CLERMONT AUVERGNE INP

Classes in English - AY 2024/25

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INP School	Departement	Course title	Description	ECTS credits	Semester	Specific period
ISIMA	Computer Science	Computer Science / Core Course (mandatory) Fondamentals of Optimization	This course presents the fundamental concepts and algorithmic techniques of linear, convex, and nonlinear optimization. Besides some advanced techniques in linear optimization, a specific focus will be placed on convex analysis, Lagrangian duality, and gradient-based algorithms for unconstrained and constrained nonlinear optimization.	3	Fall Semester	
ISIMA	Computer Science	Computer Science / Core Course (mandatory) Algorithms and Complexity (20 hours)	This course presents some methods to analyzing the complexity of recursive algorithms, improving their running time, and showing the limitation of dynamic programming. We then show the meaning of Non-deterministic Polynomial algorithms (NP) and how to define the difficulty of some decision/search problems. Then assuming P = NP, we emphasize on Blackbox algorithm design. We also focus on communication complexity: deterministic communication protocols and methods to obtain lower bounds.	3	Fall Semester	
ISIMA	Computer Science	Computer Science / Core Course (mandatory) Machine Learning and Data Mining (20 hours)	This course is an introduction to data mining and machine learning techniques. It introduces basic concepts, principles, methods, implementation techniques, and applications of data mining, with a focus on three major data mining functions: classification and regression, pattern discovery, and cluster analysis. This course develops skills of using recent data mining software for solving practical problems.	3	Fall Semester	
ISIMA	Computer Science	Computer Science / Core Course (mandatory) Seminar Series (20 hours)	The seminar series consists of weekly talks by faculty, guest speakers from the academic and industrial sectors, and graduate students. The lectures feature current topics in decision and data sciences and more generally in the research areas of the LIMOS research unit. Each student will be required to give at least one 30-minute talk to present the research project he/she is working on during the year.	3	Fall Semester	
ISIMA	Computer Science	Foreign-Language Courses / one to choose English	This course includes the following orientations: computer terminology; drafting of scientific/formal abstract and report; professional environment and business world; training in external language exams (TOEIC).	3	Fall Semester	
ISIMA	Computer Science	Foreign-Language Courses / one to choose French as a Foreign Language	Training to listening and reading skills at beginner's level, training to oral and written communication in everyday life, French civilization, intercultural differences.	3	Fall Semester	
ISIMA	Computer Science	Decision-Science Courses / Combinatorial Optimization Specialization Courses (Five courses need to be taken from the two specialization areas: decision science and data science. The area from which the most courses are taken determines the specialization of the student.)	In this course, we introduce polyhedral techniques to solve combinatorialoptimization problems. Combinatorial-optimization problems are defined through examples. It is shown how these problems reduce to the solution of linear programs. In general, their systems of inequalities are huge and not easy to describe. However, for specific objective functions, partial descriptions are sometimes sufficient. A cutting-plane algorithm is presented to find integer solutions to linear programs having a very large number of inequalities. This approach is based on solving separation problems that generate violated valid inequalities. It is applied to the maximum weight matching and the traveling salesman problems.	3	Fall Semester	
ISIMA	Computer Science	Decision-Science Courses / Approximation Algorithms Specialization Courses (Five courses need to be taken from the two specialization areas: decision science and data science. The area from which the most courses are taken determines the specialization of the student.)	To avoid drawbacks of classical optimization techniques (high complexity for exact techniques and no guaranty for heuristics), approximation algorithms have been introduced a few decades ago. The idea is to relax the constraint of obtaining an exact solution and to propose polynomial time algorithms for which the quality of the output can be analytically compared to the optimal solution. Hence, they provide a theoretical and a practical framework for addressing (some) NP-complete problems solving.	3	Fall Semester	
ISIMA	Computer Science	Decision-Science Courses / Decision and Learning Under Uncertainty Specialization Courses (Five courses need to be taken from the two specialization areas: decision science and data science. The area from which the most courses are taken determines the specialization of the student.)	The objective of this course is to present an introduction to different methods of modeling and handling uncertainty and learning in decision problems. These methods will be illustrated on several applications (network design, gambling machines, stochastic shortest path problems, stochastic games, production and inventory control).	3	Fall Semester	
ISIMA	Computer Science	Decision-Science Courses / Graphs and Algorithms Specialization Courses (Five courses need to be taken from the two specialization areas: decision science and data science. The area from which the most courses are taken determines the specialization of the student.)	This course introduces graph complexity parameters that, when bounded, allow to solve NP-hard problems. After quickly reviewing classical parameters and why they are not enough to measure hardness of interesting problems, we introduce some families of graphs and polynomial-time algorithms, when reduced to these graph classes, for notorious NP-hard problems. The objective is to highlight how specific structures can help in solving hard problems. In the second part, we introduce the notion of parameterized complexity and some key features for studying the finegrained complexity of problems. For case study, we will introduce the notion of treewidth and some techniques for quickly solving, by dynamic programming, a bunch of NP-hard problems appearing in several areas such as in Databases, graphs, compilers, biology, etc. We will also survey bi-dimensionality theory. A last part will focus on applications (representing data, register allocation, query evaluation, etc.).	3	Fall Semester	
