

Semester S5

Code	Course Unit	ECTS	Code	Course	Coeff	Teacher	Vol	CM	TD	TP
8JUAIN01	Information science	9	5JEAIN10	Modeling of Signals, Systems and Link Graphs	0,334	V. Louis-Dorr	36	19	7	10
			5JEAIN11	Programming and Algorithms	0,334	?	36	11	10	15
			5JEAIN12	Discrete Mathematics	0,334	J.-F. Pétin	40	22	18	0
5JUAIN02	Engineering Sciences 1	6	5JEAIN20	Foundations of mathematics for engineers	0,3	V. Lecuyer	49	20	29	0
			5JEAIN21	Transformation & complex analysis	0,2	V. Lecuyer	31	16	15	0
			5JEAIN22	Analytical Modeling in Mechanics and Electricity	0,3	S. Dufour	40	20	20	0
			5JEAIN23	Electrical Circuits and Applications	0,2	M.Hinaje	40	18	14	8
			5JEAIN24	Energy efficiency and sustainable development	pass/fail	T. Boileau	6	6	0	0
5JUAIN03	Humanities 1	5	5JEAIN30	English 1	0,3	S. Gallaire	24	0	24	0
			5JEAIN31	second foreign language-1 English support	0,3	S. Gallaire	24	0	24	0
			5JEAIN32	Project management	0,2	J.-C. Marpeau	10	0	10	0
			5JEAIN33	Communication 1	0,2	A. Thimon	16	0	16	0
			5JEAIN34	Workplace Safety 1	pass/fail	T. Boileau	8	8	0	0
5JUAIN04	S5 Company	10	5JEAIN35	French language clearance 1	pass/fail	In Quesada	1	0	1	0
				Technical competence						
				Methodological competence						
				Interpersonal skills						
			5JEAIN40	Report 1A						

Total hours : 36
Lecture hours : 19
Tutorials hours : 7
Practical/lab hours : 10

Objective

The objective is to train: - in the time and frequency analysis of signals and in the analysis of linear and translation-invariant systems. This course allows the introduction of basic signal processing tools. The typical application is the functional analysis of the instrumentation chain - in the modeling of physical systems using a graph representation allowing both a functional, structural (causal properties) and behavioral analysis (deduction of mathematical models: state equations) of the systems.

Skills acquired

Being able to manipulate classical mathematical models of signals and systems (transfer function, differential equation, impulse response, convolution, link graph, etc.), knowing how to solve a simple analog signal processing problem, knowing how to assign and analyze the causality of processes. This know-how is on the one hand theoretical and on the other hand it is applied to real processes in practical work. The skills acquired are the bases of modeling engineering, analysis of continuous systems and signal processing.

Prerequisites

First and second order linear physical systems and linear differential equations

Assessment

We assess students' ability to manipulate theoretical models to answer a process behavior study and analyze signals. Through continuous assessment and the end-of-semester exam, we assess the ability to manipulate theoretical modeling tools. In practical work, we assess students' ability to understand a real system and compare the modeling to the real system.

Teaching program

CM1 to CM2 Classification of continuous-time, discrete-time, deterministic or random signals, definition of the energy and power of a signal (instantaneous, average), concept of correlation. CM3 to CM6 Linear and translation-invariant dynamic system: definition, impulse response, convolution, transfer function, frequency analysis. Identification of first- and second-order linear systems CM7 to CM8 Analog filtering: concept of noise in signals, noise generated in electronic components, signal-to-noise ratio, modeling of narrowband noise. Impulse and step response of the first and second order. Analysis and synthesis of passive and active analog filters, template, first and second order, harmonic response, Bode diagram, polynomial approximations of Butterworth, Tchebychev, Bessel. CM9 Application of analog amplitude modulation-demodulation: Interest of modulation in information processing. CM10 to CM15 Analogies in linear systems: Maxwell and Darieus models, Bond-Graph theory / Structure, effort and flow / - Sources of effort and causal flow / Establishment of state equations from the bond graph / Bond graph-block diagram transition 6 1-hour tutorials 1. Convolutional system & Fourier transform 2: Template and synthesis of a filter 3: Modulation - Demodulation in the instrumentation chain 4: Study of the same system using different modeling tools: differential equation, convolution, transfer function 5: Modeling by bond graphs 6 Establishment of state equations from the bond graph 3 lab work: TP1 identification of 1st and 2nd order system, TP2 Study and analysis of filtering in electronic CAD TP3 Study of an instrumentation chain the dynamometer

Total hours : 36
Lecture hours : 11
Tutorials hours : 10
Practical/lab hours : 15

Objective

The objective of this EC is to acquire and consolidate the basics of Python programming, algorithms and computer machine architectures: numbering system and assembler, advanced Python programming, numerical calculation algorithms

Skills acquired

Design algorithms - Develop programs in Python language - Understand how a processor/microcontroller works

Prerequisites

None

Assessment

- Know how to design an algorithm for a given problem - Know how to develop a program in Python language
Assessment methods: continuous assessment and a practical final exam on a computer

Teaching program

This EC is broken down into 5 tutorials and 6 practical exercises: The 5 tutorials: Tutorial 1: Numbering systems (integer, relative, real) Tutorial 2: Moving from high-level code to assembly code Tutorial 3: Introduction to object-oriented programming in Python Tutorial 4: Scientific programming in Python Tutorial 5: Algorithms in 2-dimensional arrays The 6 practical exercises: - Practical exercise 1: Programming a processor in assembly language - Practical exercise 2: Structured Python programming - Practical exercise 3 and Practical exercise 4: Scientific programming in Python - Practical exercise 5: Power of 4 project - Practical exercise 6: Synthesis

Total hours : 40
Lecture hours : 22
Tutorials hours : 18
Practical/lab hours : 0

Objective

The objective of this EC is to acquire the theoretical bases of Discrete Mathematics (graphs, propositional logic, languages, automata, etc.) which constitute prerequisites for the training of engineers in Information and Communication Sciences and Technologies (optimization, scheduling, control, IT, etc.).

Skills acquired

At the end of this course, students will be able to: - model a discrete event system using language theory and finite state automata. - solve an optimization problem using graph theory - conduct and analyze/demonstrate reasoning using propositional logic.

Prerequisites

None

Assessment

Written (assessment of theoretical knowledge on the four parts of the EC program)

Teaching program

The courses include 4 parts: - Graph theory: ordered structures (lattices, graphs and trees), directed and undirected graphs, paths and properties (chain, paths, cycle, circuits, Eulerian, Hamiltonian, Chinese), connectivity and decomposition, adjacency and incidence matrix, graph isomorphism, graph algorithms (shortest path, number of paths of length n, determination of flows, coloring, notion of complexity). - Boolean algebra: Boolean expression and functions, Lagrange normal forms, simplification laws, Karnaugh diagrams. - Discrete Event Systems: Introduction to the notion of state, Huffmann method, theory of languages and automata (words and languages, operations on languages, prefix closure, regular expressions, deterministic and non-deterministic automata, Kleene's theorem, synchronous product and composition, determination, controllability theorem, controllable supreme, synthesis of supervisors. - Propositional logic: proposition and logical formula, connectives, predicates and quantifiers, propositional equivalences, proof methods, first-order predicate logic, extensions and temporal logics

Total hours : 49
Lecture hours : 20
Tutorials hours : 29
Practical/lab hours : 0

Objective

Master the mathematical concepts useful for engineering sciences.

Skills acquired

During this course, apprentices will: - improve their reasoning skills, - master the mathematical concepts useful for engineering sciences. 2 hours of lecture and 10 hours of tutorial are reserved at the very beginning of the semester for revision in mathematics.

Prerequisites

Final year mathematics program. And in addition: matrix calculus, integral calculus, differential calculus, functions of one variable, functions of several variables.

Assessment

A test in November, continuous assessment

Teaching program

The program covers knowledge reviews and an introduction to basic mathematics for the engineer as a tool. Continuity; Differential calculus; Integral calculus (of lines, surface and volume); Modeling for Engineering Sciences; Linear algebra; Differential equations. The course will be illustrated with exercises (physical examples taken from the industrial world), so that apprentices approach the concepts using inductive methods.

Total hours : 31
Lecture hours : 16
Tutorials hours : 15
Practical/lab hours : 0

Objective

Master the mathematical concepts useful for engineering sciences.

Skills acquired

Transformations: During this course, students will: - improve their reasoning skills, - master the mathematical concepts useful for engineering sciences. Complex analysis: Mastery of complex variable functions and the links between harmonicity and holomorphy.

Prerequisites

Foundations of mathematics for S5 engineers

Assessment

Continuous assessment

Teaching program

Transformations: Convolution; The Laplace transform; Hilbert spaces; Fourier series; The Fourier transform of functions. Complex analysis: Complex differentiability; Holomorphism; Link with conformal transformations; Curvilinear integrals; Cauchy's theorem and integral formula; Link between harmonicity and holomorphism; Analytic functions; Complex trigonometry; Logarithmic function; Analytic functions; Singularities of holomorphic functions. The course will be illustrated with exercises (physical examples taken from the industrial world), so that apprentices approach the concepts using inductive methods.

Total hours : 40
Lecture hours : 20
Tutorials hours : 20
Practical/lab hours : 0

Objective

The EC aims to be a foundation course for the analysis of complex systems. This objective is achieved through the study of analytical methods of mechanics applied to systems with localized variables: mechanical, electrical and electromechanical.

Skills acquired

Modeling in electricity and mechanics of discrete systems comprising a finite but potentially large number of degrees of freedom; Consolidation (and amplification) of basic knowledge in this field.

Prerequisites

Newtonian point and solid mechanics; electric circuits based on linear dipoles; composition, derivation, integration in the Riemann sense; multivariate functions, partial derivatives; minimal knowledge of a scripting language (examples are illustrated by simulations in Maxima language).

Assessment

NF: final EC grade EE: final exam grade I1: grade for written questioning in session No. 1 I2: grade for written questioning in session No. 2 I3: grade for written questioning in session No. 3
 $NF = (9 \times EE + i1 + i2 + i3) / 12$

Teaching program

The program is structured around ten lessons: L1: The Euler-Lagrange and Hamilton methods are introduced for non-dissipative problems with 1 degree of freedom (dof); L2: they are extended to the case of 2 dofs, the Lagrange multiplier method is introduced; L3: and finally they are generalized to the case of any finite number of dofs; the related vocabulary is proposed. L4: These methods are applied to linear electrical circuit problems; L5: the circuit with non-linear self-inductance is then treated as a support for the notions of phase plane and quadrature. L6: The previous elements are then used to treat electromechanical problems. L7: The variational foundations of the methods are explained. L8: Systems with holonomic or non-holonomic connections are approached via the Ferrers and Lagrange multiplier methods. L9: Viscous and Joule dissipations are introduced using the Rayleigh dissipation function. L10: Some theoretical developments around the Hamilton-Jacobi equations conclude the discussion.

Total hours : 40
Lecture hours : 18
Tutorials hours : 14
Practical/lab hours : 8

Objective

Review of methods for studying electrical circuits in steady state (continuous and sinusoidal). Presentation of methods for studying transient conditions. These study methods will be implemented in various applications such as instrumentation, power electronics, and electrical energy transmission networks.

Skills acquired

Mastery of methods for studying single-phase and three-phase electrical circuits (including power calculations) Knowledge of electronic circuit associations ensuring correct operation. Analysis at different levels of a static converter

Prerequisites

Physics program for preparatory classes for Grandes Écoles MP, PC, PSI.

