2020 - 2021
ESIGELEC
3rd Year / Semester 9

COMMON CURRICULUM
(Enseignements Transversaux)

General Education Requirements: Engineering Careers, English, Electives, and Interviewing Practice (ET3 C1, C2, C3, C4) = 5 ECTS credits

(ET3 C1-F) Engineering Careers ***(students choose from the following options):*** **30 hours of instruction**

∗ Entrepreneur / *Ingénieur Entrepreneur*

Objectives

- Students will situate professional development within a changing economic context. They will also be finding their entrepreneurial spirit.

Coursework

- Taking over, developing, and structuring businesses
- The different aspects of starting up
- Skills, talents, and know-how of entrepreneur engineers
- Case studies

∗ Quality Engineer / *Ingénieur Qualiticien*

Objectives

- Students will learn about the careers involved in implementing quality and their importance
- Students will understand the role quality assurance plays in reliability and competitiveness of products and services.
- Students will learn the place of quality in the ever changing business world: globalisation, new technologies, the environment, and so on.

Coursework

- The role of the quality engineer
- Quality: definition and its importance
- The responsibilities of a quality engineer
- The skills and characteristics of a quality engineer
- The importance of quality, its scope and the future of the quality engineering

∗ Engineer as a Project Manager / *Ingénieur Chef de Projet*

Objectives

- Students will learn the meaning of a project for modern company development, and discover their appreciation for teamwork and team evolution.

Coursework

- Summary of a group project experience (in groups)
- Project management principles
- Team management and motivation
- Promulgating new ideas and diagnosing obstacles
- A testimonial of a R&D team project leader
- Rights and duties of a project engineer / team leader

∗ International Engineering Careers / *Ingénieur à l'International*

Objectives

- Students will come to understand what's at stake for an international career, notably for its interpersonal aspects. Students will also be learning about intercultural exchanges, management and communication in multi-cultural situations.

Coursework

- An engineer's place in Europe and around the world

- International contexts: globalization, political and geo-economic approaches
- Approaches to multicultural situations
- Fundamentals of international marketing
- Intercultural communication / multinational perspectives of HR departments
- Using knowledge

* Research & Development / *Ingénieur Recherche et Développement*

Objectives

- Students will learn about the place and management of research and development in companies; the purposes of R&D, and understand R&D techniques.

Coursework

- Industry and professions
- R&D techniques
- Information management
- Interpersonal relations

* Business Engineering / *Ingénieur d'Affaires*

Objectives

- Students will learn about the professions associated with sales, the specific tools, and develop and master a complete process (from prospecting to finalizing).

Coursework

- The role of a business engineer and their adaptability and flexibility
- The tasks and qualities of a business engineer
- Initiation to negotiation and selling
- Communicating in an increasingly difficult field

* Consultant / *Ingénieur Conseil*

Objectives

- Students will learn about the different facets of consulting and how to deal with expectations when working with others.

Coursework

- The consulting market
- The profile of a consulting engineer and putting together projects
- The field and how it works

* Financial Engineering / *Ingénieur Financier*

Objectives

- Students will learn about the sought after field of financial engineering and its particular mix of science and financial management; students will also be discovering their dual talents and teamwork skills.

Coursework

- Financial Engineering: its makeup and careers
- Managing financial projects: teams, partners and companies and tools
- Professional communication
- Skills and qualities of financial engineers

* Production Engineer / *Ingénieur de Production*

Objectives

Students will learn about:

- various types of processes;
- how to situate production and production management in how a company works,
- the economic aspects of production management,
- planning and production scheduling,
- the tools for managing flux and understand their impact on overall performance,
- maintenance and replacement plans for production tools
- the various performance indicators (production and maintenance)

Coursework

- Models and methods for planning and production management
- The tools needed for flux
- Maintenance and equipment
- The people aspect

(ETC 2-A) English: 30 hours of class

- For students with ***less than 785 points (B2 CECRL level) on an official TOEIC***, obligatory English class provides intensive TOEIC preparation
- Students with ***at least 785 points on an official TOEIC*** may choose a theme based course: these vary from year to year

(ET3 C3-F) ELECTIVES: 18 hours of class ⇨ Students choose between the following options

* Management Issues

Objectives

- The professor will teach about and encourage reflection on management practices. Students will discover the different dimensions of management, how to make the right decisions, and adopt managerial skills for an engineering career.

Coursework

- Understand the role of a manager / Elements for effective management / Tools for success when overseeing others / The role of a manager/coach

* Corporate & Social Identities

Objectives

- To encourage students to reflect upon and understand the concept of identity
- To think about the concept of identity as a complex process, in and out of the working-world

Coursework

- Building identity / Controversial notions and characteristics building our identities / Professional identities / The part work plays in building our identities / problems accessing the working-world / Individual identity as opposed to group identity / High-level professionals and engineers

* Companies: Psychological Mechanisms

Objectives

- This course hopes to make students aware of the human factors influencing the world of work. What are the principal psychological mechanisms in place during interpersonal interaction? Students will learn the tools allowing them to understand and adapt to teamwork and professional hierarchies.

Coursework

- General presentation of psychology and social psychology, language, active listening, transactional analysis, sophrology

* Economic Intelligence: a major tool of economic warfare

Objectives

- Students will be introduced to the notions of economic intelligence, learn about vigilance (a vital tool in today's companies)

Coursework

- Fundamental elements of vigilance / The ubiquity of information / Vigilance and strategy / Steps towards vigilance in companies

* Human Resources Management

Objectives

- Students will learn in depth about the Human Resources Department and its purpose in a company, they will also learn about management techniques within a HR department.

Coursework

- The history of company organization and Human Resources management / The various purposes of the HR / (organization charts) / Managing people / Elements of HR management / Social interaction / Interviewing basics

* Innovation Management - *Objectives and coursework not currently available*

* Ethics and Performance Management

Objectives

- Students will learn about how ethics can be applied in companies, see how ethics encourage performance and encourage students to adopt a personal ethical code.

Coursework

- Economic testimonials / Social testimonials / Ethics / Ethical management / Ethics and freedom

* Health and Safety Management

Objectives

- This course hopes to make students aware of the risks for health and security in the workplace; measuring risks, controlling risk, applying workplace and security legislation, designing an improved security program

Coursework

- Prevention: what's at stake / Legislation for the protection of workers and in the workplace / Assessing risk / Dangers / The principal security management systems

* The Philosophy of Technology

Objectives

- Extract essential philosophical concepts related to technology from texts
- Using rational arguments, convince an audience based on a technology-related topic
- Develop logical reasoning skills and apply them to real-world engineering cases
- Acquire notions of general culture related to the major philosophical questions throughout the history of technology

Coursework

- General introduction: fundamental concepts, definitions, economic perspectives on technology (Uber-ization, Bitcoin...), the myth of Prometheus
- Science and technology: how they interact, the Galileo moment, the complicated relationship with philosophy in history
- Artificial intelligence: is it really an intelligence, Aristotle's reflection on automation today, the future of intelligence in the age of technology
- Technology and ethics: what should humanity do with its technical prowess, the relationship between moral and technical progress, ethical reasoning
- Technology and responsibility: decision-making, the chain of responsibility, conundrums of legal liability regarding automation
- Action and reality: do we dominate reality or is it the other way around, an engineer's role in their relationship to reality, and philosophical reflections on the future of engineering

(ET3 C4-F) Interviewing Practice: 2 hours

Objectives: Students will participate in practice interviews with recruiters then benefit from a performance evaluation.

(PI3 C1-F) Engineering Project: 150 hours
10 ECTS Credits

In the third year the project teams will be finalizing their project, making sure it takes into account previously established specifications previously set fourth after preliminary studies done during the second year.

Course Evaluation: Report and oral presentation

(ST3 C1-F) Final Engineering Internship
27 ECTS Credits

Evaluation: Final report and oral presentation

(PP3 C1-F) Professional and Individual Project
3 ECTS Credits

Objectives: To encourage students to be actors of their professional futures; to network with alumni and companies.

Course Evaluation: Report

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MAJOR COURSEWORK
15 ECTS Credits

ARI - *Industrial Automation and Robotics*

ASR – *Networks and Architecture Security*

BDTN – *Big Data*

EDD – *Energy and Sustainable Development*

ESAA – *Electronic Systems for Auto and Aerospace Engineering*

GET – *Electrical Engineering and Transport*

IA DES – *Business Engineering: Energy & Signals*

IA IR – *Business Engineering: I.T. & Networks*

ICOM – *Telecommunications Engineering*

IF – *Financial Engineering*

ISE-OC – *Embedded Systems Engineering: Communicating Objects*

ISE-VA – *Embedded Systems Engineering: Autonomous Vehicles*

ISN – *I.T. Services Engineering*

ISYMED – *Medical Systems Engineering*

MCTGE – *Mechatronic & Electrical Engineering*

MAJOR ARI:
INDUSTRIAL AUTOMATION AND ROBOTICS

DATA PROCESSING: ARI 301, 302, 303, 304, 305 = 4 ECTS Credits

(ARI 301-F) Dynamic Models: 11 hours lecture
and **(ARI 302-F) Lab: Dynamic Models: 9 hours laboratory**

Objectives: This course will present the techniques and tools and methods necessary for the analysis, design and simulation of dynamic models. This course is aimed at the design of systems, which bring together components and also sub-assemblies, similar to industrial installations. At the end of this course students will be able to:

- model a simple system by using equations
- take a complex system and simplify it
- identify model parameters using certain techniques (i.e. ARX and ARMAX)

Coursework

- Introduction to identification and modelling processes
- Goals and choices for modelling
- Techniques for reducing models
- Identifying nonparametric regression models
- ARX (Auto Regressive model with eXternal inputs) and ARMAX Auto Regressive Moving Average with eXternal inputs) models (P, PI, PID controllers)
- Recursive and optimization methods

(ARI 303-A[1]) Advanced DSP (Digital Signal Processing): 11 hours lecture
and **(ARI 304-A) Lab: Advanced DSP: 9 hours**

Objectives: To master advanced DSP techniques

Coursework

- Random variables and processes / Signal models (AR, ARMA: autoregressive moving average models, and so on) / Statistics tests to detect events /Time-frequency and wavelets

(ARI 305-A) Image Processing: 8 hours lecture, 3 hours class, 9 hours laboratory

Objectives: To master image processing techniques used in industrial fields. The main goal being to select useful information from images.

Coursework

- Amplitude and geometric transformation / Analysis by frequency approach / Texture analysis and classification

ADVANCED CONTROL and APPLICATIONS: ARI 306, 307, 308 = 3 ECTS Credits

(ARI 306-A) Calculator Control: 11 hours lecture
and **(ARI 307-A) Lab - Calculator Control: 9 hours laboratory**

Objectives: Theoretical and practical application of control theory have yielded a better understanding of the field and validated results of industrial processes in fields such as petrochemicals, aeronautics, automotive, and so on. This course shows methodology, the techniques and tools necessary for analysis, design and simulation of dynamic system control laws. Students will learn to approach the study and analysis of processes while considering real-world constraints (time, energy and quality for example) and then apply what they have learned to industrial installations.

Coursework

- General concepts of adaptive control / Adaptive control techniques / Internal model control systems / model predictive control systems / Optimization of discreet control systems

(ARI 308-F) Advanced Control for Diesel Motor Design - 10 hours lecture, 4 hours class, 6 hours laboratory

Objectives: To introduce the fundamental concepts of non-linear automatic engineering. Tools and techniques specific to non-linear systems will be presented.

Coursework

[1] Course codes that have the letter "A" in the suffix indicate that the course is in English

- Non-linear systems / Phenomena associated with non-linear systems / Stability of non-linear systems / Control engineering techniques associated with non-linear phenomena / Examples of how they can be applied

INDUSTRIAL SYSTEM MONITORING: ARI 309 and 310 = 3 ECTS Credits

(ARI 309-F) Diagnosis of Industrial Processes: 11 hours lecture, 9 hours laboratory

Objectives

Today one of the most important issues in automation is reliability, availability, and operational safety of technological processes. Indeed, the automation of production processes has used optimization techniques to increase productivity by implanting high-performance controls. At the end of this course students will be able to

- understand the architecture of surveillance systems
- design surveillance and diagnostic systems (depending on a given situation)
- establish detection methods to determine if functions are viable
- analyze data yielded by a system to determine its state
- use a methodology to reduce the time of intervention

Coursework

- General notions of industrial process monitoring
- Fault detection in continuous-time systems
- Detection by state variable estimation
- Fault detection by parametric model
- Data validation of complex systems
- Optimal placement of sensors
- Decision making

(ARI 310-F) Reliability: 13 hours lecture, 3 hours class, 4 hours laboratory

Objectives

- To present the methodology, concepts, techniques and tools necessary for assessing reliability
- The goal is to make the reliability, availability, maintainability as well as the safety of industrial systems better

Coursework

- Fundamental concepts for reliability / Traditional analysis techniques and methods / Advanced analysis techniques and methods / Case studies

FUNCTIONAL ANALYSIS: ROBOTICS & AUTOMATION: ARI 311 = 5 ECTS Credits

(ARI 311-F) Functional Analysis – Robotics & Automation I: 22 hours lecture, 10 hours, 48 hours laboratory

Objectives: At the end of this course, students will be able to

- Apply basic methods of functional analysis to simple design specifications
- List the hardware and software from a FAST (Function Analysis System Technique) analysis as well as putting together a diagram of necessary functions
- Establish entry and exit parameters as well as sizing parameters for each of the necessary functions
- Apply a modelling method to a mechanical structure
- Use a functional analysis to design control in a FAST format
- Size sensors as well as the electronic and digital processes to meet the requirements of a simple design specification
- Choose an industrial speed-change drive unit depending on the type of control
- Apply a specific analysis method to an existing automated system
- Develop a HCI (Human-Computer Interaction) graphic from a simple application using Siemens materials
- Understand the vocabulary used and the types of architectures offered by companies such as Siemens and Schneider

Coursework

- Functional analysis
- Functional analysis for a robotic set-up
- Definitions of functions to work on
  *F1. Robot design and modelling / *F2. Actuator control / *F3. Instrumentation / *F4. Integration / *F5. Robotics *F6. Looking at the whole system

MAJOR ASR:
NETWORKS AND ARCHITECTURE SECURITY

CYBERSECURITY: ASR 301, 302, 303 and 304 = 5 ECTS Credits

(ASR 301-F) Intrusion Testing: 12 hours lecture, 8 hours laboratory

Objectives- For students to understand the context leading to intrusion, practice attack scenarios and digital defense solutions

Coursework

- The context of security / Attacks and dangers / Tools for and against attacks / Implementing attack scenarios / Implementing defense solutions / Security solutions : cyprography, SSL, VPN, IPsec, Kerberos / Systems for network intrusion detection

(ASR 302-F) Threat Intelligence: 16 hours lecture, 4 hours laboratory

Objectives - For students to learn about Threat Intelligence and how it works to detect persistent and advanced threats.

Coursework

- The definition of threat intelligence
- Design and assessment of a threat intelligence program
- Strategic threat intelligence (highly sensitive data i.e. government)
- Operational threat intelligence (Case study of a specific attack: incident response center)
- Tactical threat intelligence (methodologies, tools and tactics of attackers: architects and system administrators)
- Technical threat intelligence (indicators of specific malware: operational security centers)

(ASR 303-F) Blockchain & Digital Security (Trust Models): 20 hours lecture

Objectives – For students to understand Blockchain technology, its applications, and how to use it to deploy trusted models in networks

Coursework

- Introduction to blockchain & Bitcoin
- Authentication management for a blockchain
- Managing authentication in a blockchain
- Managing digital security in a blockchain
- Different uses for blockchain technology
- Establishing a trust model for Blockchain-type networks

(ASR 304-F) Cyberdefense: 12 hours lecture, 8 hours laboratory

Objectives - Cyber defense is a set of defense systems against cyber-attacks; in a virtual, borderless world, it is the future of defense. At the end of this course, students will be able to:

- Understand cyber defense issues and existing solutions for cyber-attacks.
- Understand perimeter protection: firewalls, IDS, IPS, Proxy, Reverse-Proxy
- Understand security architectures
- Implement a simple and advanced security policy
- Designing a complete protection solution: in-depth security

Coursework

- Introduction to network security
- Introduction to security solutions
- Overview of perimeter protection equipment
- Overview of secure architectures
- Security policies
- Authentication systems
- Case study and putting together a complete solution for perimeter protection

ORGANIZATIONAL SECURITY: ASR 305 and 306 = 3 ECTS Credits

(ASR 305-F) Risk Analysis: 20 hours lecture

Objectives - This course allows students to learn about and acquire the skills and methodology for EBIOS (*Expression des besoins et identification des objectifs de sécurité)* risk analysis.

