Double degree study organisation:

Student external to ESIEE

Year		Autumn semester	Summer semester
Double degree study	Equiv. in standard study		
1st	4th	ESIEE 1	ESIEE 2
2nd	5th	UWB 1	UWB 2
3rd	6th	ESIEE 3	ESIEE/UWB

Student at ESIEE at least from the 3rd year

Year		Autumn semester	Summer semester
Double degree study	Equiv. in standard study		
1st	4th	UWB 1	UWB 2
2nd	5th	ESIEE 3	ESIEE/UWB

ESIEE 1 - Autumn Term

Department	Subj. abbrev.	Subject	Credits	Classes per term	Labs per term
CS	GA	Graph Algorithms	3	Classes	Labs
CS	OP	Optimization	3	Classes	Labs
CS	TI	Theory of Information	3	Classes	Labs
CS	SS	Signals & Systems	3	Classes	Labs
CS	OOP	Object Oriented Programming	3	Classes	Labs
CS	AA	Advanced Algorithms	3	Classes	Labs
CS	CA	Computer Architecture	3	Classes	Labs
CS	OS	Operating Systems	3	Classes	Labs
CS	RTS	Real Time Systems	3	Classes	Labs
CS	FL	French Language	2	Classes	Labs
CS	FCI	French Culture and Intercultural	2	Classes	Labs
CS	MAN	Management	2	Classes	Labs
		Sum:	**33**		

Graph Algorithms

3 ECTS

Aim: This course is an introduction to the most popular algorithms produced by graph theory, and used in pattern recognition, combinatorics, AI, and problem resolution amongst others. It aims to provide attendees with the ability to : formalize a given problem in terms of graphs; identify whether the problem has a known solution or not; and in case not, suggest a new algorithm and evaluate its complexity.

Content:

- Graph traversal, connected components
- Shortest path
- Minimum spanning tree
- Maximal flow

Optimization

3 ECTS

Content:

- Simplex algorithm
- Branch & bound, and A*
- Integer programming

Theory of Information

3 ECTS

Aim: These lectures deal with statistical information processing and theory. The course first introduces estimation theory, with the fundamendal Cramer-Rao bound associated with Fisher information. Then we deal with classical information theory: ayesia entropy, Kullback-Leibler divergence and present the source and channel coding theorems, with applications in compression and data transmission. The lectures are illustrated with labs in estimation concepts and on an implementation of a compression algorithm.

Content:

- Estimation theory (maximum likelihood, Bayesian approaches)
- Entropies and divergences
- Source coding (compression)
- Channel coding

Signal and Systems

3 ECTS

Aim: The objective of these notes is to give an accessible introduction to signals and systems for electrical engineering, computer engineering, and computer science.

Content:

- Fundamentals of continuous-time/discrete-time signals: (a) Introduction to Fourier and Laplace transforms; (b) theory of convolution and the concept of transfer function; (c) sampling and reconstruction
- Essentials of feedback control: (a) representation of dynamical systems (state-space, input-output); (b) basic feedback loops and more abstract representations; (b) structural properties (controllability, observability); (c) stability (internal, input-output) and sensitivity (load disturbance, noise); (d) control algorithms and methodologies (PID, state feedback, pole placement, observers)
- Dealing with uncertainty and systems' limitations (measurement noise, actuator saturation, process dynamics)

Object-Oriented Programming

3 ECTS

Aim: This course explains the main principles and advantages of object-oriented programming around Java. It assumes attendees are already familiar with a procedural programming language, such as C, and provide them with the necessary background to write and test a complete application under Linux or Windows in Java.

Content:

- Introduction to Object-Oriented Languages (OOL).
- Inheritance and abstraction. Exceptions.
- Collections and generics.
- I/O operations, threads.
- Packages from JDK, commands.

Advanced Algorithms

3 ECTS

Aim: This course is a continuation to the "Graph Algorithms" course, and pertains specifically on problems solving. We present resolution methods from three widespread families of algorithms, all providing either exact, or approximate but guaranteed solutions within a given

tolerance. Typical examples are provided in the case of stock management, transportations, or resource assignment problems

Content:

- Dynamic programming
- Divide & conquer
- Greedy algorithms

Computer Architecture

3 ECTS

Aim: This course is a first introduction to computer architecture and its impact on performances. More precisely, we study how the structure of a program, once implemented on a particular architecture, can impact on performances. We present a design methodology that permits to obtain an optimized implementation (on RISC or DSP) of a program given its algorithmic specification.