ISIMA	Computer Science	Decision-Science Courses / Advanced Topics in Optimization Specialization Courses (Five courses need to be taken from the two specialization areas: decision science and data science. The area from which the most courses are taken determines the specialization of the student.)	This course presents interior-point methods and studies the particular case of conic programming for several cones (linear, second order cone, and SemiDefinite Programming (SDP)). Outer and inner approximation frameworks are studied for generic mathematical programs with an emphasis on SDP relaxations and advanced cutting-planes for integer or nonconvex optimization problems. In the case of numerically costly functions, metamodels based on Gaussian processes can be used to speed up the search. An introduction to conditional Gaussian processes and their use in unconstrained optimization is given.	3	Fall Semester	
ISIMA	Computer Science	Data-Science Courses / High Performance Computing, Parallel Programming Models, Hybrid Computing, Numerical Reproducibility Specialization Courses (Five courses need to be taken from the two specialization areas: decision science and data science. The area from which the most courses are taken determines the specialization of the student.)	High Performance Computing (HPC) has moved from a selective and expensive endeavor to a cost-effective technology within reach of virtually every budget with the massive arrival of many cores processors (APU, GPU…). The purpose of this course is to introduce Scientific computing, parallel programming architectures and models deployed on supercomputers, computing clusters and grids. Hybrid computing is also presented with modern accelerators, including General Purpose Graphical Processing Units, manycore and also disruptive technologies like photonic and quantum computing. This course presents the history, the theoretical laws, the modern concepts and the future of High Performance Computing. It gives a particular focus on stochastic distributed computing and parallel random numbers and on numerical Master of Science in Computer Science - International Track 5 reproducibility which provide a robust and resilient approach to address the increase in soft errors met on our roadmap towards Exascale performances (2022).	3	Fall Semester	
ISIMA	Computer Science	Data-Science Courses / Advanced Topics in Machine Learning and Data Mining Specialization Courses (Five courses need to be taken from the two specialization areas: decision science and data science. The area from which the most courses are taken determines the specialization of the student.)	This lecture provides an overview of big data analysis. It successively tackles the major issues of the field and presents latest advances and new applications. The content covers architecture for big data analysis, the concept of scalability in learning (supervised and unsupervised), an overview of deep learning, an exploration and visualization of big data analysis, and an overview of tools (SPARK/FLINK, TensorFlow, Scikit Learn).	3	Fall Semester	
ISIMA	Computer Science	Data-Science Courses / Knowledge Representation and Reasoning Specialization Courses (Five courses need to be taken from the two specialization areas: decision science and data science. The area from which the most courses are taken determines the specialization of the student.)	The course covers some basic foundations underlying theories and systems that aim at expressing structured knowledge and reasoning with it in a principled way. It particularly addresses description logics as an important class of logic-based knowledge representation languages, and their application in database and semantic web areas.	3	Fall Semester	
ISIMA	Computer Science	Data-Science Courses / Mobile Networks and Mobile Data Collection Specialization Courses (Five courses need to be taken from the two specialization areas: decision science and data science. The area from which the most courses are taken determines the specialization of the student.)	This course discusses various technologies for mobile networks (MANET, VANET, DTN, etc.), routing protocols specially designed to route data from/to mobile nodes, as well as protocols intended to optimize the collection of the data generated by nodes.	3	Fall Semester	
ISIMA	Computer Science	Data-Science Courses / Information System Security Specialization Courses (Five courses need to be taken from the two specialization areas: decision science and data science. The area from which the most courses are taken determines the specialization of the student.)	Nowadays security is one of the main concerns. In a first part we present historical and modern cryptographic mechanisms. We after describe existing models for evaluating the security of cryptographic primitives. Then we see how it is possible to use these primitives to ensure secure communications over unsecure channels or in a hostile environment, that is, in the presence of an intruder controlling the communication.	3	Fall Semester	
ISIMA	Computer Science	Research Activities (Both activities need to be taken.) Research Project at CNRS Research Unit LIMOS	This five-month research project consists of realizing a state-of-the-art study and research contribution in decision or data science. This project will be proposed and supervised by researchers, mainly from the Laboratory of Informatics, Modeling, and Optimization of Systems (LIMOS), a CNRS research unit at the University Clermont Auvergne.	9	Spring Semester	