Assessment

T: grade obtained on the test and the graded tutorial. E: grade obtained on the exam NP: average of the grades from the lab work reports NT: $\max((2E+T)/3, E)$, Final grade: $0.8*NT+ 0.2*NP$

Teaching program

Lectures Principles: - Steady state study method - Transient state study methods Application example n° 1: Electronic components - Modeling and association of basic electronic components - Application to the instrumentation chain and the control of power semiconductor components Application example n° 2: Power electronics - Switching, conversion functions (course); - Different levels of study of a static converter Application example n° 3: Electrical networks - Electrical power, - Three-phase networks and Transformers Directed work Circuit simulation in transient state with Simulink Association of electronic components Study using MATLAB of the operation of a static converter Power calculation and transformer Practical work Implementation of an instrumentation amplifier Power measurement on a transformer

Total hours : 6
Lecture hours : 6
Tutorials hours : 0
Practical/lab hours : 0

Objective

Understanding the economic and social challenges of energy transition and sustainable development

Skills acquired

Ability to take into account the economic and social challenges of energy transition and sustainable development

Prerequisites

None

Assessment

In-person attendance at conferences

Teaching program

This EC, mainly delivered in the form of industrial conferences, aims to provide all ENSEM students with a solid scientific culture in the field of energy and sustainable development. It is devoted to the issues and challenges of energy efficiency and sustainable development: performance of energy systems in terms of energy efficiency, optimization of energy use in the field of transport or industrial processes, accommodation of energy supply to demand, methods and tools for sustainable development. Energy efficiency: - energy yields - passive and active energy efficiency measures - co-generation - circular economy Sustainable development: - the 3 pillars of sustainable development: the environment, the social and the economy. - product life cycles, systems: modeling and analysis tools - development indicators - analysis and evaluation tools and methods

Total hours : 24
Lecture hours : 0
Tutorials hours : 24
Practical/lab hours : 0

Objective

The aim of this course is to consolidate students' knowledge in the 4 language activities (written production, oral production, continuous and interactive, written comprehension, oral comprehension), to bring weaker students up to speed, to meet (at least) the English quitus level B1 (see CECRL or CTI 2010 description) aiming for B2. To develop professional skills.

Skills acquired

Professional skills and know-how: written and oral comprehension, written and oral production (continuous and interactive) in a foreign language.

Prerequisites

Have followed instruction in this language, as LV1 or second foreign language, during secondary studies, i.e. for at least 5 years. Have at least level B1

Assessment

Missing information

Teaching program

Students are offered activities aimed at perfecting the 4 language activities while keeping in mind the final professional tasks. Introduction to the TOEIC test. Consolidation of grammatical and lexical bases. Work on improving oral and written skills in order to be able to write professional documents such as a CV, a cover letter and a technical report in English. Knowing how to highlight academic and professional skills orally. Action-oriented approach: the activities and materials used in class link skills to communicative tasks

Total hours : 24
Lecture hours : 0
Tutorials hours : 24
Practical/lab hours : 0

Objective

The aim of this course is to consolidate students' knowledge in the four language activities (written production, interactive oral production, written comprehension, oral comprehension), and to bring weaker students up to speed in English, so that they meet (at least) level B1 of the CEFR, aiming for B2. It also aims to develop professional skills.

Skills acquired

Professional skills and know-how: written and oral comprehension, written and oral production (continuous and interactive) in a foreign language. Knowing how to set goals, learning how to learn.

Prerequisites

For students who have not yet reached a B2 level in English, the second language will take the form of an English skills reinforcement course. Students who have already validated the B2 level in English will be able to follow courses in one of the second languages taught at ENSEM (groups will be opened according to the number of students concerned).

Assessment

Missing information

Teaching program

Apprentices are offered activities aimed at perfecting the four language activities. Emphasis is also placed on consolidating grammatical and lexical foundations. Materials and methods are adapted according to the level. Action-oriented approach: the activities and materials used in class link skills to communicative tasks. German and Spanish: refresher. General and everyday language work: knowing how to talk about yourself, your situation, and your daily activities (studying, living, playing sports, etc.).

Total hours : 10
Lecture hours : 0
Tutorials hours : 10
Practical/lab hours : 0

Objective

Acquire the basics of engineering project management and know how to present yourself in relation to your professional project.

Skills acquired

Analysis of needs and identification of project issues Understanding the drafting of specifications Writing a specification document Planning and identifying project monitoring criteria
Leading project meetings, writing reports, writing activity reports

Prerequisites

Scientific and technical skills at CPGE level, common sense and open-mindedness, Mastery of the French language

Assessment

Missing information

Teaching program

tutorial 1: - What is a project? - Systemic vision and complexity of a project tutorial 2: - Contextualization of a project and analysis of needs - From needs to functions tutorial 3: - Risks and opportunities - Converging towards a solution tutorial 4: - Planning your project - monitoring your project tutorial 5 - closing your project - Documentation, supports and tools

Total hours : 16
Lecture hours : 0
Tutorials hours : 16
Practical/lab hours : 0

Objective

Self-knowledge. Knowing how to present and list your skills, know-how and interpersonal skills. - CV, cover letter and email. - Knowing how to think about your career plan. - Interpersonal skills in business. - PowerPoint presentation

Skills acquired

Knowing how to present yourself. - Knowing how to identify your skills and think about your career plan. - Business skills. - Writing a CV, using social media - Creating a PowerPoint presentation.

Prerequisites

Good command of the French language

Assessment

Missing information

Teaching program

Using grids and questionnaires, learn to identify your skills, interpersonal skills, know-how, and knowledge in order to create a CV, a portfolio, and use professional networks. - Writing cover letters and emails (spontaneous applications and in response to an advertisement). - Interpersonal skills in business. - Writing a PowerPoint presentation. - Each session includes a grammar/vocabulary refresher.

Total hours : 8
Lecture hours : 8
Tutorials hours : 0
Practical/lab hours : 0

Objective

The objective of this module is to provide students with the necessary knowledge to validate the theoretical and practical part of the electrical qualification at the "BE Essai" level.

Skills acquired

Behavior should be appropriate in the presence of electrical voltage. Know how to take the necessary measures to avoid putting yourself in danger in the presence of electrical voltage. React appropriately in the event of an electrical accident.

Prerequisites

Basic laws of electricity (Ohm's law, mesh law, node law, Ampere's theorem and Laplace's force)

Assessment

Missing information

Teaching program

Lectures Physiological effects of current Electrical equipment (standardized diagrams, functions) Safety measures (against direct and indirect contact) Protective equipment Safety instructions (area and distance to be respected) Lockout Authorization levels Life-saving actions Intervention in the event of a fire

Total hours : 1
Lecture hours : 0
Tutorials hours : 1
Practical/lab hours : 0

Objective

For students whose mother tongue is not French: 100% validation of level 2 at the end of semester 6. For students whose mother tongue is French: 100% validation of level 3 at the end of semester 6

Skills acquired

Improvement of the French language with the achievement of a specific level (2 or 3 depending on the mother tongue). Possibility of going beyond the imposed objective, up to 100% of level 4. Reduction, or even disappearance of errors made by the student in grammar and spelling. Training in the ability to work independently and regularly, at the rate of one hour per week.

Prerequisites

Have an A2 level in French if French is not your mother tongue

Assessment

Missing information

Teaching program

Independent work on French grammar and spelling on the Orthodidacte e-learning platform. A diagnostic assessment is carried out by each student at the beginning of the year on the platform. Based on this assessment, a personalized course is established. Rules are reviewed and errors are gradually eliminated, following the progression established by the platform. Continuous progress is made until the set objective is reached, or even beyond.

Total hours :
Lecture hours :
Tutorials hours :
Practical/lab hours :

Objective

Identify the technical areas of the company: specification, design, development, testing, maintenance of energy systems (production, transport, distribution, storage, efficiency)... Know how to implement them with assistance

Skills acquired

Missing information

Prerequisites

Missing information

Assessment

Missing information

Teaching program

Missing information

Total hours :
Lecture hours :
Tutorials hours :
Practical/lab hours :

Objective

Follow an action plan with your tutor Research and structure information Write a report Analyze and establish a balance sheet of acquisitions

Skills acquired

Missing information

Prerequisites

Missing information

Assessment

Missing information

Teaching program

Missing information

Total hours :
Lecture hours :
Tutorials hours :
Practical/lab hours :

Objective

Integrate into the company Dialogue and report Be an active participant in work meetings Identify interlocutors and their functions

Skills acquired

Missing information

Prerequisites

Missing information

Assessment

Missing information

Teaching program

Missing information

Total hours :
Lecture hours :
Tutorials hours :
Practical/lab hours :

Objective

Missing information

Skills acquired

Missing information

Prerequisites

Missing information

Assessment

Missing information

Teaching program

Missing information

Semester S6

Code	Course Unit	ECTS	Code	Course	Coeff	Teacher	Vol	CM	TD	TP
6JUAIN01	Applied Sciences and Technology	9	6JEAIN10	Automatic - Dynamics and Control of Systems	0,223	J. Daafouz	36	14	7	15
			6JEAIN11	Algorithmics and Object-Oriented Programming	0,223	T. Docquier	30	7	5	18
			6JEAIN12	Database	0,134	?	18	6	3	9
			6JEAIN13	Algorithms and data structures	0,2	Y.-Q. Song	27	9	6	12
			6JEAIN14	System Design Office	0,223	V. Louis-Dorr	50	0	0	50
6JUAIN02	Engineering Sciences 2	6	6JEAIN20	Numerical analysis	0,334	V. Lecuyer	31	16	15	0
			6JEAIN21	Probability and statistics	0,334	A. Gueudin	22	10	12	0
			6JEAIN22	Dynamics of Energy Systems & Applied Kinematics	0,334	B. Remy	30	10	8	12
6JUAIN03	Humanities 2	5	6JEAIN30	English 2	0,3	S. Gallaire	32	0	32	0
			6JEAIN31	second foreign language-2 English support	0,3	S. Gallaire	24	0	24	0
			6JEAIN32	Business environment	0,2	F. Temsamani	10	10	0	0
			6JEAIN33	Communication 2	0,2	A. Thimon	12	0	12	0
			6JEAIN34	Workplace Safety 2	pass/fail	T. Boileau	3,5	3	0	0,5
6JUAIN04	S6 Company	10	6JEAIN35	French language clearance 2	pass/fail	A. Quesada	1	0	1	0
				Technical competence						
				Methodological competence						
6JUAIN04	S6 Company	10		Interpersonal skills						
			6JEAIN40	Defense 1A			0,5	0	0,5	0

Total hours : 36
Lecture hours : 14
Tutorials hours : 7
Practical/lab hours : 15

Objective

At the crossroads of engineering, applied mathematics and physics, Automation is a science that deals with the modeling, analysis and control of dynamic systems. This EC will equip future engineers with the basic skills for modeling, analysis and control of linear dynamic systems. The objective is to master the concept of closed loop and know how to use the basic tools for stability analysis and the calculation of correctors with frequency approaches and state space approaches.

Skills acquired

Modeling of a dynamic system, Analysis of stability and structural properties, synthesis of a regulator

Prerequisites

Mathematics at the 1st cycle of scientific level or preparatory classes for the major scientific schools

Assessment

NF: final grade of the EC, EE: written exam, MT: Average of 3 tutorial tests, lab work: lab work grade $NF = \max ((3*EE + \text{lab work})/4), (2*EE + MT + \text{lab work})/4).$

Teaching program

Lectures State representation of dynamic systems Controllability and observability properties. Criteria in the case of linear systems invariant by translation in time State feedback with observer. Separation theorem of eigenvalues Application to the single-input-single-output case Graphical methods for assessing stability and robustness: Nyquist criterion, stability margins Rejection of disturbances Role of classical regulators Frequency approach for the adjustment of regulators Practical work Modeling and control of a Segway robot Modeling and control of a helicopter Bibliography KJ Astrom and RM Murray, "Feedback systems: an introduction for scientists and engineers", Princeton University Press

Total hours : 30
Lecture hours : 7
Tutorials hours : 5
Practical/lab hours : 18

Objective

The objectives of this EC are to present the fundamental concepts of algorithm design, object-oriented modeling, and their implementation. This EC is essential for addressing more advanced concepts of embedded, distributed, and network systems in various application areas related to engineering training. It is also a fundamental foundation for any engineering training.

Skills acquired

Design algorithms Model and design in the form of objects Master a programming technique Be autonomous in programming and be able to appropriate other languages

Prerequisites

Information representation, Algorithms and programming, Software tools.

Assessment

Assessment methods: continuous assessment and a final practical computer-based exam

Teaching program

Concept of classes, inheritance. Scope of variables and modules. Data structure and associated algorithms (list, sets, dictionary strings). File, Exception. Recursion.

Total hours : 18
Lecture hours : 6
Tutorials hours : 3
Practical/lab hours : 9

Objective

A large majority of IT systems (industrial or corporate) rely on database management systems for data storage and querying. This EC covers the design and operation of relational and NoSQL databases as well as their querying via connectors and their exploitation in a computer program.