At the end of this course students will be able to:

- Model risk
- Understand the security norms associated with risk analysis
- Use EBIOS methodology adapted to a specific institution
- Continually better a study, in real-time, to take into account the real-world situation
- Know how to bring parties together to put together solutions

Coursework

- *Politique de sécurité des systèmes d'information* (PSSI): a defined plan of action for a predefined level of security
- Modeling risk
- Risks at stake
- Examples of threats
- Concept availability

(ASR 306-F) Computer Security Auditing: 16 hours lecture, 4 hours class

Objectives - Information systems require management that is both preventive and reparative; this type of management is known as security auditing. To demonstrate and explain computer security auditing issues; students will consider case studies allowing them to better understand auditing processes.

At the end of this course students will be able to:

*Describe the principle standards to follow
*Complete a security audit
*Analyze the results of an audit

Coursework

- Why audit? / General approach to security auditing / Audits and norms / How-to and methodology according to type / Tools / Case studies

SECURITY AND NETWORKS: ASR 307, 308, 309 = 4 ECTS Credits

(ARI 307-F) Operator Services: 20 hours lecture

Objectives - Today I.T. and telecom have come together to become part of the overall services of telecom and internet service companies. To help students understand this technical challenge, students (at the end of this course) will be able to

- describe the technical specifications for the 3rd Generation Partnership Project (3GPP) and how audio/video services on mobile networks are handled
- analyze market evolutions leading up to today's offers

Coursework

- SMS and MMS
- Merging technologies
- Session Initiation Protocol (SIP)
- Managing mobility
- Security issues
- Information transfer
- Evolved Packet System (EPS)
- Packet Switched Streaming (PSS)
- Integrated Mobile Broadcast (IMB)
- Long Term Evolution (LTE)
- WiMax
- Company services and case studies

(ARI 308-F) Network Supervision: 10 hours lecture, 10 hours laboratory

Objectives - This course aims to help students understand and put together IT equipment supervision (switches, routers, servers) by using graphic interfaces.

Coursework

- Shell programming
- Presentation and implementation of SNMP (Simple Network Management Protocol)
- Installing the supervision server
- Handling the SNMP
- Creating an equipment map
- Creating a robot to monitor response times

(ARI 309-F) MPLS and High-Speed Networks: 16 hours lecture, 4 hours class

Objectives - At the end of this course students will be able to:

- Explain the evolution of digital transport networks
- Put together solutions for WAN architecture (to connect distant sites)
- Use MPLS (Multiprotocol Label Switching) to manage traffic

Coursework

- LAN (Local Area Network) topologies
- Service integrated digital networks
- Frame relay and synchronous digital hierarchy
- Asynchronous transfer techniques (ATM) and quality of service
- MPLS (Multiprotocol Label Switching) and BGP (Border Gateway Protocol)

NETWORK TECHNOLOGIES: ASR 310 and 311= 3 ECTS Credits

(ASR 310-A) Mobile Network Architecture: 20 hours lecture

Objectives - Being mobile is and will stay a fundamental element of today's economy. In order to fulfill the need for mobility, a variety of network architectures exist. At the end of this course students will be able to:

- Describe mobile telecom network architecture
- Explain the evolution of aforementioned solutions
- Assess the consequences of these innovations on company networks

Coursework

- Fundamentals of radio-wave network propagation
- Radio mobility management
- GSM / Global Systems for Mobile communications
- 3G UMTS / Universal Mobile Telecommunication Systems
- LTE / Long-Term Evolution Systems
- 5G networks and the Internet Of Things (IoT)

(ASR 311-F) Ad Hoc Networks: 20 hours lecture

Objectives - Today communication technology has become independent of pre-installed infrastructures in order to create a network. Mobile equipment can form a spontaneous network structure. At the end of this course students should be able to explain how Ad Hoc networks can be set up.

Coursework

- Introduction to (WLAN) Wireless Local Area Networks
- IEEE 802.11p architecture
- Vehicle Ad Hoc Network (VANET) Technologies
- Proactive and reactive MANET (Mobile Ad hoc Network) protocols
- Data transfer
- Security aspects for inter-vehicle communication

MAJOR BDTN:
BIG DATA

PREDICTIVE MODELING: BDTN 301 and 302 = 4 ECTS Credits

(BDTN 301-A) Part 1 Statistics: 14 hours lecture, 14 hours laboratory
(BDTN 302-A) Part 2 Modeling: 12 hours lecture, 16 hours laboratory

Objectives - These courses are an introduction to statistics and applied predictive modeling
At the end of these courses students will be able to:

- Use statistical tools required for Machine Learning
- Explain the concepts of regression and classification
- Select a model adapted to a given problem
- Define the necessary steps to validate a predictive model
- Apply these concepts to R language

VISUALISATION and RECOMMENDATION SYSTEMS: BDTN 303 and 304 = 4 ECTS Credits

(BDTN 303-A) Recommender Systems: 10 hours lecture, 14 hours laboratory
(BDTN 304-F) Visualization: 8 hours lecture, 16 hours laboratory

Objectives - To put together a web application integrating a recommendation system
At the end of these courses students will be able to:

- Explain various types of recommendation systems
- Using an algorithm in Python and in a DBMS
- Compare different JavaScript visualization systems
- Implement a web application using a d3.js

BIG DATA DEVOPS: BDTN 305, 306 and 307 = 4 ECTS Credits

(BDTN 305-A) I.T. System Security: 10 hours lecture, 8 hours laboratory
(BDTN 306-A) PL / SQL: 4 hours lecture, 12 hours laboratory
(BDTN 307-F) Docker Deployment: 8 hours lecture, 14 hours laboratory

Objectives - To acquire the fundamentals of DBMS programing, IS security, and deployment

At the end of these courses students will be able to:

- Implement a PL/SQL program
- Explain the fundamental principles of IS security
- Use API cryptography
- Set up an SSL certificate
- Work with LINUX command lines
- Develop an application in the form of a Docker container

LARGE SCALE PROCESSING: BDTN 308 = 3 ECTS Credits

(BDTN 308-F) Large Scale Processing: 20 hours lecture, 28 hours laboratory

Objectives – To build and put into place a Big Data system within the framework of an Agile project

At the end of these courses students will be able to:

- Describe the various components of the Hadoop / Spark ecosystems
- Satisfy a business need by applying the agile SCRUM method
- Define batch and streaming architectures
- Implement a solution using a defined architecture
- Deploy the solution on the Cloud

MAJOR EDD:
ENERGY AND SUSTAINABLE DEVELOPMENT

NEW ENERGY TECHNOLOGIES: EDD 301, 302, 303 and 304 = 6 ECTS Credits

(EDD 301-F) Energy Efficiency: 30 hours lecture, 10 hours laboratory

Objectives

- To learn about integrating energy systems into buildings
- To learn about and study climate and climate data

Coursework

- Heating and types of heating / Physical conditions: materials, heat transfer, thermal exchanges / Case study: thermal inertia, thermal dynamics / Natural ventilation / Thermal regulations

(EDD 302-F) Energies: 20 hours lecture

Objectives: To introduce energy management solutions and building design in order to reduce consumption.

Coursework: This course covers the evolution of past and present regulations. The advent of the Positive Energy Building and the Smart Grid has made us rethink the way we consume energy; we are no longer mere consumers, but Consumption Managers. Tracking self-consumption of energy is an essential and strategic issue. It will be addressed in this class as we look at photovoltaics from both a technical and economic point of view.

(EDD 303-F) Thermal Dynamics for Buildings: 18 hours lecture

Objectives

To introduce fields specializing in energy-efficiency and the engineers that work in them

Coursework

Eco-energy engineering

- Specialized design and technical research offices / Thermal and fluid project management / Project management for the entire building / Project management assistance

Design and Technical research offices

- Energy audits and specifications / Building inventory / Description of the layout / Description of the technical equipment / Energy consumption calculations / Lead-up to construction / Financial estimations

Fluid dynamics

- Main types of heating systems; incorporating renewable energies (solar, heat pumps, biomass) / Main types of ventilation systems / Project: Esigelec energy audit case study

(EDD 304-F) Smart Buildings: 16 hours lecture, 4 hours laboratory

Objectives

Smart buildings are defined as buildings equipped with components capable of exchanging information with each other, reacting to the demands of the external environment, ensuring the best possible comfort. The increase in the "digital" value of buildings is inevitable. Smart Buildings, because they are connected, tend to become a platform for multiple services contributing to and enhancing its value. This transformation of the construction industry is leading to new professions focusing on these services. If energy (as much as mobility and health care) is a driving force, then data is the key element.

The objective of this module is to report on the issues, requirements and perspectives associated with Smart Buildings.

1-Thermal regulations and make way for the Positive Energy Building.
2- A connected building is first and foremost an intelligently designed building.
2- Smart Building design implies specific building management
3-"Smart" in 3 layers
5-Technical elements to be implemented
6-Impact of technical building management in energy efficiency
7-Smart Buildings lead to new services

ELECTRICAL ENGINEERING II
EDD 305, 306, 307 and 308 = 6 ECTS Credits

(EDD 305-F) Static Converter Design: 20 hours laboratory

Objectives

Working from functional specifications the engineering student should be able to handle switching mode power supply (SMPS) design, assessment, sizing, and creation.

Coursework
Students will put into practice pre-existing knowledge about electronics and power electronics for SMPS (forward conversion type) schematics and design. The various steps are as follows:

- Designing 3-winding transformers, their magnetic circuits, the number of turns, sizing the copper wire, the skin effect, and so on.
- Designing components for power electronics, MOS and diodes
- Designing filtering elements
- Transistor control

(EDD 306-F) Design Office – Network Management: 8 hours class, 12 hours laboratory

Objectives: To explain the ensemble of issues around the design and development of high and low voltage electrical networks and assessing their performance using TR-CIEL and CANECO software

Coursework

- Criteria for calculations = Methods for low voltage installations / Formulas for standard circuits / Rules for calculating protection and cables / Parameters for sources / Grounding / Protecting circuit breakers and fuses / Tripping for security measures
- Using software
- Designing high/low voltage networks
- Designing low voltage networks
- Creating and calculating power supply
- Creating, modifying circuits (singlewire) and calculations
- Safety, generators, choosing security set-ups, specific cases, interpreting results
- Power balance
- Builders' data bases, parameters
- Summary: a project from start to finish

(EDD 307-F) Smart Grid: 20 hours lecture

The objective of this course is to introduce the concept of Smart Grid which is a bi-directional electric and communication network that improves the reliability, security, and efficiency of the electric system for small to large-scale generation, transmission, distribution, and storage. It included software and hardware applications for dynamic, integrated, and interoperable optimization of electric system operations, maintenance, and planning; distributed generation interconnection integration; feedback and controls at the consumer level.

Coursework

- Introduction and Definitions
- Conceptual Mode
- Stakeholders & Drivers
- Applications & Technologies
    - Advanced Metering Infrastructure, Smart Meter,Distribution Grid Management, Advanced Control systems, Renewables Integration, Energy Storage, Electric Vehicle Integration

(EDD 308-F) Power Electronics: 12 hours lecture, 4 hours class, 4 hour laboratory

Objectives:
* describe the various designs of switching mode power supply and be able to size them
* control the speed of electric motors that work with multilevel converters and scalar control

Coursework
Switching mode power supply / Buck Power /Boost converter / Buck-boost converter / Inductive flyback / Isolating transformers in power electronics / Flyback power supply / Asymetrical half bridge flyback / Multiple output flyback power supplies / Forward power supply / Asymmetrical half bridge flyback

ENERGY and the ENVIRONMENT
EDD 309 and 310 = 3 ECTS Credits

(EDD 309-F) The Energy Market and the Environment: 20 hours lecture

Objectives - Through theoretical and practical exercises, this course gives students an overview of quality, health, safety, security and environmental management concerns within a company.

Coursework

- The challenges a company faces in terms of EHS (Environment, Health and Safety): competitiveness, society, regulations
- The "zero incident" approach
- Management by Quality
- Quality Management: ISO 9000 / ISO 14000 / OHSAS 18000 & ISO 45000 / ISO 50000 standards
- Risk analysis and control measures
- Putting a EHS culture into place within a company

(EDD 310-F) Nuclear Energy: 20 hours lecture

Objectives - For students to become familiar with nuclear energy production

Coursework - Principles of fission, nuclear power plants, nuclear safety regulations, and so on.

MAJOR ESAA:
ELECTRONIC SYSTEMS FOR AUTO and AEROSPACE ENGINEERING

SYSTEMS ENGINEERING: ESA 301 = 3 ECTS credits

(ESA 301-F) Systems Engineering: 40 hours lecture

Objectives - In this second part of ESAA students will learn and work with know-how to put together a project.

Coursework

- Project management: planning and executing steps
- Needs analysis and design specifications
- Models, various degrees of modelling and bringing them together, tools
- System dependability and methodology
- IVVQ (Integration, Verification, Validation, Qualification)

ADVANCED TECHNOLOGIES: ESA 302 and 303 = 2 ECTS Credits

(ESA 302-F) Measuring Apparatus: 8 hours lecture, 4 hours class, 8 hours laboratory

Objectives - To learn about noise factor, then measure noise factor for four-terminal networks and oscillators.

Coursework

- Modelling noise factor and electrical engineering; noise factor for four-terminal networks and oscillators; using Friis' formula
- Methodology for calibration and measuring noise factor with a test bench

(ESA 303-F) Understanding and Researching Technologies: 4 hours lecture, 16 hours class

Objectives - For students to be able to self-study in a given scientific, technological or technical field; then give feedback about their research in a report and presentation.

Coursework

- Conducting research from keywords in a scientific field
- Selecting relevant and pertinent sources while defining a research base
- Detailed analysis of documentation and sources
- Writing a report and presenting

PROJECT WORK: ESA 305 and 306 = 4 ECTS Credits

(ESA 305-F) Project 1 (Software): 8 hours lecture, 8 hours class, 44 hours laboratory

Objectives - To be able to create a software program for a measurement device from design specifications stipulating certain criterion

Coursework

- Analyzing design specifications and articulating measurement needs
- Comparing and choosing measurement techniques
- Defining measurement procedures
- Piloting devices with Labview
- Presenting results in a specific format
- Project examples: Measurements using a MOSFET (Metal Oxide Semiconductor Field Effect Transistor), EOS (Electrical Over-Stress) testing on electronic components

(ESA 306-F) Project 2 (Measuring Apparatus): 8 hours lecture, 22 hours laboratory

Objectives

*To put into practice the concepts dealt with in the Measuring Apparatus courses – project content will be provided in conjunction with Esigelec's professional and industrial partners.

*To be able to design a series of tests for an electronic system working from design specifications

Coursework

The main steps of this project are

- Analyzing the functional specifications of a system
- Analyzing needs
- Translating into testing scenarios
- Choosing methods and measurements

MODULES OPTIONNELS (Students choose 2 among ESA 307, 308, 309, 310) = 6 credits

(ESA 307-F) VHDL Project: 5 hours lecture, 4 hours class, 16 hours laboratory

Objectives

For students to be able to set up a digital function or dialogue with a VHDL device

Coursework

The project is broken down into four parts; students work with a partner and each pair has the choice of the following to work on:

- I2C dialogue with an accelerometer
- SPI dialogue with a CAN
- Implementing a digital oscillator (Direct Digital Synthesis)
- PID (Proportional-Integral-Derivative / three-term) controller

(ESA 308-F) EMC & CAD software: 9 hours lecture, 16 hours laboratory

Understanding the issues surrounding EMC for designing automotive and aerospace systems by using CAD tools and models
Understanding the principle limitations and types of testing related to the parameter of EMC

This course is the follow-up to the Applied Electronics course and will allow students to:

- more deeply understand the normative context of EMC
- put together normative constraints with EMC trials
- conduct EMC tests
- interpret EMC test results using simple situation 3D electromagnetic simulations

(ESA 309-F) Reliability and Robustness of Electronic Systems: 9 hours lecture, 16 hours laboratory

When designing electronic systems reliability and robustness are important characteristics to consider. In order to do this testing and modelling are important. The objectives of this course start with defining reliability and robustness then bringing these elements together with assessment and testing of components.

