ENSEA

Beyond Engineering

Electrical & Computer Engineering

Signal Processing major
Or Electronics major

Graduate/Master Program

ENSEA – Semester 8 - English-Taught Track

Edition 2023

ENSEA Second Year Syllabus – International Program
First year of Master or Graduate studies
Signal processing Major

Level	**First year of Master's Degree/Graduate/Semester 8**		
Period	Spring semester (January to August)		
Language of tuition	English		
ECTS	30		
Courses	Code	Course	ECTS
	SIGNAL_S8_MAJ	**Signal Processing as Major [Composed of:]**	**6**
	DEE_2211	Statistics and numerical methods	
	DEE_2216	Information theory and multimedia compression	
	ELECTRONICS_S8_MIN	**Electronics as Minor [Composed of:]**	**4**
	DEE_2311	Analog modulations & Noise	
	DEE_2312	Electromagnetic Compatibility, Signal Integrity	
	MANAGEMENT_PROJECT_S8	**Management & Project [Composed of:]**	**6**
	DEE_2711	Project	
	DSH_2611	Industrial Management	
	DSH_2612	Recruitment meeting	
	LANGUAGES_S8	**Languages [Composed of:]**	**4**
	DSH_2111	English	
	DSH_2116	French for international students	
	OPTION_S8	**Elective course**	**6**
	STAGE	**Engineer assistant internship**	**4**

SIGNAL_S8_MAJ Signal Processing as Major (6 ECTS)

DEE_2211 Statistics and numerical methods(Lectures: 14h / Tutorial classes: 12h / Lab: 16h)

This course gathers applied mathematics methods. Two main chapters – estimation and significance tests – are seen from both the aspects of inferential and industrial statistics. The first point of view allows to solve random signals problems, only using time-method, and some telecommunications problems (decoding with maximum likelihood). Other topics, dealing with industrial statistics and Engineer general knowledge, are presented, such as Chi-Squared testing and quality control. Optimization problems coming from statistics are solved with a numerical method. Conversely, statistical methods allow the solution of optimization problems : a topic over stochastic optimization is discussed.

- Random vectors, random processes, statistical samples management
- Likelihood of a statistical model
- Estimation one-point or over a range
- Significance testing: parametric (Neyman-Pearson) and non-parametric (Chi-Squared)
- Finite differences
- Multiple-variable Differential Calculus
- Optimization: gradient method, Newton method, least-squared method
- Stochastic optimization

DEE_2216 Information theory and multimedia compression (Lectures: 10h / Tutorial classes: 10h / Lab: 16h)

This course introduces the fundamentals in coding theory, source coding, error correction coding. Multimedia compression is then discussed (image, audio, video). JPEG images compression will be the golden thread since it includes lossless and lossy compression.

- Information theory and digital communications: entropy, mutual information, source coding (Shannon theorem, Huffman algorithm, Markov sources), differential entropy of continuous random variables, Gaussian channel capacity.
- Lossless compression, reversible: statistical algorithms, dictionary-based methods, arithmetic compression
- Lossy compression, non-reversible: scalar and vector quantification, transformations and preparation to compression, restitution quality versus compression rate.
- Channel coding: discrete channel without memory, capacity, Shannon theorem for coding theory, binary linear codes.
- JPEG norms.

ELECTRONICS_S8_MIN Electronics as Minor (4 ECTS)

DEE_2311 Analog modulations & Noise(Lectures: 6h / Tutorial classes: 6h / Lab: 8h)

This course allows the study of signal transmission, in its analog aspect.

- Noise
- Amplitude modulation
- Frequency modulation
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DEE_2312 Electromagnetic Compatibility, Signal Integrity (Lectures: 8h / Tutorial classes: 10h / Tutorial classes machine: 4h / Lab: 8h)

This course focuses on different electromagnetic interferences and their effects on electronic systems, especially the signal integrity issues and power (crosstalk, electromagnetic interferences, overshoot, multiple reflection, signal skew…). The idea is to make students aware of these issues as soon as the design of the circuit.