ISIMA	Computer Science	Research Activities (Both activities need to be taken.) Internship starting after March 1 st	A five-to-six-month internship in an academic research institute or an industrial research-and-development department anywhere in the world.	21	Spring Semester	
Polytech Clermont	Civil Engineering	Synthesis technical project	Real project in progress of a technical study and interdisciplinary design presenting several materials and forms of structure from the programming phase to the details of execution. Additional theoretical contributions in project management and design methodology	5	Fall Semester	
Polytech Clermont	Civil Engineering	Technical Option (4 courses choosen) / Wood construction	Wood construction technology and calculation of wooden structures.	5	Fall Semester	
Polytech Clermont	Civil Engineering	Technical Option (4 courses choosen) / Mixed construction	Technology of mixed steel-concrete contrusction (+ other materials) and calculation of mixed steelconcrete structures (beam, column, slab, assemblies).	5	Fall Semester	
Polytech Clermont	Civil Engineering	Technical Option (4 courses choosen) / Soils and infrastructures	Concept and management of the different aspects of road and network project.	5	Fall Semester	
Polytech Clermont	Civil Engineering	Technical Option (4 courses choosen) / Concrete Structure	Mastery of the analysis and dimensioning of prestressed concrete structures.	5	Fall Semester	

Polytech Clermont	Civil Engineering	Educational units (3 courses have to be taken)	• Semi-rigid behavior of connections in steel and timber structures • Design of Geotechnical works • Design and verification of wooden structures • Inspection, Maintenance and Repair of Works • Inspection, Maintenance and Repair of Buildings • Composite Construction - Eurocode 4 • Behavior of structures in fire • Dynamics approaches and design of structures for earthquake resistance • Advanced applications of Eurocodes 3 • Soil mechanics and hazard • Auscultation and soils investigation • Soil reinforcement (design and experimental testing) • Risk management for civil engineering • Pedagogical experimentation: another modeling tool • Geosynthetics • Service life of civil engineering works • Introduction to unsaturated soils behavior • Application of full field measurements for the characterization of civil engineerin structures • Tree biomechanics: residual stress distribution resulting from the growth of a lignified stem • Introduction to LEAN Construction	9 (for 3 courses)	Fall Semester	
Polytech Clermont	Civil Engineering	French Courses	French courses are available at the center of French learning FLEURA in Clermont-Ferrand.	3	Fall Semester	
Polytech Clermont	Civil Engineering	Training courses		15	Fall or Spring Semester	
Polytech Clermont	Civil Engineering	Individual research projects	In relation with supervisors specialized in civil engineering, structures, infrastructures, biomaterials in different Laboratories on the Cézeaux campus, the objectives of the individual research projects will be to develop innovative techniques or knowledge on a topic given by specialized companies in civil engineering industry.	15	Fall or Spring Semester	
Polytech Clermont	Civil Engineering	Internships in research Laboratories	An internship (2 MONTHS) is encouraged to be a unique international experience for doing research. International students will be host by Academic French Laboratories on the Cézeaux campus for a 2 month-internship in the fields of civil Engineering	15	Fall or Spring Semester	
Polytech Clermont	Engineering Physics	Mathematics 1 (Mathematics Statistics)	Main mathematical knowledge for engineers	3	Fall Semester	S5
Polytech Clermont	Engineering Physics	Computer Science	To master the main computing tools: algorithmic, language, computer architecture, LINUX	4	Fall Semester	S5
Polytech Clermont	Engineering Physics	Applied Physics (Electronics Fluid Dynamics)	Basics in the physics of elementary electronic components and application Characterization of a fluid and of the main conservation equations of a fluid flow	5	Fall Semester	S5
Polytech Clermont	Engineering Physics	Quantum Physics (Mathematical Tools Quantum Physics)		3	Fall Semester	S5
Polytech Clermont	Engineering Physics	Scientific Complements (selection of 2 courses)	Energetics Matter and Materials Solid Mechanics Electronics Biology Signal Processing	2	Fall Semester	S5
Polytech Clermont	Engineering Physics	Project 1	Conception and development of a manufactured product developed in group: bibliography and theoretical phase	6	Fall Semester	S5
Polytech Clermont	Engineering Physics	Social Sciences 1 (Law Economics)	Learning business through economics and law	4	Fall Semester	S5
Polytech Clermont	Engineering Physics	Communication 1 (Written and oral expression in French – Cultural background self-improvement English language)	To improve communication competences and develop autonomy and self-confidence in French and English	3	Fall Semester	S5
Polytech Clermont	Engineering Physics	Mathematics 2	Main tools for engineers: Laplace and Fourier transforms, Stokes theorem – Complex analysis	3	Spring Semester	S6
Polytech Clermont	Engineering Physics	Modeling and Simulation (Database Numerical Analysis)	Fundamental basics in database and in numerical analysis for engineers - application	2	Spring Semester	S6
Polytech Clermont	Engineering Physics	Physics of Fields (Waves and magnetism Strength of Materials)	Fundamental basics in physics of complex systems involving advanced phenomena in electricity, mechanics, optics, and heat transfer – Electromagnetic wave propagation	4	Spring Semester	S6
Polytech Clermont	Engineering Physics	Condensed Matter Physics (Geometrical Crystallography Solid State Physics: lattice vibrations, electronic states Statistical Physics)	Going from microscopic to macroscopic scale: vibrational, electronic, and magnetic properties of matter – comprehension of crystal structure of atoms in crystalline materials	4	Spring Semester	S6