(ESA 310-F) Research Fundamentals: 5 hours class, 20 hours project work

Objectives

Graduate students are often hesitant to pursue a future in the fields of research due to lack of what it constitutes. This course provides an opportunity for students to discover the practices related to the applied research conducted at the IRSEEM research institute. After students become acquainted with the research done at IRSEEM students will collaborate with a doctoral student. The most common research fields dealt with are:

- Components testing and characterisation
- Modelling
- Developing automated measurement benches

The overall objective is to prepare students to work independently on a scientific theme with set objectives to obtain and deadlines to meet.

MAJOR GET:
ELECTRICAL ENGINEERING AND TRANSPORT

SMART CITY, SMART GRIDS, and MICRO GRIDS: GET 301, 302, and 303 = 5 ECTS Credits

(GET 301-A) Architectures and Data Analysis in Intelligent Networks: 13 hours lecture, 3 hours class, 4 hours laboratory

Objectives:

- learn about and be able to analyze a complex system in an intelligent network
- interpret and analyze data in a complex system

Coursework

- Principles of an intelligent networks
- Principles of "system of systems" and Machine Learning
- Energy sources
- Database and data analysis in intelligent networks
- Different types of control in intelligent networks

(GET 302-F) Incorporating Renewable Energies in Microgrids: 10 hours lecture, 4 hours class, 9 hours laboratory

Objectives:

- Learn about renewable energy resources (wind and solar)
- Analyse and Model renewable energies
- Define and analyse the impact of renewable energies on electricity grids and networks
- Simulate an energy conversion chain using renewable energy
- Integrating renewable energies into a Micro grid

Coursework

- Different technologies for generating energy
- Definition and architecture of a Micro grid
- Scientific, economic, and environmental aspects of renewable energies
- Production facilities
- National and global situation

(GET 303-F) Smart City Control: 20 hours lecture, 2 hours class, 8 hours laboratory

Objectives:

- Learn about and analyse public lighting installations
- Learn about remote management techniques
- Learn about the principle of connected objects and understand the needs of a community
- Learn about V2E (Vehicle 2 Everything) technology

Coursework

- Overview of outdoor lighting, standards, sizing, design, energy performance, light source technologies
- Understanding management systems and more particularly transforming electricity networks into high-speed digital networks
- Connecting electric vehicles and smart networks
- Electric Vehicle Charging Stations and Intelligent Energy Management

POWER CONVERSION and TRANSMISSION FOR INDUSTRIAL APPLICATIONS GET 304, 306, and 307 = 5 ECTS Credits

(GET 304-F) Advanced Power Electronics: 16 hours lecture, 6 hours class, 6 hours laboratory

Objectives

At the end of this course students will be able to:

* master certain principles of power electronics
* describe the various designs of switching mode power supply and be able to size them
* control the speed of electric motors that work with multilevel converters and scalar control

Coursework

- New power electronics structures
  - soft switching, multi-level, resonant converters
- Switching mode power supply

- Buck Power / Boost converter / Buck-boost converter / Inductive flyback / Isolating transformers in power / electronics / Flyback power supply / Asymetrical half bridge flyback / Multiple output flyback power supplies / Forward power supply / Asymmetrical half bridge flyback

- Vector control
  - asynchronous motors / control limits / modelling asynchronous motors / Park and Clarke transforms / estimating electrical quantities / examples of calculations

(GET 306-F) Power Electronics Project: 20 hours laboratory[2]

Objectives

Working from specifications the engineering student should be able to handle switching mode power supply (SMPS) design, assessment, sizing, and creation.

Coursework

Students will put into practice pre-existing knowledge about electronics and power electronics for SMPS (forward conversion type) schematics and design. The various steps are as follows:

- Designing 3-winding transformers, their magnetic circuits, the number of turns, sizing the copper wire, the skin effect, and so on.
- Designing components for power electronics, MOS and
- Designing filtering elements
- Transistor control

(GET 307-A) Electrical Distribution and Transport Networks: 16 hours lecture, 4 hours class, 6 hours laboratory

Objectives

This course presents production, transport and distribution systems for electric energy. Students will learn how to calculate "load flow"; they will also learn to set and calibrate electrical systems, and take precautions for electrical systems and equipment.

Coursework

- Electric network interconnection and transport of electricity
- Electric networks and power distribution, modelling, the mathematical equations
- Setting voltage
- Limitations for reactive power flow
- Voltage control
- Frequency control
- Precautions and security issues

CONTROL and ENERGY DISTRIBUTION SYSTEMS; INDUSTRIAL STANDARDS and RISKS GET 308, 309, 310, and 311 = 5 ECTS Credits

(GET 308-F) Control Engineering and Distributed Control Systems: 11 hours lecture, 11 hours class

Objectives

- Continuously monitor electrical energy distribution networks
- Master the diversity of information in an energy distribution network
- Analyse and manage the geographical dispersion of electrical equipment

Coursework

- Temporary or permanent operation of internal production groups
- Managing energy consumption based on energy costs
- Compensating for reactive energy
- Transfer from a failing source to an emergency source
- Network load management
- Inter activation of switching devices
- Homopolar generator switching
- Energy quality control
- Multi-function electrical programming

(GET 309-F) Control and DSP (Digital Signal Processing): 6 hours class

Objectives

- To study principles for design methodology

[2] same as EDD305-F Static Converter Design (in EDD major)

- To acquire the skills necessary for creating control algorithms
- To apply the tools of DSP

Coursework

- Fundamentals of DSP
- Fields where DSP is used
- Internal architecture
- Interfacing systems
- Data formats
- Tools for development
- Spectral distribution
- Convolution
- Digital signals
- Filtering
- Generating control algorithms
- Programming algorithms

(GET 310-F) Industrial Risks: 16 hours lecture, 2 hours class, 6 hours lab

Objectives

This course provides students the opportunity to analyze and study industrial risks and dangers as well as learn about prevention and protection.

Coursework

- Protection against direct and indirect contact
- Regulatory measuring and testing
- Infrared thermography
- Lightning and its direct and indirect effects
- Lightning on electrical networks
    - Different types, effects, and protection against
- Grounding
- Sizing a ground connection
- Electromagnetic interference and compatibiltiy, coupling and risks
- Polution problems for electrical networks

(GET 311-F) Design Office – Calls for Tender: 20 hours class

Objectives

This course explores a special theme may encompasses all the steps such as installation, equipment or special electric machines.

Coursework

- Project specifications and technical descriptions
- Creating, designing, and completing projects
- Feasibility studies
- Digital simulations and calculations
- Project follow-up
- System comparisons
- Client document management
- Technical assistance

IA DES
BUSINESS ENGINEERING – Energy & Signals

FRENCH LAW - 3 ECTS credits
(IA DES 301-F) Introduction to French Law: 40 hours lecture

Objectives

At the end of this course students are expected to

- Understand employment contracts, their legal implications, as well as the principal governing laws and obligations
- Understand associated administrative formalities
- Propose solutions to simple legal situations associated with employment contracts as well as understand their implications
- Describe the principal events affecting employment contracts and their legal repercussions
- Explain the principal group-dynamics in the workplace
- Describe structures with or without legal status and the main legal effects resulting
- Choose, among the main existing legal forms, the one that is most appropriate in a case scenario
- Describe how the French S.A. and S.A.R.L. legal status function
- Describe how legal structures evolve
- Explain the fundamentals of various and specialized employment contracts and their legal specificities
- Outline the procedures for tendering
- Explain conflict resolution methods
- Conduct research on a given legal subject and present their findings

Coursework

- Individuals in the working world
- Employment contracts
  - Definition, versions, the nature of, administrative formalities, contents of, working conditions, aspects affecting employment contracts
- Collective / social aspects at work
  - Employee delegates, collective negotiations, conflicts and conflict resolution
- The legal structure of French business
  - Legal entities such as the SARL, SA, companies, and evolving status
- Human relations
  - Private and public partners
- Legal arbitration
  - Commercial courts and arbitration

BUSINESS PRACTICES - 3 ECTS credits
(IA DES 302-F) Business Practices: 41 hours lecture

Objectives

For students to be able to:

- describe business procedures and the various steps to projects
- explain in their own words the role of project manager and management plans
- use tools that measure costs, deadlines, progress assessment, quality

Coursework

- Definitions (projects & people involved)
- Business / Project plan (contents, how to get started, writing the necessary documents)
- Risk management (methods and situation simulation)
- Getting a project off the ground (tasks, functional charts, technical concerns, scheduling, costs, progress assessment, defining needs and means and responsibilities, situation simulations)
- Project follow-up (documents and contracts, signs, useful information, project meetings and reports, handling changes, situation simulations)
- Financial management (fundamentals of analytical project management, cost and price analysis, treasury, Mono and Multi-project indicators, impacts on the "profit center", situation simulations)

CALLS FOR TENDER - 3 ECTS credits
IA DES 303 & 304

(IA DES 303-F) Calls for Tender: 18 hours lecture

Objectives

- Analyse and interpret call for tender documents
- Put together a tender response (technical aspects and budgeting)
- Negotiate and defend a tender response in front of a jury

(IA DES 304-F) Negotiation Case Studies: 20 hours lecture

Objectives

- Identifing the usual contacts (external & internal) of a business engineer
- Figuring out the organization, structure, business, strengths and weaknesses of the client company
- Preparing a business meeting
- Listening before presenting or selling, questioning, etc.
- Building a client-based argument
- Evaluate the client's financial flexibility in relation to yours
- Integrate psychology, relational skills, empathy or opposition into the negotiation, without forgetting one's own objectives.
- Concluding a negotiation, knowing how to say no

Coursework

- 2 hours negotiation from the buyers point of view
- 2 hours negotiation from seller's point of view
- 8 two-hour case study role plays
- Analysis and critique of case studies

DIGITAL TOOLS & TECHNIQUES
IA DES 305 & 306 = 3 ECTS Credits

(IA DES 305-F) Building Information Modeling: 4 hours lecture, 8 hours laboratory

Objectives:

- Explain what BIM is and its importance
- BIM projects and actors
- Design simple BIM models

Coursework

- BIM fundamentals and basics
- BIM modelling with a viewer

(IA DES 306-F) Energy Performance in Buildings: 18 hours lecture

Objectives

1. Explain what's at stake when building energy efficient buildings
2. Comprehend the limitations of already built structures
3. Use measuring methodology and tools to assess energy performance
4. Evaluate a global strategy incorporating investment, maintenance, and use of a building
5. Explain what a datacenter is, categories, market trends and parameters that influence a site
6. Describe technical infrastructure characteristics of a datacenter, what's at stake for service, and various factors affecting energy performance

MANAGEMENT & BUSINESS STRATEGIES: IA DES 307, 308, 309 and 310 = 3 ECTS Credits

(IA DES 307-F) Management: 20 hours lecture

Objectives

- Describe various trends in management
- Identify the latest legal developments impacting managerial practices
- Explain the roles and skills expected of team managers and superiors
- Lead a multicultural team
- Lead a team through change
- Explain what proximity management is
- Describe the basics of management at different sites

Coursework

- Evolution and trends in management
- Recent legal evolutions impacting management practices
- The roles and expectations for managers, teams and management
- Running international teams
- Leading change with a team
- Management basics for running multiple sites

(IA DES 308-F) Risk Analysis and Business Intelligence: 25 hours lecture

Objectives

- Explain the importance of setting up risk analysis and management approaches (defensive approach) associated with an offensive Economic Intelligence approach
- Propose adapted operational techniques allowing a company to protect itself and to improve its economic performance

Coursework

- Context and challenges of corporate risk analysis: Speculative risks & pure risks
- Causal analysis of a feared event: tree diagram (Default Tree)
- System Methodology - Operational Safety Parameters
- Risk management techniques (SRM, MOSAR, MADS, AMDEC, HAZOP)
- Economic Intelligence

(IA DES 309-F) "Quality, Health, Safety and Environment" Conference: 3 hours lecture

(IA DES 310-F) "Risk and Insurance" Conference: 4 hours lecture

ENGINEERING CAREERS & Elective
IA DES 311, 312 & 313 = 3 ECTS Credits

(IA DES 311-A) International Management Techniques: 20 hours class

The goal of the course is to provide an introduction to the basic skills and techniques to manage international business. After attending the course the students will be able to:

- Explain the steps in taking your company global
- Describe foreign corruption practices
- Explain how to implement a Corporate Responsibility Policy
- Describe the Strategic Pyramid Methodology to select countries for business
- Describe the process for establishing International Joint Ventures
- Explain the steps and process to manage an international sales force

(IA DES 312-F) Managing Meetings: 10 hours lecture / class

Objectives

- Describe the different types of meetings and the different ways to manage them
- Identify background elements that may explain the success or failure of a meeting
- Organize an information meeting to prepare a final report
- Conduct an annual performance review respecting the different steps, listening skills, analysis, proposal and reframing interactive skills
- Organize a brainstorming session on a simple theme, taking into account group dynamics and integrating the points of view of all participants
- Conduct a decision-making meeting

Coursework

- Different types of meetings, their specific constraints, their purpose, their key factors for success
- Analysis of the causes of failure of a meeting. Differentiated analysis according to the categories of actors (participants, organizers, etc.). Mastery of techniques for organizing information meetings to ensure that a message has been correctly conveyed and biases have been minimized
- Understanding the specific characteristics of annual performance reviews. Analysis of the factors explaining the development of this type of meeting. Partial mastery of the techniques for conducting APRs.
- Rules for organizing a brainstorming and decision-making meeting. Analysis of potential malfunctions and their causes

(IA DES 313-A) Business English: 20 hours class

Objectives

In this course students will be working in situations as close to real business world as possible, students will be learning and how to use professional English in situations such as conducting meetings, negotiations, problem solving, crisis management, strategizing, and so on. They should be able to express themselves, explain, answer questions, and debate specific situations. All resources for this class are in English.

Students will work on the following skills:
Oral comprehension: students should be able to understand conversations, presentations and discussions relating to professional situations and the business world.
Written comprehension: students should be able to analyze and memorize information given in documents in order to be able to use it in a situation simulation or role-play.
Oral expression: students should be able to express themselves with correct language and register in various professional and real world business situations.
Written expression: students should be able to write (with correct language and register) short professional documents, such as meeting minutes with decision justifications, information for a colleague, or office memo.

IA IR
BUSINESS ENGINEERING & I.T. Networks

I.T. and COMMUNICATION TECHNOLOGIES
IA IR 301 & 302 = 4 ECTS credits

(IA 301- F/A) Architecture & Services: 10 hours lecture / class, 18 hours laboratory

Objectives - At the end of the course, students should be able to:

- Know the different uses of PBX solutions; understand substation technologies (analog, digital, IP, DECT, Wi-Fi); understand operator connections (analog line, Numéris T0 and T2, Trunk SIP)
- Know how to identify the different user profiles of communication solutions (reception desk, administrative desk, mobile desk, technician desk, converging fixed/mobile desk)
- Know how to identify the different multi-site architectures (centralized IP with remote IP workstations, independent multi-PBX, networked multi-PBX)
- Know how to carry out an audit of an existing traditional communications infrastructure (TDM, PSTN)
- Know how to carry out an IP transformation project for a company incorporating choice of cabling, the LAN environment, the supply of PoE switches, the terminal (headset, fixed station, smartphone)
- Know how to name the major players in this sector and how to differentiate their beginnings (PBX manufacturers, software publishers, OTT, operators)
- Acquire basic knowledge of the administration of an Office365/Teams unified communications solution (e-mail messaging, instant messaging, collaborative work, unique number, DID assignments, and so on...)

