generator	Lectures : 14h00 Tutorials : 14h00 Lab Work : 8h00
Industrial Organisation S5	6	**Industrial Methods**	Description : • Processes for the transformation and processing of metallic and plastics materials. • Introduction to unconventional and CNC (Computer Numerical Control) Manufacturing processes. • Study of workpiece fixturing and development of machining process planning for mechanical parts.	Lectures : 8h00 Tutorials : 10h00
		Industrial Organisation	Description : • Problem solving metholology and related tools (PDCA, 5W2H, Pareto, Ishikawa, risks analysis, 5 Whys & Action Plan) • Industrial Planning management • Manufacturing flows and technical data (Bill of Materials, routing sheet) • Plant implementation and workstation study • Calculation of direct product costs • The MRP2 system with its 3 levels: S&OP (Sales & Operations Planning), determination of the MPS (Master Production Schedule), load calculations and introduction to MRP (Materials Requirements Planning). Link with capacity planning. • Lean Management • TPM: OEE, OOE, 6 major losses • Basics of inventory management • VSM • FMECA	Lectures : 16h00 Tutorials : 16h00
Mathematics for Engineering S5	7	**Mathematics for Engineers 5**	Description : * Lebesgue integration and Hilbert Spaces - Parameter dependant integrals. * Fourier Series * Fourier Transform * Laplace Transform * Some Classical examples in Partial Differential Equations * optimization: non linear optimization (unconstrained and constrained optimisation for functions of several variables) linear optimisation (simplex method)	Lectures : 30h00 Tutorials : 30h00

Semester 5				
TEACHING UNIT	**ECTS**	**TEACHING UNIT COMPONENT**	**Content**	**TEACHING HOURS**
		Networks & Security	Description : 1 - Understand the fundamentals of computer networks, including their historical context and various use cases. 2 - Learn about the client/server model of communication, network components, and infrastructure. 3 - Gain knowledge of communication protocols and their specifications, as well as TCP/IP and OSI models for communication. 4 - Understand addressing schemes at layer 2 (MAC Address) and layer 3 (IP Address), frames and packet processing, and the role of end devices and intermediary devices in network communication. 5 - Gain an in-depth understanding of communication on local and remote networks, including the Address Resolution Protocol (ARP). 6 - Understand the critical aspect of information system security and learn about internal and external threats to information systems. 7 - Learn about cryptographic schemes to encrypt and decrypt data, as well as the Information Systems Security Policy (ISSP). 8 - Gain knowledge of the General Data Protection Regulation (GDPR) and its impact on data protection and privacy for individuals in the EU and EEA.	Lectures : 20h00 Tutorials : 6h00 Lab Work : 8h00
Mechanical Engineering S5	7	**Introduction to Heat Transfer**	Description : - General introduction : fundamentals of heat transfer, heat transfer mechanisms, relationship to thermodynamics, methodology of analysis. - Fundamentals of conduction : Heat conduction equation, Fourier's law, one-dimensional heat conduction equation solutions with/without heat generation, variable thermal conductivity, boundary and initial conditions. - Steady heat conduction : heat conduction in plane walls, cylinder wall and spherical shell, thermal resistance concept, generalized thermal resistance network, notion of thermal contact temperature, critical radius of insulation, heat transfer from finned surfaces. - Fundamentals of convection : physical mechanisms, hydrodynamic/thermal boundary layer equations, Nusselt and Prandtl numbers, boundary layer similarity, Reynolds analogy. - External forced convection : laminar and turbulent flow, heat transfer correlations for the parallel flow over flat plates and the flow over cylinders and spheres, flow across tube banks. - Internal forced convection : laminar and turbulent flow in tube, thermal entry length, general thermal analysis, log mean temperature difference, heat transfer correlations for circular/non-circular tubes. - Introduction to radiation: spectral and directional distribution, notion of solid angle, blackbody radiation, Stefan-Boltzmann law, emission from real surfaces, radiative properties (emissivity, absorptivity, transmittivity, reflectivity), Kirchoff's laws.	Lectures : 12h00 Tutorials : 12h00 Lab Work : 8h00
		Materials 2	Description : 1. Diffusion • Mechanisms of Diffusion • Diffusion Flux • Factors of Diffusion 2. Phase Diagrams I • Microstructure • Equilibrium and Non-Equilibrium Cooling 3. Phase Diagrams II • Binary Eutectic Systems • Hypoeutectic and Hypereutectic • Relative Amounts in the Micro-constituents • Equilibrium and Non-Equilibrium Cooling of Binary Systems	Lectures : 6h00 Tutorials : 6h00 Lab Work : 12h00

Semester 5				
TEACHING UNIT	**ECTS**	**TEACHING UNIT COMPONENT**	**Content**	**TEACHING HOURS**
		Strength of Materials	Description : - Introduction: review of Statics and Solid Mechanics (stress and strain) - Axial loads: stress concentrations, stresses due to temperature change, solutions of hyperstatic systems - Torsional loads: torsion of shafts due to applied torques, design of transmission shafts, stress concentrations - Analysis of beams under later loads: shear and moment diagrams - Pure bending of beams: normal stresses, properties of cross-sections - Deflection of beams: elastic curve equation, resolution of hyperstatic systems	Lectures : 12h00 Tutorials : 12h00 Lab Work : 8h00
Multidisciplinary Project S5	3	**Ecodesign Project Part 1 - Environnement**	Description : The project contains 3 expected content types: courses & tutorials, project sessions (labs), and personal work. Content of Semester 5: 1. Courses & tutorials: basics of environmental evaluation & LCA. - Courses topics: global environmental issues, impacts and indicators, life cycle thinking, environmental evaluation using LCA - Tutorials on Simapro 2. Project sessions (labs) supervised by the teacher. - Energy measurements: data acquisition using a data logger - Dismantling (tools available) and BoM definition - Life cycle modelling on Simapro 3. Personal work: information search, interpretation of LCA results. Content of semester 6: 1. Courses & tutorials: Ecodesign approaches and strategies. - Courses topics: Ecodesign regulations & strategies, Materials & environment, Design for Sustainable behaviour, Thermal insulation & downsizing, Ecodesign of packaging, design for End-of-life, Innovation for ecodesign. - Tutorials: CES EduPack (choice of materials), Simapro, CREO (CAD modelling) 2. Project sessions (labs) supervised by the teacher: Developing 3 levels of ecodesigned solutions - Solutions developments: calculations, CAD modelling, LCA modelling of the 3 levels 3. Personal work: information search, interpretation of LCA results.	Lectures : 5h00 Tutorials : 10h00 Project : 4h00
		Ecodesign Project Part 1 - Technical	Description : The project contains 3 expected content types: courses & tutorials, project sessions (labs), and personal work. For each semester, this projects represents ~40h of work on-site + 20h-30h of personal work. The total workload for each semester is estimated to 60- 70h/student.	Lectures : 3h00 Lab Work : 8h00 Project : 2h00
Society, Management & Entrepreneurship 5	4	**Engineering Ethics**	Description :	Lectures : 4h00 Project : 8h00
		French as a Foreign Language	Description : 6 hour lessons every week : 4h face-to-face +2h guided autonomy Expanded vocabulary Introduction of grammar points Improvement of phonological control A1 Can establish basic social contact by using the simplest everyday polite forms of: greetings and farewells; introductions; saying please, thank you, sorry etc.	Lab Work : 21h00
Semester 5	30			

Semester 6_Mechanical Engineering				
TEACHING UNIT	**ECTS**	**TEACHING UNIT COMPONENT**	**Content**	**TEACHING HOURS**
Control Engineering S6	6	**Introduction to Control Theory**	Description : 1. Introduction to continuous Linear Time-Invariant (LTI) systems 2. Mathematical models of LTI systems 3. Block diagram and the reduction rules 4. Time-domain analysis of a first order system 5. Time domain analysis of a second order system 6. PID controllers for TLI systems	Lectures : 14h00 Tutorials : 10h00 Lab Work : 8h00
		Power Electronics	Description : This course introduces a comprehensive overview of different power electronics components and applications. It presents the basics of devices, their characteristics, their principle of operation, and their range of applications as well. The course also underlines the principle of operation of converters used in DC drives (diodes rectifiers, controlled rectifiers and choppers). It discusses the principle of harmonics, performance parameters and filtering techniques. Furthermore, upon completion of this course, the student will be able to outline the characteristics and operation principle of power AC drives (inverters and AC-AC controllers). Mainly full bridge and three phase circuits are highlighted. The effect of inductive loads and protection schemes are discussed as well. The student will understand and be able to describe switching techniques and conduct both performance and harmonical studies. The student will be able to demonstrate a certain familiarity with the various configurations and applications and to develop models and simulations. o Introduction & Basics in Power Electronics: Purpose, History &Application, Devices & Circuits Characteristics, Ideal and Practical device, Semi-conductors basics o Conversion Basics & Diodes Rectifiers : Conversion Circuits Types, Switching Sequence & Methodology, Protection, Performance Parameters, FW SP Diode Rectifier, FW 3P Diode Rectifier o Controlled Rectifiers & DC/DC converters: FW SP Controlled Rectifier, FW 3P Controlled Rectifier, o Introduction to DC-DC drives: Buck Converter, Boost Converter, Buck Regulator, Other topologies o DC/AC Conversion: Introduction to AC Drives, SP Full Bridge Inverter, 3P Full Bridge Inverter o AC-AC Conversion: R Load	Lectures : 10h00 Tutorials : 6h00 Lab Work : 8h00
Mathematics for Engineering S6	6	**Mathematics for Engineers**	Description : Introduction to statistics and probability - Graphical Tools to represent data Meaningful Values Probability Theory Common Discrete and Continuous Probability Distributions Convergence Theorems Sampling Estimations and Confidence intervals Statistical Tests Comparison of Normal Distributions Normality Assumption checking Homogeneity of a population: ANOVA Chi-Square test Correlation and linear regression	Lectures : 16h00 Tutorials : 16h00
		Object-Oriented Programming	Description : Basics of Java Introduction to Object Oriented Programming Classes and Methods Inheritance Standard Library of Java	Lectures : 6h00 Tutorials : 4h00 Lab Work : 12h00 Project : 8h00

Semester 6_Mechanical Engineering				
TEACHING UNIT	**ECTS**	**TEACHING UNIT COMPONENT**	**Content**	**TEACHING HOURS**
Mechanical Engineering S6	8	**Advanced Heat Transfer**	Description : 12 hours (lecture), 12 hours (tutorial) - Steady Heat conduction : heat transfer in common configuration, conduction shape factors. - Transient conduction : lumped system analysis, Biot number, transient heat conduction in large plane walls, long cylinders, and spheres with spatial effects, transient heat conduction in semi-infinite solids. - Numerical methods in heat conduction : finite difference formulation of differential equations, two-dimensional steady heat conduction. - Natural convection : physical mechanisms, equation of motion and the grashof number, natural convection over surfaces, natural convection inside enclosures, combined natural and forced convection. - Boiling and condensation : boiling heat transfer, pool Boiling, flow boiling, condensation heat transfer, film condensation, dropwise condensation - Heat exchangers : heat exchanger types, overall heat transfer coefficient, the log mean temperature difference, the effectiveness-NTU method, heat exchanger design and performance calculations. - Radiation heat transfer : the view factor, view factor relations, black surfaces, diffuse and gray surfaces, radiation shields and the radiation effect.	Lectures : 12h00 Tutorials : 12h00
		Hydraulics	Description : - Hydraulic networks: fundamentals of fluid flow in pipes, major and minor and head loss, system head, branches in parallel and series. - Pumping systems: classification of pumps, operation of dynamic pumps, pump main parameters, pump performance curves, pumps combined in series and parallel, matching a pump to a piping system, cavitation and net positive-suction head, dimensionless pump performance, similarity rules, specific speed, adaptation of operating conditions. - Hydraulic power systems: Fundamentals of Hydraulic Power Transmission, hydraulic power generation, positive displacement pumps (design and performance), hydraulic power distribution (hydraulic valves: types, design and function), hydraulic power deployment (hydraulic cylinders, hydraulic motors, hydrostatic transmission), hydraulic circuits.	Lectures : 10h00 Tutorials : 10h00
		Materials 3	Description : 1. Introduction to Phase Transformation • Processes and Types of Phase Transformation • Types of Nucleation • Phase Transformation Rate 2. Part 1: Heat Treatment • Equilibrium and Non-equilibrium States • Eutectoid, Hypereutectoid and Hypoeutectoid Points • Martensite Transformation 3. Part 2: Heat Treatment • Mechanical Properties of Martensite • Tempering of Steel Alloys • Continuous Cooling Transformation Diagrams 4. Structural Hardening of Aluminum • Equilibrium Diagram of Aluminum Alloys • Heat Treatments of Aluminum Alloys 5. Corrosion • Redox Reactions • Types of Corrosion • Methods for Corrosion Prevention	Lectures : 10h00 Tutorials : 10h00 Lab Work : 12h00