Skills acquired

- Design a relational database - Implement and operate a relational or NoSQL database

Prerequisites

Algorithms and Programming 1A

Assessment

- Know how to design and operate a relational or NoSQL database (MongoDB) Assessment methods: continuous assessment (practical test), written exam

Teaching program

Lectures: - General introduction: Data, Databases and Database Management Systems (DBMS). - The Entity/Association model: Entities, associations (binary and generalized), attributes and identifiers. - The relational model: Definition of a relational schema. Transition from an E/A schema to a relational schema. - The SQL language: Simple queries, queries on several tables, nested queries. Aggregation. Update. - Introduction to NoSQL and MongoDB databases Tutorials: - Modeling a database, transition to the relational schema and normalization - Relational algebra and SQL queries Practical work: - Design and implementation of a database under MySQL and its query in SQL - Programming a Python application to query a database - Implementation and querying a MongoDB database

Total hours : 27
Lecture hours : 9
Tutorials hours : 6
Practical/lab hours : 12

Objective

- Advanced knowledge and techniques in programming, dynamic data structures and algorithm design. - Java development skills (use of the Java language as a course support).

Skills acquired

Autonomy in designing efficient algorithms and developing modular software. Mastery of object-oriented programming in Java.

Prerequisites

Knowledge of algorithms and object-oriented programming.

Assessment

Skills in algorithm design and use of dynamic data structures, as well as in Java programming are assessed by continuous assessment and a final practical test.

Teaching program

Courses: 1. Introduction to object-oriented programming in Java 2. Dynamic data structures (list, stack, queue, graph, tree, heap, dictionary and hash table) 3. Principle of algorithm design (Brute force, backtracking, ...) 4. Verification and unit testing Tutorials: Tutorial 1: Programming in Java (under Eclipse) Tutorial 2: Object-oriented programming in Java (under Eclipse) Tutorial 3: Linked list and graph (Dijkstra) Tutorial 4: Trees and heaps Tutorial 5: design of backtracking algorithms Tutorial 6: Unit testing (JUnit) Practical work: Practical work 1: Object-oriented programming in Java (simulation of a distributor) Practical work 2: Graph and Dijkstra (bus routes) Practical work 3: Algorithms on Trees (management of a directory) Practical work 4: Backtracking (n queens problem)

Total hours : 50
Lecture hours : 0
Tutorials hours : 0
Practical/lab hours : 50

Objective

The objective of this course is to conduct the study of a system in the form of a partially autonomous design office. The chosen application is the control of a fleet of robots: traveling salesman problems traveling N points under the constraint of the smallest distance

Skills acquired

Be able to implement a design and development project for a complex system, and to implement multidisciplinary skills within the framework of collaborative project management.

Prerequisites

Courses in automation, modeling, signals and systems, computer science

Assessment

We assess the ability to collaborate in a multidisciplinary context, to present work carried out independently, to present a scientific approach consisting of several phases: modeling, development, control and testing.

Teaching program

Definition of project objectives Specifications and deliverables: Definition of specifications and expected results Functional and technical specifications Design and unit simulation of the mathematical, automatic and computer parts Unit development Cross-validations (Math, Info, Auto) Mid-term review Prototyping Technical integration of processes Presentation Demonstration

Total hours : 31
Lecture hours : 16
Tutorials hours : 15
Practical/lab hours : 0

Objective

This course provides an introduction to the various techniques for numerically solving problems encountered in engineering science. Its objective is to provide numerical mathematical problem-solving techniques, the associated algorithms, and their computer implementation (in Matlab) for simulating deterministic problems.

Skills acquired

Students are led, step by step, towards understanding numerical mathematics useful in their engineering training. Individual problem solving should lead students to demonstrate greater autonomy. In particular, at the end of this course, students should be able to analyze the problem posed, determine the numerical method most suited to solving the problem, implement this method and analyze the results obtained.

Prerequisites

good command of the "basic" mathematical concepts (analysis, algebra, etc.) acquired during the first two years of higher education and within the framework of the "Mathematics for Engineers" module is required. Similarly, a mastery of computer tools, algorithms and basic programming is assumed.

Assessment

Practical work grade: obtained from one or more practical work reports and/or a practical work exam. Written grade: written exam at the end of the semester. The EC grade = 0.4*Practical work+0.6*E.

Teaching program

Errors in numerical analysis; Numerical resolution of nonlinear equations; Interpolation and polynomial approximation; Numerical derivation and integration; Numerical resolution of differential equations; Numerical resolution of linear systems

Total hours : 22
Lecture hours : 10
Tutorials hours : 12
Practical/lab hours : 0

Objective

Learn to manipulate random variables in order to model random problems (which can later be used in signal analysis, system safety, modeling component lifetimes, etc.).

Skills acquired

Model random phenomena. Calculate probabilities and expected values. Understand the concept of independent variables. Use the law of large numbers. Use the central limit theorem and the normal distribution (to calculate probabilities and construct a confidence interval). Model queues using Markov chains and Poisson processes.

Prerequisites

Integral calculus, series calculations

Assessment

Written exam and practical work report

Teaching program

Lectures: - Definitions of probability on finite, countable or continuous universes. - Notions of conditional probability, independence, and Bayes' theorem. - Real random variables and vectors and their distribution (discrete or density). - Distribution function and characteristic function. - Expectation, variance, covariance. - Law of large numbers, central limit theorem and application to confidence intervals. - Markov chains - Poisson processes - Queues tutorial: Exercises applying the course. Exercises chosen for their content close to the concerns of engineers and the industrial world. lab work: Modeling a random phenomenon such as a queue, or Markov chain, on Matlab.

Total hours : 30
Lecture hours : 10
Tutorials hours : 8
Practical/lab hours : 12

Objective

This involves learning to model mechanical and energy systems based on the implementation of models derived from physical principles (conservation of momentum and conservation of energy), clearly identifying the input and output parameters of these systems and establishing input-output type relationships between these quantities.

Skills acquired

Know how to break down a mechanical system into simple elements, identify the types of connection and model this part on Computer Aided Design (CATIA) software. Know how to model the behavior of an energy system or one of its elements in static or dynamic mode.

Prerequisites

None

Assessment

Assessment on Machines for the Kinematics section, End of module test for the Thermodynamics section. Final grade = (lab work grade) * 1/2 + (Test) * 1/2

Teaching program

The 27-hour course is made up of two parts: - A mechanical part (Kinematics under CATIA) of 12 hours (3 x 4 = 12 hours of practical work under catia). - A thermodynamic part of 18 hours (7 x 2 hours of lectures and 2 x 2 = 4 hours of tutorials) 1. Mechanical Part: The lecture part will aim to review the different types of mechanical connections (Pivot, rotation, embedding, etc.) used to connect mechanical parts and to introduce the CATIA mechanical design software. The practical part will consist of putting into practice the concepts seen in class. Students will have to design a mechanical system under CATIA and study its kinematics. 2. Thermodynamics / Energy of systems section: The course section will aim to learn how to model complex energy systems by reviewing the different possible models: - Thermodynamic approach - Enthalpic methods or energy balances - Analytical or numerical models - Convolutional and parametric methods These different techniques will then be used in the context of two tutorials.

Total hours : 32
Lecture hours : 0
Tutorials hours : 32
Practical/lab hours : 0

Objective

This module aims to prepare students to work effectively within international teams by enabling them to develop intercultural communication skills.

Skills acquired

Professional skills and know-how: written and oral comprehension, written and oral production (continuous and interactive) in a foreign language in an international context, intercultural skills.

Prerequisites

Have followed instruction in this language, as LV1 or second foreign language, during secondary studies, i.e. for at least 5 years. Have at least level B1

Assessment

The assessment is carried out through continuous monitoring: tests on the content of the workshops, assessment of reports and oral presentation, assessment of the final reflection work.

Teaching program

Students are taking a joint course with the University of Cincinnati: the Global Technical Workforce. They attend various workshops taught jointly (reflection on culture, cross-cultural communication, working efficiently in virtual teams, etc.). They work in Franco-American teams on two projects (one of which is technical), leading them to jointly submit a report and give a comprehensible and interesting oral presentation to a French and American jury. At the end of the course, apprentice students must complete a reflection project on the lessons they learned from this work with American students.

Total hours : 24
Lecture hours : 0
Tutorials hours : 24
Practical/lab hours : 0

Objective

The aim of this course is to consolidate students' knowledge in the four language activities (written production, interactive oral production, written comprehension, oral comprehension), and to bring weaker students up to speed in English, so that they meet (at least) level B1 of the CEFR, aiming for B2. It also aims to develop professional skills.

Skills acquired

Professional skills and know-how: written and oral comprehension, written and oral production (continuous and interactive) in a foreign language. Knowing how to set goals, learning how to learn.

Prerequisites

For students who have not yet reached a B2 level in English, the second language will take the form of an English skills reinforcement course. Students who have already validated the B2 level in English will be able to follow courses in one of the second languages taught at ENSEM (groups will be opened according to the number of students concerned).

Assessment

Students are assessed through continuous assessment in the 4 language skills.

Teaching program

- Oral comprehension and more or less free or guided oral production work, debates, role plays - General and idiomatic lexical enrichment activities - Consolidation of grammar through manipulation and fixation activities

Total hours : 10
Lecture hours : 10
Tutorials hours : 0
Practical/lab hours : 0

Objective

•Introduce the fundamental concepts of macroeconomic models to microeconomic foundations. •Understand the interaction of economic actors •Assimilate the exercise of business

Skills acquired

•Have a structured vision of the economy •Interpret the basic concepts of macroeconomic, microeconomic and financial analysis

Prerequisites

None

Assessment

Continuous assessment

Teaching program

•lecture 1: The structures of economic activity •lecture 2: Introduction to macroeconomics •lecture 3: The economic environment •lecture 4: The functions of the company •lecture 5: Marketing and customer relations •lecture 6: Innovation management •lecture 7: The challenges of globalization

Total hours : 12
Lecture hours : 0
Tutorials hours : 12
Practical/lab hours : 0

Objective

- Meeting management. - Written expression techniques (argumentation, summary, document synthesis). - Writing the internship report and oral defense.

Skills acquired

- Know how to organize a meeting and write the minutes. - Conflict management and agile methods. - Write an internship report and oral defense. - Written expression techniques: developing an argument, summarizing a text, summarizing documents.

Prerequisites

S6 knowledge and good command of the French language

Assessment

- Oral assessment 50% of the final grade. - Written assessment 50% of the final grade.

Teaching program

- Conflict management. - Agile methods. - Meeting management: the different types of meeting management and practical exercises. Knowing how to write meeting minutes. - Written expression techniques: argumentation, text summary, and the methodology for document synthesis. - The internship report: preparation for writing the internship report and for the oral presentation.

Total hours : 3,5
Lecture hours : 3
Tutorials hours : 0
Practical/lab hours : 0,5

Objective

The first objective of this module is to validate the practical part of the "BE Essai" level accreditation. The second objective is to raise students' awareness of regulations in the areas of health and safety at work.

Skills acquired

At the end of this course, students will know the principles that govern regulations in the fields of health and safety at work, which will allow them to implement them more easily. React appropriately in the event of an electrical accident. Know how to implement the theoretical skills acquired during the theoretical part of the electrical authorization module.

Prerequisites

Theoretical course for S5 accreditation

Assessment

Individual assessment, by verifying the correct implementation of the appropriate safety instructions when carrying out the proposed practical work

Teaching program

Practical work Practical assessment for the "BE Essai" qualification, carrying out an electrical manipulation given by specifications 3 hours of lectures Organization of safety and working conditions Approach to preventing occupational risks Implementation of prevention

Total hours : 1
Lecture hours : 0
Tutorials hours : 1
Practical/lab hours : 0

Objective

For students whose mother tongue is not French: 100% validation of level 2 at the end of semester 6. For students whose mother tongue is French: 100% validation of level 3 at the end of semester 6.

Skills acquired

Improvement of the French language with the achievement of a specific level (2 or 3 depending on the mother tongue). Possibility of going beyond the imposed objective, up to 100% of level 4. Reduction, or even disappearance of mistakes made by the student in grammar and spelling. Training in the ability to work independently and regularly, at the rate of one hour per week

Prerequisites

see an A2 level in French if French is not the mother tongue

Assessment

French language quitus indexed to obtaining 100% of level 2 or 3, depending on the mother tongue. Semester quitus which conditions the obtaining of the Human Sciences UE.