(IA 302 – F/A) Cloud Computing – Architecture & Applications: 18 hours lecture

Objectives - At the end of the course, students should be able to:

- Know how a data center works
- Propose scenarios for updating and modernizing
- Classify data centers
- Direct a customer to a data center according to their needs
- What's at stake in the field
- Conduct an infrastructure audit / Identify the type of architecture (END OF ROW, TOP OF RACK, DOUBLE ADDUCTION...)
- Develop migration scenarios (ONE SHOT, SEQUENTIAL FASHION...)
- Design a modernization scenario by including the notion of capacity (ENERGY, PRECABLING, RACK CHOICE...)

ANSWERING CALLS FOR TENDER
IA IR 303, 304 & 305 = 4 ECTS credits

(IA 303 – F) Tendering in Private Markets: 30 hours lecture, 5 hours class

Objectives - In a professional context, a team of students in a simulated corporate structure will learn to respond to a private market call for tenders. At the end of this module, students will be able to:

- Identify the phases of a project
- List the steps in a complete business cycle
- Communicating: rules for expression
- Identify and understand the various forms of tendering
- Design a response to a call for tenders: technical file, costing, legal aspects, normative aspects, etc.
- Consolidate your offer
- Respect customer constraints before submitting the offer
- Negotiate and defend your proposal before a jury of professionals

(IA 304 – F) High Speed Network Rollout: 15 hours lecture

Objectives - At the end of the module, students should be able to:

- Analyze client needs
- Design a technical solution that meets specifications while respecting constraints:
- Price the technical solution
- Defend your proposal and negotiate

(IA 305 – F) Case Studies (Public Contracts): 20 hours lecture

Objectives - At the end of the module, students should be able to:

- Learn about and identify public buyers and their sectors of activity

- Learn about the different public procurement procedures
- Analyze a business consultation file and develop a response strategy
- Create a company and put together a call for tenders
- Defend your response file during a negotiation
- Learn about the standard forms and produce the administrative elements of the various stages of public tendering

Coursework

- Class sessions combine theoretical presentations, discussions with students, public market studies and real-world situations
- Out of class work for the students will consist of developing a response to an open call for tenders for technical project management assistance to support a community in its digital projects
- The course will help students to acquire general and complete notions of public markets but especially to develop interest in free markets and equal in the treatment of candidates
- Students will be able to create a company and develop it acquiring clients thanks to this course

BUSINESS SKILLS = 2 ECTS credits

(IAIR 306-F) Business Skills: 20 hours lecture

This course accentuates the importance of "know-how" rather than theoretical knowledge.
Discovery of the entire business cycle process:

- Identifying the usual contacts of a Business Engineer, external (as a customer) or internal (as a supplier)
- Knowing how to understand an organization, structure, business, and the strengths and weaknesses of a client's company
- Identifying the Business Engineer as the sum of a commercial and a project manager
- Preparing a business meeting
- Using "partnership" and " win-win" convincingly
- Learning to listen before presenting or selling
- Knowing how to ask questions
- Building convincing arguments
- Evaluating a client's financial situation for room to maneuver
- Understanding that negotiating is as much an art as it is a process
- Integrating psychology, relationships, empathy or opposition, without forgetting one's own objectives
- To know how to wrap up a deal, knowing how to say no

INNOVATION = 2 ECTS credits

(IAIR 307-F/A) Innovation: 28 hours lecture / class

Objectives

At the end of this course students will have a deeper understanding of economic intelligence and vigilance, two all-important tools for companies today.
Students will be able to

- Explain the necessity of economic vigilance
- Propose and choose (according to the situation) from real-world techniques
- Put together a plan for vigilance
- Protect a company's information and knowledge heritage
- Understand the main dilemmas related to innovation: Propose technologies or respond to markets? Develop products or develop processes? Launch a new technology or develop a new business model?
- Anticipate and possibly influence the diffusion of innovations
- Decide whether it is better to be the first to enter a market, and define how established competitors can respond to an innovative new player
- Describe the challenges entrepreneurs face in each phase of their business development
- Understand the imperatives and specificities of entrepreneurs when creating new organizations tackling societal issues

(IA 308–A) Business English: 20 hours

Objectives

In this course students will be working in situations as close to real business world as possible, students will be learning and how to use professional English in situations such as conducting meetings, negotiations, problem solving, crisis management, strategizing, and so on. They should be able to express themselves, explain, answer questions, and debate specific situations.

Students will work on the following skills:

Oral comprehension: students should be able to understand conversations, presentations and discussions relating to professional situations and the business world.
Written comprehension: students should be able to analyze and memorize information given in documents in order to be able to use it in a situation simulation or role-play.
Oral expression: students should be able to express themselves with correct language and register in various professional and real world business situations.
Written expression: students should be able to write (with correct language and register) short professional documents, such as meeting minutes with decision justifications, information for a colleague, or office memo.

INTERNATIONAL MANAGEMENT = 2 ECTS credits

(IA IR 309-A) International Management: 40 hours lecture / class

The goal of the course is to provide an introduction to the basic skills and techniques to manage international business. After attending the course the students will be able to:

- Explain the steps in taking your company global
- Describe the Foreign Corrupt Practices Act
- Explain how to implement a Corporate Responsibility Policy inside a Corporation
- Describe the Strategic Pyramid Methodology to select the best countries to do business in
- Describe the process for establishing International Joint Ventures
- Explain the steps and process to manage an international sales force

Negotiating with the Chinese and Establishing a Technology Joint Venture—Preparation Phase
---Chinese business past and present / Chinese Leadership/ Chinese American relationships between countries / Chinese culture in business / Tiananmen Square and effect on business in country

Training of American and Chinese Negotiation Teams (6 teams in total)
--- 8 items critical for American success / 8 items critical for Chinese success / Which JV items are most critical and which items cannot be given away to the other side / Composition of the negotiation team and key roles on each team.

Six Teams Negotiate (3 AT&T and 3 Chinese) the Shanghai AT&T Joint Venture for Telecom Wireless Base Stations.
---3 Separate negotiation sessions are conducted in 2 or 3 different rooms.
---A final review of key points with each set of teams.
---Teams negotiate a joint venture and complete a singed AT&T/Shanghai agreement.
---Review Conclusion of negotiations and agreements made by the teams in the 3 sessions.
---Key issues and problems in the negotiation session
---Review what happened in the actual negotiation session for the real JV in China
---What happened after negotiation sessions ended and what were the lessons learned

Entrepreneurship, Comparison of Key Entrepreneurial leaders and Securing Angel Money for Investment, and Key Investment Issues and Technology Joint Ventures

Disruptive Leaders and Comparison of Steve Jobs (Apple), Elan Musk (Tesla and Space X), and Jeff Bezos (Amazon)
---Personality Characteristics / How did they lead / Common characteristics of entrepreneurial leaders / Industries that were disrupted by the three industry leaders / Negative Leadership characteristics

Securing Funds from Angel Investors
---How do they function as investors / What do the individuals look for in companies/ Key elements of the presentation to secure funding

Technology Joint Ventures in 12 countries
---Purpose of Joint Venture / Partners of the Joint Venture / What were the problems and solutions for the Joint Ventures

Global Leadership Traits for the 21st Century
--3000 Europeans gather together in 30 leadership seminars to define the key issues for new leadership of the company throughout Europe and Middle East and Africa / Leadership Management Skills / Key Comments from Global CEO's / The 7 S Methodology for Assessing Company Strengths and Weaknesses / Six Global Leadership Traits and their definition / Group Exercise to identify leadership traits in friends, family, business and at work / The 9 C's of Leadership as seen in the Lee Iacocca Speech in Chicago / Human Resources responsibilities to support Global Leaders and their organization

Assessment Centers to Evaluate People for Business

LAW = 2 ECTS credits

(IA IR 310-F): 40 hours lecture / class

French Employment Law

Objectives

At the end of this course students are expected to

- Understand employment contracts, and their legal implication, as well as the principal governing laws and obligations
- Understand associated administrative formalities
- Propose solutions to simple legal situations associated with employment contracts as well as understand their implications
- Describe the principal events affecting employment contracts and their legal repercussions
- Explain the principal group-dynamics in the workplace

French Business Law

Objectives

At the end of this course students will be able to:

- Differentiate between organizations according to their juridical personality
- Be able to choose between the principle legal forms for businesses
- Be able to describe the schema and how the French business models "SA" and "SARL" function
- Explain (in an overview) laws that govern businesses in difficulty
- Identify the principle responsibilities of managers and/or directors

Coursework

- Overview of the principle legal structures for businesses
- Those with and without juridical personality
- Businesses and how they evolve: towards success or failure
- Legal responsibilities of managers and/or directors: civil, penal and fiscal responsibilities

MAJOR ICOM:
COMMUNICATIONS ENGINEERING

TELECOM INFRASTRUCTURES
ICOM 301, 302, 303, 304 and 305 = 4 ECTS Credits

(ICOM 301-F) Broadband and Fiber Optic Access: 13 hours lecture, 3 hours class

Objectives: At the end of this course students will

- know the new high speed broadband transmission techniques that use wavelength multiplexing as well as access and distribution methods
- be able to quantify the performance of a Wavelength-Division Multiplexing (WDM) chain
- assess the importance of the various parts of a WDM chain
- assess the importance and performance of a Fiber to the Home (FTTH) solution

Coursework

High bandwidth optical communications and WDM (multiplexing, calculations, elements of the chain)

- norms, CWDM, DWDM, and ITU grid
- emitters, receptors, Mux / Demux, optical amplifiers
- WDM network examples and throughput

High Bandwidth Access (HBA) and FTTH / PON (complementary or competing technologies? Innovations)

- FTTH solutions (P2P, AON, PON)
- GPON in detail
- Installation (horizontal and vertical)
- Private and public networks
- Evolution, increasing bandwidth, WDM-PON

(ICOM 302-F) FTTH (Fiber To The Home) Design Office: 9 hours lecture, 3 hours class

Objectives: This conference real-world studies focusing on a FTTH access network between a node and several residential or professional areas. Students will propose a technical solution with a budget and defend them.

Coursework

- FTTH studies – a crucial step
- The work/construction phase
- Labwork focusing on connection
- Real-world situations: connecting a building to a FTTH network, studying cadaster maps, writing technical documents, budgeting from price schedules, defending your proposition and price estimate

(ICOM 303-F) Geographic Information System: 7 hours lecture

Objectives:

- Understand the usefulness of a GIS in the telecom field
- Familiarize students with GIS software

Coursework

- What can be done with a GIS?
- The addition to the spatial dimension to network analysis
- Arcgis, Qgis, Grace TDH
- Interfacing with other software

(ICOM 304-F) New Optical Technologies: 17 hours lecture, 3 hours class

Objectives:

- to acquire an overview of optical transmission
- to know which criteria to prioritize when designing optical information transmission (considering the major parts as well as the peripheral components - lasers and photodiodes for example
- to know the aspects of Radio-over-Fiber (RoF) for radio signals as well as terahertz (THz) waves

Coursework

- Brief overview of semiconductor physics
- Lasers (DFB, DBR, FP, VCSEL), photodiodes (PIN, APD, UTC) and optical modulators (LiNbO3, Mach-Zehnder)

- Fibre optics (performance and limitations): PMD (polarization mode dispersion), dispersion, nonlinear effects, attenuation
- Optical amplification (Erbium and Raman amplifiers)
- Optical dispersion
- Components of Fibre optic networks
- New techniques for optical modulation (IQ, DPSK, APoISK, and so on.) and their transmission performance
- How hyper frequency electronics and optics come together: Radio over Fibre (RoF) for example.
- Using electronics and Fibre optics techniques with detecting tetrahertz; how this is used in wireless telecommunications, spectrometry (detection of chemical pollutants for example), and millimeter-wave imagery (airport body scans for example)

(ICOM 305-F) Laboratory Telecom1: 16 hours

Objectives: At the end of these laboratory session students will

- Know how to use and compare results of various radiofrequency measuring apparatuses or simulation tools and then interpret the results (constellation diagrams and spectrums)
- Simulate FTTH and observe related phenomena

Coursework

High bandwidth

- Erbium-doped optical fibre amplifiers
- Lithium niobate crystals and light modulation
- Transmission simulations - FWM (Four Wave Mixing) and PON (Passive Optical Network)

MOBILE TELECOM
ICOM 306, 307, 308, 309, 310 and 311 = 4 ECTS Credits

(ICOM 306-F) From 2G to 5G Networks: 23 hours lecture

Objectives

At the end of this course students will be able to:

- Describe GSM / UMTS / LTE architectures
- Explain the principles of TDMA (Time Division Multiple Access) / FDMA (Frequency Division Multiple Access) / WCDMA (Wideband Code Division Multiple Access) / OFDM (Orthogonal Frequency Division Multiplexing)
- Describe the principal steps
- Explain the impact of various factors affecting coverage, performance on QoS
- Identify future evolutions

Coursework

- The history of mobile devices in France
- Introduction to fundamental concepts of 2G (GSM / GPRS / EDGE networks) fundamental notions
- 3G technology (R99 / HSDPA / HSUPA): coverage, sizing and performance
- How does roll-out work?
- QoS
- 4G (LTE) technology
- Moving on to 5G
- The current competitive situation and what's at stake

(ICOM 307-F) Mobile Network Rollout: 9 hours lecture, 3 hours class

Objectives

- Students will be able to explain the various steps for rollout of a telephone or other infrastructure
- Students will be able to write and defend a technical document detailing a mobile telephone site

Coursework

- Presentation of the steps for rollout of a mobile network infrastructure and the associated players and professions (negotiation, design, construction and client/employer assistance, roll-out and maintenance)
- Design office: to put together a complete technical file (including technical solutions, price estimates, scheduling, construction choices and administrative concerns) after having consulted technical specifications and other crucial documents

(ICOM 308-F) Long Range (LoRa) and Connected Objects: 6 hours class

Objectives

Students will discover wireless Low-Power Wide-Area Networks (LPWAN) which are designed to allow long range communications at a low bit rate

Coursework

- Presentation, roles, usage, LPWAN limitations, rate and autonomy
- LoRa technology : physical layer, frequencies, modulation, topology
- Why companies such as Bouyges are involved

(ICOM 309-F) GSM-Railway Communications (Global Systems for Mobile Communications): 3 hours lecture

Objectives:

- Understand how GSM is used for communication, its specificities and limitations

Coursework

- Rollout of GSM-R for the French national railways (SNCF)
- Radios & alerts
- Data & protocols
- IM3 problems, non-linearity
- Optimizing GSM-R

(ICOM 310-F) Microwave Radio System Transmission: 13 hours class

Objectives: Students will learn to

- Situate the Microwave Radio (*FH*: *Faisceau Hertzien)* transmission in an operator's mobile network
- Calculate the Fresnel ellipsoid
- Establish link budget for a wireless transmission system
- Calculate interference and threshold decline
- Propose solutions to increase performance

Coursework

- Situation the Microwave Radio (*FH*: *Faisceau Hertzien)* transmission in a mobile network
- Electromagnetic wave propagation
- Organisation and sharing of frequencies
- Equipment used: IDU, ODU, satellite dishes
- Interferences
- Link budget, gross margin
- Increasing capacity, adaptive modulation
- FH and NLOS
- Other: optical fibre or LL

(ICOM 311-F) Laboratory Telecom 2: 14 hours

Objectives: At the end of these laboratory session students will

- Relate the performance of a standard to its characteristics by using radiofrequency measurement devices or simulators, and interpret the results in the form of spectra or constellation diagrams
- With the help of software, prove the feasibility of a point-to-point microwave link (using software) studying topography and identifying operator pylons

Coursework

Wireless communications

- Studying modulation – GSM (Global System for Mobile Communications), WiFi, WiMax, LTE
- Point to point wireless network feasibility, Freesnel zone
- 3G, 4G and WiFi network coverage
- RFID and NFC studies

COMPANY TELECOM SYSTEMS
ICOM 312, 313, 313 and 314 = 3 ECTS credits

(ICOM 312-F) Digital Company Systems: 14 hours lecture

Objectives

- Understand the architecture and value of ToIP for companies
- Explain the architecture of a unified communications system, the tools and what it can bring to a business

