DIGITAL SYSTEMS PROGRAMME SPRING SEMESTER (S4)

MODULES	TITLE	ECTS	
HUMANITIES			
	French as a foreign language	2	P2
	Physical education	2	P3
	English	2	P4
TECHNICAL			
	Digital communications	2	P5
	Image processing	2	P6
	Electronic Interfaces	2	P7
	VHDL based design	4	P8/9
	VLSI Integrated Circuits and Systems	2	P10
	Real time systems	3	p11/12
	Advanced Algorithmic	2	P13
PROJECTS			
	Technical project	7	P14
		30	

❒1st / ☑2nd/❒3rd year / COMPUTER SCIENCE

Course Title : French for foreigners
Course Coordinator : Nathalie Caradec Nathalie.caradec@enssat.fr
Type of module Compulsory module Prerequisite: placement test for level group
Course duration: 30hrs
Module components /Types of Courses • Practical courses in small group Dialogues- role play –variety of teaching material through the media and digital technology
2 ECTs
Work load: In class studying
Content: CEFR French levels are used on the four skills speaking – listening-reading and writing • Level A1-A2 can introduce him/herself, can ask and answer questions about personal details such as where he/she lives, people he/ she knows, and things he/she has. Can interact in a simple way provided the other person talks slowly and clearly. • Level B1-B2 Can understand the main points of clear standard input on familiar matters regularly encountered in work, school, leisure, etc. Can deal with most situations likely to arise whilst travelling in an area where the language is spoken. Can produce simple connected text on topics which are familiar or of personal interest. Can describe experiences and events, dreams, hopes & ambitions and briefly give reasons and explanations for opinions and plans. Common European Framework of References : CECRL (Cadre Européen Commun de Références pour les Langues)
Learning outcomes: Development of the different skills according to the level.
Assessment - Written assignment - Oral assignment
Language of instruction: French
Additional information

❒1st / ☑2nd/❒3rd year / COMPUTER SCIENCE

Course title	PHYSICAL EDUCATION
Course coordinator	Mr. Bertrand LEFEBVRE bertrand.lefebvre@enssat.fr
Type of module (compulsory module, required Elective module, elective module)	Compulsory
Course duration	30 hrs
Course components /Types of Courses (lectures, practical course, lab, tutorial, internship, …)	
2 ECTS	
Work load	Not requested
Content	TENNIS OR WINDSURFING
Learning outcomes	- Health and safety - Team spirit - Local sport activities
Assessment	- Written assignment: A final report to be handed in. - Oral assignment
Language of instruction	ENGLISH/FRENCH
Additional information: swimming skills are mandatory for water sports.	

☑2nd/❒3rd year / COMPUTER SCIENCE

Course title	GENERAL ENGLISH COURSES
Course Coordinator	Claire LE PAGE claire.le-page@enssat.fr
Type of module (compulsory module, required Elective module, elective module)	Compulsory
Course duration	30 hrs
Course components /Types of Courses (lectures, practical course, lab, tutorial, internship, …)	Practical courses in small groups
2 ECTs	
Work load	-In class studying 30 hrs -Student managed learning: 20 hrs

Content

This course is designed to teach students at an "independent level" to communicate effectively in English at the B2 /C1 level on general topics.

Learning outcomes:

At the end of this course students will be able to

- Do presentations
- Debate on topical issues
- Interact with a degree of fluency which makes communication with a native speaker possible
- Write reports on a wide range of interests.
- Understand the main ideas of complex texts on concrete or abstract topics
- Understand extended speech or conferences

Assessment: continuous assessment

- Written assignment ☑
- Oral assignment ☑

Language of instruction	ENGLISH
Additional information: B1 level is a prerequisite	