Teaching program

Independent work on French grammar and spelling on the Orthodidacte e-learning platform. A diagnostic assessment is carried out by each student at the beginning of the year on the platform. Based on this assessment, a personalized course is established. The students review the rules and gradually eliminate errors by following the progression established by the platform. Continuous progress is made until the set objective is reached, or even beyond.

Total hours :
Lecture hours :
Tutorials hours :
Practical/lab hours :

Objective

Identify the technical areas of the company: specification, design, development, testing, maintenance of energy systems (production, transport, distribution, storage, efficiency)... Know how to implement them with assistance

Skills acquired

Missing information

Prerequisites

Missing information

Assessment

Missing information

Teaching program

Missing information

Total hours :
Lecture hours :
Tutorials hours :
Practical/lab hours :

Objective

Develop and follow an action plan with your tutor. Obtain information. Write a report (technical report). Analyze and establish a balance sheet of technical, organizational, human and economic acquisitions.

Skills acquired

Missing information

Prerequisites

Missing information

Assessment

Missing information

Teaching program

Missing information

Total hours :
Lecture hours :
Tutorials hours :
Practical/lab hours :

Objective

Dialogue and report Being an active participant in work meetings Identifying interlocutors and their functions

Skills acquired

Missing information

Prerequisites

Missing information

Assessment

Missing information

Teaching program

Missing information

Total hours : 0,5
Lecture hours : 0
Tutorials hours : 0,5
Practical/lab hours : 0

Objective

Missing information

Skills acquired

Missing information

Prerequisites

Missing information

Assessment

Missing information

Teaching program

Missing information

Code	Course Unit	ECTS	Code	Course	Coeff	Teacher	Vol	CM	TD	TP
?	Modeling and piloting of systems	?	?	Modeling, control and evaluation of DES (Discrete Event System	0,3	J.-F. Pétin	36	12	8	16
		?	?	Static optimization	0,14	P. Riedinger	18	8	10	0
		?	?	Nonlinear Systems and Robustness	0,28	J. Daafouz	34	20	6	8
		?	?	Dynamic Optimization	0,14	P. Riedinger	18	8	10	0
		6	?	Data analysis	0,14	R. Ranta	16	8	8	0
?	Computer science and signal processing	?	?	Software Analysis and Design	0,23	H. Cirstea	40	20	6	14
		?	?	Algorithms and complexity	0,1	V. Chevrier	20	10	10	0
		?	?	Transmission of Information	0,17	V. Louis-Dorr	36	16	4	16
		?	?	Signal Processing	0,17	D. Wolf	36	20	4	12
		?	?	Computer networks	0,17	YQ Song	18	6	2	10
9	?	?	System programming and C language	0,16	?	18	6	0	12	
7JUPPN03	Humanities 3		7JEPPN30	English Preparation Certification B2	0,4	C. Corringier	24	0	24	0
			7JEPPN31	second foreign language-3 English support	0,3	C. Corringier	24	0	24	0
		5	7JEPPN32	Communication 3	0,3	A. Thimon	20	0	20	0
?	S7 Company	10		Technical competence Methodological competence Interpersonal skills Report 2A						

Total hours : 36
Lecture hours : 12
Tutorials hours : 8
Practical/lab hours : 16

Objective

Discrete event system (DES) dynamics is characterized by discrete state variables and changes caused by external stimuli. They are therefore present in many industrial applications such as transportation systems, production systems, computer systems, communication systems, etc. This EC provides the scientific basis for the modeling and analysis of DES.

Skills acquired

At the end of this course, students will be able to: - model any system characterized by discrete event systems-type behavior, - analyze its properties, particularly those relating to safety or liveness - design the control of an discrete event systems and analyze its performance

Prerequisites

This EC complements the theoretical foundations acquired in the Discrete Mathematics EC of 1A (Boolean Algebra, Language Theory, Finite State Automata).

Assessment

- Written (theoretical knowledge on the analysis of RdP and skills in modeling discrete event systems) - Role-play through the modeling and analysis of a case study (oral defense of the work carried out in practical work).

Teaching program

- Generalized Petri Nets: syntax and semantics, property analysis (liveness, blocking, marking and crossing invariants), marking graph, tree and coverage graph, - Colored Petri Nets - Non-autonomous Petri Nets: Timed Petri Nets (formalism, stationary regime, average crossing frequency, average marking), Interpreted Petri Nets - Performance evaluation of DES modeled by colored Petri Nets (CPN) - CPN Tools software. - Grafcet: syntax and semantics elements, modeling, simulation and integration of a control system

Total hours : 18
Lecture hours : 8
Tutorials hours : 10
Practical/lab hours : 0

Objective

The objective is to provide and complete a basic culture in numerical optimization under constraints in support of the other courses of the diploma. Formulation and methods of numerical resolution of the main optimization problems of the engineer: least squares, quasi Newton, Simplex, quadratic programming, SQP, convex optimization, integer problem

Skills acquired

Knowledge of the necessary minimum conditions (KKT) under constraints. Formulation and translation of an optimization problem. Know how to operate in the choice of a numerical resolution method depending on the nature of the problem and its implementation.

Prerequisites

Mathematics at the 1st cycle level in science or preparatory classes for the major scientific schools. Differential calculus

Assessment

Written exam and platform report

Teaching program

Unconstrained optimization - Necessary and sufficient conditions of local minimum - Principle of descent methods and Convergence criterion - Descent procedure in a given direction - Algorithms: Gradient, Newton, Quasi-Newtonian (BFGS, DFP), Least squares: Gauss Newton and Levenberg Marquard, Conjugate gradients. Constrained optimization - Lagrange multipliers and Kuhn and Tucker conditions - Algorithms: - Linear programming - Quadratic programming (Eliminations and Lagrangian, active constraints) - Nonlinear programming (penalization method, SQP) Case of convex problems - Duality / Interior point algorithms Discrete case - Integer programming (Branch and Bound). Platform: Schumacher problem - Synthesis of a trajectory in minimum time of a mobile robot. Objective: Determine the trajectory and the control of a vehicle allowing the travel of a circuit in minimum time and without slipping. Translation of physical and dynamic constraints and numerical resolution

Total hours : 34
Lecture hours : 20
Tutorials hours : 6
Practical/lab hours : 8

Objective

The control of physical systems requires the consideration of nonlinearities and modeling uncertainties. The objective is to introduce the main nonlinear phenomena and to present the basic methods for the stability analysis of nonlinear systems. Methods for the synthesis of control laws for such systems are also presented. The concepts and tools necessary for the representation of uncertainties and their consideration in both the stability analysis phase and the control law synthesis phase are also addressed, with particular attention paid to methods based on convex optimization.

Skills acquired

Robustness analysis of a control loop, synthesis of control laws taking into account uncertainties, stability analysis and synthesis of control laws for nonlinear systems

Prerequisites

Mathematics at the 1st cycle level in science or preparatory classes for the grandes écoles in science. First-year automatic control courses.

Assessment

NF: final grade of the EC, EE: written exam, lab work: lab work grade, $NF = (2 \cdot EE + \text{lab work})/3$

Teaching program

Nonlinear phenomena
Stability analysis: Lyapunov method and Lasalle invariance principle
Nonlinear control laws
Notions of uncertainty
Representation of parametric uncertainties
Notion of robustness in stability and performance
Linear matrix inequalities and convex optimization
Convex optimization-based approach for the synthesis of robust control laws
Bibliography
Hassan K. Khalil. “Nonlinear Systems”, Prentice Hall
Kemin Zhou, John C. Doyle, “Essentials of Robust Control”, Prentice Hall.
Daniel Alazard, Christelle Cumer, Pierre Apkarian, Michel Gauvrit and Gilles Ferreres. “Robustness and optimal control”, Cépadués-Editions, Toulouse

Total hours : 18
Lecture hours : 8
Tutorials hours : 10
Practical/lab hours : 0

Objective

The objective of this course is to present the two main principles (Bellman Principle and Minimum Principle) at the basis of the optimization of dynamic processes and systems. These principles are applied to decision problems (multiple allocations, investment plan, inventory management, etc.) but also to the optimal piloting and control of dynamic systems with some results commonly used in automation.

Skills acquired

Application of nonlinear programming to parametric optimization and identification problems. Application of dynamic programming to discrete-time decision and optimization problems. Synthesis of state feedback by optimizing a quadratic criterion (LQ regulator).

Prerequisites

Mathematics at the 1st cycle level in science or preparatory classes for the grandes écoles in science. Differential calculus. Static Optimization courses.

Assessment

Written exam and platform report

Teaching program

Course: Nonlinear programming (NLP). Applications to parametric optimization and identification. Dynamic programming (Bellman principle). Applications to the search for optimal strategies (inventory management, multiple allocations, minimum weight path, etc.) and to the control of discrete-time systems. The minimum principle: Applications to LQ and minimum-time control of continuous-time dynamic systems. Platform: Optimal control of a Buck Boost power converter. Objective: Implementation of the "Forward Backward Sweep" algorithm on a problem of controlling a DC-DC converter by optimizing a quadratic criterion.

Total hours : 16
Lecture hours : 8
Tutorials hours : 8
Practical/lab hours : 0

Objective

Data analysis is a family of statistical methods whose main characteristics are that they are multidimensional and descriptive. Some methods, mostly geometric, help to highlight the relationships that may exist between different data and to extract statistical information that allows for a more succinct description of the main information contained in these data. Other techniques allow data to be grouped in such a way as to clearly reveal what makes them homogeneous, and thus to better understand them.

Skills acquired

Know how to extract important information from a dataset and interpret the results. Know how to classify data, either using supervised techniques when the information is available, or by highlighting natural separations between classes (clustering).

Prerequisites

Basic statistics, matrix calculus

Assessment

Grading of reports of tutorial sessions

Teaching program

Course - Introduction to factor analysis - Normalized principal component analysis - Supervised classification 1: linear and quadratic discriminant analysis - Supervised classification 2: large margin separators - Unsupervised classification, clustering (distances and aggregation methods, dendrogram, dynamic cloud methods, k-means) Tutorials based on Matlab - Normalized principal component analysis - Discriminant analysis (Fisher's iris) - Programming elementary functions and using the Matlab "Statistics" toolbox - Large margin separators (linearly separable data and soft margins)

Total hours : 40
Lecture hours : 20
Tutorials hours : 6
Practical/lab hours : 14

Objective

Master best practices in object-oriented programming. Master the principles and tools of version control and build automation. Master unit testing techniques. Know other types of testing. Know the main software development models and their activities. Master object-oriented modeling methods, techniques, and languages (UML). Design object-oriented software by applying a set of software engineering principles and methods.

Skills acquired

Object-oriented analysis and design of an application. Implementation and testing in an object-oriented language. Versioning and automatic construction. Teamwork.

Prerequisites

Mastery of basic object-oriented programming techniques. Know how to use integrated programming environments.

Assessment

NF: final grade of the EC EE: written exam ETP: practical work exam $NF = EE * 0.7 + ETP * 0.3$

Teaching program

Review of the fundamental concepts of the object-oriented paradigm. Best practices for object-oriented programming (classes and interfaces, object creation, common methods, etc.). - Testing methodology and techniques; unit tests and stubs. - Continuous integration. Version control techniques and tools. Software build automation techniques and tools. - Introduction to the software development process: software development process models, software development process activities. Introduction to agile methods. - Use of diagrams (UML) in the development process. Interaction modeling (use case diagrams, sequence diagrams, communication diagrams). Behavioral modeling (activity diagrams, state diagrams). - Structural modeling (class diagrams, package diagrams, component diagrams, deployment diagrams).