Content:

- Computer architectures and performances
- Architecture of RISC processors
- Memory hierarchy

Operating Systems

3 ECTS

Aim: This course aims to provide the basic working principles of any modern operating system. We outline the various components which a computer is made of,, then focus on tasks, memory, and disks, and the various problems that they raise. We explain some well-known solutions to these problems, evaluate their efficiency, and illustrate their action with concrete examples for Unix, Linux and Windows NT/XP operating systems.

Content:

- Process and scheduling
- Process communication
- Memory management
- Disks and file systems

Real Time Systems

3 ECTS

Content:

- Real time scheduling algorithms (feasibility analysis, optimality analysis, resource sharing)
- Real time Linux (RTAI)

French Language (option)

2 ECTS

French culture and Intercultural (option)

2 ECTS

Management (option)

2 ECTS

Content:

- Marketing
- Finance
- IT law

ESIEE 2 - Spring Term

Department*	Subj. abbrev.	Subject	Credits	Classes per term	Labs per term
CS	OEC	Optimal Estimation and Control	3	Classes	Labs
CS	MC	Model Checking	3	Classes	Labs
CS	MM	Mathematical Morphology	3	Classes	Labs
CS	CG	Computational Geometry	3	Classes	Labs
CS	NET	Networking	3	Classes	Labs
CS	PRML	Pattern Recognition, Machine Learning	3	Classes	Labs
CS	MAN2	Management	2	Classes	Labs
CS	FL	French Language	2	Classes	Labs
CS	PROJ	Project	5	Classes	Labs
		Sum:	**27**		

Optimal Estimation and Control

3 ECTS

Aim: The objectives of these lectures are twofold: first, to give a better comprehension of the emerging dynamics induced by systems' interconnections (limitations, "trade-offs", etc.), and second to introduce necessary tools to optimize the dynamic behavior of discrete/continuous linear systems in the presence of uncertainty and/or of various constraints on the dynamics. Different problems such as optimal estimation and observation and optimal/robust control will illustrate the theoretical part. The lectures will end with basic notions and tools in robust control as well as with various discussions on the methods to be used in constructing appropriate controllers. Various examples (networked control systems, synchronization movement over networks) will complete the presentation.

Content:

- Interconnections and dynamics. Case studies and discussions
- Nonlinear optimization: constrained nonlinear optimization, Lagrange multipliers
- Dynamic programming: principle of optimality, dynamic programming, discrete/continuous LQR
- Optimal estimation/observation of linear (discrete/continuous) systems
- Robust control and controller construction

Model Checking

3 ECTS

Aim: This course is an introduction to model checking, an automatic verification technique of concurrent and reactive systems. In the first part of the course we study the kripke structure as a model of reactive concurrent systems, then we introduce the linear and branching time temporal logics and model checking algorithms for these logics. Finally we describe how to represent

Content:

- Reactive Systems Modeling
- Temporal Logics (CTL, LTL, CTL*)
- Model Checking Algorithms
- Binary Decision Diagram
- Symbolic Model Checking

Mathematical morphology

3 ECTS

Aim: The aim of this course is to provide the fundamentals of mathematical morphology. We introduce new concepts in non-linear signal analysis, then explain the basic operators used in mathematical morphology and their main properties, and skeletonization. The problem of image segmentation is then considered, with the very popular watershed segmentation approach. Non-linear filtering and detection are illustrated on a wide variety of problems.

Content:

- Non-linear signal processing
- Erosion, dilation, closing, opening
- Skeletons
- Watershed segmentation, connected operators

Computational geometry

3 ECTS

Aim: This course is an introduction to computational and digital geometry. Computational geometry is a realm devoted to the study of efficient algorithms and their associate data structures for solving geometrical problems in terms of basic objects such as points, lines, polygons, etc. Digital geometry specially deals with digitized objects in digital images. Conceivable applications for both include computer graphics, image analysis, robotics, geographic information systems, and computer-aided engineering.