❒1st / ☒2^{nd}/❒3rd year / ❒Master of photonics

Course title:	Digital Communications
Coordinator(s):	Claude Cariou – Pascal Scalart
Type of module (compulsory module, required Elective module, elective module)	Compulsory module
Course duration	1 semester
Course components /Types of Courses (lectures, practical course, lab, tutorial, internship, …)	Lectures : 12 hrs, tutorials: 4 hrs, labs : 10 hrs
2 ECTS	
Work load	-In class studying: 26 hrs -Student managed learning : 12 hrs
Content	• Introduction to communications sytems at PHY layer: access techniques (TDMA, FDMA, WDMA, CDMA), main digital modulation techniques (base band, narrow band) • Communication channels: physical channel model (noise, attenuation, nonlinear effects, multipath channels) and communication channel model (Tx/Rx filters) • Baseband modulation: pulse shaping (NRZ, RZ, Manchester, RB, etc.); digital signal model; calculation of baseband line code power spectrum (Bennett formula) • Optimal receiver for infinite band channel: adapted filter, calculation of the binary error probability; receiver model for bandlimited channels; extension to multipolar digital signals • Narrow band digital signals: main modulation formats (ASK, PSK, FSK, QAM) • Labs: Practise and experimental study of real digital communications with baseband and several bandlimited modulations (ASK, BPSK, QPSK, BFSK, QAM-8) over different channels (bifilar, coaxial, radio, fiber optics, infrared)
Learning outcomes	• Ability to model, analyze and design basic communication systems at the physical layer • Ability to design a plan experimentation with specialized instrumentation (spectrum analyzer)
Assessment	- Written assignment + labs report
Language of instruction	ENGLISH
Additional information	

❒1st / ☑2nd/❒3rd year / ❒Master of photonics

Course title:	Image Processing
Course coordinator:	Prof. Kacem CHEHDI Kacem.Chehdi@enssat.fr
Type of module (compulsory module, required Elective module, elective module)	compulsory module
Course duration	1 semester
Course components /Types of Courses (lectures, practical course, lab, tutorial, internship, …)	Lecture: 12 hrs, tutorial: 6hrs, practical course: 8 hrs
2 ECTS	
Work load	-In class studying: 26 hrs -Student managed learning : 16 hrs
Content	• General introduction • Sensors • Basic tools • Image processing methods • Detection objects methods • Feature extraction

Expected learning outcomes:
Mastery of the fundamental tools required for the design of automatic decision-making systems.

Description:
The different steps of the vision-based automatic decision making system are described: several examples of so-called "intelligent" systems are presented. After a description of the human visual system and the presentation of different image sensors, the methods and tools for improving image quality are detailed. Then, the main methods for analyzing and extracting the information content of non-textured images are developed. Finally, in order to implement the learning and identification steps, the methods of feature extraction for the characterization of objects or shapes are presented.
Most of the problems solved during the tutorials correspond to real cases.
Two sessions of practical work complete this course.

Bibliography:

- J.S. Lim, "Two-dimensional signal and image processing", Prentice Hall, New Jersey, 1990.
- A.K. Jain, "Fundamentals of digital image processing", Prentice Hall, New Jersey, 1989.
- D.E. Dudgeon, R.M. Mersereau," Multidimensional signal processing", Prentice Hall, New Jersey, 1984.

Assessment	Written assignment
Language of instruction	ENGLISH
Additional information	

❒1st / ☒2nd/❒3rd year / ❒Master of photonics

Course title:	**Electronic Interfaces**
Course coordinator:	Antoine Courtay Antoine.Courtay@enssat.fr
Type of module (compulsory module, required Elective module, elective module)	Compulsory Module
Course duration	1 semester
Course components /Types of Courses (lectures, practical course, lab, tutorial, internship, …)	Lecture : 14 hrs, lab : 16 hrs
2 ECTS	
Work load	-In class studying: 30 hrs -Student managed learning : 20 hrs
Content	• Microcontroller programming • Microcontroller communication interfaces • USB, UART, SPI, I2C, 1-Wire, CAN … ○ History, application, protocol, electrical features, use cases
Learning outcomes	This course aims to present how to communicate and exchange data with a microcontroller development board and various electronic components/devices. These components can be on the shelf components (temperature, digital potentiometer, IMU, memory card, LCD screen…) or more complex devices such as a computer or laboratory instruments (scopes, programmable power supply …). Some labs with two different platforms will explore communication standards. USB communication and driver will be the topic of one project. Then UART, SPI, I2C and 1-Wire communications will be explored with real component examples in another one.
Assessment	- Written assignment and lab
Language of instruction	ENGLISH
Additional information	

ENSSAT LANNION

❐1st / ☒2nd/❐3rd year / ❐Master of photonics

Course title:	VHDL based design
Course coordinator:	Olivier Sentieys olivier.sentieys@enssat.fr
Type of module (compulsory module, required Elective module, elective module)	Compulsory module
Course duration	1 semester
Course components /Types of Courses (lectures, practical course, lab, tutorial, internship, …)	Lecture: 18hrs, lab: 40hrs
4 ECTS	
Work load	-In class studying: 58hrs -Student managed learning: 24hrs