EC ?	Algorithms and complexity	UE ? Computer science and signal processing	V. Chevrier
Total hours : 20 Lecture hours : 10 Tutorials hours : 10 Practical/lab hours : 0			
Objective			
Objectives Understand algorithmic complexity and its major classes, Study efficient algorithms on prototypical problems, Study algorithm construction strategies Implement these concepts on prototypical examples			
Skills acquired			
Know how to recognize the major classes of complexity, Study efficient algorithms for prototypical problems (sorting, searching, etc.) Know and be able to apply algorithm construction strategies			
Prerequisites			
Algorithms and programming (object) 1A			
Assessment			
Written exam			
Teaching program			
The course is built around 5 algorithm construction strategies: greedy algorithms, divide and conquer, dynamic programming, brute force, and backtracking. The course is preceded by a personal reflection and reading assignment to introduce the problems addressed. It is followed by implementation exercises and individual personal work.			

Total hours : 36
Lecture hours : 16
Tutorials hours : 4
Practical/lab hours : 16

Objective

Understand the fundamentals of information theory and their implementation in digital data transmission, in baseband, and transposed quadrature with x states xQAM. The modeling of transmission media is covered as well as the format and coding of data Quantity of information, entropy of a source, joint entropy of 2 sources, entropy of Markovian sources Source coding compression concepts, adaptation of the source to the channel

Skills acquired

Ability to understand the concepts and tools of digital data transmission across all physical layer media. It also addresses the concept of information measurement.

Prerequisites

1st year analog and digital electronics and 2nd year signal processing courses

Assessment

Assessment of skills, both theoretical and practical, on the ability to use transmission design and analysis tools and on the implementation of these tools.

Teaching program

CM1 to CM8 Quantity of information, entropy of a source, joint entropy of 2 sources, Markovian source entropy Source coding: coding technique, concepts of compression, adaptation of the source to the channel Channel coding: coding technique lecture 9 to CM18 Modeling of transmission media Nonlinear quantization Data format and coding Valence, Modulation speed, bit rate Power spectral density of digital transmissions Intersymbol interference, Nyquist filter, phase trajectory, x-state modulation xQAM, tutorial: Huffman coding Practical work lab work 1 Huffman coding lab work 2 Baseband transmission lab work 3 & 4 QAM 16 modulation in a radio transmission channel with noise: simulation and real application

Total hours : 36
Lecture hours : 20
Tutorials hours : 4
Practical/lab hours : 12

Objective

Master classic signal processing tools for analyzing continuous and digital signals without noise and with noise

Skills acquired

Computer spectral analysis Sampling Linear filtering of digital signals Characterization and analysis of random signals

Prerequisites

Functional analysis, concepts of distribution, concepts of signals, Fourier transform, probabilities

Assessment

2-hour exam, 2 tests, 1 tutorial report and 1 practical work report

Teaching program

Continuous signals and Fourier analysis: Frequency representation of signals Convolution Convolution operators in physics Fourier transform of functions Fourier transform of tempered distributions Sampling and series Energy properties and Fourier transform Limits of Fourier analysis Digital signals and processing: Digital signals and digital convolution Z-transform Z-transmittance of digital filters Frequency analysis of digital filters Synthesis of filters in IIR form, synthesis of filters in FIR form Random signals: Reminders on random variables Description of random processes (probability density at order 1 and 2, moments) Spectral densities, correlation functions, time and frequency representations Definitions of signal-to-noise ratio, white noise

Total hours : 18
Lecture hours : 6
Tutorials hours : 2
Practical/lab hours : 10

Objective

This course presents the fundamental concepts of computer networks on which Internet technology is built: the OSI model, local area networks (e.g., Ethernet), Internet protocols (IP, ICMP, ARP, DHCP, TCP, UDP, DNS), the principles of network interconnection with practice on network equipment: hub, switch and router. The implementation consists of installing switched and routed networks, as well as the development of communicating applications (client-server) via sockets in C language.

Skills acquired

Knowledge of the principles of how the Internet works - Know how to configure switches and routers and install a network - Know how to develop communicating applications using the client-server model

Prerequisites

Information theory, Transmission and coding of information, Algorithms and programming (C language)

Assessment

The skills acquired are assessed by a written exam concerning the fundamental concepts of networks on the one hand, and by an individual project on mastering the development of communication applications on the other hand.

Teaching program

Course: - OSI model, encapsulation, principle of error detection - MAC protocols (eg, ALOHA, CSMA, Ethernet) - Internet protocols (IP, ICMP, ARP, DHCP, DNS, TCP/UDP) - Network interconnection (Ethernet switching, IP routing) - Communicating client-server applications with socket (C language) Practical work: - Protocol analysis with Wireshark - Socket programming - IP routing - Ethernet switching

Total hours : 18
Lecture hours : 6
Tutorials hours : 0
Practical/lab hours : 12

Objective

The objective of this EC is to introduce the basics of programming in C language (primitive types, arrays, pointers and structures) and multi-tasking applications: threads, synchronization and semaphore management.

Skills acquired

- Implement C language programs and multi-threaded applications

Prerequisites

Algorithms and Programming 1A

Assessment

- Know how to implement a program in C language and with threads for a given problem
Assessment methods: mini-project grade, written exam

Teaching program

Course: - C programming: language elements - Pointers and structures - Threads and semaphores
Practical work: - First programs in C language - Programming the power of 4 project in C -
Programming threads and semaphores
Individual mini-project: programming in C of an advanced program and communication (in connection with the EC Computer Networks of S7)

Total hours : 24
Lecture hours : 0
Tutorials hours : 24
Practical/lab hours : 0

Objective

The objective of this module is to prepare students for the external certification corresponding to their level and needs. The certifications prepared are as follows: -TOEIC minimum score to reach 785 (level B2) -IELTS minimum score to reach 6 (B2) -DET (Duolingo English Test) minimum score to reach 100 (B2)

Skills acquired

Skills as defined by the CEFR at level B2 or C1

Prerequisites

Have consolidated your B1 level. Have completed the 1A TOEIC test initiation.

Assessment

Continuous assessment: diagnostic, formative and summative assessments (vocabulary, oral/written comprehension type TOEIC/IELTS/DET, written productions type IELTS and/or DET and continuous or interactive oral productions) + Final assessment type TOEIC or IELTS in oral and written comprehension

Teaching program

Work on strategies, formats to master and consolidation of grammatical and lexical bases in order to be more effective in the TOEIC/IELTS/DET tests. TOEIC: Using the manual Preparation for the TOEIC test, Bruce Rogers. Typical exercises, methodology, training on complete tests. IELTS: Typical exercises, methodology, training on complete tests. DET: Typical exercises, methodology

Total hours : 24
Lecture hours : 0
Tutorials hours : 24
Practical/lab hours : 0

Objective

This course aims to consolidate students' knowledge in the four language activities (written production, interactive oral production, written comprehension, oral comprehension), and to bring weaker students up to speed in English, so that they meet (at least) level B2 of the CEFR. It also aims to develop professional skills

Skills acquired

Professional skills and know-how: written and oral comprehension, written and oral production (continuous and interactive) in a foreign language. Knowing how to set goals, learning how to learn

Prerequisites

For students who have not yet reached a B2 level in English, the second language will take the form of an English skills reinforcement course. Students who have already validated the B2 level in English will be able to follow courses in one of the second languages taught at ENSEM (groups will be opened according to the number of students concerned).

Assessment

Continuous monitoring (regular tests + ongoing investment).

Teaching program

In German or Spanish, the B1/B2 level is targeted. The activities in the 5 language activities will be structured around 2 themes: professional language and scientific language. Business and work world. Written expression and written comprehension activities such as CVs, cover letters, reports, summaries, syntheses. In English support, work on various TOEIC preparation and training exercises. The emphasis is on oral comprehension, written comprehension, grammatical and vocabulary reinforcement.

Total hours : 20
Lecture hours : 0
Tutorials hours : 20
Practical/lab hours : 0

Objective

- public speaking - Presentation technique - Technical internship report - Analyzing and summarizing a file.

Skills acquired

- Be comfortable speaking verbally in a group and/or individually. - Know how to give a presentation. - Write a technical report. - Write a summary based on a file.

Prerequisites

Knowledge acquired during S5 and S6. Good command of the French language

Assessment

An oral mark (50%) and a written mark (50%)

Teaching program

Presentation technique. The word "work" will be the common thread of the proposed themes (workplace stress, working abroad, entrepreneurial spirit, the circular economy, etc. 35 themes identified). In-depth study of meeting management and practical exercises. The internship report and oral defense. Continuation of reflection on the professional project (including updating the CV, portfolio, etc.).

Total hours :
Lecture hours :
Tutorials hours :
Practical/lab hours :

Objective

Use the main techniques of an energy engineer Improve your skills and put them into practice independently

Skills acquired

Missing information

Prerequisites

Missing information

Assessment

Missing information

Teaching program

Missing information

Total hours :
Lecture hours :
Tutorials hours :
Practical/lab hours :

Objective

Define an action plan to achieve the objectives set by the tutor Manage short tasks and in-depth tasks Propose reasoned solutions Lead a meeting (minutes, action plan) Carry out and conclude a company mission

Skills acquired

Missing information

Prerequisites

Missing information

Assessment

Missing information

Teaching program

Missing information

Total hours :
Lecture hours :
Tutorials hours :
Practical/lab hours :

Objective

Give instructions, enforce them and verify their application Develop your assertiveness within a team Acquire autonomy Manage deadlines with internal and external suppliers Implement the expected skills Define resources and means

Skills acquired

Missing information

Prerequisites

Missing information

Assessment

Missing information

Teaching program

Missing information

Total hours :
Lecture hours :
Tutorials hours :
Practical/lab hours :

Objective

Missing information

Skills acquired

Missing information

Prerequisites

Missing information

Assessment

Missing information

Teaching program

Missing information

Semester S8

Code	Course Unit	ECTS	Code	Course	Coeff	Teacher	Vol	CM	TD	TP	
?	Learning, control and optimization	7	?	Identification of Systems	0,15	M.Giaccaqli	18	8	0	10	
			?	Learning Methods	0,17	M.Kallas-Edelson	20	10	10	0	
			?	Reinforcement learning	0,18	J. Daafouz	22	?	?	?	
			?	Numerical Control	0,25	J. Kreiss	28	10	8	10	
			?	Predictive ordering	0,13	P. Riedinger	16	?	?	?	
				?	Event order	0,12	R. Postoyan	16	6	2	8
	?	Embedded systems and safety	8	?	Digital systems design	0,22	M.Kallas-Edelson	26	6	4	16
				?	Computer vision design office	0,18	S. Le Cam	22	0	0	22
				?	IoT systems	0,13	YQ Song	16	5	2	9
				?	Operational Safety	0,34	N. Brinzei	40	20	2	18
?				Security of Automated Systems	0,13	?	16	6	2	8	
8JUPPN03	Humanities 4	6	8JEPPN31	Dynamic presentations	0,3333	C. Corringier	24	0	24	0	
			8JEPPN32	second foreign language-4 English support	0,3333	C. Corringier	24	0	24	0	
			8JEPPN30	Financial Management and Accounting	0,3333	J.-C. Marpeau	40	22	18	0	
S8 Company		10		Technical competence							
				Methodological competence							
				Interpersonal skills							
				2A Defense							

Total hours : 18
Lecture hours : 8
Tutorials hours : 0
Practical/lab hours : 10

Objective

The control of dynamic systems requires a model whose identification is carried out from experimental measurements on the system in operation, generally subject to disturbances. The objective of this course is to introduce the concepts and tools necessary for mastering the basic techniques of identifying dynamic systems.

Skills acquired

Know how to identify a model from experimental data

Prerequisites

Mathematics and optimization courses, first- and second-year automation courses, and second-year signal processing courses

Assessment

Identification of a system on a computer from experimental measurements

Teaching program

Introduction: Definition and objectives of identification
Model structures: Principle of parsimony, Identifiability
Deterministic models and stochastic models
Classical identification methods
Graphical methods
Least squares methods
Instrumental variable methods
Optimization-based methods
Implementation and validation
Choice of input signals
Validation
Bibliography
T. Soderstrom and P. Stoica. System Identification. Prentice Hall, 1989.
Y. Landau, Identification des systèmes, Editions Hermes, 1998

Total hours : 20
Lecture hours : 10
Tutorials hours : 10
Practical/lab hours : 0

Objective

The EC is divided into 2 parts: On the one hand, the presentation of kernel methods. A particular focus will be made through the SVM (Support Vector Machine) classification method which is one of the most used. On the other hand, the introduction to neural networks from a perceptron to the multi-layer perceptron (Multi-Layer Perceptron MLP) and finishing with the convolutional neural network used for image classification.