Content:

- Spatial decompositions
- Geometric searching
- Convex hull algorithms
- Geometrical simplification

Networking

3 ECTS

Aim: This course provides attendees with the lost essential concepts from low to mid-level networking. The most widespread networking technologies are first introduced. It is then shown how these different technologies may be abstracted in the first layers of the OSI model. Routing is considered, with concrete example given on CISCO routers. Large networks, and their administration, are explained at last.

Content:

- OSI model, layer abstraction
- Paquet switching (OSI layer 2)

- Routing (CISCO routers, OSI layer 3)
- WAN (Wide Area Network) and VPN (Virtual Private Network)

Pattern recognition, machine learning

3 ECTS

Aim: This course introduces the fundamentals of statistical pattern recognition and machine learning. We first explain Bayesian decision theory, and show how a given PR problem may be expressed in terms of probabilities and distributions. We then study various well-known techniques usable to solve the problem raised as the outcome of formalization. Generalization theory, and elements of machine learning are introduced at last. Examples are provided on real problems, most of which arise from medical imaging or sensoring.

Content:

- Bayesian decision theory
- Maximum-likelihood based methods (naïve Bayes, EM, HMM)
- Linear discriminant analysis
- Multilayer neural networks
- Introduction to Support Vector Machines

Management

2 ECTS

Content:

- Strategy
- Entrepreneurship
- Change management
- Human resources

French language (option)

2 ECTS

Project

5 ECTS

UWB 1 - Autumn Term

Department*	Subj. abbrev.	Subject	Credits	Classes per week	Labs per week
KAE	CZS	Digital Signal Processing	6	3	2
KAE	SYS1	Synthesis of Electronic Systems 1	6	3	2
KAE	PSR	Systems and models of controlled processes	4	2	2
KAE	DZS	Reliability and Diagnostics. in Electronics	5	3	2
KAE	EZO	Electronics in Image Processing	4	2	2
		Sum:	**25**	**13**	**10**

Optional subjects (min. 11 ECTS in autumn and spring term)

Department*	Subj. abbrev.	Subject	Credits	Classes per week	Labs per week
UJP	AEL3	English for Students of El. Engineer. 3	2	0	2
UJP	A3	English 3	4	0	4
UJP	CPC1	Czech for Foreigners 1	4	0	4
UJP	F3	French 3	4	0	4

Digital Signal Processing

6 ECTS

(3 hours classes, 2 hours labs)

Content: Fundamental mathematical equations for digital signal processing digitized signal properties. Possible errors in processing, problems of digital system stability. DSP architecture, A/D and D/A converters and DSP interfacing. FIR and IIR filters implementation. Discrete Fourier and Fast Fourier Transform algorithms, hardware implementation of FFT. FIR and IIR adaptive filtering, DSP applications.

Synthesis of Electronic Systems 1

6 ECTS

(3 hours classes, 2 hours labs)

Content: Simulation of analogue circuits using the PSPICE software. Active filters. Phase-locked loops, utilization in frequency synthesizers and in data transmission. The VHDL language and its use in the design and simulation of combinatorial and sequential circuits. Implementation by PLD. System design with emphasis on maximum speed - pipelining, parallelism.

Systems and models of controlled processes

4 ECTS

(2 hours classes, 2 hours labs)

Content: Systems and models of controlled processes. Control systems, signals and information. Open loop, closed loop and feedback control systems, standard controllers in industry. Control and stabilization by means of state feedback. Optimal control, nonlinear stabilization, asymptotic state reconstruction, experimental identification. Principles of adaptive control and structures of adaptive and self-learning systems. Representations of controlled systems. Frequency response of controlled systems, transfer functions, state space representations, structure diagrams, interrelationships between specific types of system representations. Stability analysis, state uncontrollability and state inobservability testing, mode instability detection, control of deterministic chaos. Principles of linear and nonlinear control system synthesis with state feedback; linear, nonlinear and adaptive filter and state observer design. Separation principle. Synthesis of adaptive control systems and their analogue, digital and hybrid realization.

Reliability and Diagnostics. in Electronics

5 ECTS

(3 hours classes, 2 hours labs)

Content: Fundamentals of diagnostics, methods of test generation : detection and localization tests, tests for combinatorial circuits, tests for sequential circuits, test minimization, scan methods, boundary scan, error detecting and correcting codes : self-checking circuits, theory of linear codes, cyclic codes, Hamming codes, Read-Solomon codes, principles of totally self-checking circuit design: alternating logic, two-wire logic, principles of fault tolerant circuit design, testing of systematic structures: memory chip testing, VLSI chips testing: microprocessors, peripheral chips and other VLSI chips; testing devices : troubleshooters, signature analyzers, logic analyzers, digital oscilloscopes, in-circuit emulators, small and large testers.