Semester 6_Mechanical Engineering				
TEACHING UNIT	**ECTS**	**TEACHING UNIT COMPONENT**	**Content**	**TEACHING HOURS**
Multidisciplinary Project S6	3	**Ecodesign Project Part 2 - Environment**	Description : The project contains 3 expected content types: courses & tutorials, project sessions (labs), and personal work. For each semester, this projects represents ~40h of work on-site + 20h-30h of personal work. The total workload for each semester is estimated to 60- 70h/student. Content of semester 6: 1. Courses & tutorials: Ecodesign approaches and strategies. - Courses topics: Ecodesign regulations & strategies, Materials & environment, Design for Sustainable behaviour, Thermal insulation & downsizing, Ecodesign of packaging, design for End-of-life, Innovation for ecodesign. - Tutorials: CES EduPack (choice of materials), Simapro, CREO (CAD modelling) 2. Project sessions (labs) supervised by the teacher: Developing 3 levels of ecodesigned solutions - Solutions developments: calculations, CAD modelling, LCA modelling of the 3 levels 3. Personal work: information search, interpretation of LCA results.	Lectures : 3h00 Tutorials : 4h00 Project : 8h00
		Ecodesign Project Part 2 - Technical	Description : The project contains 3 expected content types: courses & tutorials, project sessions (labs), and personal work. For each semester, this projects represents ~40h of work on-site + 20h-30h of personal work. The total workload for each semester is estimated to 60- 70h/student. Content of semester 6: 1. Courses & tutorials: Ecodesign approaches and strategies. - Courses topics: Ecodesign regulations & strategies, Materials & environment, Design for Sustainable behaviour, Thermal insulation & downsizing, Ecodesign of packaging, design for End-of-life, Innovation for ecodesign. - Tutorials: CES EduPack (choice of materials), Simapro, CREO (CAD modelling) 2. Project sessions (labs) supervised by the teacher: Developing 3 levels of ecodesigned solutions - Solutions developments: calculations, CAD modelling, LCA modelling of the 3 levels 3. Personal work: information search, interpretation of LCA results.	Lectures : 3h00 Tutorials : 2h00 Project : 8h00
Society, Management & Entrepreneurship 6	4	**French as a Foreign Language**	Description :	Lab Work : 21h00
		Global affairs	Description :	Lectures : 4h00 Project : 10h00
		Principles of Marketing	Description : This course is designed to provide with students with an introduction to the marketing system. They will be exposed to the major concepts of marketing known as the marketing mix or 4 P's (product, place, price, and promotion). The course presumes no prior understanding of marketing, provides a complete overview of the marketing process, and touches on a variety of topics. Students will gain a sound understanding of the core concepts in marketing and its role in business and consumers' lives.	Lectures : 6h00 Project : 8h00
Systems Engineering S6	3	**Quality**	Description : Introduction to Quality, its history and evolution. Learn about quality management with the main tools related to it. Analysis and understanding of the ISO 9001 standard, its purpose, context and stakes. Audit: Preparing and conducting an Audit. QRQC : Operational method of quality management and problem solving. Discovery and appropriation of A3 and Kanban communication tools. Experience plan: Initiation to the PEX tool, mathematical approach and method.	Lectures : 8h00 Tutorials : 10h00

Semester 6_Mechanical Engineering				
TEACHING UNIT	**ECTS**	**TEACHING UNIT COMPONENT**	**Content**	**TEACHING HOURS**
		Vibrations	Description : The course resumes the basics of vibration analysis. At first the vibration analysis and its matrix formalism is presented and applied at two degrees of freedom systems. Then, damping and vibration isolation is presented. Exercises are done after each notion to put into practice formula and method introduced in the course.	Lectures : 12h00 Tutorials : 4h00 Lab Work : 4h00
Semester 6_Mechanical Engineering	30			
Semester 6_Robotique and Automation				
TEACHING UNIT	**ECTS**	**TEACHING UNIT COMPONENT**	**Content**	**TEACHING HOURS**
Control Engineering S6	6	**Introduction to Control Theory**	Description : 1. Introduction to continuous Linear Time-Invariant (LTI) systems 2. Mathematical models of LTI systems 3. Block diagram and the reduction rules 4. Time-domain analysis of a first order system 5. Time domain analysis of a second order system 6. PID controllers for TLI systems	Lectures : 14h00 Tutorials : 10h00 Lab Work : 8h00
		Power Electronics	Description : This course introduces a comprehensive overview of different power electronics components and applications. It presents the basics of devices, their characteristics, their principle of operation, and their range of applications as well. The course also underlines the principle of operation of converters used in DC drives (diodes rectifiers, controlled rectifiers and choppers). It discusses the principle of harmonics, performance parameters and filtering techniques. Furthermore, upon completion of this course, the student will be able to outline the characteristics and operation principle of power AC drives (inverters and AC-AC controllers). Mainly full bridge and three phase circuits are highlighted. The effect of inductive loads and protection schemes are discussed as well. The student will understand and be able to describe switching techniques and conduct both performance and harmonical studies. The student will be able to demonstrate a certain familiarity with the various configurations and applications and to develop models and simulations. o Introduction & Basics in Power Electronics: Purpose, History &Application, Devices & Circuits Characteristics, Ideal and Practical device, Semi-conductors basics o Conversion Basics & Diodes Rectifiers : Conversion Circuits Types, Switching Sequence & Methodology, Protection, Performance Parameters, FW SP Diode Rectifier, FW 3P Diode Rectifier o Controlled Rectifiers & DC/DC converters: FW SP Controlled Rectifier, FW 3P Controlled Rectifier, o Introduction to DC-DC drives: Buck Converter, Boost Converter, Buck Regulator, Other topologies o DC/AC Conversion: Introduction to AC Drives, SP Full Bridge Inverter, 3P Full Bridge Inverter o AC-AC Conversion: R Load	Lectures : 10h00 Tutorials : 6h00 Lab Work : 8h00
Mathematics for Engineering S6	6	**Mathematics for Engineers**	Description : Introduction to statistics and probability - Graphical Tools to represent data Meaningful Values Probability Theory Common Discrete and Continuous Probability Distributions Convergence Theorems Sampling Estimations and Confidence intervals Statistical Tests Comparison of Normal Distributions Normality Assumption checking Homogeneity of a population: ANOVA Chi-Square test Correlation and linear regression	Lectures : 16h00 Tutorials : 16h00

Semester 6_Robotique and Automation				
TEACHING UNIT	**ECTS**	**TEACHING UNIT COMPONENT**	**Content**	**TEACHING HOURS**
		Object-Oriented Programming	Description : Basics of Java Introduction to Object Oriented Programming Classes and Methods Inheritance Standard Library of Java	Lectures : 6h00 Tutorials : 4h00 Lab Work : 12h00 Project : 8h00
Multidisciplinary Project S6	3	**Ecodesign Project Part 2 - Environment**	Description : The project contains 3 expected content types: courses & tutorials, project sessions (labs), and personal work. For each semester, this projects represents ~40h of work on-site + 20h-30h of personal work. The total workload for each semester is estimated to 60- 70h/student. Content of semester 6: 1. Courses & tutorials: Ecodesign approaches and strategies. - Courses topics: Ecodesign regulations & strategies, Materials & environment, Design for Sustainable behaviour, Thermal insulation & downsizing, Ecodesign of packaging, design for End-of-life, Innovation for ecodesign. - Tutorials: CES EduPack (choice of materials), Simapro, CREO (CAD modelling) 2. Project sessions (labs) supervised by the teacher: Developing 3 levels of ecodesigned solutions - Solutions developments: calculations, CAD modelling, LCA modelling of the 3 levels 3. Personal work: information search, interpretation of LCA results.	Lectures : 3h00 Tutorials : 4h00 Project : 8h00
		Ecodesign Project Part 2 - Technical	Description : The project contains 3 expected content types: courses & tutorials, project sessions (labs), and personal work. For each semester, this projects represents ~40h of work on-site + 20h-30h of personal work. The total workload for each semester is estimated to 60- 70h/student. Content of semester 6: 1. Courses & tutorials: Ecodesign approaches and strategies. - Courses topics: Ecodesign regulations & strategies, Materials & environment, Design for Sustainable behaviour, Thermal insulation & downsizing, Ecodesign of packaging, design for End-of-life, Innovation for ecodesign. - Tutorials: CES EduPack (choice of materials), Simapro, CREO (CAD modelling) 2. Project sessions (labs) supervised by the teacher: Developing 3 levels of ecodesigned solutions - Solutions developments: calculations, CAD modelling, LCA modelling of the 3 levels 3. Personal work: information search, interpretation of LCA results.	Lectures : 3h00 Tutorials : 2h00 Project : 8h00
Robotics & Automation Engineering S6	8	**Introduction to Robotics**	Description : -Introduction to robotic systems and controllers -Robots in their contexts -Mechanical structures: serial and parallel robots, mobile robots -Forward, Inverse and Differential Kinematics for Robot Arm -Differential Drive robots -Motion planning for mobile robot (Dijkstra, A*) -Practical introduction to robot programming (mBot, poppy)	Lectures : 10h00 Tutorials : 12h00 Lab Work : 8h00
		Sensing & Perception	Description : -Inertial sensors, GPS and odometry / sonar sensing / vision, bio-inspired sensors, force sensors -Transformation of information into electric properties and its implication -Signal conditioning -ADC: sampling, quantization, windowing -MCU: Application of data acquisition, data analysis, data processing -Introduction to image processing	Lectures : 8h00 Tutorials : 4h00 Lab Work : 12h00