Coursework

- Overview of fundamentals (TCP/IP, routing, QoS)
- LAN, MAN, WAN, Data center networks and architectures
- VoIP and ToIP
- Unified communications and collaborative tools
- Video
- Computer workstations
- Cloud computing

(ICOM 313-F) Telecom Calls for Tender: 6 hours lecture, 6 hours class

Objectives

- To understand what a call for tenders is and how to manage one
- To understand the life cycle of a telecom project and the various players
- To put together a call for tenders (taking into account client specifications)
- Negotiate with potential clients and win the tender in a competitive environment

Coursework

- Definitions (MOA, MOE, RLE, RLI, RA, ITIL, PMI)
- Financial aspects
- Project management, managing internal and external partners, wrapping up a project
- Drafting the call for tender
- RFI, RFP, RFQ, CCTP, STB, EDB
- How to respond to a call for tenders
- Structuring business needs, Competition,
- Technical and financial proposals, Legal concerns,
- Client choice
- Role-play (providing a call for tender, specifications, proposal expectations, design, budget, etc.) presenting a response to a call for tender
- Team ranking and selection of a winning team
- Team case study debriefing
- Presentation of a call for tenders which would have "won".
- Questions & Answers

(ICOM 313[3]-F) Excel: 6 hours lecture

No course description currently available

(ICOM 314-A) WiFi and Bluetooth: 16 hours lecture, 4 hours

Objectives

- Wireless technologies are a common alternative to guarantee information transfer. This course offers an opportunity to understand the norms and how they affect performance
- Experimenting with formulae for coverage estimates and power range of equipment

Coursework

- Broadband wireless access technology
- WiFi: norms, characteristics, performance and MIMO routers
- Bluetooth: principles and applications
- Zigbee: principles and interests, wireless sensor networks, energy harvesting techniques

ADDITIONAL COURSES
ICOM 315 & 316 = 4 ECTS credits

(ICOM 314-F) Data Compression: 13 hours lecture, 3 hours class

Objectives

- Master the principles of digital coding
- Calculate and size the throughput depending on signal source characteristics and vice versa.
- Understand the norms for sound, image and video compression
- Acquire notions of digitizing and image processing

[3] This is the 2nd course with the same code number (313)

Coursework

- Digitizing (source coding, sampling, narrow frequency band, Shannon's limit, resolution)
- Compression (reversible and non-reversible methods)
- Sound (CCITT G711, NICAM, ADPCM G726, G722, MP3, G728, G729)
- Image (coding, filters, and compression types: GIF, JPEG)
- Video (analysing, image recovery, digitizing, MPEG2, MPEG4, H264, H265)

(ICOM 316-A) GPS & Inter-vehicle Communication: 14 hours lecture, 4 hours class

Objectives

This course provides strong foundations in GPS and its use in Intervehicular Communications, and also in Ad hoc Networks covering the principles and concepts of Manets and Vanets

Coursework

- In-vehicle networking
  - CAN, LIN, FLEXRAY, MOST
- IVC (Intervehicular Communications)
  - vehicle to vehicle, vehicle to infrastructure
  - Wireless LAN standards
  - IEEE802.11p/WAVE
  - Routing in MANETs, QOS in MANETS
  - Transport Layer for Ad hoc Networks
- GPS (global positioning system)
  - Principles used in GPS, GPS Components
  - Signal structure and frame formats
  - Dilution of Precision, Position calculations
  - Data formats, DGPS, Applications
  - Galileo, Glonass

MAJOR IF:
FINANCIAL ENGINEERING

(IF 301-A) Statistics, Probabilities, and Optimization for Data Analytics: 32 hours lecture, 24 hours lab

4 ECTS Credits

Contents of the course:

- Unit 1: Descriptive statistics (6 hours) (Software: Excel)
- Unit 2: Probability and probability distributions (9 hours) (No need of software)
- Unit 3: Statistics inference (12 hours) (Software: R)
    - Confidence intervals
    - Hypothesis tests
    - Analysis of Variance (ANOVA)
    - Regression analysis
- Unit 4: Mathematical programming (18 hours) (Software: Excel)
    - Linear programming
    - Integer programming
    - Non-linear programming
- Unit 5: Machine learning applications (12 hours) (Software: VBA Excel)
    - Clustering
    - Metaheuristic Algorithms: GRASP and genetic.

Learning Objectives

1. Summarizing large amount of data by means of descriptive statistics
2. Computing the probability of simple and complex events
3. Modeling some real random behavior by means of probability distribution
5. Estimating the average and variance of populations normally distributed from sample data
6. Comparing the average and variance in two different normal populations
7. Comparing the average in three or more groups by means of an analysis of the variance.
8. Explaining the behavior one random variable from one (or more) explanatory variables: Regression

At the end of the course the students are able to answer questions like:

- I want to ensure a certain minimum return: what portfolio should I invest in so that my risk is minimized?
- My company is about to introduce a new product in the market: what price should it have?
- My partners and I have obtained a certain profit working together: how should we share this benefit so everyone is happy?
- My company is spreading up, and I want to build new factories. Where these new factories should be located to maximize my benefits?

(IF 302 –F/A) Business Intelligence & Business Analytics: 26 hours lecture, 8 hours class, 24 hours laboratory

3 ECTS Credits

Objectives

- Recognize and use the language of I.T. systems architecture
- List and describe various types of architectures
- Analyse and comment on a type of architecture
- Describe the importance of decision architecture
- Define some decision architectures
- Understand the constraints related to information quality and quantity
- Design and work with a multidimensional models
- Design a star schema adapted to a company’s BI needs
- Explain the roles of various players for IT projects and most notably that of the architect
- Explain the various life cycle phases for a BI project

With the help of SAP Business Objects and BDD Oracle, the student will be able to

- Put in place a data warehouse (DW) meeting specific needs
- Define various tables (aggregate, detail, dimension, fact)
- Write SQL queries to contribute to the warehouse
- Define queries
- Complete a BI project

(IF 303 –A) Blockchain Rollout: 18 hours lecture, 40 hours laboratory

4 ECTS Credits

We thank BearingPoint for accompanying us with the Blockchain courses

Objectives:

- understand the challenges of Blockchain technology (which is revolutionizing the world of banking and insurance),
- master the key concepts and architecture of Blockchain technology (beyond Bitcoin)
- use the Ethereum database
- develop Smart contracts with Solidity for in web applications
- test the various functions offered (wallets, sending and receiving ether, using the code included in the contracts, etc.)
- implement and test practical cases following guided exercises: installation and configuration of the necessary tools
- At the end of this course students should be able to roll out a private blockchain

(IF 304 –F/A) Artificial Intelligence: 18 hours lecture, 20 hours laboratory

3 ECTS Credits

This course is a presentation and manipulation of the main algorithms, libraries, and artificial intelligence technologies.

Objectives:

- Analyze a difficult NP problem
- Modeling problems mathematically
- Solving the problem: implementing the right algorithm
- Choosing an appropriate AI algorithm
- Implementing it in R or Python

The main algorithms and libraries of artificial intelligence in R and Python studied will be as follows: neural networks; deep learning; learning by reinforcement; genetic algorithms; multi-agent systems; rule systems and expert systems

A project, based on real data from Kaggle, will be carried out by the students in teams:

- Each team member will have to choose one of the six algorithms studied
- Each student should be able to present his algorithm
- The team should be able to perform a comparative analysis between the six approaches
- A summary must be put together

(IF 305 –F) General Data Protection Regulation (GDPR) & Data Governance: 28 hours lecture

2 ECTS Credits

Presentation of the principles and techniques applicable to the regulation of personal data

Objectives: At the end of the teaching unit, the student will be able to:

- audit a data management system containing personal data
- prioritize the risks associated with a management system containing personal data
- learn about and identify appropriate data encryption systems
- carry out an impact analysis on personal data or PIA (Privacy Impact Assessment) and learn about good practices;
- set up a data breach strategy

(IF 307-A) Financial English: 20 hours class

2 ECTS Credits

Objectives

- Acquire a good understanding of the English vocabulary for finance and economics
- Be able to discuss financial issues in English and present financially complex information
- A general improvement in a student's English spoken and listening ability

Coursework

- To understand the how and why of weekly changes in the world's financial markets
- Student presentations of various financial and economic issues using appropriate vocabulary
- Discussions of articles from the financial press
- Improving listening skills with the BBC's financial news
- Analysis and solution of financial case studies

MAJOR ISE OC:
EMBEDDED SYSTEMS ENGINEERING – Communicating Objects

WIRELESS SYSTEMS
ISE OC 301 and 302 = 4 ECTS Credits

(ISE OC 301-A) Machine to Machine: 16 hours lecture, 12 hours laboratory

Objectives: For students to learn about

- the all business and technical aspects of Machine-to-Machine (M2M) communications and M2M ecosystem with an interest to M2M functional architecture and middleware standard protocols
- Address communication technologies commonly used for M2M with a particular focus on Low Power Wide Area Network technologies such as LoRa and SIGFOX completed with the study of the MTC 3GPP (2G, 3G and LTE) for M2M
- Introduce the basic concepts of M2M architecture, middleware service layers and communication flow as defined by the new standard OneM2M.
- Learn how to conduct an M2M design and systems engineering work starting from the requirements definition, followed by M2M modules selection and the consideration of security aspects. Programming examples are shown on how to develop an M2M communication solution through cellular networks
- Explain for four vertical market business cases, M2M use case scenario description, M2M actors, Communication/connectivity networks, System conditions and Interactions between actors and system
- Carry out Lab projects in M2M application development through embedded programming and system integration to build M2M experimental solutions using WLAN and cellular networks

Coursework

Part I. Machine-to-Machine Communications Overview
1. M2M definition and applications / 2. M2M vs IoT / 3. M2M network architecture / 4. M2M ecosystem and market forecast

Part II. Communication Technologies for M2M Solutions
1. Wireless Technologies for M2M / 2. Communication Networks & Internet Protocol / 3. LoRa LPWAN / 4. SIGFOX LPWAN / 5. MTC in 3GPP for M2M

Part III. M2M Middleware *OneM2M Service Layers*
1. OneM2M Standard Overview / 2. OneM2M Functional Architecture / 3. OneM2M Common Services Functions / 4. OneM2M Communication Flow

Part IV. M2M Design & Systems Engineering
1. M2M Requirements / 2. M2M Module Selection Guide / 3. M2M Security / 4. M2M Development Project

Part V. M2M Use Case Applications
1. Energy Use Case / 2. Healthcare Use Case / 3. Public Services Use Case / 4. Transportation Use Case

(ISE OC 302-F) RF Communication in Objects: 8 hours lecture, 20 hours laboratory

Objectives

- For students to learn about the fundamentals of radiofrequency information transmission
- For students to be able to describe the major aspects of influence for the BAN (Body Area Network) standard
- For students to be able to compare and describe current RF technologies and methods for RF connectivity of objects
- For students to put together an RFID function in a simple microcontroller
- For students to put together a simple function with ZigBee

Coursework

- Fundamental notions of radiofrequency transmissions
- The BAN standard for communicating objects
- RF transmission systems and how they are adapted for connected objects
- RFID and NFC for identification and communication
- Zwave and ZibBee for smart homes

COMMUNICATING ON-BOARD SYSTEMS
ISE OC 303, 304 and 305 = 6 ECTS Credits

(ISE OC 303-F) Real-Time Energy Management for Embedded Systems: 12 hours lecture, 16 hours laboratory

Objectives: For students to

- Be able to list and describe the theoretical elements affecting energy consumption in embedded systems
- Calculate / estimate consumption in a simple electronic circuit
- Design an application for a microcontroller optimizing energy use
- List and describe currently existing power supply systems as well as other mechanisms for energy supply

Coursework

- The importance of energy management for connected objects
- ARM architecture and MSP432 microcontrollers
- MSP432 microcontroller integrated low-power modes
- Autonomous power management for connected objects
- EnergyTrace tool for development

(ISE OC 304-F) Security and Cryptography: 10 hours lecture, 8 hours laboratory

Objectives

- For students to learn about the issues involved around the security of embedded objects
- For students to learn all the vocabulary and jargon associated with cryptography and security
- For students to gain skills for securing an embedded communicating system

Coursework

- Definitions and theoretical approach / Background / What's at stake and examples / Methods and applications / Detailed case studies / Labwork: putting together secured data transmission link & securing embedded systems with firmware

(ISE OC 305-F) Communicating Objects: 10 hours lecture, 20 hours laboratory

Objectives

- For students to use the theory from previous classes to design and put together a communicating system with a data display function (on a smartphone for example). Sigfox system will be used for data transmission.

Coursework

- This course is an opportunity to work in a team on a multi-step project.
- Project steps:
  - Transposing needs analysis findings into design specifications
  - Bringing together necessary skills for the project and previously acquired knowledge
  - Organizing project steps and task attribution
  - Design, testing and validation for basic functions
  - Overall project validation

ISE-OC Electives / ECTS Credits = 5

Students choose 4 of the following courses (course codes ES, ED and EP); only one ED course is permitted

ES *(Électifs Spécialisés)*

- ❑ ES01: Big Data and Cloud Computing
- ❑ ES02: Smart Sensors
- ❑ ES03: RF Transmission and Measurements

ED *(Électifs Départementaux)*

- ❑ ED01: Advanced LabVIEW and certification
- ❑ ED02: Mobile Robotics and Vision

EP *(Électifs Partagés*)

- ❑ EP01: DSP Signal Processing
- ❑ EP02: Programmable Logic Devices: from FPGA to SoC
- ❑ EP03: Python Programming

ES *(Électifs Spécialisés)*

(ES 01-A) Big Data and Cloud Computing: 10 hours lecture, 8 hours laboratory

Objectives

- To understand the issues surrounding Big Data in the wold of IoT
- To know the different platforms available (Iaas, Paas, Saas)
- To understand the Cloud structure and the problems to solve

(ES 02-A) Smart Sensors: 18 hours lecture

Objectives

Sensors have become more and more complex and contain more and more "smart" functions.
The objective of this elective is to understand the complexity and the benefits of using this kind of technology.

Coursework

1) "Smart" vs "dumb" sensors
    i) Motivations and definitions
2) Observer (human) effect and Schrödinger's cat dilemma in sensing
    i) Effects of adding sensors to the system – redundancy
    ii) Structural integrity and structure re-design for sensing (e.g. optical fiber in a composite material)
    iii) Changes to the measured value due to observations
    iv) Effect of sensors reliability on overall reliability
3) Statistical modeling of sensing/measurements
    i) Introduction to statistics (review)
    ii) Stochastic systems – noise sources, modeling, and its effects
    iii) False positives, false negatives, and other metrics
4) Statistical modeling of reliability – fault-tolerance
    i) System reliability vs component reliability – modeling and tools
    ii) Cascading failures
5) Signal processing for smart sensing
    i) Noise handling
    ii) Virtual sensing
    iii) Outliers and data corruption
    iv) Fallback/Exception handling
6) Communication systems
    i) Sensor networks and requirements
    ii) Challenges in sensor networking
    iii) Wired vs wireless networks and applications
    iv) Approaches to network reliability
7) Case studies
    i) 2 to 4 case studies
    ii) Discussed during the course at appropriate times

(ES 03-F) RF Transmission and Measurements: 6 hours lecture, 12 hours laboratory

Objectives

- Compare the various existing RF systems in the field of communicating objects
- Describe their main characteristics and their limitations
- Describe the fundamental principles of RF measurement and the tools used

Coursework

- Fundamental principles of information transmission
- General principles for link budgets
- Antennae and their characteristics
- RF and impedance matching
- Vector network and spectrum analyzers
- Labwork on measuring and characterizing RF setups

ED *(Électifs Départementaux)*

(ED 01-F) Advanced LabVIEW and Certification: 5 hours lecture, 5 hours class, 9 hours laboratory

This is an extension of the LabVIEW Fundamentals 1 course that teaches how to use common design models to successfully implement and use LabVIEW applications for research, engineering, and testing environments. The first 12 hours of course instruction will cover topics such as programming control of the user interface, techniques to optimize the reuse of existing

code, the use of file-based I/O functions, and tools to create executables and installers. This course focuses on LabVIEW's features that meet the needs of user applications and allows students to quickly start developing applications. A second 8-hour section of the course is specifically dedicated to preparing for the LabVIEW first level certification: the CLAD. This certification demonstrates a student's solid working knowledge of the LabVIEW environment, a basic understanding of good coding and documentation practices, and the ability to understand and interpret existing code.