Electronics in Image Processing.

4 ECTS

(2 hours classes, 2 hours labs)

Content: Signal sources, image acquisition, data storage, image pre-processing, segmentation, object description and representation, image recognition, systems for image processing and recognition, applications of FPGA devices.

English for Students of El. Engineer. 3

2 ECTS

Aim: The course is designed for FEL students with intermediate knowledge of English. It further develops the knowledge of grammar, lexicology, reading and comprehension skills. The course is aimed at improving passive knowledge of general English as well as preparing written specialised presentation.

English 3

4 ECTS

Aim: It requires intermediate knowledge of the language, enhances vocabulary and basic grammatical structures and creates the ability to understand written as well as spoken English in various contexts with respect to the chosen subject of study.

Czech for Foreigners 1

4 ECTS

French 3

4 ECTS

Aim: The course requires pre-intermediate knowledge of French. Students enhance their vocabulary and grammar. They develop the ability to understand written as well as spoken French in various contexts, with respect to the chosen subject of study.

UWB 2 - Spring Term

Department*	Subj. abbrev.	Subject	Credits	Classes per week	Labs per week
KAE	ENZ	Electronic Power Supplies	4	2	2
KAE	SYS2	Synthesis of Electronic Systems 2	5	3	2
KAE	RIS	Control and Information Buses	6	3	2
KAE	PLO	Programmable Logic Devices	4	2	2
KAE	SAC	Sensors and Actuators	5	2	2
		Sum:	**24**	**12**	**10**

Optional subjects (min. 11 ECTS in autumn and spring term)

Department*	Subj. abbrev.	Subject	Credits	Classes per week	Labs per week
KET	TASE	Introduction to Business Management	3	2	1
UJP	AEL4	English for Students of El. Engineer. 4	2	0	2
UJP	A4	English 4	4	0	4
UJP	CPC2	Czech for Foreigners 2	4	0	4
UJP	F4	French 4	4	0	4

Electronic Power Supplies

4 ECTS

(2 hours classes, 2 hours labs)

Content: Power supplies in modern electronic systems, batteries and accumulators of miscellaneous types, transformers and rectifiers, voltage filters, linear regulators, pulse power supplies and regulators, AC-DC and DC-DC converters, examples of integrated circuits for converters manufactured by the main world producers, power supplies for consumer and industrial electronics, uninterruptible power supplies.

Synthesis of Electronic Systems 2

5 ECTS

(3 hours classes, 2 hours labs)

Content: Electronic circuit design methodology covering the whole process from beginning to end. Special emphasis is on low_power circuits and design testing. Input data gathering. Block diagrams of solution. Theoretical solution, simulation. Necessary bread_boarding. Testing, maintenance. Cost to performance ratio. VHDL-AMS simulation. System reliability. Design of circuits and systems with enhanced reliability.

Control and Information Buses

6 ECTS

(3 hours classes, 2 hours labs)

Content: Data links, data networks, ISO/OSI models, parallel and serial buses, bus drivers RS232, RS-485. Access to bus - Token Bus, Token Ring, CSMA/CD, CSMA/AMP. Asynchronous and synchronous transmitters/receivers. Bit and character synchronization. Protocol Modbus, LonWorks. USB interface. Automotive buses: CAN bus, std. 2.0A, 2.0B, drivers, CAN bus controllers. Lin bus, FlexRay Protocols for automotive application (Transport Protocol, Network Management). Tools for bus monitoring.

Programmable Logic Devices

4 ECTS

(2 hours classes, 2 hours labs)

Content: Basics of programmable logic; CPLD and FPGA produced by different manufacturers, such as Altera, Lattice, Xilinx; programmable logic utilization; basics of the VHDL language, algorithms for digital processing, basic digital circuits such as gates, multiplexers, flip-flops, RAM and ROM memories and finite state machines; functional simulation and time simulation of design, real-time debugging. Microcontroller and microprocessor utilization in FPGA as complex system components.