Polytech Clermont	Engineering Physics	Engineering Physics (Metallurgy Physico-Chemistry Polymers)	Solid knowledge of the characterization techniques in physico-chemistry of materials and in observation metallographic techniques, which will help to correlate the microstructural, physicochemical, and mechanical properties	5	Spring Semester	S6
Polytech Clermont	Engineering Physics	Communication 2 (English language Written and oral expression in French)	Reinforcement of communication competences: better autonomy and confidence in French and English	3	Spring Semester	S6
Polytech Clermont	Engineering Physics	Social Sciences 2 (Innovation Strategy)	Scientific and technical intelligence	1	Spring Semester	S6
Polytech Clermont	Engineering Physics	Free Credit		1	Spring Semester	S6
Polytech Clermont	Engineering Physics	Project 2	Conception and development of a manufactured product developed in group: technological analysis and technical files – CAD formats – Basics of project management	5	Spring Semester	S6
Polytech Clermont	Engineering Physics	Training period 1	One month in a professional environment	2	Spring Semester	S6
Polytech Clermont	Engineering Physics	Matter and Radiation 1 (X-Ray Diffraction Solid State Physics 2: heat capacity, dielectric, and magnetic properties Metallurgy)	Physical analysis of solid materials – link to the observed state or the elaboration process	5	Fall Semester	S7
Polytech Clermont	Engineering Physics	Physico-chemistry (Interfaces Practical Training)	Panorama of the solid/liquid and solid/gas interface phenomena	4	Fall Semester	S7
Polytech Clermont	Engineering Physics	Numerical Methods (Numerical methods for transport phenomena)	Modeling fundamentals of transport phenomena and simulation with FVM and FEM techniques	3	Fall Semester	S7
Polytech Clermont	Engineering Physics	Electrical Engineering 1 (Automatic Control Electrotechnics)	Fundamentals in automatic control, electronics and electrotechnics - application	5	Fall Semester	S7
Polytech Clermont	Engineering Physics	Project 3	Conception and development of a manufactured product: realization of sub-systems	5	Fall Semester	S7
Polytech Clermont	Engineering Physics	Business Management	Law Management English language Psychosociology	8	Fall Semester	S7
Polytech Clermont	Engineering Physics	Matter and Radiation 2 (Generalized functions: theory and application Spectroscopies Nuclear Energy)	Fundamentals in nuclear physics and application to power plants Solid knowledge in characterization of materials based on spectroscopy by coupling with quantum mechanics	4	Spring Semester	S8
Polytech Clermont	Engineering Physics	Electrical Engineering 2 (Logical Design Electrotechnics (practical training))	Fundamentals in logical design – fundamentals applied in electrotechnics and power electronics	4	Spring Semester	S8
Polytech Clermont	Engineering Physics	Communication 3 (Written and oral expression in French and culture English language)	Improvement of communication and English skills	3	Spring Semester	S8
Polytech Clermont	Engineering Physics	Project 4	Conception and development of a manufactured product: assembling of subsystems and test	4	Spring Semester	S8
Polytech Clermont	Engineering Physics	Training period 2	4 months abroad / or in lab for exchange students	14	Spring Semester	S8
Polytech Clermont	Engineering Physics	Physics and Materials Engineering cursus / Non-Destructive Testing	To acquire solid knowledge in all non-destructive testing applied in industry to be able to implement the proper one	5	Fall Semester	S9
Polytech Clermont	Engineering Physics	Physics and Materials Engineering cursus / Development and implementation of engineering materials	Main materials used in industry: metallic, composite, ceramic materials – elaboration, implementation, performance – damage and defectology	4	Fall Semester	S9
Polytech Clermont	Engineering Physics	Physics and Materials Engineering cursus / Interaction of radiation with matter, optronics	Solid knowledge in materials used in optoelectronics or microelectronics and their characterization with advanced technologies	4	Fall Semester	S9
Polytech Clermont	Engineering Physics	Physics and Materials Engineering cursus / Surface and interface physics	Advanced knowledge in physico-chemistry of interfaces – application to surface condition analysis, corrosion, heterogeneous catalysis	3	Fall Semester	S9
Polytech Clermont	Engineering Physics	Energy cursus / Energy and Energetics: economic and scientific fundamentals	Energy and Energetics: economic and scientific fundamentals	4	Fall Semester	S9
Polytech Clermont	Engineering Physics	Energy cursus / Carbon-free renewable energies: bioenergy, wind, geothermal, hydraulic, solar	Carbon-free renewable energies: bioenergy, wind, geothermal, hydraulic, solar	3	Fall Semester	S9
Polytech Clermont	Engineering Physics	Energy cursus / Carbon and nuclear fossil energies	Carbon and nuclear fossil energies	3	Fall Semester	S9
Polytech Clermont	Engineering Physics	Energy cursus / Storage, transport, and distribution of electrical energy	Storage, transport, and distribution of electrical energy	3	Fall Semester	S9
Polytech Clermont	Engineering Physics	Energy cursus / Control of energy consumption: building and industry	Control of energy consumption: building and industry	3	Fall Semester	S9
Polytech Clermont	Engineering Physics	Specific course	Offer changes by AY. Please contact IRO for more information.	6	Fall Semester	S9
Polytech Clermont	Engineering Physics	Communication skills and English	Development of professional and personal projects, communication in different situations, Psychology in company, English level B2 / C1	8	Fall Semester	S9
Polytech Clermont	Engineering Physics	Training period 3	5 or 6 months	30	Spring Semester	S10
Polytech Clermont	Biological Engineering	Genetic engineering and Bioinformatics	Tools for sequences alignment Techniques for cloning DNA fragment in bacterial/yeast systems Experimental techniques of genetic engineering and molecular biology (cloning, PCR, Southern Blot) Organize and plan an experiment 1. Construction of DNA probes of a gene of interest 2. Cloning of DNA fragments (probes) in plasmids 3. Genomic DNA Extraction 4. Enzymatic digestion with restriction enzymes 5. Probe and Molecular Hybridization (Southern)	3	Fall Semester	S7