- Definitions and rules specific to Electromagnetic Compatibility
- Electromagnetic interferences. Classification by origin, time, spectrum, coupling type (conduction, , both), differential and common propagation mode, frequency and time characterization.
- Coupling mechanism in harmonic state and transient state.
- Screening effect
- Devices and specific methods of EC protection

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	ELECTRONICS_S8_MAJ	**Electronics as Major [Composed of:]**	**6**
	DEE_2311	Analog modulations & Noise	
	DEE_2312	Electromagnetic Compatibility, Signal Integrity	
	DEE_2316	Electronic Systems III	
	SIGNAL_S8_MIN	**Signal Processing as Minor [Composed of:]**	**4**
	DEE_2211	Statistics and numerical methods	
	MANAGEMENT_PROJECT_S8	**Management & Project [Composed of:]**	**6**
	DEE_2711	Project	
	DSH_2611	Responsible and sustainable marketing for the engineer	
	DSH_2612	Recruitment meeting	
	LANGUAGES_S8	**Languages [Composed of:]**	**4**
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ELECTRONICS_S8_MAJ Electronics as Major (6 ECTS)

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- Coupling mechanism in harmonic state and transient state.
- Screening effect
- Devices and specific methods of EC protection

DEE_23126 Electronic Systems III (Lectures: 10h / Tutorial classes: 8h / Tutorial classes m: 2h Lab: 16h)
We study in this major some applications, from the point of view of analog signal, systems and associated components. Simulation tools specific to the field will be used in lectures and in practical sessions.
Analog demodulations in the presence of noise, phase noise.
Noise in linear quadrupoles, noise factor.
Link budget of a radio link or a wire link.
Operation of electronic labels. RFID. Contactless charger.
Atomic clocks, phase noise. GPS systems.
Low voltage, low consumption electronics. Example: MOS in low inversion regime.

SIGNAL_S8_MIN Signal Processing as Minor (4 ECTS)

DEE_2211 Statistics and numerical methods(Lectures: 14h / Tutorial classes: 12h / Tutorial classes m: 4h / Lab: 16h)

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Core subjects & Option

MANAGEMENT PROJECT_S8 (4 ECTS)

DEE_2711 PROJECT Lab : 40h

The project initiated during the previous semester is continuing and will result in

at the end of the year, to the writing of an activity report given during the

the final technical demonstration

DSH_2611 Responsible and sustainable marketing for the engineer

Lectures:10H /Tutorial Classes: 12h

The course should enable students to understand the fundamental knowledge and tools of marketing, such as defining a marketing approach, perform a marketing diagnosis (PESTEL,

(PESTEL, SWOT), develop a marketing strategy (segmentation, positioning mapping), build a marketing mix and plan and follow up marketing actions.

Students must understand the concept of responsible and sustainable marketing

and make the link with the CSR commitment of an organization. For example, the need to analyze the impact of market positioning on the environment, define operational marketing methods and tools to build a responsible and sustainable offer in coherence with the ecosystem (sustainable or eco-responsible products, non-commercial communication

responsible consumption, short circuits/channels of distribution and sales channels).

Students can transpose the concepts of responsible and sustainable marketing to the case of an engineering project (ethical framework, short circuit, sustainability...). They learn to position engineering projects sustainably by developing a strategic and operational vision of the main SD and CSR issues.

They must also know how to manage customer satisfaction throughout an throughout an engineering project in a sustainable perspective.

The Tutorial classes (Tds) favor an edutainment approach (or in the form of a serious game) which consists in designing and marketing strategy in line with its ecosystem.

DSH_2612 Job Interview Training Tutorial classes : 4h

This training is intended for all students to enable them to better apprehend the job or internship interviews they will have to face at the end of their studies.

The activity is given by industrialists specialized in the recruitment of young graduates.

- Presentation of the system, general rules, preparation (analysis of job offers),

- Personalized interview,

- Conclusion and feedback.

LANGUAGES_S8 Languages (4 ECTS)

DSH_2111 English(Lectures: -h / Tutorial classes: 24h / Lab: -h)
The goal of this year is to prepare for the international experience, either academic or internship mobility. Focus will be given to resume and cover letter redaction, Business English, intercultural workshop, the way to speak in professional context or daily life, advanced notions on linguistic aspects. Workshops dedicated to different language certificates can be also suggested.

DSH_2116 FLE (French for foreigners) (Lectures: -h / Tutorial classes: 20h / Lab: -h)
The main goal of this class is training the foreign students through communication fundamentals for everyday life, proposing them an introduction to French culture and civilization and more advanced knowledge in order to work in a French company during the final internship period.

OPTION_S8 Elective course (6 ECTS)

[Choose one]

DEE_2802 Drones (Lectures: 36h / Tutorial classes: -h / Lab: 28h)

This elective course is an introduction to the design, realization, instrumentation and remote control of drones. These techniques could be generalized to other autonomous mechatronics systems.