Sensors and Actuators

5 ECTS

(2 hours classes, 2 hours labs)

Content: Sensor definition, features, types. Temperature sensors industrial temperature measuring. Force, pressure and torque sensors. Position, displacement and rotary angle sensors. Velocity and angle velocity measuring, accelerometers, inclinometers. Liquid flow measuring, volume and mass flow meter, level measuring, powdery material flow measuring, volume measuring. Motion sensors, person identification, security system sensors, automotive sensors. Humidity sensors, optical fibre sensors, electrochemical sensors, radioactivity measurement. Intelligent sensors, standardized interfaces and industrial buses. Computer analogue inputs, galvanic separation. Actuators - control and use, relays, semiconductor switching devices, frequency converters. Sensor mounting and operation rules.

Introduction to Business Management

3 ECTS

Content:

- Business management trends
- Economic relation in the electrical engineering industry and markets
- Company and its function, company association
- Fundamentals of business strategic management
- Management of business processes
- Marketing and marketing mix
- Electrical engineering product and innovation.
- Innovation planning
- Introduction to financial management and planning
- Electronic communication for business processes
- Logistic and resource management and planning
- Audit in the electrical engineering company
- Legislative and specific condition for business in the electrical engineering industry

English for Students of El. Engineer. 4

2 ECTS

Aim: This course is a follow-up to AEL3. It further enhances the knowledge of grammar and vocabulary, and develops reading, comprehension and reproduction skills. Students learn to write their structured CV and job application. The course is aimed at mastering passive knowledge of general language and work with dictionaries.

English 4

4 ECTS

Aim: It improves the knowledge of vocabulary and grammatical structures and creates the ability to write and speak in selected situations with respect to the chosen subject of study. The course is aimed at mastering the language on the level equivalent to internationally recognised standard Threshold User.

Czech for Foreigners 2

4 ECTS

French 4

4 ECTS

Aim: Students of this course improve their vocabulary and grammar. They also develop speaking and writing skills in particular contexts, with respect to the chosen subject of study.

ESIEE 3 - Autumn Term

Option 1 : Computer Graphics - France

Department*	Subj. abbrev.	Subject	Credits	Classes per term	Labs per term
CS	IA	Image Analysis	3,5	Classes	Labs
CS	IP	Image Processing	3,5	Classes	Labs
CS	IS	Image Synthesis	3,5	Classes	Labs
CS	HPIP	Hardware for Parallel Image Processing	3,5	Classes	Labs
CS	CV	Computer Vision	3,5	Classes	Labs
CS	A1	Applications I (project)	3,5	Classes	Labs
CS	A2	Application II (project)	3,5	Classes	Labs
CS	FL	French Language	2	Classes	Labs
CS	MAN	Management	2	Classes	Labs
CS	PMI	Project Management and Innovation	2	Classes	Labs
		Sum:	**30,5**		

Option 2 : Distributed Systems - France

Department*	Subj. abbrev.	Subject	Credits	Classes per term	Labs per term
CS	MVRTS	Modelling and Verification of Real Time Systems	3,5	Classes	Labs
CS	WNRS	Wireless Networks, Routing, Sensors	3,5	Classes	Labs
CS	RTDCS	Real Time Distributed Control Systems	3,5	Classes	Labs
CS	DC	Distributed Control	3,5	Classes	Labs
CS	MDDD	Model-driven Design and Development	3,5	Classes	Labs
CS	DAD	Distributed Applications Development	3,5	Classes	Labs

CS	DS	Distributed Software	3,5	Classes	Labs
CS	FL	French Language	2	Classes	Labs
CS	MAN	Management	2	Classes	Labs
CS	PMI	Project Management and Innovation	2	Classes	Labs
		Sum:	**30,5**		

Image Analysis

3,5 ECTS

Aim: This course covers the most popular techniques used in image analysis. We study the fundamental problem of image segmentation, which consists in separating objects in the foreground of a given image from its background, and also separating objects one to each other. This problem is formulated both in the classical framework of optimization (functional minimization), and in the frequency domain for textured segmentation. Various measurements techniques (such as perimeter, surface, volume, or diameter estimation for instance) are then presented. Direct applications of wavelet theory and Fourier analysis are also considered.