Polytech Clermont	Biological Engineering	Plant biotechnology	Acquisition of notions in botany (major plant kingdoms), physiology of seed and plant development, plant function at the cellular level (plant hormones and cell signaling under normal culture conditions and biotic and abiotic stresses), in vitro culture, techniques of genetic transformation of plants and industrial applications. Use and handling of plants grown in vitro, manipulation of unicellular plant organisms in association with microorganisms, concept of industrial uses of plants and properties, genetic transformations of plants. 1. Plant in vitro culture 2. Genetic transformation of the moss Physcomitrella patens 3. Application of an AFNOR Standard on plants 4. Demonstration of the action of giberrelins in barley seeds germination 5. Study of the antibacterial activity of essential oils 6. Analysis of the composition of mint essential oil 7. Plants-microorganism associations 8. Carrageenans extraction of a red algae: Euchema Cottonii	3	Fall Semester	S7
Polytech Clermont	Biological Engineering	Microbiology	Standardized methods in microbiology for the detection of bacteria, introduction to the quality insurance (traceability) Microorganisms at the center of biotechnology - Useful and harmful bacteria. 1. Standards to the application: standardized methods of research and enumeration of major bacteria in food hygiene 2. Use of molecular detection technologies for microorganisms 3. Constraints of work organization in microbiology: holding of a laboratory notebook, traceability	3	Fall Semester	S7
Polytech Clermont	Biological Engineering	Biomolecule synthesis	Consolidate fundamental principles of chemistry in order to understand molecular biological processes. Understand the constraints and the methods developed for the synthesis of bioactive molecules. Amino acid coupling, racemic splitting, Stereospecificity of enzymatic reactions	3	Fall Semester	S7
Polytech Clermont	Biological Engineering	French courses	French courses are available at the center of French learning FLEURA in Clermont-Ferrand.	3	Fall Semester	S7
Polytech Clermont	Biological Engineering	Industrial technologies (1 courses to choose)	BIOTECHNOLOGY Host cell systems for the production of recombinant proteins. Acquisition of a global vision of the process from the production to the purification of recombinant proteins. Production system in bacteria and yeast. Developing autonomy in a lab context	3	Spring Semester	S7
Polytech Clermont	Biological Engineering	Industrial technologies (1 courses to choose)	MICROBIOLOGY Production and use of microorganisms and / or enzymes in the food industry. Separation and purification techniques Introduction to Experimental Plans Simulation and Modeling	3	Spring Semester	S7
Polytech Clermont	Biological Engineering	Genetics	Prokaryotes and eukaryotes genetics for industrial uses Bacterial genetics: contributions / applications in terms of molecular tools and technologies that stem from knowledge of bacterial genetics. Plant genetics: quantitative genetics, genetic breeding, segregation, molecular markers, physical map and genetic map, genetics of association, genomic selection, molecular marker generation and polymorphism study, genetics of association, optimal use of marker-assisted selection.	4	Spring Semester	S7
Polytech Clermont	Biological Engineering	Immunology	Acquire the basics in immunology and immunological techniques Understanding the mechanisms involved in the immune response. Knowledge of some major known pathologies and different detection methods: 1. Double immuno-diffusion (Ouchterlony) 2. Detection of antigens by the spotting method (Dot blot) 3. Study of the components of a rabbit serum by Western Blot 4. ELISA technique: BSA / anti-BSA system 5. SDS-PAGE Technology	2	Spring Semester	S7
Polytech Clermont	Biological Engineering	Bioprocesses and biocatalysis	Give an overview of the nature and economic importance of current industrial biological processes. Development of skills in the field of the application of biocatalysts (microorganisms or isolated enzymes) for the production of molecules of industrial interest. Analysis of the constraints related to the production of molecules of biological interest. Proposed biotechnological solutions.	4	Spring Semester	S7
Polytech Clermont	Biological Engineering	French courses	French classes are available in both semesters (Fall/Spring).	2	Spring Semester	S7
Polytech Clermont	Biological Engineering	Individual research projects	In relation with supervisors specialized in bioprocess engineering, genetic engineering, metabolic engineering in different Laboratories on the Cézeaux campus, the objectives of the individual research projects will be to develop innovative techniques or knowledge on a topic given by specialized companies in Food, pharmaceutical, or environmental industry.	15	Fall Semester	S7
Polytech Clermont	Biological Engineering	Internships in research Laboratories	An internship is encouraged to be a unique international experience for doing research. International students will be host by Academic French Laboratories on the Cézeaux campus for a 2 month internship in the fields of Bioprocess Engineering, Food science or Environment	15	Spring Semester	S7
SIGMA Clermont	Mechanical Engineering	French Basics	Tutorials 2 hours per week Thematic focus on news items, travel, means of transport, accommodation, French gastronomy	2	Fall Semester	S7
SIGMA Clermont	Mechanical Engineering	French	Tutorials 2 hours per week Thematic focus on travel, acommodation, means of transport, French gastronomy	2	Fall Semester	S7