Semester 6_Robotique and Automation				
TEACHING UNIT	**ECTS**	**TEACHING UNIT COMPONENT**	**Content**	**TEACHING HOURS**
		Signal Processing Wireless Communications	Description : -Signals: general properties and transformations (convolution…) -Spectral analysis (DFT, FFT…) -Sampling -Signals and systems (stability, causality…) -Filters (FIR, IIR) -Random signals (autocorrelation, intercorrelation…) -Time-frequency analysis -Image processing	Lectures : 12h00 Tutorials : 12h00 Lab Work : 8h00
Society, Management & Entrepreneurship 6	4	**French as a Foreign Language**	Description :	Lab Work : 21h00
		Global affairs	Description :	Lectures : 4h00 Project : 10h00
		Principles of Marketing	Description : This course is designed to provide with students with an introduction to the marketing system. They will be exposed to the major concepts of marketing known as the marketing mix or 4 P's (product, place, price, and promotion). The course presumes no prior understanding of marketing, provides a complete overview of the marketing process, and touches on a variety of topics. Students will gain a sound understanding of the core concepts in marketing and its role in business and consumers' lives.	Lectures : 6h00 Project : 8h00
Systems Engineering S6	3	**Quality**	Description : Introduction to Quality, its history and evolution. Learn about quality management with the main tools related to it. Analysis and understanding of the ISO 9001 standard, its purpose, context and stakes. Audit: Preparing and conducting an Audit. QRQC : Operational method of quality management and problem solving. Discovery and appropriation of A3 and Kanban communication tools. Experience plan: Initiation to the PEX tool, mathematical approach and method.	Lectures : 8h00 Tutorials : 10h00
		Vibrations	Description : The course resumes the basics of vibration analysis. At first the vibration analysis and its matrix formalism is presented and applied at two degrees of freedom systems. Then, damping and vibration isolation is presented. Exercises are done after each notion to put into practice formula and method introduced in the course.	Lectures : 12h00 Tutorials : 4h00 Lab Work : 4h00
Semester 6_Robotique and Automation	30			

Semester 6_SupplyChain				
TEACHING UNIT	**ECTS**	**TEACHING UNIT COMPONENT**	**Content**	**TEACHING HOURS**
Multidisciplinary Project S6	3	**Ecodesign Project Part 2 - Environment**	Description : The project contains 3 expected content types: courses & tutorials, project sessions (labs), and personal work. For each semester, this projects represents ~40h of work on-site + 20h-30h of personal work. The total workload for each semester is estimated to 60- 70h/student. Content of semester 6: 1. Courses & tutorials: Ecodesign approaches and strategies. - Courses topics: Ecodesign regulations & strategies, Materials & environment, Design for Sustainable behaviour, Thermal insulation & downsizing, Ecodesign of packaging, design for End-of-life, Innovation for ecodesign. - Tutorials: CES EduPack (choice of materials), Simapro, CREO (CAD modelling) 2. Project sessions (labs) supervised by the teacher: Developing 3 levels of ecodesigned solutions - Solutions developments: calculations, CAD modelling, LCA modelling of the 3 levels 3. Personal work: information search, interpretation of LCA results.	Lectures : 3h00 Tutorials : 4h00 Project : 8h00
		Ecodesign Project Part 2 - Technical	Description : The project contains 3 expected content types: courses & tutorials, project sessions (labs), and personal work. For each semester, this projects represents ~40h of work on-site + 20h-30h of personal work. The total workload for each semester is estimated to 60- 70h/student. Content of semester 6: 1. Courses & tutorials: Ecodesign approaches and strategies. - Courses topics: Ecodesign regulations & strategies, Materials & environment, Design for Sustainable behaviour, Thermal insulation & downsizing, Ecodesign of packaging, design for End-of-life, Innovation for ecodesign. - Tutorials: CES EduPack (choice of materials), Simapro, CREO (CAD modelling) 2. Project sessions (labs) supervised by the teacher: Developing 3 levels of ecodesigned solutions - Solutions developments: calculations, CAD modelling, LCA modelling of the 3 levels 3. Personal work: information search, interpretation of LCA results.	Lectures : 3h00 Tutorials : 2h00 Project : 8h00
Control Engineering S6	6	**Introduction to Control Theory**	Description : 1. Introduction to continuous Linear Time-Invariant (LTI) systems 2. Mathematical models of LTI systems 3. Block diagram and the reduction rules 4. Time-domain analysis of a first order system 5. Time domain analysis of a second order system 6. PID controllers for TLI systems	Lectures : 14h00 Tutorials : 10h00 Lab Work : 8h00

Semester 6_SupplyChain				
TEACHING UNIT	**ECTS**	**TEACHING UNIT COMPONENT**	**Content**	**TEACHING HOURS**
		Power Electronics	Description : This course introduces a comprehensive overview of different power electronics components and applications. It presents the basics of devices, their characteristics, their principle of operation, and their range of applications as well. The course also underlines the principle of operation of converters used in DC drives (diodes rectifiers, controlled rectifiers and choppers). It discusses the principle of harmonics, performance parameters and filtering techniques. Furthermore, upon completion of this course, the student will be able to outline the characteristics and operation principle of power AC drives (inverters and AC-AC controllers). Mainly full bridge and three phase circuits are highlighted. The effect of inductive loads and protection schemes are discussed as well. The student will understand and be able to describe switching techniques and conduct both performance and harmonical studies. The student will be able to demonstrate a certain familiarity with the various configurations and applications and to develop models and simulations. o Introduction & Basics in Power Electronics: Purpose, History &Application, Devices & Circuits Characteristics, Ideal and Practical device, Semi-conductors basics o Conversion Basics & Diodes Rectifiers : Conversion Circuits Types, Switching Sequence & Methodology, Protection, Performance Parameters, FW SP Diode Rectifier, FW 3P Diode Rectifier o Controlled Rectifiers & DC/DC converters: FW SP Controlled Rectifier, FW 3P Controlled Rectifier, o Introduction to DC-DC drives: Buck Converter, Boost Converter, Buck Regulator, Other topologies o DC/AC Conversion: Introduction to AC Drives, SP Full Bridge Inverter, 3P Full Bridge Inverter o AC-AC Conversion: R Load	Lectures : 10h00 Tutorials : 6h00 Lab Work : 8h00
Industrial Engineering and Supply Chain Management	8	**The Fresh Connection**	Description : - The Fresh Connection: serious game in a web-based simulation	Lectures : 4h00 Tutorials : 12h00
		Industrial Engineering	Description : • To study process flows before implementation of a manufacturing plant • Workstation analysis, determination and optimization of times • Design, methods and tools for industrialization • Exploring the challenges facing Total Productive Maintenance • Total Productive Maintenance - TPM : Reliability functions, probability density functions. Serie and Parallele systems Failure rate, MTTF (Mean Time To Failure), MTBF (Mean Time Between Failure), MTTR (Mean Time To Repair) • Analysis & specifications of product • (Re)Designing a product with Creo Parametric • Being able to define standard documents • To understand the types and levels of maintenance • Establish a simple version of the maintenance plan • Flow simulation with FLEXSIM	Lectures : 8h00 Tutorials : 22h00
		Introduction to Supply Chain Management	Description : - Ergonomy, Health and Security at work - Inventory Management: Define and manage the economic quantity, the safety stock and the stock classification - Approach of Inventory Management - Knowledge in Financial Management in industries	Lectures : 12h00 Tutorials : 12h00
Mathematics for Engineering S6	6	**Mathematics for Engineers**	Description : Introduction to statistics and probability - Graphical Tools to represent data Meaningful Values Probability Theory Common Discrete and Continuous Probability Distributions Convergence Theorems Sampling Estimations and Confidence intervals Statistical Tests Comparison of Normal Distributions Normality Assumption checking Homogeneity of a population: ANOVA Chi-Square test Correlation and linear regression	Lectures : 16h00 Tutorials : 16h00

Semester 6_SupplyChain				
TEACHING UNIT	**ECTS**	**TEACHING UNIT COMPONENT**	**Content**	**TEACHING HOURS**
		Object-Oriented Programming	Description : Basics of Java Introduction to Object Oriented Programming Classes and Methods Inheritance Standard Library of Java	Lectures : 6h00 Tutorials : 4h00 Lab Work : 12h00 Project : 8h00
Society, Management & Entrepreneurship 6	4	**French as a Foreign Language**	Description :	Lab Work : 21h00
		Global affairs	Description :	Lectures : 4h00 Project : 10h00
		Principles of Marketing	Description : This course is designed to provide with students with an introduction to the marketing system. They will be exposed to the major concepts of marketing known as the marketing mix or 4 P's (product, place, price, and promotion). The course presumes no prior understanding of marketing, provides a complete overview of the marketing process, and touches on a variety of topics. Students will gain a sound understanding of the core concepts in marketing and its role in business and consumers' lives.	Lectures : 6h00 Project : 8h00
Systems Engineering S6	3	**Quality**	Description : Introduction to Quality, its history and evolution. Learn about quality management with the main tools related to it. Analysis and understanding of the ISO 9001 standard, its purpose, context and stakes. Audit: Preparing and conducting an Audit. QRQC : Operational method of quality management and problem solving. Discovery and appropriation of A3 and Kanban communication tools. Experience plan: Initiation to the PEX tool, mathematical approach and method.	Lectures : 8h00 Tutorials : 10h00
		Vibrations	Description : The course resumes the basics of vibration analysis. At first the vibration analysis and its matrix formalism is presented and applied at two degrees of freedom systems. Then, damping and vibration isolation is presented. Exercises are done after each notion to put into practice formula and method introduced in the course.	Lectures : 12h00 Tutorials : 4h00 Lab Work : 4h00
Semester 6_SupplyChain	30			

Semester 6_ Sustainable Energy				
TEACHING UNIT	**ECTS**	**TEACHING UNIT COMPONENT**	**Content**	**TEACHING HOURS**
Multidisciplinary Project S6	3	**Ecodesign Project Part 2 - Environment**	Description : The project contains 3 expected content types: courses & tutorials, project sessions (labs), and personal work. For each semester, this projects represents ~40h of work on-site + 20h-30h of personal work. The total workload for each semester is estimated to 60- 70h/student. Content of semester 6: 1. Courses & tutorials: Ecodesign approaches and strategies. - Courses topics: Ecodesign regulations & strategies, Materials & environment, Design for Sustainable behaviour, Thermal insulation & downsizing, Ecodesign of packaging, design for End-of-life, Innovation for ecodesign. - Tutorials: CES EduPack (choice of materials), Simapro, CREO (CAD modelling) 2. Project sessions (labs) supervised by the teacher: Developing 3 levels of ecodesigned solutions - Solutions developments: calculations, CAD modelling, LCA modelling of the 3 levels 3. Personal work: information search, interpretation of LCA results.	Lectures : 3h00 Tutorials : 4h00 Project : 8h00
		Ecodesign Project Part 2 - Technical	Description : The project contains 3 expected content types: courses & tutorials, project sessions (labs), and personal work. For each semester, this projects represents ~40h of work on-site + 20h-30h of personal work. The total workload for each semester is estimated to 60- 70h/student. Content of semester 6: 1. Courses & tutorials: Ecodesign approaches and strategies. - Courses topics: Ecodesign regulations & strategies, Materials & environment, Design for Sustainable behaviour, Thermal insulation & downsizing, Ecodesign of packaging, design for End-of-life, Innovation for ecodesign. - Tutorials: CES EduPack (choice of materials), Simapro, CREO (CAD modelling) 2. Project sessions (labs) supervised by the teacher: Developing 3 levels of ecodesigned solutions - Solutions developments: calculations, CAD modelling, LCA modelling of the 3 levels 3. Personal work: information search, interpretation of LCA results.	Lectures : 3h00 Tutorials : 2h00 Project : 8h00
Control Engineering S6	6	**Introduction to Control Theory**	Description : 1. Introduction to continuous Linear Time-Invariant (LTI) systems 2. Mathematical models of LTI systems 3. Block diagram and the reduction rules 4. Time-domain analysis of a first order system 5. Time domain analysis of a second order system 6. PID controllers for TLI systems	Lectures : 14h00 Tutorials : 10h00 Lab Work : 8h00