Skills acquired

- Ability to manipulate large data sets and extract relevant information - Proficiency in implementing basic techniques - Ability to manipulate algorithms and parameterize them correctly - Ability to classify high-dimensional data

Prerequisites

- Basic notions of linear algebra (matrix calculus, eigenspace, projection) (S5) - Basic notions of optimization (S6) - Basic elements of probability and statistics (S7)

Assessment

The final grade is composed of: 30% the grade of the report on SVM 30% the grade of the report on RN 40% the grade of the tree leaf classification project

Teaching program

Kernel Methods and SVM Lectures - Presentation of the SVM method in the case of linearly separable data - Introduction of spring variables to deal with the case of linearly non-separable data - Concept of kernel and related properties - Transposition from the linear case to the non-linear case by the "kernel trick" Practical work on a computer machine - Complete programming of the method in the linear case and application to toy examples - Programming of kernel SVM Neural networks Lectures - Introduction to the perceptron, extension to the multi-layer perceptron with presentation of back propagation - Introduction to the convolutional neural network used in the case of image processing Practical work on a computer machine - Complete programming of the backpropagation algorithm and application to toy examples Mini-project The objective is to classify tree leaves

Total hours : 22
Lecture hours : ?
Tutorials hours : ?
Practical/lab hours : ?

Objective

Missing information

Skills acquired

Missing information

Prerequisites

Missing information

Assessment

Missing information

Teaching program

Missing information

Total hours : 28
Lecture hours : 10
Tutorials hours : 8
Practical/lab hours : 10

Objective

This course is dedicated to the modeling, analysis and control of discrete-time dynamic systems. The objective is to introduce the basic concepts and techniques of synthesizing numerical control laws and to understand the challenges related to numerical implementation. Emphasis is placed on the state-space approach and modern methodologies for designing numerical control laws. The concepts introduced will be illustrated with academic examples in tutorials and implemented on a Lego robot in simulation followed by experimental validation.

Skills acquired

Master the basic concepts of digital control. Understand the phenomena specific to digital control. Know how to design digital control and analyze its performance.

Prerequisites

First-year automation course, mathematics for engineers, basic concepts of signal processing (sampling, z-transform).

Assessment

Written exam and long practical work on implementing a digital control

Teaching program

Contents: - Introduction: issues related to numerical control - Modeling and representation of discrete-time systems and sampled systems - Stability analysis and structural properties - Synthesis of discrete-time correctors: emulation, direct synthesis, polynomial approach. - Implementation aspects of numerical control. References: K.J. Astrom, B. Wittenmark, Computer-Controlled Systems: Theory and Design, Prentice Hall. Katsuhiko Ogata, Discrete-time control systems, Prentice Hall.

Total hours : 16
Lecture hours : ?
Tutorials hours : ?
Practical/lab hours : ?

Objective

Missing information

Skills acquired

Missing information

Prerequisites

Missing information

Assessment

Missing information

Teaching program

Missing information

Total hours : 16
Lecture hours : 6
Tutorials hours : 2
Practical/lab hours : 8

Objective

Event-driven control consists of updating system inputs only when necessary to meet the specifications, rather than at fixed time intervals as in classic periodic sampling schemes. This strategy makes it possible to significantly reduce the use of resources (such as network bandwidth or computing power), while maintaining stability or performance guarantees. The objective of this EC is to discover this field and to familiarize oneself with the main existing techniques, in particular via a practical exercise on the distributed control of a fleet of autonomous cars.

Skills acquired

Understand the motivations and challenges associated with using event-driven control. - Know how to mathematically model a system subject to an event-driven control law. - Know and apply the main event-driven control techniques. - Be able to simulate an event-driven control law using Matlab/Simulink.

Prerequisites

Linear automatic

Assessment

1-hour exam Practical work report

Teaching program

Lectures: 1. Introduction 2. Modeling 3. Sampling laws 4. Inter-transmission time: what guarantees? 5. Control by output feedback 6. Robust control 7. Experimental validation 8. Conclusion tutorial: familiarization with the relative threshold technique lab work: distributed control of a vehicle fleet in an event-driven manner

Total hours : 26
Lecture hours : 6
Tutorials hours : 4
Practical/lab hours : 16

Objective

To give students mastery of digital system design tools and the means to design medium complexity circuits (a few thousand logic gates) on configurable circuits (FPGA)

Skills acquired

Students gain skills in modeling digital integration systems on reconfigurable FPGA targets. The expertise is in the field of digital system design, whether combinatorial or sequential, and in rapid prototyping.

Prerequisites

Machine architecture, coding of digital numbers

Assessment

The final grade is made up of: 50% of the average of the 4 grades of the practical work 50% of the grade of the partial with a written exam of 1h30

Teaching program

Lectures Classification of integration targets: programmed and wired solutions. From specifications to design, reminders of Boolean Algebra Logic simulation. VHDL modeling Design and equation of combinational and sequential systems up to the finite state machine Tutorials Boolean Algebra, Coding, Realization of a parity bit generator High beam ignition control, synchronous counter, shift register Practical work Getting started with Quartus software, declaration of a project and graphic description. Functional and temporal analyses. Implementation on the hardware target VHDL description of combinational solutions then wiring of FPGA target, functional and temporal analyses code coverage: the 4-bit adder. Study of a professional simulator (MODELSIM): use of a test program (testbench). VHDL description of sequential solutions then FPGA target wiring, functional and timing analyses code coverage: clocks, counters

Total hours : 22
Lecture hours : 0
Tutorials hours : 0
Practical/lab hours : 22

Objective

The objective of this design office is to apply project-based learning to design, develop and experiment with a digital solution. It also allows students to learn project management through practice, develop autonomy and apply the S5, S6 and S7 courses through practice. It is dedicated to the development of a computer vision application for the detection and recognition of road signs in 2D images and video streams.

Skills acquired

Know and apply certain techniques of computer vision and recognition of objects in images - Implement an application for detection and recognition of objects

Prerequisites

Programming and algorithms, Matlab programming, object-oriented programming, software analysis and design, data structures, machine learning methods

Assessment

- Know how to apply image processing and machine learning techniques for object detection and recognition
Assessment methods: project score

Teaching program

- Definition of the solution specifications - Image processing techniques using OpenCV and Matlab: Image filtering and denoising, Segmentation and thresholding (colors), Edge detection (Canny filter), Feature extraction for shape recognition, Template matching algorithms (SIFT, ORB) - Software development of the solution: Image acquisition, Object detection, Object recognition - Unit and integration testing - Validation and evaluation of the solution: accuracy rate - Demonstration of the solution

Total hours : 16
Lecture hours : 5
Tutorials hours : 2
Practical/lab hours : 9

Objective

The Internet of Things (IoT) and wireless sensor networks represent a significant evolution of the Internet towards distributed cyber-physical systems. This course aims to introduce the IoT ecosystem by focusing on both data transmission protocols on the sensor network side and data distribution in the cloud.

Skills acquired

Understand the concepts of low-power protocols. Know how to develop IoT applications to collect and transmit sensor data and distribute it over the Internet/Cloud.

Prerequisites

Computer Networks Programming in Python

Assessment

The skills acquired in developing IoT applications will be assessed through practice (practical notes).

Teaching program

lecture: IoT Eco-systems: embedded platforms, transmission protocols for sensor networks (e.g. WiFi, IEEE802.15.4, Zigbee, LoRa), publisher/subscriber data distribution model (MQTT), data visualization and processing. tutorial: Sensor network simulation. lab work: - Short-range networks (XBEE) - Long-range networks (LoRa) - Sensor data distribution and processing (MQTT, Node-Red)

Total hours : 40
Lecture hours : 20
Tutorials hours : 2
Practical/lab hours : 18

Objective

Digital systems used to control or improve the performance of industrial systems must meet reliability and/or availability requirements in order to be safe in their operation. This EC introduces the fundamental concepts of Operational Safety (OS) and shows any engineer that the failure of a system is not inevitable and that it is possible to determine the causes of failures and assess their impact on performance. The EC addresses the modeling and analysis of the OS of systems and their components using different formalisms, highlighting their complementarity.

Skills acquired

At the end of this EC, students will be able to: • analyze a system from a dysfunctional point of view • evaluate the reliability of components • model systems in order to probabilistically evaluate their operational safety

Prerequisites

- Probabilities & statistics (S6) - Modeling of Discrete Event Systems (S7)

Assessment

examination to assess the level of theoretical knowledge of approaches to modeling and assessing the operational safety of systems, to assess the implementation of these approaches - continuous assessment in tutorial and lab work to assess the ability to model, assess and analyze the operational safety of critical industrial systems

Teaching program

Lectures: • Concepts and definitions: reliability, availability, maintainability, safety (RAMS), MTTF, MTBF, MTTR • Component reliability • Qualitative approaches for risk analysis: APR, AMDEC, HAZOP • Combinatorial approaches for modeling and evaluating the SdF of systems: - reliability block diagrams (RBD) - fault trees (AdD) • State-transition approaches for modeling and evaluating the SdF of systems: - analytical approaches: Markov chains (CoM), stochastic Petri nets (RdPS) - simulation approaches: Stochastic Activity Networks (SAN) • Functional safety: study and analysis of Safety Instrumented Systems (SIS) in accordance with current norms and standards (IEC 61508); Safety Integrity Levels (SIL) Tutorials: • Modeling of systems by SAN Practical work: • Modeling and probabilistic evaluation of binary and non-repairable systems by RBD and AdD (GRIF software) • Modeling and probabilistic evaluation of repairable/reconfigurable multi-state systems by CdM and RdPS (GRIF software) • Modeling and evaluation of the SIL level of SIS (GRIF software)

Total hours : 16
Lecture hours : 6
Tutorials hours : 2
Practical/lab hours : 8

Objective

Autonomous and industrial systems have become a prime target for cyber attacks due to their criticality and in many situations, these systems are not sufficiently protected against computer attacks. In this EC, we identify the risks in terms of cyber attack on an autonomous and industrial system in order to identify and implement protective barriers using cryptographic methods and cybersecurity tools (detection and defense).

Skills acquired

Apply a cryptographic system to protect data and information - Analyze the risks of cyber attacks on an industrial system - Implement defense barriers (perimeter and in depth)

Prerequisites

Python Programming, Communication Networks

Assessment

- Know how to apply and choose a cryptographic system to protect data and information - Know how to analyze and identify the risks of cyber attacks and implement defense barriers in an industrial application case. Assessment methods: 50% written exam + 50% practical work notes

Teaching program

Course: - Cryptographic system: symmetric, asymmetric encryption, and hash functions - Analysis of cyber risk in industrial systems: attacks and threats - Protection system: intrusion detection, firewall Tutorials: - Study of cryptographic systems Practical work: - Role-play with an industrial application case (ENSEM Cyber suitcase platform) to identify and remedy attacks on the control of an industrial and automated system (SCADA and control automation systems)

Total hours : 24
Lecture hours : 0
Tutorials hours : 24
Practical/lab hours : 0

Objective

Semester focused on oral English: the objective is to lead students to deliver a clear and structured project presentation to an audience using effective communication techniques. Students will work regularly in groups and will be required to analyze their presentations.

Skills acquired

Communication techniques. Optimized use of different presentation tools (PPT, PREZI)

Prerequisites

Have reached a B2 level.

Assessment

Continuous assessment: regular formative and/or summative oral assessments (in the form of recordings and in public, individual and group) and final oral assessment.

Teaching program

Preparation for continuous public speaking: -use of documents (written and audio) in order to work on the structure and expressions necessary for guidance (signposting) -optimization of content and use of slides on PowerPoint or Prezi -management of non-verbal communication -work on pronunciation, rhythm, voice placement -work on communication techniques (impact techniques, rapport building) -work on marketing techniques (elevator pitch, sales speech)

Total hours : 24
Lecture hours : 0
Tutorials hours : 24
Practical/lab hours : 0

Objective

The aim of this course is to consolidate students' knowledge in the four language activities (written production, interactive oral production, written comprehension, oral comprehension), and to bring weaker students up to speed in English, so that they meet (at least) level B2 of the CEFR. It also aims to develop professional skills.