Content:

- measurements (2D, 3D)
- segmentation based on functional minimization
- application of linear methods (wavelet, FFT)

Image Processing

3,5 ECTS

Image Synthesis

3,5 ECTS

Aim: This course introduces various theoretical and practical aspects of computer graphics. We study 3D modeling, real time rendering techniques (OpenGL), but also more sophisticated strategies (global enlightenment techniques such as ray shooting, photon mapping, or simulation of natural phenomenons). We also study advanced real-time techniques (occlusion mapping), and games graphical engines, such as Halo 3, or problems dealing with rendering in multimedia post-production.

Content:

- Illumination models, reflections models (phong, Catmull klark...)
- Graphic pipeline, multitexturing
- Real time techniques (illumination maps, ambiant occlusion, env maps...)
- Global illumination algorithms : photon mapping, metropolis, radiosity...
- PRT

Hardware for Parallel Image Processing

3,5 ECTS

Aim: These lectures are a continuation to "Computer Architecture" (given in common core), and emphasizes on parallelisation issues in a hardware standpoint.

Content:

- Introduction to parallelism (SIMD, MIMD, PRAM models. Message passing based architectures. Introduction to PVM and MPI)
- Intraprocessor parallelism (RISC, CISC, superscalar, VLIW, SoC architectures)
- Multicomponent parallelism (multi-DSP, FPGA)

Computer vision

3,5 ECTS

Aim: This course introduces the main ingredients of computer vision, such as 2D and 3D projective geometry, and computer vision problems with one to n cameras. Some extensions to the field of computer vision, such as augmented or virtual reality, are also presented. At last, an overview of current challenges and commercial applications is given.

Content:

- 2D and 3D projective transformations
- Camera calibration
- Epipolar geometry
- Trifocal tensor
- Augmented Reality

Applications I (project)

3,5 ECTS

Content:

- Biomedical imaging
- Geographical Information Systems

Applications II (project)

3,5 ECTS

Content:

- Games and multimedia
- Virtual and augmented reality

French language

2 ECTS

Management

2 ECTS

Content:

- Intercultural management
- Team-building
- Leadership
- Inter-personal skills

Project Management and Innovation

2 ECTS

Content:

- International project management
- Innovation

Modeling and Verification of Real Time Systems

3,5 ECTS

Aim: The aim of this lecture is to provide to students the theory of automata and some of their applications. In the first part, we introduce the basic theory of finite automata and its application to indexing structures and pattern matching. In the second part, we show how

quantitative information can be added to finite automata, we present timed automata an extension of finite automata used for checking real time properties of distributed systems.

Content:

1. Finite Automata and Indexing Structures
    - Words, regular languages and automata
    - Operations on languages and automata : set operations, product, star
    - Determinization, Minimization
    - Quotient of automata
    - Borders, Periods
    - Suffix automaton, Suffix tree
    - Compaction, Minimization of a cyclic automata
    - Forbidden minimal words
2. Timed Automata and Model Checking
    - Modeling using timed automata
    - Clock Regions
    - Clock Zones
    - Difference Bound Matrices
    - UPPALL Model Checker
    - Timed game automata

Wireless Networks, Routing, Sensors

3,5 ECTS

Real Time Distributed Control Systems

3,5 ECTS

Content:

- Distributed Architectures
- Multiprocessor Scheduling
- Algorithm Architecture Adequation Methodology
- Parallel computing for real time systems
- Communication Models , ex :CAN, Ethernet ...

Distributed Control

3,5 ECTS

Content:

- Optimal scheduling for distributed control applications
- Distributed control under resource constraints
- Off line optimal scheduling/control
- On line optimal scheduling/control

Model-driven design and development

3,5 ECTS

Content:

- UML, UML-RT
- Structure Diagram (class diagram, object diagram)
- Behavior Diagram (statecharts)
- Software Component and Aspect-oriented Programming

Distributed applications development

3,5 ECTS

Content:

- Distributed Objects (CORBA et RTCorba)
- Data-Distribution Service for Real-Time Systems (DDS)

Distributed software

3,5 ECTS

ESIEE/UWB - Spring Term

Department*	Subj. abbrev.	Subject	Credits	Classes	Labs
KAE / CS	FP	Final Project	30	Classes	Labs
		Sum:	**30**		

Final Project

30 ECTS