Contents

- Notions of mechanics
- Aerodynamics
- Motorization
- Sensor specifications (accelerometer, gyroscope, magnetometer, GPS…)
- Sensor data fusion (Complementary or Kalman filter)
- Control (PID, multivariable)
- Microcontroller (STM32 family)

Laboratory project

- Testing a pre-built quadcopter drone
- Acquisition (I2C/SPI protocols) and processing of sensors data (accelerometer, gyroscope, magnetometer…)
- Generation of PMW control signals for motors
- Dynamic modeling and simulation with Matlab/Simulink
- Feedback and PID control

DEE_2807 Internet of Things (Lectures: 36h / Tutorial classes: -h / Lab: 28h)
IoT networks interconnect embedded physical objects such as distributed control systems used in autonomous vehicles and sensor networks used in structural health monitoring and smart cities. According to predictions, IoT will account for 45% of all Internet traffic by 2020, showcasing the importance of IoT applications.
This elective course focuses on the architectures and protocols of IoT communication networks; we will study cases such as wireless sensor networks and vehicular IoT networks (V2V, V2X, X2V to assist driving). The option covers a wide range of topics, starting from the physical layer (PHY), and moving to IoT MAC and network layers (802.15.4, 6LoWPAn, ZigBee, etc.). Special topics, including IoT security protocols – IPSec. DTLS, etc., will also be covered. Students will have the chance to get introduced to the realm of IoT and experiment with intelligent, interconnected objects, they can potentially conceptualize, design and develop in the future as engineers.
Contents
• Communication networks for IoT
• Fundamental trade-offs between rate, connectivity, latency
• Wireless sensor networks
• Energy consumption, energy harvesting
• IoT PHY: NB-IoT
• Networking for IoT, TCP-IP, IPv6, 6LoWPAN, ROLL/RPL
• IoT Protocols, 802.15.4, ZigBee, RIOT, CoAP
• IoT Security, DTLS, IPSec
• Automotive IoT, V2V, V2X, X2V

Laboratory topics:
Laboratory sessions include MatLab® based experiments, experimentation with real IoT devices and remote access experimentation using the IoT FIT Lab at INRIA Saclay https://www.iot-lab.info/.

Partners: Huawei, PSA

DTI_2811 DITN_2810 Artificial Intelligence and Big Data (Lectures: 36h / Tutorial classes: -h / Lab: 28h)
This elective course is an introduction to artificial intelligence and its application to the processing of big quantities of data. Classification and prediction questions will be studied through different AI methods in order to find solutions for automatic image indexation or for recommendation systems.

Contents
- Data mining, introduction to data bases
- Statistical learning, linear classifier, neuron networks, decision trees
- Introduction to deep learning
- Visual recognition, image interpretation
- Recommendation systems, user profile generation

Partners: Criteo, Qwant

DTI_2811 Image and Virtual Reality (Lectures: 36h / Tutorial classes: -h / Lab: 28h)

This elective course introduces digital signal processing for images, computer vision, virtual and augmented reality. After formal lecturing on these concepts, students will develop a project in teams of two students.

Contents

- Image generation, camera types
- Image processing, linear filtering
- Mathematical morphology, pattern recognition (Hough transform), segmentation
- Computer vision: camera calibration, stereovision, structured light
- Virtual reality: VR helmets technology, 3D modeller, 3D engine
- Augmented reality: effects insertion, image synthesis

Partners: Illumination McGuff, Morpho, Onx, SNCF

DSH_2812 Human-centered design (Lectures: 36h / Tutorial classes: -h / Lab: 28h)

This option is based on the assumption that engineers have a responsibility not to design more products that are useless, counterintuitive or difficult to use. Thus, it presents the methods and techniques for the design, realization and evaluation of user-friendly and efficient human-machine interfaces. It also presents theories and models that allow us to better understand the user's behavior (decision making, cognitive, cognitive bias, development of expertise) interactive systems. The teaching covers both software aspects (information visualization) and software aspects (information visualization, interactive techniques, Artificial Intelligence), hardware (STM, sensors and actuators) and human factors (user-centered design, prototyping, evaluation, perception). Objectives:

- Introduce the basic principles of user-centered design.
- Know the design and development cycle of an interactive system.
- Understand a set of methods for user requirements analysis, system prototyping methods, and system evaluation methods.

These methods are directly implemented through a project that will result in an iteration of project that will result in an iteration of low-fidelity prototypes.