Semester 6_ Sustainable Energy				
TEACHING UNIT	**ECTS**	**TEACHING UNIT COMPONENT**	**Content**	**TEACHING HOURS**
		Power Electronics	Description : This course introduces a comprehensive overview of different power electronics components and applications. It presents the basics of devices, their characteristics, their principle of operation, and their range of applications as well. The course also underlines the principle of operation of converters used in DC drives (diodes rectifiers, controlled rectifiers and choppers). It discusses the principle of harmonics, performance parameters and filtering techniques. Furthermore, upon completion of this course, the student will be able to outline the characteristics and operation principle of power AC drives (inverters and AC-AC controllers). Mainly full bridge and three phase circuits are highlighted. The effect of inductive loads and protection schemes are discussed as well. The student will understand and be able to describe switching techniques and conduct both performance and harmonical studies. The student will be able to demonstrate a certain familiarity with the various configurations and applications and to develop models and simulations. o Introduction & Basics in Power Electronics: Purpose, History &Application, Devices & Circuits Characteristics, Ideal and Practical device, Semi-conductors basics o Conversion Basics & Diodes Rectifiers : Conversion Circuits Types, Switching Sequence & Methodology, Protection, Performance Parameters, FW SP Diode Rectifier, FW 3P Diode Rectifier o Controlled Rectifiers & DC/DC converters: FW SP Controlled Rectifier, FW 3P Controlled Rectifier, o Introduction to DC-DC drives: Buck Converter, Boost Converter, Buck Regulator, Other topologies o DC/AC Conversion: Introduction to AC Drives, SP Full Bridge Inverter, 3P Full Bridge Inverter o AC-AC Conversion: R Load	Lectures : 10h00 Tutorials : 6h00 Lab Work : 8h00
Mathematics for Engineering S6	6	**Mathematics for Engineers**	Description : Introduction to statistics and probability - Graphical Tools to represent data Meaningful Values Probability Theory Common Discrete and Continuous Probability Distributions Convergence Theorems Sampling Estimations and Confidence intervals Statistical Tests Comparison of Normal Distributions Normality Assumption checking Homogeneity of a population: ANOVA Chi-Square test Correlation and linear regression	Lectures : 16h00 Tutorials : 16h00
		Object-Oriented Programming	Description : Basics of Java Introduction to Object Oriented Programming Classes and Methods Inheritance Standard Library of Java	Lectures : 6h00 Tutorials : 4h00 Lab Work : 12h00 Project : 8h00
Society, Management & Entrepreneurship 6	4	**French as a Foreign Language**	Description :	Lab Work : 21h00
		Global affairs	Description :	Lectures : 4h00 Project : 10h00

Semester 6_ Sustainable Energy				
TEACHING UNIT	**ECTS**	**TEACHING UNIT COMPONENT**	**Content**	**TEACHING HOURS**
		Principles of Marketing	Description : This course is designed to provide with students with an introduction to the marketing system. They will be exposed to the major concepts of marketing known as the marketing mix or 4 P's (product, place, price, and promotion). The course presumes no prior understanding of marketing, provides a complete overview of the marketing process, and touches on a variety of topics. Students will gain a sound understanding of the core concepts in marketing and its role in business and consumers' lives.	Lectures : 6h00 Project : 8h00
Sustainable Energy & Environmental Engineering S6	8	**Advanced Heat Transfer**	Description : -Steady Heat conduction : heat transfer in common configuration, conduction shape factors. - Transient conduction : lumped system analysis, Biot number, transient heat conduction in large plane walls, long cylinders, and spheres with spatial effects, transient heat conduction in semi-infinite solids. - Numerical methods in heat conduction : finite difference formulation of differential equations, two-dimensional steady heat conduction. - Natural convection : physical mechanisms, equation of motion and the grashof number, natural convection over surfaces, natural convection inside enclosures, combined natural and forced convection. - Boiling and condensation : boiling heat transfer, pool Boiling, flow boiling, condensation heat transfer, film condensation, dropwise condensation - Heat exchangers : heat exchanger types, overall heat transfer coefficient, the log mean temperature difference, the effectiveness-NTU method, heat exchanger design and performance calculations. - Radiation heat transfer : the view factor, view factor relations, black surfaces, diffuse and gray surfaces, radiation shields and the radiation effect.	Lectures : 12h00 Tutorials : 12h00 Lab Work : 12h00
		Heating Ventilation & Air Conditioning HVAC	Description : The purpose of this course is to deeply understand Heat, Ventilation and Air Conditioning technologies and their importance in the building and industry sectors (buildings energy consumption, thermal comfort, ...) and to manage to size and optimize and HVAC system. The course addresses also the future of the HVAC&R industry (EU F-Gas regulation, use of new refrigerant fluids, improvement of energy efficiencies, etc.). course content (10h of lectures + 10h of tutorials) • Introduction to HVAC (Importance of HVAC processes in our current society, cold production, cold chain management, energy consumption, environmental consequences) and classic mechanical refrigeration • Different Refrigeration technologies, and their performance (specificities and comparison) • Heat pumps specificities and performance (different heating technologies) • Humid air: Psychrometrics and thermodynamics of moist air. • Air Handling Units for air conditioning (components and technology evolution) Labs: (12h) Study of a volumetric compressor of a refrigerating machine Study of a refrigeration machine with a water secondary circuit Study of an Air Handling Unit with a recycling option	Lectures : 10h00 Tutorials : 10h00 Lab Work : 12h00
		Hydraulics	Description : - Hydraulic networks: fundamentals of fluid flow in pipes, major and minor and head loss, system head, branches in parallel and series. - Pumping systems: classification of pumps, operation of dynamic pumps, pump main parameters, pump performance curves, pumps combined in series and parallel, matching a pump to a piping system, cavitation and net positive-suction head, dimensionless pump performance, similarity rules, specific speed, adaptation of operating conditions. - Hydraulic power systems: Fundamentals of Hydraulic Power Transmission, hydraulic power generation, positive displacement pumps (design and performance), hydraulic power distribution (hydraulic valves: types, design and function), hydraulic power deployment (hydraulic cylinders, hydraulic motors, hydrostatic transmission), hydraulic circuits.	Lectures : 10h00 Tutorials : 10h00

Semester 6_ Sustainable Energy				
TEACHING UNIT	**ECTS**	**TEACHING UNIT COMPONENT**	**Content**	**TEACHING HOURS**
Systems Engineering S6	3	**Quality**	Description : Introduction to Quality, its history and evolution. Learn about quality management with the main tools related to it. Analysis and understanding of the ISO 9001 standard, its purpose, context and stakes. Audit: Preparing and conducting an Audit. QRQC : Operational method of quality management and problem solving. Discovery and appropriation of A3 and Kanban communication tools. Experience plan: Initiation to the PEX tool, mathematical approach and method.	Lectures : 8h00 Tutorials : 10h00
		Vibrations	Description : The course resumes the basics of vibration analysis. At first the vibration analysis and its matrix formalism is presented and applied at two degrees of freedom systems. Then, damping and vibration isolation is presented. Exercises are done after each notion to put into practice formula and method introduced in the course.	Lectures : 12h00 Tutorials : 4h00 Lab Work : 4h00
Semester 6_ Sustainable Energy	30			

Semester 7_Sustainable Energy				
TEACHING UNIT	**ECTS**	**TEACHING UNIT COMPONENT**	**Content**	**TEACHING HOURS**
Sustainable Energy & Environmental Engineering	12	**Advanced Electrical Machines**	Description : This course covers the basics needed for the design of an electrical machine. It introduces the different electrical machines, their components, and the main definitions / technical vocabulary needed for the design. It also sheds the light on the different methods of numerical modelling of magneto static systems as well as the finite element approach for the synchronous machine modelling. This course presents the basic analytical method for designing the various parts of a machine while relying on the client requirements (operating voltage, needed speed, geometrical sizing…). It also provides the student with the in depth knowledge needed to simulate the machine's construction using CAD and Matlab software. o Electrical Machines Design – Basics & Background: Overview on the different electrical machines, Machines Specifications, Analytical sizing of an electrical machine, CAD Design of an electrical machine o Electrical Machines Design – Analytical Method for Design: Overview of the winding and the rotating field, Winding layers & Coefficients, Electric machines: materials & components, Design methodology for a PM Synchronous Machine o Project: Design of an electric machine for a given predefined application using Matlab & FEMM 4.2 software	Lectures : 4h00 Tutorials : 2h00 Lab Work : 12h00
		Compressible Flows & Propulsion Systems	Description : This course aims to understand • Jet propulsion systems and their performance criteria applied to Air-Breathing and Rocket engines: Thrust; Specific Impulse; Propulsion efficiency; Tsiolkovsky rocket equation; Breguet aircraft equation. • Fundamental of Compressible flows: Mach number and thermodynamics of compressible flows; Shockwaves; Conservation laws; application to Isentropic flows. • Rocket engine design: Stagnation and critical states; operating mode of nozzles in rocket engines; influence of combustion pressure and temperature and of nozzle geometry on the thrust finally produced. Calculation of the resulting specific impulse. • Propulsion systems combustion processes: influence of fuel composition and of Air-Fuel Ratio on the performance of air-breathing combustion processes; use of liquid and solid propellants in rocket engine combustion processes. • Air-breathing propulsion turbomachines: Thermodynamic cycles used in turbojet or turbofans engines; influence of pressure ratios, air and fuel mass flow rates, blades geometries on the engine performances (specific impulse, propulsion efficiency and specific fuel consumption).	Lectures : 12h00 Tutorials : 12h00

Semester 7_Sustainable Energy				
TEACHING UNIT	**ECTS**	**TEACHING UNIT COMPONENT**	**Content**	**TEACHING HOURS**
		Computational Fluid Dynamics	Description :	Lectures : 6h00 Lab Work : 16h00
		Gas Turbines	Description : • Gas turbine technologies (Heavy Duty, aeroderivatives, etc.), improvements (cogeneration, combined cycles) and uses. • Gas turbines specific combustion processes: operating modes, thermodynamics models, practical fuels and pollutants management. • Theory of turbomachines applied to compressible flows and gas turbines. • Gas turbines thermodynamic cycles. • Main components and technological aspects of gas turbine technologies.	Lectures : 10h00
		Renewable Energy Systems	Description :	Lectures : 18h00
Innovation Project S7	7	**IP Ideation**	Description :	Lectures : 4h00 Project : 2h00

Semester 7_Sustainable Energy				
TEACHING UNIT	**ECTS**	**TEACHING UNIT COMPONENT**	**Content**	**TEACHING HOURS**
		IP Introduction Project Management	Description : Project management through time and different types of management. Definition of a project Project Management Plan (PMP): - Purpose and goals. - Structure of the PMP. Tasks, milestones and deliverables: - Definition of a task - Defining Project Milestones - Definition of a deliverable Project planning: - Definition of project planning - The breakdown of the project - Task scheduling - The schedule Risk identification. Quality of planning. Planning techniques: GANTT, PERT, …: - The GANTT diagram - The PERT technique - The History Network Budgeting a project: - Example of budgeting Project management software: - BITRIX 29 Project management. Resource monitoring. Prior planning of human resources. Human/material resources management and communication: - The climate, the working atmosphere - Human resources monitoring. - The follow-up of material resources Pilot indicators: - The notion of indicator - Examples of indicators The quality approach: - Definition of the quality approach - The quality approach during the project Project communication management.: - Communication plan - Communication technologies and media Relevant project information. Case study corresponding to a project within a Small and Medium Industries that designs, manufactures and markets connected objects linked to the ECAM 4.0 platform.	Lectures : 5h00 Tutorials : 4h00 Project : 4h00
		IP Project Management Review	Description :	Lectures : 1h00 Project : 2h00
		IP Marketing	Description :	Lectures : 8h00 Tutorials : 2h00 Project : 8h00