Content

1. Introduction: Why HDLs?
2. Design Flow and Tools
3. Basic Language Concepts
4. Signal and Delay Models
5. Modeling Digital Systems
6. Concurrent and Sequential Processes
   - Process statement, process event behavior, signals vs. variables, timing behavior of processes
7. Modeling Structures
   - Structural models, generics, the Generate statement
8. Simulation and Validation
   - Concepts, writing testbenches, configurations
9. RTL and Logic Synthesis
   - Writing style for logic synthesis, combinational logic, sequential logic, RTL and logic synthesis CAD algorithms
10. Fil Rouge Example: FIR filter

Learning outcomes

The objectives of this course are to give the necessary basics about the VHDL language to be able to simulate and synthesize from the Register-Transfer Level (RTL) an application-specific integrated circuit or an FPGA. After a general introduction on hardware description languages, the design flow and execution models using HDLs are presented. The rest of the course focuses on learning the VHDL language, with first some general notions on abstractions, simulation, hardware synthesis before to present VHDL syntax and semantics following event-driven simulation of digital systems. The course ends with the presentation of the semantics following the RT level to ensure correctness by design of circuits synthesized form VHDL.
The in-class part of this course is realized using several examples that will be simulated and synthesized to illustrate the theoretical concepts. We use Mentor Graphics ModelSim for simulation and Synopsys Design Compiler for synthesis. Beyond the in-class part, this course includes a lab dedicated to logic synthesis from RTL, and a large project to design the VHDL code for a full system and to run it on an FPGA board. This project is conducted in teams of 4 to 5 students to mimic real-life design teams and to learn how to work in a team context. Examples of systems that are used in the projects are a digital oscilloscope including an FFT accelerator, a wireless CDMA emitter/receiver, a real-time audio processing system, a real-time image processing system, etc.

Assessment - Written assignment + lab
Language of instruction ENGLISH
Additional information

❐1st / ☒2nd/❐3rd year / ❐Master of photonics

Course title:	VLSI Integrated Circuits and Systems: Principles and Design Method
Course coordinator:	Olivier Sentieys olivier.sentieys@enssat.fr
Type of module (compulsory module, required Elective module, elective module)	Compulsory module
Course duration	1 semester
Course components /Types of Courses (lectures, practical course, lab, tutorial, internship, …)	Lecture: 22hrs, lab: 4hrs
2 ECTS	
Work load	-In class studying: 26hrs -Student managed learning: 12hrs

Content	• Integrated Circuit (IC) Technologies
	  ○ MOS Technology, IC Fabrication, Silicon Technology Evolutions
	• Design of CMOS Cells
	  ○ Combinatorial Logic Cells, Layout Design, Sequential Logic Cells, Delay and Power
	• IC Design Methods
	  ○ IC Classification, Design Methods and CAD Tools, IC Specification
	• Synchronous Design of IC
	  ○ Synchronous Design Rules and Principles, Finite State Machine (FSM) plus Datapath Model, Arithmetic Operators

Learning outcomes	The objectives of this course are to give the necessary basics in the design of application-specific integrated circuits and FPGAs. After a general introduction on the history and evolution of CMOS technology and applications, the main technologies are presented. The rest of the course focuses on CMOS circuits by presenting the main device (MOS transistor) in details. Then, transistor-level and layout-level design methods for combinatorial and sequential cells are introduced, as well as their characterization in terms of power and propagation delay. ASIC and FPGA design tools and methodologies are then presented. Finally, the last part of course focuses on synchronous design methods at logic and architecture levels. This part also includes basic notion on designing and optimizing arithmetic operators.
Assessment	- Written assignment + lab
Language of instruction	ENGLISH
Additional information	

❒1st / ☒2nd/❒3rd year / ❒Master of photonics

Course title: Real time systems	
Course coordinator: Benoît Vozel Benoit.Vozel@enssat.fr	
Type of module (compulsory module, required Elective module, elective module) Compulsory module	
Course duration 1 semester	
Course components /Types of Courses (lectures, practical course, lab, tutorial, internship, …) Lecture : 12 hrs, tutorial : 12hrs, lab : 12 hrs	
3 ECTS	
Work load -In class studying: 36 hrs -Student managed learning : 24 hrs	