Objectives
- Using variables to modify front panel controls or stop parallel loops
- Applying common design models that use queues and events
- Manipulating user-interface objects
- Evaluating file-based I/O formats and use them in applications
- Modifying existing code to make it easier to use
- Take the LabVIEW First Level Certification Examination "CLAD".

Coursework
- Using variables: This lesson explains how to use local variables to change the value of front panel controls, stop parallel loops, and bypass data flow restrictions.
- Data communication between parallel loops: This lesson describes asynchronous communication techniques for creating code that is controlled by the UI and synchronizes data between parallel loops.
- Implementing design models: This lesson introduces students to design models; the benefits and features specific to design models and how they can be used to reduce development time. Two categories of design models are studied: single-loop and multi-loop design models.
- User interface controls: This lesson introduces methods for controlling the attributes of front panel objects via programming, such as temporarily disabling a command. Students learn how to use the VI Server to access the properties and methods of the objects on the front panel.
- File-based I/O techniques: This lesson describes various file formats for data collection and recording, and how to select the appropriate format for applications. Students will practice implementing modular code that reads or writes measurement data.
- Improving an existing VI: This lesson focuses on methods of refactoring legacy LabVIEW code and how to optimize the reuse of existing code. Re-factoring is the process of editing the software to make it more readable and easier to maintain without altering its observable behavior.
- Creating and distributing applications: This lesson describes the process of creating standalone executables and installers for LabVIEW applications. You will learn how to use the Application Builder in LabVIEW.
- CLAD certification test preparation: Review LabVIEW courses 1 and 2as well as practice tests to prepare for the certification exam

(ED 02-F) Mobile Robotics and Vision: 5 hours lecture, 15 hours laboratory

Objectives
- To be able to name and function of the different elements of a mobile robot
- Describe the architecture of a mobile robot.
- Design, code and test an algorithm that allows the robot to move while avoiding obstacles.
- To be able to mention the problems of mobile robotics: modeling, trajectory planning, localization, navigation
- This module uses Project / Problem Based Learning (APP)

Coursework
- Introduction to mobile robotics / Sensors used in mobile robotics / Actuators used in mobile robotics / The different mobile platforms / Modelling and control laws in mobile robotics / Tracking / Navigation and trajectory planning

EP *(Électifs Partagés*)

(EP 01-A) DSP (Digital Signal Processing): 8 hours lecture, 12 hours laboratory

Objectives
To study the principle DSP (digital signal processors and processing) algorithms and their impact on DSP architecture

Coursework
- Sampling, Convolution / Linear filtering / Fourier transforms / DSP processor characteristics / TMS320C31 architecture

(EP 02-A) Programmable Logic Devices – from FPGA to SoC: 8 hours lecture, 12 hours laboratory

Objectives:
- To understand types, use and applications of embedded systems.
- To distinguish the main features and requirements on Reconfigurable Systems.
- To understand the VLSI process in the Reconfigurable Systems Design.

- To obtain a medium level on the use of Hardware Description Language (VHDL) use and application.
- To understand the use and design process of FPGA as programmable devices to implement System on Chip.
- To analyse the process, requirements and problematic on the microcontroller-based-design on programmable devices.
- To design medium-level designs of System on Chip using FPGA

Coursework

- Reconfigurable Embedded Systems
- System on Chip: Architecture / Interconnection buses / Hardware and software IP / Design for test

(EP 03-A) Python Programming: 5 hours lecture, 14 hours laboratory

For years, Python language has become one of the most useful programming tool for engineers. Applicative areas growth more and more and even embedded systems begin to use Python.
The objective of this elective is to understand the environment, the tools, and the possibilities of this language.

Coursework

1. Python Development Environment
   - Python distributions and their installation
   - Python as a script language
   - Python as a programming language
   - Interactive Python (jupiter-notebook)
   - Comparison to other programming languages
   - Installing important libraries (pip)
2. Python Basics : The first program, Docstrings, Blocks and indentation, First Control structures
3. Simple data types and expressions : Boolean, integer, float, complex numbers, strings, bytes
4. More data types : lists, tuples, sets, dictionaries, strings, numpy, arrays
5. Control structures : Loops, alternatives, exceptions
6. Comprehension and slicing
7. Object oriented Python : Class definition, Class instantiation, Generators and iterators
8. Files : Files, Serialization, Important file formats
9. Specialized topics (optional) : Writing and installing your own libraries, Regular expressions, etc.

MAJOR ISE-VA:
EMBEDDED SYSTEMS ENGINEERING – Autonomous Vehicles

VISION and ENVRONMENTAL PERCEPTION
ISE VA 301 & 302 = 6 ECTS credits

(ISE VA 301-F) Computer Vision: 10 hours lecture, 8 hours class, 20 hours laboratory

Objectives
- Introduce students to the notions and practices of image processing and computer assisted image processing
- Identify the various types of image processing and know when to use them
- Use 3D geometry to solve computer image resolution problems

Coursework
- Fundamental notions of image processing
- Image sensors and how images are produced
- Pre-processing
- Image segmentation
- Mathematical morphology
- Stereo Vision and 3D
- Focusing on points and regions
- Robust estimation methods
- Using OpenCV

(ISE VA ?-F) Artificial Intelligence for Autonomous Vehicles: 16 hours lecture, 22 hours laboratory

Objectives
- Identify artificial intelligence problems specific to autonomous vehicles
- Describe the principles of some of the most common artificial intelligence systems
- Develop a simple application for an autonomous-vehicle problem, based on existing building blocks and software tools

Coursework
- Problems specific to artificial intelligence
- Possible applications in the field of autonomous automobiles: recognizing road signs, obstacles, pedestrians, faces, etc.
- Study of some of the most widespread methods
- Existing systems in the automotive sector
- Implementation with C/C++ programming, Scilab, python, and use of the OpenCV library

VEHICLE ARCHITECTURE and SECURITY
4 ECTS credits

(ISE VA 304-A) Safety and Constraints: 22 hours lecture

Objectives: Making students aware of constraints for the automotive sector and for safety
- EMC, Vibration, Thermal, Software/Embedded systems, integration and cost, Electrical safety; short-circuit protection strategy, embedded software design for safety, ISO26262, Safety validation aspects

Coursework
- Automotive equipment constraints: EMC, Vibration, Thermal, Software/Embedded systems, integration and cost

Functional safety: Electrical safety; short-circuit protection strategy, embedded software design for safety, ISO26262, Safety validation aspects

(ISE VA 302-F) Data Fusion for Localization: 8 hours lecture, 6 hours class, 6 hours laboratory

Objectives
- Students will learn about data fusion and its relation to information fusion for localization of light-weight vehicles
- Students will be able to put a processing chain in place for an intelligent vehicle for localization in a given space.

Coursework
- First, students will become acquainted with the theory behind Bayesien filtering (important for data fusion) and how it is applied to localization of objects. Then, three main types of filtering will be presented. These two aforementioned themes will be dealt with in the lecture part of the course. In the class portion students will be using mathematical

concepts and algorithms for programming with Matlab. Students skills will be tested thanks to examples given using various vehicle sensors in 1D, 2D, and 3D. The laboratory portion of this course will allow students to experiment with theoretical concepts (V-REP data) and real-world data from autonomous vehicles.

(ISE VA 305-F) Advanced Driver Assistance Systems: 16 hours lecture

Objectives

- For students to learn about driver assistance systems and consider the limitations for automotive manufacturers when creating autonomous and communicating vehicles

Coursework

1. Introduction: Road safety, Euro NCAP, ABS - ESP
2. Current ADAS function
3. Introduction to intellectual property and TRIZZ low
4. Lateral Control: cameras, ultrasound, panoramic video camera, Driver Attention Assist generation
5. Longitudinal control: lidar, laser scanner, radar, geolocation
6. Autonomous driving
7. Car2X

ISE VA Electives / ECTS Credits = 5

Students choose 4 of the following courses (course codes ES, ED and EP); only one ED course is permitted

ES *(Électifs Spécialisés)*

- ❑ ES01: Augmented Reality
- ❑ ES02: Advanced Driver Assistance Systems (ADAS) Prototyping with RT-MAPS
- ❑ ES03: Parallel Computing

ED *(Électifs Départementaux)*

- ❑ ED01: Mobile Robotics and Perception
- ❑ ED02: Advanced LabVIEW and certification

EP *(Électifs Partagés*)

- ❑ EP01: DSP Signal Processing
- ❑ EP02: Programmable Logic Devices: from FPGA to SoC
- ❑ EP03: Python Programming

ES *(Électifs Spécialisés[4])*

(ES 01-F) Augmented Reality: 8 hours lecture, 8 hours class, 4 hours laboratory

Objectives

- Understand fundamental concepts, algorithms, techniques and the issues involved in augmented reality
- Using a 3D modeling software
- Using a Game Engine
- Developing an augmented reality application

Coursework

- Introduction to augmented reality
- Introduction to 3E modeling
- ARToolkit library
- Tracking and stereoscopy for AR
- Unity 3D software
- Unity and Vuforia
- Brainstorming and studies: studying 'DennoCoil' animation

(ES 02-F) Advanced Drivers Assistance Systems (ADAS) Prototyping with RealTime Mult-Sensor Applications (RTMAPS): 8 hours lecture, 12 hours laboratory

Objectives

- Make students aware of the benefits of the RealTime Mult-Sensor Applications (RTMAPS) framework, a platform for processing asynchronous multi-sensor data.

[4] The ES courses have the same codes as courses in ISE OC, but they are **not** the same courses

- Component programming in RT-MAPS
- Manipulate data from real sensors (lidar, cameras, etc.) to develop an ADAS

Coursework
- Programming components in RTMAPS
- Use of real data for the development of an ADAS

(ES 03-A) Parallel Computing for Image Processing: 8 hours lecture, 12 hours laboratory

Objectives
- To initiate students to issues of parallel computing (data, its applications and problem solving)
- To introduce students to theory but also the most-used tools and methods for parallel computing

Coursework
- Introduction
- Methods and tools for parallel computing
- Open MP, MPI and CUDA

ED *(Électifs Départementaux)*[5]

(ED 01-F) Mobile Robotics and Vision: 5 hours lecture, 15 hours laboratory

Objectives
- To be able to name and function of the different elements of a mobile robot
- Describe the architecture of a mobile robot.
- Design, code and test an algorithm that allows the robot to move while avoiding obstacles.
- To be able to mention the problems of mobile robotics: modeling, trajectory planning, localization, navigation
- This module uses Project / Problem Based Learning (APP)

Coursework
- Introduction to mobile robotics / Sensors used in mobile robotics / Actuators used in mobile robotics / The different mobile platforms / Modelling and control laws in mobile robotics / Tracking / Navigation and trajectory planning

(ED 02-F) Advanced LabVIEW and Certification: 5 hours lecture, 5 hours class, 9 hours laboratory

This is an extension of the LabVIEW Fundamentals 1 course that teaches how to use common design models to successfully implement and use LabVIEW applications for research, engineering, and testing environments. The first 12 hours of course instruction will cover topics such as programming control of the user interface, techniques to optimize the reuse of existing code, the use of file-based I/O functions, and tools to create executables and installers. This course focuses on LabVIEW's features that meet the needs of user applications and allows students to quickly start developing applications. A second 8-hour section of the course is specifically dedicated to preparing for the LabVIEW first level certification: the CLAD. This certification demonstrates a student's solid working knowledge of the LabVIEW environment, a basic understanding of good coding and documentation practices, and the ability to understand and interpret existing code.

Objectives
- Using variables to modify front panel controls or stop parallel loops
- Applying common design models that use queues and events
- Manipulating user-interface objects
- Evaluating file-based I/O formats and use them in applications
- Modifying existing code to make it easier to use
- Take the LabVIEW First Level Certification Examination "CLAD".

Coursework
Using variables = This lesson explains how to use local variables to change the value of front panel controls, stop parallel loops, and bypass data flow restrictions.
Data communication between parallel loops = This lesson describes asynchronous communication techniques for creating code that is controlled by the UI and synchronizes data between parallel loops.
Implementing design models = This lesson introduces students to design models; the benefits and features specific to design models and how they can be used to reduce development time. Two categories of design models are studied: single-loop and multi-loop design models.
User interface controls = This lesson introduces methods for controlling the attributes of front panel objects via programming, such as temporarily disabling a command. Students learn how to use the VI Server to access the properties and methods of the objects on the front panel.

[5] The ED courses have the same code as courses in ISE OC, but **not** the same course

File-based I/O techniques = This lesson describes various file formats for data collection and recording, and how to select the appropriate format for applications. Students will practice implementing modular code that reads or writes measurement data.
Improving an existing VI = This lesson focuses on methods of refactoring legacy LabVIEW code and how to optimize the reuse of existing code. Re-factoring is the process of editing the software to make it more readable and easier to maintain without altering its observable behavior.
Creating and distributing applications = This lesson describes the process of creating standalone executables and installers for LabVIEW applications. You will learn how to use the Application Builder in LabVIEW.
CLAD certification test preparation =Review LabVIEW courses 1 and 2as well as practice tests to prepare for the certification exam

EP *(Électifs Partagés*)

(EP 01-A) DSP (Digital Signal Processing): 8 hours lecture, 12 hours laboratory

Objectives
To study the principle DSP (digital signal processors and processing) algorithms and their impact on DSP architecture

Coursework
- Sampling, Convolution / Linear filtering / Fourier transforms / DSP processor characteristics / TMS320C31 architecture

(EP 02-A) Programmable Logic Devices-from FPGA to SoC: 8 hours lecture, 12 hours laboratory

Objectives
- To understand types, use and applications of embedded systems.
- To distinguish the main features and requirements on Reconfigurable Systems.
- To understand the VLSI process in the Reconfigurable Systems Design.
- To obtain a medium level on the use of Hardware Description Language (VHDL) use and application.
- To understand the use and design process of FPGA as programmable devices to implement System on Chip.
- To analyse the process, requirements and problematic on the microcontroller-based-design on programmable devices.
- To design medium-level designs of System on Chip using FPGA

Coursework
Reconfigurable Embedded Systems
System on Chip (Architecture / Interconnection buses / Hardware and software IP / Design for testing)

(EP 03-A) Python Programming: 5 hours lecture, 14 hours laboratory

For years, Python language has become one of the most useful programming tool for engineers. Applicative areas growth more and more and even embedded systems begin to use Python. The objective of this elective is to understand the environment, the tools, and the possibilities of this language.

Coursework
1. Python Development Environment
   - Python distributions and their installation
   - Python as a script language
   - Python as a programming language
   - Interactive Python (jupiter-notebook)
   - Comparison to other programming languages
   - Installing important libraries (pip)
2. Python Basics : The first program, Docstrings, Blocks and indentation, First Control structures
3. Simple data types and expressions : Boolean, integer, float, complex numbers, strings, bytes
4. More data types : lists, tuples, sets, dictionaries, strings, numpy, arrays
5. Control structures : Loops, alternatives, exceptions
6. Comprehension and slicing
7. Object oriented Python : Class definition, Class instantiation, Generators and iterators
8. Files : Files, Serialization, Important file formats
9. Specialized topics (optional): Writing and installing your own libraries, Regular expressions, etc.