Semester 7_Sustainable Energy				
TEACHING UNIT	**ECTS**	**TEACHING UNIT COMPONENT**	**Content**	**TEACHING HOURS**
		IP Requirements	Description :	Lectures : 8h00 Tutorials : 2h00 Project : 8h00
		IP User Research	Description :	Lectures : 4h00 Tutorials : 4h00 Project : 8h00
Semester project	6	**Semester project**	Description : Choice of topic: Students select a project topic in agreement with their supervisor. The topic can be technical (such as developing an application, data analysis, etc.). Implementation: Execution of the project according to the established plan, with possible adjustments based on needs and unforeseen circumstances. Write-up: Compilation of results, analysis, and conclusions into a written document. Preparation for the defense: Preparation of a structured and convincing oral presentation.	Tutorials : 20h00 Project : 130h00
Sustainable Management S7	4	**Carbon Footprint**	Description : This course is an introduction to the carbon footprint calculation method proposed by a French association, "Association Bilan Carbone". It will consist of a : - Reminders about Green House Gases and introduction to global warming potential - Definition of carbon footprint - Definition of the 3 scopes - Presentation of the carbon Footprint computation method - Presentation of th Carbon Footprint approach	Lectures : 4h00 Tutorials : 6h00 Project : 4h00
		Operational Quality and Lean Management	Description : Introduction to experience plans : - What is an experience plan and how to implement it ? - Several notions : factors, levels of the factors, mathematical model - Experience plans : 2 factors and 2 levels - Experience plans : 3 factors and 2 levels Product FMECA : One case of study to understand what is the purpose of product FMECA and how to implement it : how to reduce the problem at the conception phase of a product Lean-6 sigma tools : Discovery of the different lean tools in the context of a problem-solving approach : - What is the Lean (context and historical approach) - What is 6 sigma (context and historical approach) - What are the tools related to these topics (DMAIC, 5S, Ishikawa, root causes : 5W…) - Possiblity to implement all of these tools with one tutorial : A3 problem solving method.	Lectures : 4h00 Tutorials : 12h00
		Research Methods	Description :	Lectures : 4h00 Tutorials : 8h00

Semester 7_Sustainable Energy				
TEACHING UNIT	**ECTS**	**TEACHING UNIT COMPONENT**	**Content**	**TEACHING HOURS**
Systems Engineering S7	1	**Electrical Machine & Drives**	Description : This course covers the basic characteristics of DC and AC motors and describe their principle of operation and control within a power electronic environment. Basics in power electronics, electric machines and control circuits are reviewed and the overall systems is studied. Control techniques for DC drives are underlined and the four-quadrant operation is analysed. Control strategies for AC drives are discussed as well, mainly the scalar control, the field oriented control and the direct torque control. Detailed modelling of the control of induction motors using the FOC method is carried out. o Electrical Machines Drives – General Overview: Review on Control Systems, Review on Power Electronics, Review on Electrical Machines o DC Motors Control: Introduction to DC Drives, Four-Quadrant Control, Closed Loop Control, Electronic Control o AC Motors Control: Basic Control of Induction Motors (Vs, Vr, F, V/F), Scalar Control o AC Motors Control: Understanding the Challenges, Park Transformation (dq domain), Dynamic Model of Induction Motors, DC Machine Analogy, Field Oriented Control	Lectures : 8h00 Tutorials : 6h00 Lab Work : 4h00
Semester 7_Sustainable Energy	30			

Semester 7_Mechanical Engineering				
TEACHING UNIT	**ECTS**	**TEACHING UNIT COMPONENT**	**Content**	**TEACHING HOURS**
Innovation Project S7	7	**IP Ideation**	Description :	Lectures : 4h00 Project : 2h00

Semester 7_Mechanical Engineering				
TEACHING UNIT	**ECTS**	**TEACHING UNIT COMPONENT**	**Content**	**TEACHING HOURS**
		IP Introduction Project Management	Description : Project management through time and different types of management. Definition of a project Project Management Plan (PMP): - Purpose and goals. - Structure of the PMP. Tasks, milestones and deliverables: - Definition of a task - Defining Project Milestones - Definition of a deliverable Project planning: - Definition of project planning - The breakdown of the project - Task scheduling - The schedule Risk identification. Quality of planning. Planning techniques: GANTT, PERT, …: - The GANTT diagram - The PERT technique - The History Network Budgeting a project: - Example of budgeting Project management software: - BITRIX 29 Project management. Resource monitoring. Prior planning of human resources. Human/material resources management and communication: - The climate, the working atmosphere - Human resources monitoring. - The follow-up of material resources Pilot indicators: - The notion of indicator - Examples of indicators The quality approach: - Definition of the quality approach - The quality approach during the project Project communication management.: - Communication plan - Communication technologies and media Relevant project information. Case study corresponding to a project within a Small and Medium Industries that designs, manufactures and markets connected objects linked to the ECAM 4.0 platform.	Lectures : 5h00 Tutorials : 4h00 Project : 4h00
		IP Project Management Review	Description :	Lectures : 1h00 Project : 2h00
		IP Marketing	Description :	Lectures : 8h00 Tutorials : 2h00 Project : 8h00

Semester 7_Mechanical Engineering				
TEACHING UNIT	**ECTS**	**TEACHING UNIT COMPONENT**	**Content**	**TEACHING HOURS**
		IP Requirements	Description :	Lectures : 8h00 Tutorials : 2h00 Project : 8h00
		IP User Research	Description :	Lectures : 4h00 Tutorials : 4h00 Project : 8h00
Mechanical Engineering	12	**Advanced Vibrations**	Description :	Lectures : 16h00 Lab Work : 8h00
		Compressible Flows & Propulsion Systems	Description : • Jet propulsion systems and their performance criteria applied to Air-Breathing and Rocket engines: Thrust; Specific Impulse; Propulsion efficiency; Tsiolkovsky rocket equation; Breguet aircraft equation. • Fundamental of Compressible flows: Mach number and thermodynamics of compressible flows; Shockwaves; Conservation laws; application to Isentropic flows. • Rocket engine design: Stagnation and critical states; operating mode of nozzles in rocket engines; influence of combustion pressure and temperature and of nozzle geometry on the thrust finally produced. Calculation of the resulting specific impulse. • Propulsion systems combustion processes: influence of fuel composition and of Air-Fuel Ratio on the performance of air-breathing combustion processes; use of liquid and solid propellants in rocket engine combustion processes. • Air-breathing propulsion turbomachines: Thermodynamic cycles used in turbojet or turbofans engines; influence of pressure ratios, air and fuel mass flow rates, blades geometries on the engine performances (specific impulse, propulsion efficiency and specific fuel consumption).	Lectures : 12h00 Tutorials : 12h00
		Computational Fluid Dynamics	Description : This course introduces the student to the subject of Computational Fluid Dynamics, as well as numerical methods for predicting fluid flows and heat transfer in flows. This course aims to help students get a good level of expertise in flow modeling for engineering applications by conducting practical work on a well-known commercial tool. Lectures content (6h) • Introduction to CFD: CFD fundamentals, principles, and steps • Turbulence modeling for CFD part I: Turbulence characteristics and properties, Mean-flow equations • Turbulence modeling for CFD part II: Turbulent-viscosity models (RANS models), Near-wall treatments Practical work: (16h) • Introduction to Ansys Fluent CFD tool: Fluid Flow and Heat Transfer in a Mixing Elbow • Practice on Ansys Fluent CFD tool: Modeling external Compressible Flow • Practice on Ansys Fluent CFD tool: Modeling Transient Compressible Flow • Practice on Ansys Fluent CFD tool: Assessment project	Lectures : 6h00 Lab Work : 16h00
		Materials 4 (Polymers)	Description : Macromolecules: degree of polymerization, tacticity, synthesis. Polymers: structures, thermoplastics, thermosets, state changes, thermal and mechanical properties, additives. Specific applications of polymers. The use of conductive polymers, bio-sourced and biodegradable polymers, polymers for packaging or fuel cells are discussed. The interest of developing copolymers is also treated.	Lectures : 10h00 Tutorials : 10h00 Lab Work : 8h00

Semester 7_Mechanical Engineering				
TEACHING UNIT	**ECTS**	**TEACHING UNIT COMPONENT**	**Content**	**TEACHING HOURS**
Semester project	6	**Semester project**	Description : Choice of topic: Students select a project topic in agreement with their supervisor. The topic can be technical (such as developing an application, data analysis, etc.). Implementation: Execution of the project according to the established plan, with possible adjustments based on needs and unforeseen circumstances. Write-up: Compilation of results, analysis, and conclusions into a written document. Preparation for the defense: Preparation of a structured and convincing oral presentation.	Tutorials : 20h00 Project : 130h00
Sustainable Management S7	4	**Carbon Footprint**	Description : This course is an introduction to the carbon footprint calculation method proposed by a French association, "Association Bilan Carbone". It will consist of a : - Reminders about Green House Gases and introduction to global warming potential - Definition of carbon footprint - Definition of the 3 scopes - Presentation of the carbon Footprint computation method - Presentation of th Carbon Footprint approach	Lectures : 4h00 Tutorials : 6h00 Project : 4h00
		Operational Quality and Lean Management	Description : Introduction to experience plans : - What is an experience plan and how to implement it ? - Several notions : factors, levels of the factors, mathematical model - Experience plans : 2 factors and 2 levels - Experience plans : 3 factors and 2 levels Product FMECA : One case of study to understand what is the purpose of product FMECA and how to implement it : how to reduce the problem at the conception phase of a product Lean-6 sigma tools : Discovery of the different lean tools in the context of a problem-solving approach : - What is the Lean (context and historical approach) - What is 6 sigma (context and historical approach) - What are the tools related to these topics (DMAIC, 5S, Ishikawa, root causes : 5W…) - Possiblity to implement all of these tools with one tutorial : A3 problem solving method.	Lectures : 4h00 Tutorials : 12h00
		Research Methods	Description :	Lectures : 4h00 Tutorials : 8h00
Systems Engineering S7	1	**Electrical Machine & Drives**	Description : This course covers the basic characteristics of DC and AC motors and describe their principle of operation and control within a power electronic environment. Basics in power electronics, electric machines and control circuits are reviewed and the overall systems is studied. Control techniques for DC drives are underlined and the four-quadrant operation is analysed. Control strategies for AC drives are discussed as well, mainly the scalar control, the field oriented control and the direct torque control. Detailed modelling of the control of induction motors using the FOC method is carried out. o Electrical Machines Drives – General Overview: Review on Control Systems, Review on Power Electronics, Review on Electrical Machines o DC Motors Control: Introduction to DC Drives, Four-Quadrant Control, Closed Loop Control, Electronic Control o AC Motors Control: Basic Control of Induction Motors (Vs, Vr, F, V/F), Scalar Control o AC Motors Control: Understanding the Challenges, Park Transformation (dq domain), Dynamic Model of Induction Motors, DC Machine Analogy, Field Oriented Control	Lectures : 8h00 Tutorials : 6h00 Lab Work : 4h00

Semester 7_Mechanical Engineering				
TEACHING UNIT	**ECTS**	**TEACHING UNIT COMPONENT**	**Content**	**TEACHING HOURS**
Semester 7_Mechanical Engineering	30			
Semester 7_Robotique and Automation				
TEACHING UNIT	**ECTS**	**TEACHING UNIT COMPONENT**	**Content**	**TEACHING HOURS**
Innovation Project S7	7	**IP Ideation**	Description :	Lectures : 4h00 Project : 2h00