Content

- Basic concepts of real-time applications
  - Real-time applications issues
  - Physical and logical architecture, operating systems
- Basic concepts and illustrations for real-time task scheduling
  - Task description
  - Scheduling: definitions, algorithms and properties
  - Scheduling in classical operating systems
- Scheduling of independent tasks
  - Basic on-line algorithms for periodic tasks
    - Rate Monotonic scheduling
    - Inverse deadline (or deadline monotonic) algorithm
    - Algorithms with dynamic priority assignment (Earliest deadline first and least laxity)
  - Hybrid task sets scheduling
    - Scheduling of soft aperiodic tasks (background scheduling, task servers - polling, deferrable, priority exchange, sporadic)
  - Hard aperiodic task scheduling
    - Background scheduling of aperiodic tasks
    - Joint scheduling of aperiodic and periodic tasks
- Scheduling of dependent tasks
  - Tasks with precedence relationships
    - Precedence constraints and fixed-priority algorithms (RM and DM)
    - Precedence constraints and the earliest deadline first algorithm
  - Tasks sharing critical resources
    - Assessment of a task response time
    - Priority inversion phenomenon
    - Deadlock phenomenon
    - Shared resource access protocols
- Scheduling schemes for handling overload
- Software environment (RT-Linux, VxWorks)
- Practical study cases: analysis and design
  - User requirements and functional specification based on the graphical design notation of either the Structured Analysis for Real Time Systems (SART) or the Unified Modeling Language (UML).

○ Analysis of the functional behavior, information and control flows through a system ○ Software architecture: logical architecture and real-time tasks, assignment of operational functions to devices ○ Detailed temporal analysis
Learning outcomes This course encompasses the fundamental basics to real-time programming when the programmer has to design from scratch applications where a centralized computing system controls an environment (physical process to which it is connected) for controlling its behavior in real-time. The main objectives are both to cover the fundamental basics to real-time programming and the most significant real-time scheduling policies in use today in the industry for coping with hard real-time constraints. The bases of real-time scheduling and its major variants and developments are thus described using unified terminology and notations. In addition to exercises illustrating the underlying concepts of the techniques available in the literature to solve the standard difficulties arising for hard real-time constrained systems, practical study cases with increasing complexity allow students to acquire at the output a solid approach that will then allow them to deal with real-life practical cases and implement optimized solution in complete autonomy.
Assessment - Written and oral assignments
Language of instruction ENGLISH
Additional information

❒1st / ☑2nd/❒3rd year / ❒Master of photonics

Course title : Advanced Algorithmics	
Course coordinator : Olivier Pivert - olivier.pivert@enssat.fr	
Type of module (compulsory module, required Elective module, elective module)	Compulsory module
Course duration 36hrs	
Course components /Types of Courses (lectures, practical course, lab, tutorial, internship, …) Lectures (14hrs) Exercises (12hrs)	
2 ECTS	
Work load - In class studying 26hrs - Student managed learning 14hrs	
Content Introduction Reminder about computational complexity Divide and Conquer Trials and errors Dynamic programming Greedy algorithms	
Learning outcomes The objective is to master different classical algorithmic methods, whose list is given above. A particular attention will be paid to the computational complexity aspect.	
Assessment Written assignment	
Language of instruction ENGLISH	
Additional information	

❒1st / ☒2nd/❒3rd year / ❒Master of photonics

Course title:	Technical project
Course coordinator:	Emmanuel Casseau emmanuel.casseau@enssat.fr
Type of module (compulsory module, required Elective module, elective module)	Compulsory module
Course duration	1 semester
Course components /Types of Courses (lectures, practical course, lab, tutorial, internship, …)	Lecture : hrs, lab : hrs
7 ECTS	
Work load	-In class studying: 0 h -Student managed learning : 120 hrs
Content	• Design project in electronics/embedded systems/signal processing, as a team or individually.
Learning outcomes	The projects allow students to apply theoretical notions seen in class to a design project in electronics/embedded systems/signal processing, from problem definition, design, to implementation and experimentation. These projects are also the opportunity to develop written and oral communication skills.
Assessment	- Project report + oral assessment
Language of instruction	ENGLISH
Additional information	