SIGMA Clermont	Mechanical Engineering	How to design your personal and professional development plan	1) Cross-debriefing of what I learned in the 1A internship 2) Designing my career plan and making the final course choices in school 3) Knowing how to talk about my skills 4) Which companies are attractive to me? Why do I want to do this? What do I need to know about them, their sector, the competition in order to be credible in an interview 5) How to present myself spontaneously in an oral presentation 6) My video CV in 180 seconds 7) Simulated recruitment interviews with video recording	4	Fall Semester	S7
SIGMA Clermont	Mechanical Engineering	Marketing	chapter 1: the fundamentals of marketing, the place of marketing in the company, the market, customers, segmentation, Chapter 2: the concept of marketing mix, commercial policy (7 areas), Chapter 3: positioning, brand, price, packaging Chapter 4: negotiation and tendering Chapter 5: Visiting a shop or a shopping center, the "mystery shopper" posture, analysis of operational marketing chapter 6: market studies and supply studies chapter 7: business strategies chapter 8: business strategies chapter 9: management of sales teams Chapter 10: Marketing and commercial defense of the innovation project concepts of marketing and theorys, marketing examples, success stories	2	Fall Semester	S7
SIGMA Clermont	Mechanical Engineering	Machine Learning	Machine learning is concerned with giving computers the ability to automatically improve their performance through experience, i.e. learn from data. With the increasing amount of data being generated and made available for analysis, machine learning has made huge improvements in the past few years with strong impacts in lots of application fields : speech recognition and machine translation, recommendations, healthcare, price analysis, computer vision, robotics, driverless cars… The course will give an introduction to the main concepts of machine learning and cover some of the most widely used machine learning techniques. After a short introduction, the course focus on linear regression, parametric/ nonparametric techniques supervised/unsupervised learning. The last lectures present neural networks and deep learning recent advances.	2	Fall Semester	S7
SIGMA Clermont	Mechanical Engineering	Computer Aid Design	3 lectures : 6H General CAD Main concepts of CAD. Overview of the market and available softwares. Presentation of the different geometric modellers and the general modeling process Main tools used in CAD Overview of the main tools that will be used, CAD reminders (essential elements of part design assembly, generative shape design, drafting, DMU Kinematics), modeling techniques. Configuration of a CAD model. Assembly. Kinematics. Skeleton methodology. Smart models. Technical data exchanges (IGES, STEP). Parameterization and simulation of mechanisms Elements of geometry (reciprocal screw, families of lines, Hunt's theorem), General method for parameterizing spatial and multi-loop mechanisms 7 Tutorials : 14H 1) Reminders on volume modeling and assemblies (part design and assembly modules) (2H) 15/05/22 07:51 Page 1 /2 Reference works 2) Robust modeling of a complex part (addition of the generative shape design module) (using the skeleton methodology) (2H) 3) Robust modeling of assemblies (from a skeleton made up of geometric reference elements) (2H) 4) Surface modeling (Freestyle and Generative Shape Design modules) (2H) 5) Intelligent models (intelligent models, library management, rules and reactions, optimization, CAD data exchanges) (2H) 6) Mechanism parameterization (2H) 7) Modeling of a mechanism in the form of CAD spatial kinematic schemes (construction method from the skeleton methodology and the use of a library of kinematic joints) (2H) 2 Practical works (2x4H) 1) Modeling and parameterization of a parallel robot 2) Simulation of a parallel robot	2,5	Fall Semester	S7
SIGMA Clermont	Mechanical Engineering	System Engineering, Innovation & Sustainable Design	CM1: Functioning of the ECUE / Presentation of challenges and new design trends CM2: EAD Quality Function Deployment- Assessment QCM TD1: QFD CM3: EAD System Engineering- Assessment QCM TD2 -TD3- TD4: Autonomous weeding robot project CM4: EAD Concept creation- QCM assessment TD5: Concept creation TD 6: EAD Eco design- QCM assessment TD7: Tutorial: Ergonomics in Design CM5: EAD Safety in design- QCM assessment TD8: operational safety in Design	2	Fall Semester	S7
SIGMA Clermont	Mechanical Engineering	Programming For Robotics	This course introduces relevant concepts for the software development of robots (communication, modeling, kinematics, and control). In particular, the students will learn the main concepts of the middleware ROS (“Robot Operating System”) and apply them in a small programming project with a robot	2	Fall Semester	S7
SIGMA Clermont	Mechanical Engineering	Basic Robotics	This course presents theory and its progressive implementation. It introduces relevant topics for basic robotics. The topics address: types of robots; definition of a robot arm; configuration space, degrees of freedom, task space and workspace of a robot arm; rigid-body pose and motion; forward position kinematics; simulation and animation of robots	2	Fall Semester	S7

SIGMA Clermont	Mechanical Engineering	Computer vision	• Generalities and basics • Camera modelling o One view geometry o Multi-view geometry o Calibration o Pose estimation • Image Processing o Histogram-based processing o Convolution-based processing o Fourier-based processing • Feature detections • Matching • Tracking • OPENCV : a powerfull opensource library for computer vision • Robotic applications	2	Fall Semester	S7
SIGMA Clermont	Mechanical Engineering	Real time systems	Real-Time Systems is concerned with designing the behavior of a system so that it is constrained by the evolution of the physical process to which it is connected. With the current industrial needs of reliable and predictable system, real-time features are exploited in many fields such as robotic arm control, computer games or ABS system in a car. This course will introduce first a high level programming language, C++ and the concept of object-oriented programming. The second part of this course will focus on multitask synchronization, and different designs to share and optimize a common resource between different processes. This course will be validated with lab work projects on a robotic system.	2	Fall Semester	S7