Semester 7_Robotique and Automation				
TEACHING UNIT	**ECTS**	**TEACHING UNIT COMPONENT**	**Content**	**TEACHING HOURS**
		IP Introduction Project Management	Description : Project management through time and different types of management. Definition of a project Project Management Plan (PMP): - Purpose and goals. - Structure of the PMP. Tasks, milestones and deliverables: - Definition of a task - Defining Project Milestones - Definition of a deliverable Project planning: - Definition of project planning - The breakdown of the project - Task scheduling - The schedule Risk identification. Quality of planning. Planning techniques: GANTT, PERT, …: - The GANTT diagram - The PERT technique - The History Network Budgeting a project: - Example of budgeting Project management software: - BITRIX 29 Project management. Resource monitoring. Prior planning of human resources. Human/material resources management and communication: - The climate, the working atmosphere - Human resources monitoring. - The follow-up of material resources Pilot indicators: - The notion of indicator - Examples of indicators The quality approach: - Definition of the quality approach - The quality approach during the project Project communication management.: - Communication plan - Communication technologies and media Relevant project information. Case study corresponding to a project within a Small and Medium Industries that designs, manufactures and markets connected objects linked to the ECAM 4.0 platform.	Lectures : 5h00 Tutorials : 4h00 Project : 4h00
		IP Project Management Review	Description :	Lectures : 1h00 Project : 2h00
		IP Marketing	Description :	Lectures : 8h00 Tutorials : 2h00 Project : 8h00

Semester 7_Robotique and Automation				
TEACHING UNIT	**ECTS**	**TEACHING UNIT COMPONENT**	**Content**	**TEACHING HOURS**
		IP Requirements	Description :	Lectures : 8h00 Tutorials : 2h00 Project : 8h00
		IP User Research	Description :	Lectures : 4h00 Tutorials : 4h00 Project : 8h00
Robotics & Automation Engineering S7	12	**Advanced Robotics**	Description : -Numerical Jacobian, singularity avoidance -Trajectory and path planning for robot arms -Performance evaluation : accuracy, precision, load, repeatability, workspace -Dynamics of a robot arm (inertia, Coriolis) -Visual servoing -Programming a robotic arm and a mobile robot	Lectures : 12h00 Tutorials : 12h00 Lab Work : 12h00
		Control Theory 2a (Digital Control Systems)	Description : 1. Introduction to signals : continuous/ sampled/ discrete 2. Distinction between Difference equation (used to describe Discrete systems) and differential equation (used to describe continuous systems) 3. Signal sampling and quantization *Sampling of continuous signals *Signal reconstruction *Practical considerations for signal sampling : anti-aliasing filter *Practical reconsiderations for signal reconstruction :anti-image filter and equalizer *Analog to digital conversion *digital to analog conversion/quantization 4. Determination of the z-transform *Introduction to the z-transform and its properties *Illustration of how we determine the inverse of z-transform using the partial fraction expansion *The use of the z-transform to solve linear difference equations 5. Digital Proportional, PI and PID controllers *Determination of the equation of the digital controller (case of P , PI and PID) *The implementation of digital P, PI and PID on real systems and the evaluation of the system performances	Lectures : 6h00 Tutorials : 6h00 Lab Work : 8h00
		Control Theory 2b (Multivariable Control Systems)	Description : 1. System representation : the state-space representation SSR of monovariable and multivariable systems 2. Determinantion of the system's Block diagram 3. Determinantion of the State space representations in canonical forms : Controllable,Observable,Diagonal/Jordan 4. Evaluation of the Controllability and the observability of a given LTI system using the Kalman citerion 5. Design of State-feedback controller using the Ackermann's formula 6. Analysis of system performances : precision, rapidity, robustness against the presence of disturbances 7. System linearization using the Tylor expansion	Lectures : 10h00 Tutorials : 6h00 Lab Work : 8h00
		IT & Robotic Labs	Description : The scrum methodology is introduced to the students. Then, they apply this agile framework during the whole duration of the project. Each group of students receives a project of robotic application. They state the problem before designing the robotic system that corresponds to the specifications. Then, they build their system and test it extensively. Finally, each group presents their work and write a report describing the technical and managerial aspects of the project.	Lab Work : 28h00

Semester 7_Robotique and Automation				
TEACHING UNIT	**ECTS**	**TEACHING UNIT COMPONENT**	**Content**	**TEACHING HOURS**
Semester project	6	**Semester project**	Description : Choice of topic: Students select a project topic in agreement with their supervisor. The topic can be technical (such as developing an application, data analysis, etc.). Implementation: Execution of the project according to the established plan, with possible adjustments based on needs and unforeseen circumstances. Write-up: Compilation of results, analysis, and conclusions into a written document. Preparation for the defense: Preparation of a structured and convincing oral presentation.	Tutorials : 20h00 Project : 130h00
Sustainable Management S7	4	**Carbon Footprint**	Description : This course is an introduction to the carbon footprint calculation method proposed by a French association, "Association Bilan Carbone". It will consist of a : - Reminders about Green House Gases and introduction to global warming potential - Definition of carbon footprint - Definition of the 3 scopes - Presentation of the carbon Footprint computation method - Presentation of th Carbon Footprint approach	Lectures : 4h00 Tutorials : 6h00 Project : 4h00
		Operational Quality and Lean Management	Description : Introduction to experience plans : - What is an experience plan and how to implement it ? - Several notions : factors, levels of the factors, mathematical model - Experience plans : 2 factors and 2 levels - Experience plans : 3 factors and 2 levels Product FMECA : One case of study to understand what is the purpose of product FMECA and how to implement it : how to reduce the problem at the conception phase of a product Lean-6 sigma tools : Discovery of the different lean tools in the context of a problem-solving approach : - What is the Lean (context and historical approach) - What is 6 sigma (context and historical approach) - What are the tools related to these topics (DMAIC, 5S, Ishikawa, root causes : 5W…) - Possiblity to implement all of these tools with one tutorial : A3 problem solving method.	Lectures : 4h00 Tutorials : 12h00
		Research Methods	Description :	Lectures : 4h00 Tutorials : 8h00
Systems Engineering S7	1	**Electrical Machine & Drives**	Description : This course covers the basic characteristics of DC and AC motors and describe their principle of operation and control within a power electronic environment. Basics in power electronics, electric machines and control circuits are reviewed and the overall systems is studied. Control techniques for DC drives are underlined and the four-quadrant operation is analysed. Control strategies for AC drives are discussed as well, mainly the scalar control, the field oriented control and the direct torque control. Detailed modelling of the control of induction motors using the FOC method is carried out. o Electrical Machines Drives – General Overview: Review on Control Systems, Review on Power Electronics, Review on Electrical Machines o DC Motors Control: Introduction to DC Drives, Four-Quadrant Control, Closed Loop Control, Electronic Control o AC Motors Control: Basic Control of Induction Motors (Vs, Vr, F, V/F), Scalar Control o AC Motors Control: Understanding the Challenges, Park Transformation (dq domain), Dynamic Model of Induction Motors, DC Machine Analogy, Field Oriented Control	Lectures : 8h00 Tutorials : 6h00 Lab Work : 4h00

Semester 7_Robotique and Automation				
TEACHING UNIT	**ECTS**	**TEACHING UNIT COMPONENT**	**Content**	**TEACHING HOURS**
Semester 7_Robotique and Automation	30			
Semester 7_SupplyChain				
TEACHING UNIT	**ECTS**	**TEACHING UNIT COMPONENT**	**Content**	**TEACHING HOURS**
Industrial Engineering & Supply Chain Management	12	**Global Supply Chain and Information System**	Description : • Information Systems in Supply Chain • Focus on ERP • Project Management in Supply Chain • Demand Management • Forecasting Management • Warehouse and Distribution Management • Procurement strategies and Suppliers Management	Lectures : 12h00 Tutorials : 4h00 Lab Work : 4h00
		Manufacturing Digital Transformation	Description : - Discover SimLab software solutions for developing VR/AR applications - Developing the first VR experience - Understanding how SimLab software works with VR/AR equipment • Product Lifecycle Management - PLM : - PLM Introduction - Windchill PLM software - Project view • Plant Layout 2 : - Redo the implementation from last year, with the simulation flows of a robotic equipment	Lectures : 4h00 Tutorials : 16h00
		The Blue Connection	Description : Business simulation THE BLUE CONNECTION (publisher INCHAINGE) which students will play via a web interface (in English). ECAM La Salle is a forerunner in the deployment of this game (we work in parallel with professors from HEC). The game takes place in 6 to 8 rounds, the students work in teams of 3 or 4 and each plays the role of a manager within the fictitious company The Blue Connection: - Sales management - Purchasing/design department - Supply chain management - Finance department The company sells bicycles (only one model) to 3 different customers and is in great financial difficulty. The goal of this game is to make the company profitable while developing a circular economy. In each round, the students test and deploy a circularity or life extension strategy (maintenance/warranty, refurbishment, remanufacturing, recycling). In the final rounds, they must choose their own strategy, implement it and explain it in an individual report.	Lectures : 2h00 Tutorials : 18h00
Innovation Project S7	7	**IP Ideation**	Description :	Lectures : 4h00 Project : 2h00

Semester 7_SupplyChain				
TEACHING UNIT	**ECTS**	**TEACHING UNIT COMPONENT**	**Content**	**TEACHING HOURS**
		IP Introduction Project Management	Description : Project management through time and different types of management. Definition of a project Project Management Plan (PMP): - Purpose and goals. - Structure of the PMP. Tasks, milestones and deliverables: - Definition of a task - Defining Project Milestones - Definition of a deliverable Project planning: - Definition of project planning - The breakdown of the project - Task scheduling - The schedule Risk identification. Quality of planning. Planning techniques: GANTT, PERT, …: - The GANTT diagram - The PERT technique - The History Network Budgeting a project: - Example of budgeting Project management software: - BITRIX 29 Project management. Resource monitoring. Prior planning of human resources. Human/material resources management and communication: - The climate, the working atmosphere - Human resources monitoring. - The follow-up of material resources Pilot indicators: - The notion of indicator - Examples of indicators The quality approach: - Definition of the quality approach - The quality approach during the project Project communication management.: - Communication plan - Communication technologies and media Relevant project information. Case study corresponding to a project within a Small and Medium Industries that designs, manufactures and markets connected objects linked to the ECAM 4.0 platform.	Lectures : 5h00 Tutorials : 4h00 Project : 4h00
		IP Project Management Review	Description :	Lectures : 1h00 Project : 2h00
		IP Marketing	Description :	Lectures : 8h00 Tutorials : 2h00 Project : 8h00

Semester 7_SupplyChain				
TEACHING UNIT	**ECTS**	**TEACHING UNIT COMPONENT**	**Content**	**TEACHING HOURS**
		IP Requirements	Description :	Lectures : 8h00 Tutorials : 2h00 Project : 8h00
		IP User Research	Description :	Lectures : 4h00 Tutorials : 4h00 Project : 8h00
Semester project	6	**Semester project**	Description : Choice of topic: Students select a project topic in agreement with their supervisor. The topic can be technical (such as developing an application, data analysis, etc.). Implementation: Execution of the project according to the established plan, with possible adjustments based on needs and unforeseen circumstances. Write-up: Compilation of results, analysis, and conclusions into a written document. Preparation for the defense: Preparation of a structured and convincing oral presentation.	Tutorials : 20h00 Project : 130h00
Sustainable Management S7	4	**Carbon Footprint**	Description : This course is an introduction to the carbon footprint calculation method proposed by a French association, "Association Bilan Carbone". It will consist of a : - Reminders about Green House Gases and introduction to global warming potential - Definition of carbon footprint - Definition of the 3 scopes - Presentation of the carbon Footprint computation method - Presentation of th Carbon Footprint approach	Lectures : 4h00 Tutorials : 6h00 Project : 4h00
		Operational Quality and Lean Management	Description : Introduction to experience plans : - What is an experience plan and how to implement it ? - Several notions : factors, levels of the factors, mathematical model - Experience plans : 2 factors and 2 levels - Experience plans : 3 factors and 2 levels Product FMECA : One case of study to understand what is the purpose of product FMECA and how to implement it : how to reduce the problem at the conception phase of a product Lean-6 sigma tools : Discovery of the different lean tools in the context of a problem-solving approach : - What is the Lean (context and historical approach) - What is 6 sigma (context and historical approach) - What are the tools related to these topics (DMAIC, 5S, Ishikawa, root causes : 5W…) - Possiblity to implement all of these tools with one tutorial : A3 problem solving method.	Lectures : 4h00 Tutorials : 12h00
		Research Methods	Description :	Lectures : 4h00 Tutorials : 8h00