Skills acquired

Professional skills and know-how: written and oral comprehension, written and oral production (continuous and interactive) in a foreign language. Knowing how to set goals, learning how to learn

Prerequisites

For students who have not yet reached a B2 level in English, the second language will take the form of an English skills reinforcement course. Students who have already validated the B2 level in English will be able to follow courses in one of the second languages taught at ENSEM (groups will be opened according to the number of students concerned).

Assessment

Continuous monitoring (regular tests + ongoing investment)

Teaching program

In German and Spanish, the semester will be structured around modules with a scientific and cultural focus. Discovery or deepening of specialist vocabulary and the language of engineering. Work on themes and documents related to the field of engineering, the engineering profession, preparation for writing summaries, reports, training for debates, simulated meetings; knowing how to describe the operation of machines, processes, etc. Preparation for laboratory or company visits. Themes: the engineering profession, manufacturing processes, mechanics, electricity, energy, etc. In English support, the activities will aim to strengthen the skills necessary for continuous and public speaking (use of authentic documents in order to work on the structure, the necessary expressions, the use of slides on Powerpoint or Prezi, non-verbal management).

Total hours : 40
Lecture hours : 22
Tutorials hours : 18
Practical/lab hours : 0

Objective

Put students in a business management situation through a business management simulation (business game) based on a competitive market scenario. Apply concepts learned in management, marketing, finance, production of goods and project management.

Skills acquired

Ability to integrate into a business organization and understand its workings.

Prerequisites

Business knowledge and project management

Assessment

Evaluation based on feedback from the business management simulation tutorial (Strategy, Finance and Project Management). Presentation of results in the form of an oral presentation.

Teaching program

lecture: - Basics of accounting and financial analysis - Business strategy - Financial evaluation of a project and its impact on the company - Law and elements of responsibility of an engineer
tutorial: In the form of a business management simulation Based on group work, this business management simulation offers an effective way to concretely understand the interweaving of commercial, financial, human, technical decisions and the company's relations with its environment. It gives everyone the opportunity to test their ability to react to the vagaries of the economic situation, to the blows of competition, from imperfect information and in necessarily limited time.

Total hours :
Lecture hours :
Tutorials hours :
Practical/lab hours :

Objective

Use the main techniques of an energy engineer (level 2) Perfect your skills (level 2)

Skills acquired

Missing information

Prerequisites

Missing information

Assessment

Missing information

Teaching program

Missing information

Total hours :
Lecture hours :
Tutorials hours :
Practical/lab hours :

Objective

Define an action plan to achieve the objectives set by the tutor (level 2) Manage short tasks and in-depth tasks (level 2) Solve a cross-functional problem in the company Lead a meeting (minutes, action plan) (level 2)

Skills acquired

Missing information

Prerequisites

Missing information

Assessment

Missing information

Teaching program

Missing information

Total hours :
Lecture hours :
Tutorials hours :
Practical/lab hours :

Objective

Give instructions, have them applied and verify their application (level 2) Develop your assertiveness within a team (level 2) Acquire autonomy Adapt to an international environment

Skills acquired

Missing information

Prerequisites

Missing information

Assessment

Missing information

Teaching program

Missing information

Total hours :
Lecture hours :
Tutorials hours :
Practical/lab hours :

Objective

Missing information

Skills acquired

Missing information

Prerequisites

Missing information

Assessment

Missing information

Teaching program

Missing information

Semester S9

Code	Course Unit	ECTS	Code	Course	Coeff	Teacher	Vol	CM	TD	TP
9KUISN12			9KEISN93	Basis of image processing	0,35	S. Le Cam	20	16	4	0
			9KEISN33	Signal detection, extraction and reconstruction	0,35	R. Ranta	20	12	0	8
			9KEISN22	Biomedical Signals and Systems	0,3	D. Wolf	16	16	0	0
			9KEISN11	Aero Application	0,3333	M.Jungers	16	4	0	12
9KUISN11			9KEISDN61	Autonomous Flight of a Drone	0,3333	P. Riedinger	16	8	8	0
			9KEISN14	Multi-Agent Systems Management	0,3333	C. Morarescu	16	8	8	0
9KUISN15	Signal, Control and Robotics	10	9KEISN52	Introduction to Robotics	0,3	D. Wolf	16	8	0	4
			9KEISN53	Autonomous Vehicle Design Office	0,7	? / J. Kreiss	28	0	0	28
9KUISN13			9KEISN32	Monitoring and Diagnosis	0,3333	S. Maza	16	12	4	0
			9KEISN31	Formal verification of automated systems	0,3333	J.-F. Pétin	16	2	2	12
			9KEISN34	Security of Automated Systems	0,3333	? / J. Daafouz	16	6	2	8
			9KEISN43	Distributed Algorithms and Blockchain	0,3333	?	16	6	2	8
9KUISN14	Safety, security and distributed systems	8	9KEISN44	Distributed Systems	0,3333	V. Chevrier	16	8	2	6
			9KEISN45	IoT systems	0,3333	YQ Song	16	5	2	9
9KUAPP02	Humanities 5	2	9KEPPN21	English Interacting Professionally	1	C. Corringer	24	0	24	0
			9KEPPN25	Validation of international experience	pass/fail	L. Traut	1	0	1	0
			9KEPPN24	Management	pass/fail	F. Temsamani	6	0	6	0
S9 Company			10	Technical competence Methodological competence Interpersonal skills						

Total hours : 20
Lecture hours : 16
Tutorials hours : 4
Practical/lab hours : 0

Objective

The techniques used to extract useful information from an image often rely on specific mathematical tools and approaches specific to the discipline. This module aims to present the most interesting theoretical means and methodologies for processing and analyzing an image.

Skills acquired

Know how to handle a simple image analysis and processing problem from data acquisition to feature extraction

Prerequisites

ENSEM Signal Processing Course

Assessment

2-hour exam

Teaching program

Image sensors and vision systems Principles and devices for image formation (different types of cameras) Vision system: general and specialized architectures Point processing Logical or arithmetic processing Transfer functions Statistical analysis – thresholding Digital filtering of images Study of continuous and discrete 2D signals Linear spatial approach: discrete 2D convolution operation Frequency approach: discrete 2D Fourier transform Digital linear filtering of images, synthesis of 2D IIR and FIR filters Non-linear filtering Segmentation Introduction to image segmentation Notion of image primitives: contours, regions, geometric primitives, etc. Image thresholding techniques: methods based on histogram analysis Mathematical morphology The foundations of mathematical morphology Elementary transformations Set and functional definitions, mathematical properties The four elementary operators: erosion, dilation, opening, closing Grayscale morphology: "top hat" transform TCHF Notions of granulometry Morphological filters: sequential alternating filters Notions of skeleton: definition, properties, methods Watershed line, application to segmentation Geodesic transformations: definitions, properties, new operators, geodesic measurements

Total hours : 20
Lecture hours : 12
Tutorials hours : 0
Practical/lab hours : 8

Objective

This module aims to present the most suitable theoretical tools and methodologies for efficiently detecting and analyzing non-stationary and/or multidimensional signals in noisy environments. The first part of the course focuses on detection theory. Classical detection methods will be presented, as well as performance measures for evaluating these detectors. In a second part, signal extraction and reconstruction tools will be discussed. Here, we will rely on decomposition and partial reconstruction techniques using different dictionaries, derived from physical models or estimated from data.

Skills acquired

Know how to detect and extract relevant information from a signal or collection of signals, after having identified the method(s) best suited to the problem posed; know how to evaluate the results.

Prerequisites

Basic knowledge of signal processing, linear algebra, probability and statistics; basics of Matlab

Assessment

Practical work report

Teaching program

Detection: Bayesian detection, risk curve MiniMax and Neyman-Pearson detectors Performance measurement, ROC curve Application to jump detection (Page-Hinkley) - Generic decompositions Short-term Fourier / spectrogram, Orthogonal wavelets, Mallat scheme, Denoising and Compression by partial reconstruction - Decompositions on pre-established dictionaries Redundant dictionaries and regression Sparse reconstruction, iterative regression - Decompositions on bases derived from data PCA reminders, whitening Source separation elements

Total hours : 16
Lecture hours : 16
Tutorials hours : 0
Practical/lab hours : 0

Objective

The rapid development of signal and image processing techniques has brought about a true revolution in medical diagnostics and treatments. Since signals have become digital, the concept of a medical signal has evolved significantly. This module will present the most recent techniques and the specificities of biomedical signals and systems. The issues and main methodologies used in the processing of signals from nuclear medicine, radiodiagnosis, radiotherapy, chemodiagnosis, and chemotherapy will be developed.

Skills acquired

The knowledge acquired on the physical principles used to capture a medical signal or image combined with specific computational processing will enable students to address biomedical engineering problems, thus offering them the opportunity to access R&D jobs in this sector.

Prerequisites

ENSEM Signal Processing Course

Assessment

2-hour exam

Teaching program

Specific issues of biomedical signals and systems
Medical instrumentation, processing machines
Physiological signal processing
Control command of biomedical systems
Image sources in GBM
US, X, nuclear tracer, scanner, DRR, etc.
Processing of medical images
Analysis of image quality
Segmentation and quantification of attributes
Multimodal analysis and image fusion
The most recent advances
Diagnosis: nuclear imaging and in particular multimodal, ECG, radiodiagnosics, photodiagnosics, PET
Dosimetry: intensity modulation in radiotherapy, PDT

Total hours : 16
Lecture hours : 4
Tutorials hours : 0
Practical/lab hours : 12

Objective

The objective is to lead students to pose a realistic control problem inspired by the aeronautical field and to solve it using the concepts of control and multivariable optimization introduced in class. In this module, they will be confronted with specifications that go beyond the academic framework and they will have to take into account the real constraints encountered during the synthesis of an autopilot for an aircraft in the landing phase (nonlinearities, disturbances, delays, engine failure, multiple time scales, etc.).

Skills acquired

Know how to break down a complex control problem into several problems of reasonable size and complexity for the synthesis of a control law.

Prerequisites

First and second year automation courses.

Assessment

Full report on the problem of piloting an aircraft during landing phase provided at the end of the module

Teaching program

Concepts of multivariable control. - Nonlinear systems and decoupling - Synthesis of correctors by dynamic output feedback - Modeling of a civil aircraft during landing - Decomposition of longitudinal movement and lateral movement - Taking into account uncertainties and the flight envelope - Synthesis of correctors for each movement - Validation of these correctors on the nonlinear model of the aircraft - Evaluation of the autopilot obtained according to several scenarios and in the context of the descent from Frankfurt airport.

Total hours : 16
Lecture hours : 8
Tutorials hours : 8
Practical/lab hours : 0

Objective

In the form of a design office, the objective of this module in advanced control is to achieve the design and development in simulation of a flatness-based control for the trajectory tracking of a "Crazyflie" drone. Deliverable: A simulator + summary report. This work is preparatory to an implementation on a model of the "drone" platform.

Skills acquired

Synthesis of a trajectory tracking control based on "flatness" and stabilizing output loop on a nonlinear system. Trajectory planning.

Prerequisites

1A and 2A automatic control courses. Dynamic Optimization courses.

Assessment

Report note + simulator.

Teaching program

Based on scientific articles, study of a model of a quadcopter and identification of the parameters. Presentation of the concept of flatness and verification of the flatness property on the drone model. Canonical form of controllability Synthesis of a state feedback on the tracking error with integral effect. Addition of an observer Generation of reference trajectories Simulation on Matlab-Simulink

Total hours : 16
Lecture hours : 8
Tutorials hours : 8
Practical/lab hours : 0

Objective

A multi-agent system is composed of a set of systems interacting according to certain rules. The dynamics of such a system includes continuous and discrete behaviors, so it is the study of a class of hybrid systems. One objective of this module is to exploit the topological properties of the interaction graph between agents in order to give easy-to-verify algebraic conditions for global agreement. We will also be interested in the problem of conditions guaranteeing a convergence speed at least equal to an initially planned speed. The targeted applications concern the cooperative control of vehicles/robots.

Skills acquired

Model a set of autonomous systems communicating with each other. Deduce the properties that ensure the controllability of this set. Implement a decentralized control strategy.

Prerequisites

Courses: Mathematics 1A, Automatics 1A 2A, Graph Theory.

Assessment

Work to be submitted or presented orally.