SIGMA Clermont	Mechanical Engineering	2nd-year project, Machines, Mechanisms and Systems speciality (80h)	These projects concern 2nd year engineering students. Spread over 80 hours per student between the months of October to May, they allow student engineers to address specific technical problems, the feasibility of a project, and to carry out technical comparisons by working in teams (6 to 12 students). The objective is to set up methodological design and project management tools to respond to the given problem. The volume of the project in S07 is 30h followed by 50h in S08.	2	Fall Semester	S7
SIGMA Clermont	Mechanical Engineering	Advanced Robotics	This course presents the theory and its progressive implementation. The topics covered are as follows: reminder of the basics of robotics; forward kinematics; inverse kinematics; control in joint space; control in Cartesian space; simulation and animation.	2,5	Spring Semester	S8
SIGMA Clermont	Mechanical Engineering	Modelling of Mechatronics Systems	Context and issues of multiphysics modeling. The bond graph language - Components of the language - Causality - Extraction of state models and block diagrams from a bond graph representation - Rules for building a bond graphs model for different physical domains The Modelica language - Object-oriented modeling concepts - Elements of the Modelica language - Modeling methodology Case studies - Application examples using OpenModelica and 3D Experience software	2,5	Spring Semester	S8
SIGMA Clermont	Mechanical Engineering	Reinforcement Learning for Robotics	Reinforcement Learning is a machine learning paradigm that rewards desired behaviors of an agent by creating a loop of action-reward-exploration. Such an approach is particularly suitable for robots when modelling complex behaviors without direct access to labelled data. Nowadays, Reinforcement Learning is used to endow robots with navigation, grasping or manipulation capabilities. This course will introduce both the theoretical and practical aspects of Reinforcement. Learning. A particular focus will be put on robotic applications with several practical classes based on ROS, GAZEBO and OpenAI tools.	2,5	Spring Semester	S8
SIGMA Clermont	Mechanical Engineering	Marketing and management : cultural and societal aspects	chapter 1: the fundamentals of marketing, the place of marketing in the company, the market, customers, segmentation, Chapter 2: the concept of marketing mix, commercial policy (7 areas), Chapter 3: positioning, brand, price, packaging Chapter 4: negotiation and tendering Chapter 5: Visiting a shop or a shopping center, the "mystery shopper" posture, analysis of operational marketing chapter 6: market studies and supply studies chapter 7: business strategies chapter 8: business strategies chapter 9: management of sales teams Chapter 10: Marketing and commercial defense of the innovation project concepts of marketing and theorys, marketing examples, success stories	2	Spring Semester	S8
SIGMA Clermont	Mechanical Engineering	Fundamentals of management	1) Evolutions and role of management: theories of organization and management in companies, periods and (r)evolutions 2) Manager with his style and in the culture of the company 3) Inter- and multi-cultural dimension of management 4) Current trends: from facts and stories to solid developments 5) From group to team: motivation and commitment - how to give meaning beyond rewards 6) Case Studies of different managerial contexts	2	Spring Semester	S8
SIGMA Clermont	Mechanical Engineering	Economics: serious game	For course description please contact the IRO at Clermont Auvergne INP	2	Spring Semester	S8
SIGMA Clermont	Mechanical Engineering	Elective course 1	For course description please contact the IRO at Clermont Auvergne INP	1	Spring Semester	S8
SIGMA Clermont	Mechanical Engineering	Electrical Actuators in Robotics and Machine-tools	3 lectures : 6h 1) Introduction to electrical actuators in robotics and machines-tools Introduction to electromechanical systems as robots and machines-tools. Advanced electric motion-control system: power transmission, transducers, electrical machines, power electronics converters. 2) Brushed direct-current motors and brushless direct-current motors Review of motor theory. Modelling for the purpose of control. Motors' characteristics. Drive for brushed and brushless D.C motors. Introduction to sensorless control for motors. 3) Synchronous motors, induction motors and stepper motors Generalised theory of electrical machines. Modelling for the purpose of control of alternating current motors. Motors' characteristics. Flux oriented vector control for synchronous and induction motors. Control of stepper motors. Conclusions. 5 Tutorials : 10h 1) Brushed direct-current motors (BDC): modelling and control. 2) Brushless direct-current motors (BLDC): modelling and control. 12/05/22 17:27 Page 1 /2Reference works 3) Synchronous motors with three-phase alternating current: modelling and flux oriented vector control. 4) Induction motors : modelling and flux oriented vector control. 5) Stepper motors and controllers. 3 Practical works (12h) 1) Design, modelling, and control of BDC and BLDC motors (sensored or sensorless approach). 2) Design, modelling, and control of synchronous motors. 3) Design, modelling, and control of induction motors.	2,5	Spring Semester	S8
SIGMA Clermont	Mechanical Engineering	Industrial Process / Additive Manufacturing	Introductory course Metal Additive Manufacturing Materials and Processes Polymeric additive manufacturing materials and processes Design and manufacturing methods Applications on a use case	2,5	Spring Semester	S8