Semester 7_SupplyChain				
TEACHING UNIT	**ECTS**	**TEACHING UNIT COMPONENT**	**Content**	**TEACHING HOURS**
Systems Engineering S7	1	**Electrical Machine & Drives**	Description : This course covers the basic characteristics of DC and AC motors and describe their principle of operation and control within a power electronic environment. Basics in power electronics, electric machines and control circuits are reviewed and the overall systems is studied. Control techniques for DC drives are underlined and the four-quadrant operation is analysed. Control strategies for AC drives are discussed as well, mainly the scalar control, the field oriented control and the direct torque control. Detailed modelling of the control of induction motors using the FOC method is carried out. o Electrical Machines Drives – General Overview: Review on Control Systems, Review on Power Electronics, Review on Electrical Machines o DC Motors Control: Introduction to DC Drives, Four-Quadrant Control, Closed Loop Control, Electronic Control o AC Motors Control: Basic Control of Induction Motors (Vs, Vr, F, V/F), Scalar Control o AC Motors Control: Understanding the Challenges, Park Transformation (dq domain), Dynamic Model of Induction Motors, DC Machine Analogy, Field Oriented Control	Lectures : 8h00 Tutorials : 6h00 Lab Work : 4h00
Semester 7_SupplyChain	30			
Semester 8_Sustainable Energy				
TEACHING UNIT	**ECTS**	**TEACHING UNIT COMPONENT**	**Content**	**TEACHING HOURS**
Innovation Project S8_ Engineering Developments	7	**IP Project Management and technical requirements**	Description : Lectures and tutorials are given as follow : -Lecture 1 : Introduction and tools for bibliographic research -Tutorial 1 : Application of the methodology to find relevant research papers -Lecture 2 : Analysis of literature review and introductions to the project phase -Tutorial 2 : Cross analysis of a set of research papers -Tutorial 3 and 4 : Project kick-start -Autonomy sessions : redaction of a literature review.	Lectures : 9h00 Tutorials : 2h00 Project : 6h00
		IP Technical Deployment	Description : Lectures and tutorials are given as follow : -Lecture 1 : Introduction and tools for bibliographic research -Tutorial 1 : Application of the methodology to find relevant research papers -Lecture 2 : Analysis of literature review and introductions to the project phase -Tutorial 2 : Cross analysis of a set of research papers -Tutorial 3 and 4 : Project kick-start -Autonomy sessions : redaction of a literature review.	Lectures : 2h00 Project : 32h00
Innovation Project S8_ Road to business	3	**IP Business Plan**	Description : Lectures and tutorials are given as follow : -Lecture 1 : Introduction and tools for bibliographic research -Tutorial 1 : Application of the methodology to find relevant research papers -Lecture 2 : Analysis of literature review and introductions to the project phase -Tutorial 2 : Cross analysis of a set of research papers -Tutorial 3 and 4 : Project kick-start	Lectures : 14h00 Project : 12h00
		IP Project closure	Description : Lectures and tutorials are given as follow : -Lecture 1 : Introduction and tools for bibliographic research -Tutorial 1 : Application of the methodology to find relevant research papers -Lecture 2 : Analysis of literature review and introductions to the project phase -Tutorial 2 : Cross analysis of a set of research papers -Tutorial 3 and 4 : Project kick-start	Lectures : 2h00 Project : 4h00

Semester 8_Sustainable Energy				
TEACHING UNIT	**ECTS**	**TEACHING UNIT COMPONENT**	**Content**	**TEACHING HOURS**
		IP User Test Awareness	Description : Lectures and tutorials are given as follow : -Lecture 1 : Introduction and tools for bibliographic research -Tutorial 1 : Application of the methodology to find relevant research papers -Lecture 2 : Analysis of literature review and introductions to the project phase -Tutorial 2 : Cross analysis of a set of research papers -Tutorial 3 and 4 : Project kick-start -Autonomy sessions : redaction of a literature review.	Lectures : 2h00
Sustainable Energy and Environmental Engineering	12	**Energy Project**	Description : Group Project structured around various sessions of group work with access to the necessary computer resources.	Project : 36h00
		Energy Storage	Description : • Presentation of different types of energy storage systems (heat, mechanical and electrochemical); • Definition of energy and power densities; • Description of the operating principle of rechargeable batteries and their fundamental electrochemistry (lithium-ion batteries, lead-acid batteries, etc.); • Definition of the electrical characteristics present in the data sheet of each electrochemical storage system; • Description of the operating principle of conventional supercapacitors using the double layer capacitance theory; • Presentation of the chemical constitution of hybrid supercapacitors such as lithium-ion capacitors; • Description of aging mechanisms that may arise in different types of batteries and supercapacitors; • Comparison of different energy storage systems using the Ragone Diagram; • Presentation of electrical modeling methods of electrochemical energy storage systems; • Presentation of power converters used with energy storage systems; • Description of the tools integrated in management systems that aim to control energy storage systems; • Presentation of an example of a complete system integrating an energy storage system, the corresponding management system and the power converters.	Lectures : 12h00 Tutorials : 12h00
		Environmental Aspects of Energy	Description :	Lectures : 18h00
		Exergy Analysis	Description : • The exergy and anergy concepts and their relation with energy. • Applications of exergy and energy balances to closed or open systems, housing or not internal reactive processes : heat engines, refrigeration machines, heat exchangers, internal combustion engines, HVAC systems; • Exergy efficiency and effectiveness of energy systems;	Lectures : 10h00 Lab Work : 4h00
		Power Systems	Description : - Electrical AC grids. - Electrical DC grids. - Electrical safety measurements. - Autonomous energy grid (smartgrid) sizing and control.	Lectures : 8h00 Tutorials : 8h00 Lab Work : 8h00
Semester project	7	**Semester Project**	Description : Choice of topic: Students select a project topic in agreement with their supervisor. The topic can be technical (such as developing an application, data analysis, etc.). Implementation: Execution of the project according to the established plan, with possible adjustments based on needs and unforeseen circumstances. Write-up: Compilation of results, analysis, and conclusions into a written document. Preparation for the defense: Preparation of a structured and convincing oral presentation.	Tutorials : 20h00 Project : 130h00

Semester 8_Sustainable Energy				
TEACHING UNIT	**ECTS**	**TEACHING UNIT COMPONENT**	**Content**	**TEACHING HOURS**
Sustainable Management S8	1	**Circular Economy**	Description : This course is an introduction to the circular economy concept. In this course, student will learn about the 7 pillars of the circular economy with many examples.	Lectures : 4h00 Project : 4h00
		Corporate Social Responsabilit y	Description :	Lectures : 4h00 Tutorials : 4h00 Project : 6h00
		Innovation Management & Intellectual Property	Description : - Innovation management for companies (different types) - Intellectual property: patent deposit, management of patents - General management of organizations for keeping the company's strategic advantages.	Lectures : 3h00
Semester 8_Sustainable Energy	30			
Semester 8_Mechanical Engineering				
TEACHING UNIT	**ECTS**	**TEACHING UNIT COMPONENT**	**Content**	**TEACHING HOURS**
Innovation Project S8_ Engineering Developments	7	**IP Project Management and technical requirements**	Description : Lectures and tutorials are given as follow : -Lecture 1 : Introduction and tools for bibliographic research -Tutorial 1 : Application of the methodology to find relevant research papers -Lecture 2 : Analysis of literature review and introductions to the project phase -Tutorial 2 : Cross analysis of a set of research papers -Tutorial 3 and 4 : Project kick-start -Autonomy sessions : redaction of a literature review.	Lectures : 9h00 Tutorials : 2h00 Project : 6h00
		IP Technical Deployment	Description : Lectures and tutorials are given as follow : -Lecture 1 : Introduction and tools for bibliographic research -Tutorial 1 : Application of the methodology to find relevant research papers -Lecture 2 : Analysis of literature review and introductions to the project phase -Tutorial 2 : Cross analysis of a set of research papers -Tutorial 3 and 4 : Project kick-start -Autonomy sessions : redaction of a literature review.	Lectures : 2h00 Project : 32h00
Innovation Project S8_ Road to business	3	**IP Business Plan**	Description : Lectures and tutorials are given as follow : -Lecture 1 : Introduction and tools for bibliographic research -Tutorial 1 : Application of the methodology to find relevant research papers -Lecture 2 : Analysis of literature review and introductions to the project phase -Tutorial 2 : Cross analysis of a set of research papers -Tutorial 3 and 4 : Project kick-start	Lectures : 14h00 Project : 12h00
		IP Project closure	Description : Lectures and tutorials are given as follow : -Lecture 1 : Introduction and tools for bibliographic research -Tutorial 1 : Application of the methodology to find relevant research papers -Lecture 2 : Analysis of literature review and introductions to the project phase -Tutorial 2 : Cross analysis of a set of research papers -Tutorial 3 and 4 : Project kick-start	Lectures : 2h00 Project : 4h00

Semester 8_Mechanical Engineering				
TEACHING UNIT	**ECTS**	**TEACHING UNIT COMPONENT**	**Content**	**TEACHING HOURS**
		IP User Test Awareness	Description : Lectures and tutorials are given as follow : -Lecture 1 : Introduction and tools for bibliographic research -Tutorial 1 : Application of the methodology to find relevant research papers -Lecture 2 : Analysis of literature review and introductions to the project phase -Tutorial 2 : Cross analysis of a set of research papers -Tutorial 3 and 4 : Project kick-start -Autonomy sessions : redaction of a literature review.	Lectures : 2h00
Mechanical Engineering	12	**Advanced CAD**	Description :	Project : 20h00
		Advanced Manufacturing	Description : Integration of the digital chain in the preparation work. Cutting conditions for solid materials. Optimization of the machining parameters (cutting conditions, CAM "Spirit", process studies, choice of tools ...).	Lectures : 2h00 Lab Work : 28h00
		Tribology	Description :	Lectures : 12h00 Tutorials : 8h00
		Structural Analysis 3	Description :	Lectures : 10h00 Tutorials : 10h00
Semester project	7	**Semester Project**	Description : Choice of topic: Students select a project topic in agreement with their supervisor. The topic can be technical (such as developing an application, data analysis, etc.). Implementation: Execution of the project according to the established plan, with possible adjustments based on needs and unforeseen circumstances. Write-up: Compilation of results, analysis, and conclusions into a written document. Preparation for the defense: Preparation of a structured and convincing oral presentation.	Tutorials : 20h00 Project : 130h00
Sustainable Management S8	1	**Circular Economy**	Description : This course is an introduction to the circular economy concept. In this course, student will learn about the 7 pillars of the circular economy with many examples.	Lectures : 4h00 Project : 4h00
		Corporate Social Responsability	Description :	Lectures : 4h00 Tutorials : 4h00 Project : 6h00
		Innovation Management & Intellectual Property	Description : - Innovation management for companies (different types) - Intellectual property: patent deposit, management of patents - General management of organizations for keeping the company's strategic advantages.	Lectures : 3h00
Semester 8_Mechanical Engineering	30			