MAJOR ISN:
I.T. SERVICES ENGINEERING

I.T.
ISN 301, 302, 303 and 304 = 5 ECTS credits

(ISN 301-A) Database Programming with PL / SQL: 5 hours lecture, 15 hours laboratory

Objectives
- Write PL/SQL modular programs to extract and manipulate information from an oracle database, using if necessary dynamic SQL statements
- Automate information processing using triggers
- Design and implement exceptions
- Use appropriate structure to implement the specified functionality
- Use appropriate SQL language clause (join, subquery or group) to query an oracle database
- Explain the role of indexes and transactions
- Create and query a view

Coursework
- Pre-requisite check : SQL queries using joins, subqueries and/or groups, SQL data creation and manipulation statements
- SQL topics among : Views, creation and query using views, Indexes, Main transactions instructions, data types
- General overview of PL/SQL
- Interaction with the database (one row and multiple rows)
- Functions & procedures (exceptions)
- Triggers (exceptions)

(ISN 302-A) IT Security Systems: 12 hours lecture, 8 hours laboratory

Objectives: The goal of the course is to provide an introduction to the basics of information systems security. After attending the course the students will be able to:
- Recall fundamental definitions and notations of the field of information systems security
- Explain the functioning of cryptographic methods
- Describe the development phases used in security engineering
- Describe methods for threat analysis and risk assessment
- Describe types of attacks and explain how to prevent them
- Explain common security mechanisms to protect computer systems and networks
- Solve number theoretic computation problems by applying the appropriate algorithms

Coursework
- Introduction
  - Basic definitions, Security requirements, Attack types, Security strategy
- Cryptography
  - Symmetric cryptosystems: purpose, functioning, operating modes, examples: AES, IDEA
  - Public key cryptosystems: purpose, functioning, example: RSA
  - Digital signatures: purpose, functioning, examples: RSA, DSA
  - Cryptographic hash functions: purpose, functioning, example: SHA-256
  - Diffie-Hellman key exchange: purpose, functioning
- Threats
  - Buffer overflows, Computer viruses, Computer worms, Trojan horses, Network insecurities
- Security Mechanisms
  - Computer security: virus scanners, access control mechanisms
  - Network security: IPSec, firewalls, e-mail security
  - Certificates and public key infrastructures
- Security Engineering
  - Design principles, Security development life cycle, Development phases, Threat analysis, Risk assessment

Two labs sessions are dedicated to the implementation in java of one system such as the RSA cryptographic system the appropriate algorithms.

(ISN 303-F) C++ Language: 6 hours lecture, 14 hours laboratory

Objectives: At the end of this course students will be able to:
- Design and develop a C++ application (in console mode with no graphics interface)
  - using the principles of object oriented programming and the specificities of C++
  - using a class diagram with relations
  - respecting programming norms
- Test and debug a C++ console application

- explain what C++ language is, the specificities of C++ as opposed to Java, the advantages and drawbacks of C++ as opposed to Java

Coursework

- Overview and presentation of C++ / Friend functions and line functions / Relationships, composition, aggregation and association / Heritage and redefinition / Polymorphism and abstract classes

(ISN 304-F) Node.js: 6 hours lecture, 14 hours laboratory

Objectives

- Write server-side programs in javascript
- Install the node.js environment and use the npm manager
- Understand and write applications using the Node.js environment
- Express framework
- Understanding how it works and using a NoSQL database : Mongo
- Write client side programs using Angular

Coursework

1/ The basics of Javascript
2/ Javascript: asynchronous and event-driven programming
3/ Presentation of the environment Node.js
4/ Installation and configuration of Node.js
5/ Presentation and use of the node.js API
6/ Installation and use of modules for node.js
7/ Using the Express framework and traffic management
8/ Presentation and use of the MongoDB NoSQL database
9/ Presenting Angular
10/Practice using Angular

JEE and PYTHON PROGRAMMING
ISN 305, 306 and 307 = 6 ECTS credits

(ISN 305-A) A.I. and Python: 5 hours lecture, 15 hours laboratory

Objectives

- Learn Python programming language
- Lean the Python skills to develop applications in the field of artificial intelligence
- Build data classification systems using machine learning
- Put various types of networks in place: Hopfield, Feedforward
- Create data classification systems using deep learning

Coursework

- Introduction to Python
- Python for AI scientists
- Machine Learning
- Artificial Neural Networks
- Deep Learning

(ISN 306-F) Java Frameworks: 6 hours lecture, 14 hours laboratory

Objectives

- Configure and use Log4J to manage application logs.
- Install, configure and use the Maven 2 dependency manager in the Eclipse IDE
- Write and configure a JAVA application that uses a database (2 or 3 tables) using the Hibernate framework
- Use the main struts taglibs (taglibs linked to forms, taglibs logic, taglibs bean)
- Explain the architecture of Struts (MVC 2) and the role of each component
- Make modifications on a provided JAVA WEB application (about 4 pages), based on the use of Struts

Coursework

- Log 4J / Maven 2 Frameworks / Hibernate and tables / Putting together hibernate with several tables / Fundamentals of JSP, presentation of MVC2 and Struts 1 / Using Struts Framework / Practicing Spring MVC, Spring IoC Frameworks

(ISN 307-F) Android: 13 hours lecture, 27 hours laboratory

Objectives: At the end of this course students will be able to

- write a program able to geolocate and show the position of the phone on a Googlemaps map

- write a program that interacts with SMS and calls
- put into place and use an Eclipse + plug-in Android environment
- write a program that will interconnect two activities by using Intent
- write a program with approximately 5 activities to manage with their associated events
- deal with persistent data management on mobile equipment (data base and text files)
- write a program interacting with a web server by using an HTTP request
- create an application using a .apk file format

Coursework

- The Android platform / Discovering activities / Creating user interfaces / Inter-application communication / Persistent data / Network management / Telephoning / Geolocalisation / Publishing an application

PROJECT & MODERN TECHNOLOGIES
ISN 308 and 309 = 4 ECTS credits

(ISN 308-F) Project Work: 8 hours lecture, 32 hours laboratory

Objectives

The goal of this course is to design a Web JEE application as well as an Android application in a project team.

- write up design specifications (functions, Use Case, IHM, scheduling, limitations);
- write up design documents;
- explain the part each software architecture (MVC2) plays;
- use a version manager (subversion) tool to share files with other developers;
- handle one or several elements of the project among the following: Mysql data base / DAO layer (JDBC for GSI ID majors / Hibernate for GSI IR majors) / DTO layer / Model / View / Controller (using Struts for GSI IR majors) / Testing / Project Management / Developing with Android
- work in a team towards a common accomplishment
- rigorously follow class diagrams in order to bring together different parts of the project
- perfect software that respects given design specifications
- defend the idea of having a strict set of design standards and specifications, rigorous testing and efficient communication between project members
- analyse team mistakes to improve methodology for future projects

Coursework

- Writing design specifications / Writing design documents (class diagrams) / Presenting project architecture and dividing tasks / Project steps and testing / Bringing it all together / Final analysis and feedback

(ISN 309-F) Technology Watch: 7 hours lecture, 13 hours laboratory

Objectives

- Conduct, as a group, an oral presentation of a recent technology.
- Describe, compare and take a critical look at I.T. tools and/or project management methods enough to give the advantages and disadvantages.
- Study the API documentation for some of the main social networks (Twitter, Facebook...)
- Set up software using these APIs by addressing the issue of Cross-origin resource sharing (CORS).

Coursework

- Conducting market research on a specific subject / Presenting a topic to the class / Creating an application with that interacts with social networks (authentication, data collection, data exchange, etc.)

MAJOR ISYMED:
MEDICAL SYSTEMS ENGINEERING

Biomedical engineering brings together an ensemble of sciences and techniques in the fields of biology and healthcare. Progress in I.T., electronics and embedded systems is ongoing and requires engineers to have new skill sets to work with the fast paced evolutions and never before seen needs. The goal of this major is to train engineers that will be able to work with and manage these technological revolutions.

MEDICAL DEVICES: REGULATIONS, FINANCIAL CONCERNS, SAFETY & SECURITY
ISY 301, 302 and 303 = 5 ECTS credits

(ISY 301-F) Medical Devices & Technologies: Environmental, Economic and Regulatory Contexts: 17 hours lecture

Coursework

- Technical support centers, their characteristics and specificities of today's market, how the market has evolved, jobs and careers. The legal and legislative context and general principles
- European directives and regulations and their evolution, political / administrative organization
- The CE (the European conformity marking for products) mark, materiovigilance, sanitary vigilance, classification, nomenclature and traceability
- Normalization, what's at stake for medical support centers and devices, normalization system, conformity, guaranteeing quality, quality management system
- Design and eco-design of medical support centers and devices, risk analysis, materials used (descriptions, technical specifications, toxicity), French legislation for electronic and electric apparatus disposal (DEEE, REP), sustainable purchasing, choosing materials
- Healthcare informatics (hosting and data protection, authorization, inside and outside of Europe transfers, the CNIL (*Commission Nationale de l'Informatique des Libertés)*
- Reimbursement of medical support centers and devices and accessing the market
- Professional – industrial relations in the field of health care (financial and legal responsibilities for French and European companies), patents and intellectual property

(ISY 302-F) CE and EMC Marking: 4 hours lecture, 4 hours class, 19 hours laboratory

Objectives

- To describe the normative system and regulations governing EMC issues in electronic medical systems and devices
- Developing a test series for EMC measurements
- Conducting EMC measurement tests
- Identify EMC filtering methods
- Develop EMC problem resolution strategies

Coursework

- Introduction
- Presentation of regulations and normative system associated with EMC constraints – for CE marking
- Putting together a set of tests
- Testing medical systems / devices in a semi-anechoic chamber
- EMC filtering
- Overview of electromagnetic waves
- Problem resolution methodology for EMC
- Writing up a project / decision-making plan
- Filtering solutions for simulations
- Testing filtering solutions for eventual validation

(ISY 303-F) Medical Devices: Standards for Embedded Systems Design: 11 hours lecture, 4 hours class, 10 hours laboratory

Objectives

- The aim of this module is to understand the IEC62304 standard and its impact on the design and development of a medical device including an embedded system, through a simplified syringe pump project. This project serves as an example for putting theory into practice; necessary for industrial product design and design verification.
- The project will make it possible to address risk control and risk analysis and then note their effectiveness on the final product, as well as analyse the residual risks. Risk analysis is crucial for design and development of products destined for medical use.

- Labwork will aim to create what has been designed; students will be able to set up electronic and software risk control models, as well as demonstrate their usefulness by carrying out verification tests.
- To conclude the course, students will turn in a technical file made up of the various class time and labwork reports. The latter will be compared to a technical file submitted for a CE marking review.

Coursework
1°) Regulatory impact on the development of a medical product: Presentation of the IEC62304 standard / Standards ISO 13485, ISO14791 referenced / Concrete impacts in a project's life cycle
2°) The V-Cycle: V-cycle theory / How to clarify? / How to check design? / The V-cycle in practice
3°) Software risks: The risks described in standards / Risks specific to embedded software / Means of controlling risks specific to software
4) Specifications & design: Putting the V-cycle into practice
5°) FMECA (Failure Modes and Effects Analysis): Principles of risk analysis / V-cycle looping
6°) Putting Risk Control Means into practice: Risk analysis from beginning to end / Designing and checking the means for risk control
7°) Risk control applied to real time: Modification of a project already started / Implementation of software MMRs / Assembling a model
8°) Finalizing a model - Functional Tests: Validating the syringe pump product / Elements of the syringe pump project / Technical file expectations for the syringe pump

BIOMEDICAL ENGINEERING: ENVIRONMENT & CAREERS
ISY 304, 305 and 306 = 5 ECTS credits

(ISY 304-F) Clinical Practices and Medical Technologies: 28 hours lecture

Objectives
- Understand the contribution of biomedical technologies in the diagnosis, monitoring, and treatment of various medical conditions.
- Revealing the biomedical technologies required for medical acts and patients.
- Gather some notions of medicine as well as some anatomical failures or deficiency of the human body.
- Provide key design and operating principles for biomedical technologies

Coursework: The following technologies will be presented:
- Imaging techniques of the human body (conventional radiology, MRI, ultrasound, endoscopy, per-operative imaging, etc.) and their diagnostic interest: tumour diagnosis, fractures, brain function, pathology of the digestive tract, fetal monitoring, functional imaging of the heart, and so on.
- Kidney substitution techniques: hemodialysis, hemodiafiltration, peritoneal dialysis and associated biomedical equipment: dialysis generator, water treatment, osmosis. Study of the kidney and renal failure.
- Functional exploration techniques in cardiology, pneumology, neurology through the following equipment and techniques: electrocardiography, cardiac stress test, spirometry, plethysmography, electromyography, electroencephalography. Study of the heart, cardiac pathologies, study of the nervous system
- The technical platform of the operating room through the most common installations (anaesthesia ventilator, scialytic, operating table, instrumentation, monitoring) and its general organization in response to the various surgical specialties
- The technical sterilization tray and its interest: sterilizers and washer-disinfector.

To approach some notions of medicine and some functional or anatomical failures of the human body :
- The renal system / The nervous system / The cardio-vascular system / Tumour spread

Provide key design and operating principles for each biomedical technology.
- Physical principles of magnetic resonance / Physical principles of X-rays / Physicochemical principles of steam sterilizers

(ISY 305-F) Computerized Maintenance Management Systems (CMMS) for Biomedical Equipment: 10 hours lecture, 10 hours class

Objectives
- Acquire the fundamentals for biomedical systems maintenance
- Use dedicated tools for planning and managing corrective or preventive maintenance for biomedical equipment

Coursework
- Maintenance costs
- Risk management in maintenance
- Maintenance in a hospital environment
- Reliability, maintainability, availability, operational safety

- Useful standards for the maintenance of biomedical equipment
- Quality and traceability
- Organization and maintenance methods
- Principles of corrective and preventive equipment maintenance
- Material vigilance
- Case study in the implementation of a CMMS

(ISY 306-F) Managing Complex Medial Systems: 10 hours lecture, 10 hours laboratory

Objectives

1. Define the roles and work of a biomedical engineer in the private sector
2. Understand what's at stake and the risks associated with biomedical equipment and how maintenance must be undertaken
3. Show what's at stake with technical installations and describe how they are financed in French public health institutions
4. Understand the importance, organization, size and management of hospital technical centers
    - For example, medical imagery, operating rooms, sterilizing equipment and dialysis equipment
5. Equipment: their functions, overall cost and common questions regarding them

Coursework

- Specify the roles and goals of a biomedical engineer working in the private sector
    a. The organisation of a biomedical department
    b. The profession of healthcare engineer – status, roles and goals, career, salary and professional advancement
    c. Purchasing, maintenance and risk management
    d. Purchasing methods
    e. Medical device vigilance – the role of French governing bodies
    f. Maintenance (accounting and management charts)
    g. Computerized Maintenance Management Systems (CMMS)
    h. Documentation management
    i. Performance indicators
- Detailing the way French public institutions finance (income and expenditure)
    a. Explanation of financing for hospitals
    b. Presenting hospital reforms and French law
    c. Presentation of "*PMSI: Programme de Médicalisation Du Système d'Information''* ; a system that allows French hospitals handle resources and materials
- Medical imagery in hospital technical centers: what's at stake, how they are managed, organized, and sized. Dealing with questions about their functions, equipment and costs.
    a. The role and purpose of medial imagery: conventional radiology, vascular, flat panels, photostimulated luminescence (PSL), ultrasound, scanners, IRM
    b. Putting an IRM in place
    c. Nuclear medicine tomographic imaging techniques: SPECT, PET and CT modalities
    d. Picture Archiving Communication Systems (PACS) and their functions
- Operating blocks in hospital technical centers: what's at stake, how they are managed, organized, and sized. Dealing with questions about their functions, equipment and costs.
    a. Operating blocks: architectural limitations, design, restoration, regulations and equipment
    b. Optimizing operating blocks: identifying, surveying and making the most of performance indicators for optimal functioning
    c. In-and-out surgery as part of an operating block
    d. Risk management in operating blocks for hospital-acquired infections
- Sterilizing equipment in hospital technical centers: what's at stake, how they are managed, organized, and sized. Dealing with questions about their functions, equipment and costs.
    a. Sterilization and disinfection of heat-sensitive medical devices: equipment, regulations, architectural aspects
    b. Public-public cooperation and public-private cooperation patterns

ISYMED Electives / ECTS Credits = 5

ES *(Électifs Spécialisés)*[6]

- ❑ ES01: Machine Learning
- ❑ ES?: Rollout for Medical Systems
- ❑ ES02: Robotic Assistance

ED *(Électifs Départementaux)*

- ❑ ED01: Mobile Robotics and Perception
- ❑ ED02: Advanced LabVIEW and certification

EP *(Électifs Partagés*)

- ❑ EP03: Python Programming

ES *(Électifs Spécialisés)*

(ES 01-F) Machine Learning: 20 hours lecture, 16 hours laboratory

Objectives: The objective of this course is to introduce students to Machine Learning techniques

ML is the science that allows machines to act without being explicitly programmed, without realizing this technology is everywhere. Teaching will alternate between classroom sessions and laboratory work. The course will begin with an introduction to the important concepts of Machine Learning (history of the discipline; concepts of attributes, classes; data preparation). Learning themes are then discussed. Various case studies based on data from the UCI database will be developed during labwork sessions. Emphasis is on the use of algorithms rather than their development: notions of linear algebras and optimization will be discussed.