Teaching program

This module has four parts: Algebraic graph theory; Spectral graph theory; Consensus protocols; Applications. The applications part is divided into several sections: Oscillator synchronization; Rendezvous problem; Decentralized formation control; Flocking (speed alignment); Community detection in a network.

Total hours : 16
Lecture hours : 8
Tutorials hours : 0
Practical/lab hours : 4

Objective

Acquire basic notions of robotics.

Skills acquired

Be able to build specifications for a robotics installation, particularly an industrial one

Prerequisites

ENSEM Solid Mechanics Course

Assessment

Exam: 2 hours

Teaching program

Functional diagram of a robot Classification of robots Examples of robots Sectors of application Articulated mechanical systems (AMS) Attitude of a reference in space Geometric models of AMS Generation of movements Control

Total hours : 28
Lecture hours : 0
Tutorials hours : 0
Practical/lab hours : 28

Objective

The objective of this design office is to apply project-based learning to design, develop, and experiment with technologies and methods associated with autonomous vehicle navigation. It also allows students to learn project management through practice, develop autonomy, and apply the S5, S6, S7, and S8 courses through practice. It is dedicated to the development of a control and trajectory planning application for autonomous vehicle navigation.

Skills acquired

- Know and apply certain techniques of trajectory control and planning - Implement an application for the navigation of an autonomous vehicle

Prerequisites

Automation, programming and algorithms

Assessment

- Know how to apply control and trajectory planning techniques for navigation Assessment methods: project score

Teaching program

Definition of the solution specifications - Control and trajectory planning techniques: control models, navigation algorithms - Software development of the solution on the QCar platform (<https://www.quanser.com/products/qcar/>) and ROS - Validation and evaluation of the solution - Demonstration of the solution

Total hours : 16
Lecture hours : 12
Tutorials hours : 4
Practical/lab hours : 0

Objective

Industrial systems are subject to failures that can lead to performance losses, safety issues, or even total shutdown of the installation. It is therefore essential to be able to detect the occurrence of faults in these systems, in order to control the resulting risks. Diagnosis is defined as the operation to detect a fault, or a failure state, and to locate its origin. Performing a diagnosis consists of comparing the instantaneous information from the system to a reference or a model representing normal and/or dysfunctional operation. The objective of the module is to present methods for detecting, locating and characterizing malfunctions of industrial systems and/or its components, whether they are described by algebraic, differential or discrete event models.

Skills acquired

Skills: - From a set of measurements or events, from recordings or acquired in real time, be able to detect a failure state or a defect and remedy it if necessary. - Be able to implement diagnostic schemes to monitor the operation of an industrial system. - In the case of a discrete dynamics system: analyze its behavior through the sequences of events it produces to diagnose the occurrence of defects and more generally the occurrence of unobservable events (absence or failure of sensors)

Prerequisites

Knowledge acquired in the ENSEM 1A and 2A core curriculum: - Basic elements of linear algebra, matrix calculus, basic linear automation (1st Year). - Basic elements of discrete event systems (a reminder of languages and state automata will be given)

Assessment

The final assessment will be based on a graded report (on the continuous part) and a written exam (on the discrete part)

Teaching program

Lectures Part (1) - Discrete Event Systems (7h) Discrete dynamic systems - Reminders on discrete event systems, languages and automata - Notion of unobservable events, observed sequence, diagnosable sequence. - State estimator of an discrete event systems described by an automaton - Diagnosis of unobservable events by: automata, chronicles, residues and RdPs. Part (2) - Continuous systems (5h) modeled by state equations - Model-based monitoring of industrial processes - Generation of residues using state observers, observer bench and structuring of residues Tutorials including a part on computer machine Part (1): 2h of machine tutorial - Application to an air conditioning system: automaton-based diagnosis with implementation on a “Supremica” synthesis software. Part (2): 2h of machine tutorial - Application of detection and localization of sensor faults by observer bench.

Total hours : 16
Lecture hours : 2
Tutorials hours : 2
Practical/lab hours : 12

Objective

The objective of this EC is to raise students' awareness of the problem of formal verification of the properties of critical programmed systems. The fundamentals of model-checking are presented and applied to case studies developed with the UPPAAL and SCADE tools.

Skills acquired

At the end of this EC, students will be able to provide proof of properties for automated systems subject to high normative requirements in terms of security.

Prerequisites

This EC complements the theoretical foundations acquired in the EC “Operational Safety” and “discrete event systems Modeling” of 2A.

Assessment

- Examination on computer machine (UPPAAL tool) for the formal verification of properties - Situational simulation through modeling and analysis of a case study (practical work report).

Teaching program

Modeling using communicating timed automata (formalism, modeling of synchronization channels, clock management, execution semantics). - Modeling of properties using CTL temporal logic (path and time quantifier) - Basic principles of model-checking (Kripke structure, exploration of state space). - Application to UPPAAL (timed automata) and SCADE (synchronous languages) tools.

Total hours : 16
Lecture hours : 6
Tutorials hours : 2
Practical/lab hours : 8

Objective

Autonomous and industrial systems have become a prime target for cyber attacks due to their criticality and in many situations, these systems are not sufficiently protected against computer attacks. In this EC, we identify the risks in terms of cyber attack on an autonomous and industrial system in order to identify and implement protective barriers using cryptographic methods and cybersecurity tools (detection and defense).

Skills acquired

Apply a cryptographic system to protect data and information - Analyze the risks of cyber attacks on an industrial system - Implement defense barriers (perimeter and in depth)

Prerequisites

Python Programming, Communication Networks

Assessment

- Know how to apply and choose a cryptographic system to protect data and information - Know how to analyze and identify the risks of cyber attacks and implement defense barriers in an industrial application case. Assessment methods: 50% written exam + 50% practical work notes

Teaching program

Course: - Cryptographic system: symmetric, asymmetric encryption, and hash functions - Analysis of cyber risk in industrial systems: attacks and threats - Protection system: intrusion detection, firewall Tutorials: - Study of cryptographic systems Practical work: - Role-play with an industrial application case (ENSEM Cyber suitcase platform) to identify and remedy attacks on the control of an industrial and automated system (SCADA and control automation systems)

Total hours : 16
Lecture hours : 6
Tutorials hours : 2
Practical/lab hours : 8

Objective

Distributed algorithms are very useful in distributed digital systems to ensure their operation in the absence of shared memory and a common time reference (desynchronization of physical or unreliable clocks). These algorithms mainly address the inherent problems related to the distribution of functions and data between the different components of a system. The methods for solving these problems are mainly mutual exclusion, the basics of clock synchronization and the integration of blockchain technologies.

Skills acquired

Identify the main classes of algorithms for distributed systems - Implement solutions and algorithms in an integrative approach

Prerequisites

Algorithms and programming, Object-oriented programming

Assessment

- Know how to integrate and exploit distributed algorithms to implement a distributed application
Assessment methods: continuous assessment (practical work notes), written exam

Teaching program

Course: - Problem statement (exclusion, time synchronization, distributed system) - Time, order and causality - Distributed mutual exclusion - Blockchain technologies (structures and components, consensus mechanism) Tutorials: - Causal dependence, logical clocks and mutual exclusion in a distributed environment Practical work: developing a distributed application with an integrative approach - TP1: sharing computation on distributed tasks in a distributed architecture - TP2: Carrying out distributed mutual exclusion - TP3: publishing data and operating a blockchain

Total hours : 16
Lecture hours : 8
Tutorials hours : 2
Practical/lab hours : 6

Objective

This course addresses the fundamental problems encountered when a computer application is built around several interacting autonomous components. It sets out these problems based on the concepts that characterize them and then presents different techniques for solving these problems.

Skills acquired

Understand and identify the fundamental problems of distributed systems (exclusion, synchronization) Master and implement solutions to these problems. Understand the basics of web services

Prerequisites

Object-oriented design and programming Computer systems and networks

Assessment

Practical exam (1/3) and on-table exam (2/3)

Teaching program

The lessons will cover the themes of mutual exclusion, synchronization of activities between processes; conceptual solutions and classical algorithms (philosophers' dinner, etc.) The main parts of the course are: Statement of problems, vocabulary and associated concepts Conceptual and software solutions: algorithms, tools (semaphores, monitors, messages, etc.) "Classical" statements and their solutions (philosophers' dinner, reader/writer, producer-consumer, sleeping hairdresser, barrier, lock, appointment, etc.) The case of web services Practical implementations in JAVA or Python will be made in order to concretize through different techniques (multi-thread, semaphore, monitor, web service, etc.) the concepts and solutions seen in class

Total hours : 16
Lecture hours : 5
Tutorials hours : 2
Practical/lab hours : 9

Objective

The Internet of Things (IoT) and wireless sensor networks represent a significant evolution of the Internet towards distributed cyber-physical systems. This course aims to introduce the IoT ecosystem by focusing on both data transmission protocols on the sensor network side and data distribution in the cloud.

Skills acquired

Understand the concepts of low-power protocols. Know how to develop IoT applications to collect and transmit sensor data and distribute it over the Internet/Cloud.

Prerequisites

Computer Networks Programming in Python

Assessment

The skills acquired in developing IoT applications will be assessed through practice (practical notes).

Teaching program

lecture: IoT Eco-systems: embedded platforms, transmission protocols for sensor networks (e.g. WiFi, IEEE802.15.4, Zigbee, LoRa), publisher/subscriber data distribution model (MQTT), data visualization and processing. tutorial: Sensor network simulation. lab work: - Short-range networks (XBEE) - Long-range networks (LoRa) - Sensor data distribution and processing (MQTT, Node-Red)

Total hours : 24
Lecture hours : 0
Tutorials hours : 24
Practical/lab hours : 0

Objective

This EC consists of two professionally oriented modules: Interacting Professionally and Scientific Communication. The objective of the EC is to give students skills in business English and scientific English.

Skills acquired

-Skills in written and oral expression and comprehension related to an engineering career -International openness -Cultural openness -Teamwork

Prerequisites

Have reached a B2 level

Assessment

Continuous assessment (written work, oral participation) and final oral assessment at the end of each module.

Teaching program

The Interacting Professionally module aims to prepare students to apply for job offers in English, to work with foreign partners (awareness of the notion of intercultural communication) and to professional communication in English (meeting management, project presentation, negotiation). For the Scientific Communication module, the focus is on scientific communication in writing (report writing, abstract writing, concise technical English) and orally (describing processes, simplifying / rephrasing technical concepts, etc.).

Total hours : 1
Lecture hours : 0
Tutorials hours : 1
Practical/lab hours : 0

Objective

Missing information

Skills acquired

Missing information

Prerequisites

Missing information

Assessment

Missing information

Teaching program

Missing information

Total hours : 6
Lecture hours : 0
Tutorials hours : 6
Practical/lab hours : 0

Objective

•Understand the management function within the company. •Acquire the basics of management and the managerial posture.

Skills acquired

•Know the role, main activities and skills required of a manager. •Develop your leadership as a manager.

Prerequisites

Basics of the business environment.

Assessment

Discharge

Teaching program

• 1 - Management in business: •Definition of management •Position and responsibility within the company (role, action and relationships) •The different types of management (interests, limits, and application) • 2 - The functions of the manager: •Role and posture •Skills and soft skills •Establishment of a hierarchical position •Setting objectives •Mobilizing resources (delegating and empowering, planning talent development) • 3 - Essential practices: •Intercultural management •Risk management •Conflict management •Conducting individual interviews

Total hours :
Lecture hours :
Tutorials hours :
Practical/lab hours :

Objective

Master the different techniques of the functions of an engineer in the field of Energy

Skills acquired

Missing information

Prerequisites

Missing information

Assessment

Missing information

Teaching program

Missing information

Total hours :
Lecture hours :
Tutorials hours :
Practical/lab hours :

Objective

Manage a project in all its dimensions Set objectives Prioritize activities and respect costs, deadlines and quality

Skills acquired

Missing information

Prerequisites

Missing information

Assessment

Missing information

Teaching program

Missing information

Total hours :
Lecture hours :
Tutorials hours :
Practical/lab hours :

Objective

Lead a working group by calling on experts
Take responsibility
Negotiate externally

Skills acquired

Missing information

Prerequisites

Missing information

Assessment

Missing information

Teaching program

Missing information