Semester 8_Robotique and Automation				
TEACHING UNIT	**ECTS**	**TEACHING UNIT COMPONENT**	**Content**	**TEACHING HOURS**
Innovation Project S8_ Engineering Developments	7	**IP Project Management and technical requirements**	Description : Lectures and tutorials are given as follow : -Lecture 1 : Introduction and tools for bibliographic research -Tutorial 1 : Application of the methodology to find relevant research papers -Lecture 2 : Analysis of literature review and introductions to the project phase -Tutorial 2 : Cross analysis of a set of research papers -Tutorial 3 and 4 : Project kick-start -Autonomy sessions : redaction of a literature review.	Lectures : 9h00 Tutorials : 2h00 Project : 6h00
		IP Technical Deployment	Description : Lectures and tutorials are given as follow : -Lecture 1 : Introduction and tools for bibliographic research -Tutorial 1 : Application of the methodology to find relevant research papers -Lecture 2 : Analysis of literature review and introductions to the project phase -Tutorial 2 : Cross analysis of a set of research papers -Tutorial 3 and 4 : Project kick-start -Autonomy sessions : redaction of a literature review.	Lectures : 2h00 Project : 32h00
Innovation Project S8_ Road to business	3	**IP Business Plan**	Description : Lectures and tutorials are given as follow : -Lecture 1 : Introduction and tools for bibliographic research -Tutorial 1 : Application of the methodology to find relevant research papers -Lecture 2 : Analysis of literature review and introductions to the project phase -Tutorial 2 : Cross analysis of a set of research papers -Tutorial 3 and 4 : Project kick-start	Lectures : 14h00 Project : 12h00
		IP Project closure	Description : Lectures and tutorials are given as follow : -Lecture 1 : Introduction and tools for bibliographic research -Tutorial 1 : Application of the methodology to find relevant research papers -Lecture 2 : Analysis of literature review and introductions to the project phase -Tutorial 2 : Cross analysis of a set of research papers -Tutorial 3 and 4 : Project kick-start	Lectures : 2h00 Project : 4h00
		IP User Test Awareness	Description : Lectures and tutorials are given as follow : -Lecture 1 : Introduction and tools for bibliographic research -Tutorial 1 : Application of the methodology to find relevant research papers -Lecture 2 : Analysis of literature review and introductions to the project phase -Tutorial 2 : Cross analysis of a set of research papers -Tutorial 3 and 4 : Project kick-start -Autonomy sessions : redaction of a literature review.	Lectures : 2h00
Robotics & Automation Engineering	12	**Introduction to Controllers**	Description : -Definition of a PLC -Hardware components of a PLC -Connection of I/O modules -Program a filling machine using Ladder, Function block, Structured text, Grafcet -Train on data types, variables	Lab Work : 12h00
		IT & Robotic Labs	Description : The scrum methodology is introduced to the students. Then, they apply this agile framework during the whole duration of the project. Each group of students receives a project of robotic application. They state the problem before designing the robotic system that corresponds to the specifications. Then, they build their system and test it extensively. Finally, each group presents their work and write a report describing the technical and managerial aspects of the project.	Lab Work : 28h00

Semester 8_Robotique and Automation				
TEACHING UNIT	**ECTS**	**TEACHING UNIT COMPONENT**	**Content**	**TEACHING HOURS**
		IT Expertise - Machine Learning	Description : * Introduction to IA and Machine Learning ° Model Based Learning - main concepts and definitions ° Exact solution, iterative solutions, Gradient Descent ° First algorithms: Regressions - Linear Regression - Logistic Regression ° Data preprocessing ° Hyperparameter tuning * Towards Deep Learning ° more on preprocessing (categories encoding) and data sets ° From biological neuron to perceptron ° Multilayer Perceptron ° Convolutional Neural Networks ° Transfer Learning * Introduction to Natural Language Processing ° Some important ideas about NLP ° Example of statistical NLP (Multinomial Naive Bayes) ° NLP with Deep Learning (LSTM) * Other algorithms * Group project (text classification, image classification, recommendation, regression...)	Lectures : 20h00
		IT expertise - Machine Vision	Description : -Introduction to camera features -Introduction to the importance of lighting in image acquisition -Introduction to various technologies in image acquisition -Practical application on quality control, robot guidance and deep learning	Lectures : 4h00 Lab Work : 8h00
		Robotic Expertise - Motion Planning	Description : -Definition of industrial networks: Ethercat, Profinet, OPC-UA, IO-Link… -Practical on PLC/sensors/actuators communication using several industrial networks. -Definition of safety regulations -Procedure to perform risk analysis -Definition of drive-based and controller-based motion planning followed by practicals	Lab Work : 12h00
		Robotic Expertise - Automation	Description : This course divided into four parts. In the first part will give an overview of industrial robots basic components and structures. Part 2 depicts principles and methods of programming robots. Part 3 describes industry robotisation and robots workstations. The final part touches the safety of industrial robots and cobots. In this course, we will explore Arm construction and drives, Coordinates systems (BASE • TOOL • TCP • Part frame/User frame/Working frame), programming methods (Online • Offline), Robotized workstations/cells, risk assessments of robotic cells and standardizations/normalizations. • Introduction to industrial robotics • Basic components of industrial robot systems • Structure of industrial robots • Collaborative, non-collaborative, and mobile industrial robot applications • Industrial robot's motion • Methods of programming robots • Hazards associated with industrial robot applications • Safety considerations for employers and workers • Risk assessments • Risk reduction measures • Applicable industry standards for industrial robot system safety	Lectures : 6h00 Tutorials : 2h00 Lab Work : 16h00

Semester 8_Robotique and Automation				
TEACHING UNIT	**ECTS**	**TEACHING UNIT COMPONENT**	**Content**	**TEACHING HOURS**
		Wireless Communications	Description : -Introduction to IoT devices and their architectures (microcontroller, antenna…) -Introduction to radio waves and principles of modulation (amplitude, frequency and phase) -Definition of the various IoT networks (Short-range, LPWAN, Cellular) -Practical case study to choose the best IoT solution given technical specifications -Practical introduction to IoT programming with Sigfox modules for Arduino board	Lectures : 4h00 Lab Work : 8h00
Semester project	7	**Semester Project**	Description : Choice of topic: Students select a project topic in agreement with their supervisor. The topic can be technical (such as developing an application, data analysis, etc.). Implementation: Execution of the project according to the established plan, with possible adjustments based on needs and unforeseen circumstances. Write-up: Compilation of results, analysis, and conclusions into a written document. Preparation for the defense: Preparation of a structured and convincing oral presentation.	Tutorials : 20h00 Project : 130h00
Sustainable Management S8	1	**Circular Economy**	Description : This course is an introduction to the circular economy concept. In this course, student will learn about the 7 pillars of the circular economy with many examples.	Lectures : 4h00 Project : 4h00
		Corporate Social Responsability	Description :	Lectures : 4h00 Tutorials : 4h00 Project : 6h00
		Innovation Management & Intellectual Property	Description : - Innovation management for companies (different types) - Intellectual property: patent deposit, management of patents - General management of organizations for keeping the company's strategic advantages.	Lectures : 3h00
Semester 8_Robotique and Automation	30			

Semester 8_SupplyChain				
TEACHING UNIT	**ECTS**	**TEACHING UNIT COMPONENT**	**Content**	**TEACHING HOURS**
Industrial Engineering & Supply Chain Management S8	12	**CSCA Certification**	Description :	Lectures : 16h00
		Industry of the Future	Description : • Strategies & Effective Meeting Falication using IoT, DMAIC, 5S, UX, HMI • Analyse the product/process impacts and propose improvements • Organisation and management of a production through a challenge in the "School Factory" platform • Discovery and Robotization Project: - To be able to manipulate robots virtually and physically - Initiation to a method of implementation of robotic equipment - To determine the cost effectiveness of robotization on workstation - Difference robot/cobot (strategic, productivity, safety ...) - Risk analysis - Robotisation criteria	Lectures : 8h00 Tutorials : 6h00 Lab Work : 22h00

Semester 8_SupplyChain				
TEACHING UNIT	**ECTS**	**TEACHING UNIT COMPONENT**	**Content**	**TEACHING HOURS**
		Robust Supply chain	Description :	Lectures : 8h00 Tutorials : 12h00 Lab Work : 4h00
Innovation Project S8_ Engineering Developments	7	**IP Project Management and technical requirements**	Description : Lectures and tutorials are given as follow : -Lecture 1 : Introduction and tools for bibliographic research -Tutorial 1 : Application of the methodology to find relevant research papers -Lecture 2 : Analysis of literature review and introductions to the project phase -Tutorial 2 : Cross analysis of a set of research papers -Tutorial 3 and 4 : Project kick-start -Autonomy sessions : redaction of a literature review.	Lectures : 9h00 Tutorials : 2h00 Project : 6h00
		IP Technical Deployment	Description : Lectures and tutorials are given as follow : -Lecture 1 : Introduction and tools for bibliographic research -Tutorial 1 : Application of the methodology to find relevant research papers -Lecture 2 : Analysis of literature review and introductions to the project phase -Tutorial 2 : Cross analysis of a set of research papers -Tutorial 3 and 4 : Project kick-start -Autonomy sessions : redaction of a literature review.	Lectures : 2h00 Project : 32h00
Innovation Project S8_ Road to business	3	**IP Business Plan**	Description : Lectures and tutorials are given as follow : -Lecture 1 : Introduction and tools for bibliographic research -Tutorial 1 : Application of the methodology to find relevant research papers -Lecture 2 : Analysis of literature review and introductions to the project phase -Tutorial 2 : Cross analysis of a set of research papers -Tutorial 3 and 4 : Project kick-start	Lectures : 14h00 Project : 12h00
		IP Project closure	Description : Lectures and tutorials are given as follow : -Lecture 1 : Introduction and tools for bibliographic research -Tutorial 1 : Application of the methodology to find relevant research papers -Lecture 2 : Analysis of literature review and introductions to the project phase -Tutorial 2 : Cross analysis of a set of research papers -Tutorial 3 and 4 : Project kick-start	Lectures : 2h00 Project : 4h00
		IP User Test Awareness	Description : Lectures and tutorials are given as follow : -Lecture 1 : Introduction and tools for bibliographic research -Tutorial 1 : Application of the methodology to find relevant research papers -Lecture 2 : Analysis of literature review and introductions to the project phase -Tutorial 2 : Cross analysis of a set of research papers -Tutorial 3 and 4 : Project kick-start -Autonomy sessions : redaction of a literature review.	Lectures : 2h00
Semester project	7	**Semester Project**	Description : Choice of topic: Students select a project topic in agreement with their supervisor. The topic can be technical (such as developing an application, data analysis, etc.). Implementation: Execution of the project according to the established plan, with possible adjustments based on needs and unforeseen circumstances. Write-up: Compilation of results, analysis, and conclusions into a written document. Preparation for the defense: Preparation of a structured and convincing oral presentation.	Tutorials : 20h00 Project : 130h00

Semester 8_SupplyChain				
TEACHING UNIT	**ECTS**	**TEACHING UNIT COMPONENT**	**Content**	**TEACHING HOURS**
Sustainable Management S8	1	**Circular Economy**	Description : This course is an introduction to the circular economy concept. In this course, student will learn about the 7 pillars of the circular economy with many examples.	Lectures : 4h00 Project : 4h00
		Corporate Social Responsabilit y	Description :	Lectures : 4h00 Tutorials : 4h00 Project : 6h00
		Innovation Management & Intellectual Property	Description : - Innovation management for companies (different types) - Intellectual property: patent deposit, management of patents - General management of organizations for keeping the company's strategic advantages.	Lectures : 3h00
Semester 8_SupplyChain	30			