SIGMA Clermont	Mechanical Engineering	Dynamics	• Elasto-dynamique o Formulations locale et intégrale o Vibrations des barres, poutres… o Méthode des éléments finis appliquée à la dynamique • Théorie modale o Paramètres modaux d'une structure o Décomposition et réduction modales o Matrice de transfert • Systèmes multi-corps flexibles o Formulation cinématique o Modèle dynamique • Dynamique des rotors o Notions de vitesses critiques- modèle simplifié du rotor de Jeffcott. o Modélisation et principales phénoménologies	2,5	Spring Semester	S8
SIGMA Clermont	Mechanical Engineering	2nd-year project, Machines, Mechanisms and Systems speciality (80h)	These projects concern 2nd year engineering students. Spread over 80 hours per student between the months of October to May, they allow student engineers to address specific technical problems, the feasibility of a project, and to carry out technical comparisons by working in teams (6 to 12 students). The objective is to set up methodological design and project management tools to respond to the given problem. The volume of the project in S07 is 30h followed by 50h in S08.	4	Spring Semester	S8
SIGMA Clermont	Mechanical Engineering	English	TD Lessons -Mergers and Acquisitions -Outsourcing -Business Ethics -Planned Obsolescence - Dark Trade Workshops - to be selected according to the student's level, their motivation and objectives. Workshops related to TOEIC but also to interculture, communication techniques and memory gain. Practical classes : -Meeting - business simulations -Individual presentations on cultural and/or intercultural subjects	2	Fall Semester	S9
SIGMA Clermont	Mechanical Engineering	French	Tutorials 2 hours per week Thematic focus on travel, acommodation, means of transport, French gastronomy	2	Fall Semester	S9
SIGMA Clermont	Mechanical Engineering	Job marketing	1) Draw a parallel between marketing and self-marketing 2) Know what you want, know how to say it with conviction and consistency 3) Update and refine CV / LM / RS recruitment documents. 4) Prepare for recruitment interviews. 5) Make a professional pitch in front of a recruiter	1	Fall Semester	S9

SIGMA Clermont	Mechanical Engineering	Business Strategy	1) Drawing a parallel between marketing and self-marketing 2) Knowing what you want, knowing how to say it with conviction and coherence 3) Updating and refining the recruitment documents CV/LM/RS 4) Prepare for recruitment interviews. 5) Make a professional pitch to a recruiter	1	Fall Semester	S9
SIGMA Clermont	Mechanical Engineering	Management	For course description please contact the IRO at Clermont Auvergne INP	1	Fall Semester	S9
SIGMA Clermont	Mechanical Engineering	Strategy and leadership	For course description please contact the IRO at Clermont Auvergne INP	1	Fall Semester	S9
SIGMA Clermont	Mechanical Engineering	Elective course 2	For course description please contact the IRO at Clermont Auvergne INP	1	Fall Semester	S9
SIGMA Clermont	Mechanical Engineering	Elective course 3	For course description please contact the IRO at Clermont Auvergne INP	1	Fall Semester	S9
SIGMA Clermont	Mechanical Engineering	Sustainable Manufacturing & Innovation	Sustainable development Product life cycle assessment Eco design Eco manufacturing Case studies Identification and formalisation of innovation problems / Innovation operators / TRIZ-ARIZ innovation problem solving algorithms / Morphological and evolutionary approaches. Patents Case study - Innovation and Patents	2	Fall Semester	S9
SIGMA Clermont	Mechanical Engineering	Innovative Materials	Introduction to Innovative materials Different types of innovative materials, composite materials, smart materials and their microstructure Notion of scale, multi-scale and multi-physics modeling Possible components of innovative materials and their properties Examples of fabrication processes of innovative materials and structures Some practical problems Advanced subjects of Innovative Materials	1,5	Fall Semester	S9
SIGMA Clermont	Mechanical Engineering	Softwares for Dynamics & Materials	• 12 h lectures: small and large motions, ADAMS and ANSYS theory, real-time simulations. • 8 h tutorials: multi-body and material problems formalization. • 8 h practicals: multi-body and material problems implementation.	1,5	Fall Semester	S9
SIGMA Clermont	Mechanical Engineering	Sensor Integration	•Sensor fundamentals •Sensor technologies •Sensor in control loop •Force control •Vision-based control •Robotic Applications •Practical work : Arduino + Raspberry + camera + actuators + opencv	2	Fall Semester	S9
SIGMA Clermont	Mechanical Engineering	Applications of Intelligent Robotics	This course introduces relevant concepts of intelligent artificial for robotics. In particular, the students will learn artificial intelligence techniques (SVM, CNN, RNN, transformers, etc). Besides, the students will learn how to control a collaborative robot based on these artificial intelligence techniques and apply them in small programming projects.	1,5	Fall Semester	S9
SIGMA Clermont	Mechanical Engineering	Special Topics on Perception and Robotics	This course introduces important topics on perception and robotic applications. The topics include, but not limited to, the following: hand-eye calibration (a.k.a. robot-camera calibration), object pose estimation from an image, iterative closest point (ICP) algorithm for point cloud registration, rigid/deformable object shape reconstruction using shape-from-X techniques where X can be motion, template. Etc.	1,5	Fall Semester	S9
SIGMA Clermont	Mechanical Engineering	Student's Project	**Expected outcome:** Knowledge: - Knowledge of project management tools, Know-how (practical knowledge): - Know how to take into account the requirements of the project, - Know how to report on the progress of the work, - Be able to report on the results of the work, - Know how to design, model, dimension and optimize - Know how to take into account the technical and economic constraints, - Know how to use digital modeling and optimization tools Know how to act (skills): - Know how to present and justify the final solution, - Know how to concretize the solutions adapted to the requirements on a numerical modeling tool and/or by physical prototyping	5	Fall Semester	S9