Coursework

Introduction

- ✓ History, Examples of applications related to ML, Fundamentals, Data preparation, Regression

In-class learning

- ✓ Logistic regression, Neural networks, Decision trees

Self-study

- ✓ K-means, Gaussian Mixture Model, PCA, ICA

Practical concepts

- ✓ Methods for choosing algorithms and models, System development, Debugging, Implementing experiments

(ES 02-F) Rollout for Medical Systems: 8 hours lecture, 8 hours class

Objectives

This course introduces regulatory constraints in the medical field (specifically that of Medical Devices). This module will allow students to understand the context in which the development of a device must be carried out. Then the students will "design" a clinical study, a key skill to get their product to market.

The objective of this module is to provide a knowledge base allowing students to be able to design clinical studies while avoiding pitfalls (for developing a medical devices) in order to have an overview during the R&D and/or marketing processes.

Coursework

1) Theory
   a. Medical devices: reminders
      - ✓ Definition & general context, Vocabulary and lexicon
   b. Regulations
      - ✓ European Regulations, CNIL, CPP, CNOM, CE Marking, ISO 13485
   c. The different types of clinical studies
      - ✓ RIPH 1, RIPH 2, RIPH 3, Retrospective study, PMCF
2) Practice
   a. Presentation of the rules of the "serious game".
   b. Establishment of working groups
   c. Definition of the context of the system (Different for each group)
   d. Bibliographic analyses of the chosen device
   e. Definition of the objectives of the study
   f. Implementation of the methodology

[6] Attention: There are the same codes for courses in ISE OC and ISE VA; but the courses do not correspond

g. Sample calculation
h. Writing a synopsis
i. Building a schedule
j. Distribution of roles: subcontracting and internal tasks
k. Going before a Notified Body (presentation of the file-Evaluation)
l. Implementation of actions according to the feedback of all regulatory bodies
m. Feedback on, and how to anticipate traps?

(ES 03-F) Robotic Assistance: 10 hours lecture, 10 hours laboratory

Objectives

- Design a computer program for an electric wheelchair that can detect and avoid obstacles as well as go through doors automatically
- Coding and testing this computer program in simulation and real-life situations

Coursework

- Discovery of the programming tool (e.g. RTMAPS)
- Designing an algorithm for obstacle avoidance and automatic door passage based on LIDAR data
- Simulation tests
- Validating the program in the autonomous navigation laboratory of ESIGELEC and using the program on an electric wheelchair

ED *(Électifs Départementaux)*

(ED 01-F) Robotics and Vision: 5 hours lecture, 15 hours laboratory

Objectives

- To be able to name and function of the different elements of a mobile robot
- Describe the architecture of a mobile robot.
- Design, code and test an algorithm that allows the robot to move while avoiding obstacles.
- To be able to mention the problems of mobile robotics: modeling, trajectory planning, localization, navigation
- This module uses Project / Problem Based Learning (APP)

Coursework

- Introduction to mobile robotics / Sensors used in mobile robotics / Actuators used in mobile robotics / The different mobile platforms / Modelling and control laws in mobile robotics / Tracking / Navigation and trajectory planning

(ED 02-F) Advanced LabVIEW and Certification: 6 hours lecture, 5 hours class, 9 hours laboratory

This is an extension of the LabVIEW Fundamentals 1 course that teaches how to use common design models to successfully implement and use LabVIEW applications for research, engineering, and testing environments. The first 12 hours of course instruction will cover topics such as programming control of the user interface, techniques to optimize the reuse of existing code, the use of file-based I/O functions, and tools to create executables and installers. This course focuses on LabVIEW's features that meet the needs of user applications and allows students to quickly start developing applications. A second 8-hour section of the course is specifically dedicated to preparing for the LabVIEW first level certification: the CLAD. This certification demonstrates a student's solid working knowledge of the LabVIEW environment, a basic understanding of good coding and documentation practices, and the ability to understand and interpret existing code.

Objectives

- Using variables to modify front panel controls or stop parallel loops
- Applying common design models that use queues and events
- Manipulating user-interface objects
- Evaluating file-based I/O formats and use them in applications
- Modifying existing code to make it easier to use
- Take the LabVIEW First Level Certification Examination "CLAD".

Coursework

Using variables = This lesson explains how to use local variables to change the value of front panel controls, stop parallel loops, and bypass data flow restrictions.
Data communication between parallel loops = This lesson describes asynchronous communication techniques for creating code that is controlled by the UI and synchronizes data between parallel loops.
Implementing design models = This lesson introduces students to design models; the benefits and features specific to design models and how they can be used to reduce development time. Two categories of design models are studied: single-loop and multi-loop design models.

User interface controls = This lesson introduces methods for controlling the attributes of front panel objects via programming, such as temporarily disabling a command. Students learn how to use the VI Server to access the properties and methods of the objects on the front panel.
File-based I/O techniques = This lesson describes various file formats for data collection and recording, and how to select the appropriate format for applications. Students will practice implementing modular code that reads or writes measurement data.
Improving an existing VI = This lesson focuses on methods of refactoring legacy LabVIEW code and how to optimize the reuse of existing code. Re-factoring is the process of editing the software to make it more readable and easier to maintain without altering its observable behavior.
Creating and distributing applications = This lesson describes the process of creating standalone executables and installers for LabVIEW applications. You will learn how to use the Application Builder in LabVIEW.
CLAD certification test preparation =Review LabVIEW courses 1 and 2as well as practice tests to prepare for the certification exam

EP *(Électifs Partagés*)

(EP 03-A) Python Programming: 10 hours lecture, 10 hours laboratory

For years, Python language has become one of the most useful programming tool for engineers. Applicative areas growth more and more and even embedded systems begin to use Python.
The objective of this elective is to understand the environment, the tools, and the possibilities of this language.

Coursework

1. Python Development Environment
   - Python distributions and their installation
   - Python as a script language
   - Python as a programming language
   - Interactive Python (jupiter-notebook)
   - Comparison to other programming languages
   - Installing important libraries (pip)
2. Python Basics : The first program, Docstrings, Blocks and indentation, First Control structures
3. Simple data types and expressions : Boolean, integer, float, complex numbers, strings, bytes
4. More data types : lists, tuples, sets, dictionaries, strings, numpy, arrays
5. Control structures : Loops, alternatives, exceptions
6. Comprehension and slicing
7. Object oriented Python : Class definition, Class instantiation, Generators and iterators
8. Files : Files, Serialization, Important file formats
9. Specialized topics (optional) : Writing and installing your own libraries, Regular expressions, etc.

MAJOR MCTGE:
MECHATRONICS AND ELECTRICAL ENGINEERING

INTELLIGENT MECHATRONIC SYSTEMS: MODELING & CONTROL
MGE 301, 302 and ES 01 = 4 ECTS credits

(MGE 301-F) Advanced Mechanical Systems: 12 hours lecture, 6 hours class

Objectives

At the end of this course students will be able to use Lagrange mechanics/ equations as well as vibration modes to describe and analyze a complex mechatronic system.

Coursework

- multibody systems for mechatronics
- analytical mechanics
- vibration mechanics / modes

(MGE 302-F) Robotics & Mechatronic Engineering: 10 hours lecture, 2 hours class, 8 hours laboratory

Objectives – This course deals mainly with a particular class of mechatronic systems, namely robots. This class is designed for students to

- have an overview of the fundamentals of robots (definitions, origins, applications, etc.)
- learn the techniques and practice using the tools needed to model a robot
- learn about robotic control, the objective here is to go from simple and classic control to more advanced techniques

Coursework

- Introduction to robotics
  - What is robotics? / What characterizes a robot? / Robot structure and composition / Examples of how they are used
- Dynamic modelling of robots
  - Introduction / Geometric and kinematic modelling / Dynamic modelling
- Fundamentals of robotic control
  - Introduction to closed-loop control / Robotic control / Non-model based control / Proportional-derivative control (PD control) / Proportional-plus-integral control (PID control) / Proportional-derivative non-linear control
  - Model based control / PD control allowing for gravity / Augmented PD control / Augmented non-linear PD control / Feedforward augmentation control
  - Case study: advanced control with a Selective Compliance Assembly Robot Arm (SCARA)
  - Comparative study of different control systems

(MGE303-A/F) Surveillance and Control of Intelligent Systems: 14 hours lecture, 6 hours laboratory

Objectives: At the end of this course, 3rd year students will be able to analyze, monitor the stability and improve the performance of a mechatronic system subjected to vibrations as well as:

- Explain vibratory phenomena
- Distinguish the main actuators and sensors
- Implement active control laws
- Implement structural control strategies

Coursework:

- Intelligent Structures and Systems / Monitoring system integrity / Structure control / Active system control

MULTI-PHYSICAL MODELING FOR MECHATRONIC SYSTEMS DESIGN
MGE 304 and 305 = 3 ECTS credits

(MGE 304-F) Bond Graphs: 18 hours lecture, 6 hours laboratory

Objectives

The goal is to go beyond an analytical approach to acquire a global "systemic" vision for the analysis and synthesis of complex systems. It is also to propose an approach for "mechatronic design" ranging from the analysis of customer needs to the various stages and methodologies for design, realization, and validation. In particular, new techniques such as Software

in the Loop (*SIL*) and Hardware in the Loop (*HIL*) to learn and develop a systematic approach for designing and engineering systems starting from the Plans (ISO) of the Detailed Instruments up to computerization.

Coursework
Chapter 1: Introduction
- Definitions, needs and contexts
- Industrial systems
- Complex systems
- Which models for mechatronic design;

Chapter 2: Tools
- Prototypes
- Hardware in the Loop (HIL)
- Software in the Loop (SIL)
- Modelling language: bond graphs;
    - Why bond graphs ?
- Simulation software (Symbols, Matlab)

Chapter 3: Case studies

(MGE 305-F) Mechatronic System Design - Multidomain Simulation & Model-Based Design of Dynamic Systems: 4 hours lecture, 12 hours laboratory

Objectives
To understand thermal and EMC compatibility when designing mechatronic systems; students will look at real-world industrial solutions and labwork will involve 3-D CAD study allowing students have a more in-depth view of thermal and EMC concerns when designing mechatronic systems.

Coursework
- Introduction on heat transfer (conduction, convection, radiation)
- Power electronic components and their applications
- Stationary problems, transient response
- Thermal interface materials
- Cooling flow balance
- Thermal problems for electronics, e.g. power amplifiers
- Thermal measurement tools for electronics
- Simulation tools: commercial products and their limitations

- EMC
    - Introduction to EMC
    - General definition
    - Concrete cases of EMC problems, Specificity of the automotive sector
    - Equivalent models of passive components in HF
- Coupling mechanisms: Radiation, Coupling, Crosstalk
    - Common impedance coupling
    - Field-to-line / field-to-loop coupling - elementary
    - Field-to-line coupling - Agrawal - Taylor - Rachidi
- Laboratory
    - Cross-talk analysis - Basis for the use of shielding
    - Implementing a topological approach

Multiphysical simulations
Use of a 3D multi-physical simulation software to study the impact of thermal and EMC phenomena on mechanical design of a system.

MECHATRONIC SYSTEMS DESIGN
MGE 306 = 3 ECTS credits

(MGE 306-F) Mechatronic System Design: 28 hours lecture, 14 hours laboratory

Essential objectives:
- define, identify and describe how a mechatronic system functions
- work with several different types of engineering such as electronic, mechanical, control and I.T., and all in real time
- analyze and distinguish between the various systems incorporated in a mechatronic system
- develop a mechatronic platform that comes from given design specifications

- organize and manage tasks in a team setting
- choose, justify and evaluate certain solutions when given a specific problem or situation

Strongly recommenced objectives:
- extract pertinent information from a technical document written in English
- give examples of applications for mechatronic systems
- use, amongst a library of function possibilities, an application taking into account design specifications
- succinctly present research findings

Necessary objectives:
- design a system integrating electronics, mechanics, automatic systems that answers to specific needs
- Put together a schema using sensors

Coursework
- Setting general conditions and design specifications
- Studying the different parts of a system: mechanics, electronics, power electronics
- Modelling, designing and validating the various sub-assemblies

MCTGE Electives / ECTS Credits = 5

ES *(Électifs Spécialisés)*[7]
- ❑ ES02: Actuators: Practice & Simulation
- ❑ ES03: Control of Nonlinear Mechatronic Systems
- ❑ ES03: Power Electronics / Design and Sizing

ED *(Électifs Départementaux)*
- ❑ ED01: Mobile Robotics and Vision
- ❑ ED02: Advanced LabVIEW and certification

EP *(Électifs Partagés*)
- ❑ EP04: MicroElectroMechanical Systems

ES *(Électifs Spécialisés)*

(ES 02-A) Actuators – Practice & Simulation: 9 hours lecture, 9 hours laboratory

Objectives:
- For students to deepen their knowledge of sensors and actuators;
- Selecting of sensor technologies and associated electronics by working on examples of subsystems from sensors to actuators

Coursework
- Overview of basic tools
- Sensor technologies (strain gauge, pressure transducer)
- Actuators
- Lab: Matlab/simulink simulations

(ES 03[8]-F) Control of Non-linear Mechatronic Systems: 8 hours lecture, 6 hours class, 6 hours laboratory

Coursework: provide an overview of the guiding principles of non-linear control systems
- Fundamentals of non-linear control systems
- What characterizes non-linear phenomena?
- Stability in non-linear systems (Lyapunov functions)
- Non-linear control techniques
- Sliding mode control
- Sliding mode control for diesel engine air loop control

[7] The irregularity in numbering respects the numbering in the Excel file
[8] There are two ES-03 courses in the Excel file.

(ES 03-F) Power Electronics – Design and Sizing: 8 hours class, 12 hours laboratory

Objectives

Working from functional specifications the engineering student should be able to handle switching mode power supply (SMPS) design, assessment, sizing, and creation.

Coursework

Students will put into practice pre-existing knowledge about electronics and power electronics for SMPS (forward conversion type) schematics and design. The various steps are as follows:

- Designing 3-winding transformers, their magnetic circuits, the number of turns, sizing the copper wire, the skin effect, and so on.
- Designing components for power electronics, MOS and
- Designing filtering elements
- Transistor control

ED *(Électifs Départementaux)*

(ED 01-F) Robotics and Vision: 5 hours lecture, 15 hours laboratory

Objectives

- To be able to name and function of the different elements of a mobile robot
- Describe the architecture of a mobile robot.
- Design, code and test an algorithm that allows the robot to move while avoiding obstacles.
- To be able to mention the problems of mobile robotics: modeling, trajectory planning, localization, navigation
- This module uses Project / Problem Based Learning (APP)

Coursework

- Introduction to mobile robotics / Sensors used in mobile robotics / Actuators used in mobile robotics / The different mobile platforms / Modelling and control laws in mobile robotics / Tracking / Navigation and trajectory planning

(ED 02-F) Advanced LabVIEW and Certification: 5 hours lecture, 5 hours class, 9 hours laboratory

This is an extension of the LabVIEW Fundamentals 1 course that teaches how to use common design models to successfully implement and use LabVIEW applications for research, engineering, and testing environments. The first 12 hours of course instruction will cover topics such as programming control of the user interface, techniques to optimize the reuse of existing code, the use of file-based I/O functions, and tools to create executables and installers. This course focuses on LabVIEW's features that meet the needs of user applications and allows students to quickly start developing applications. A second 8-hour section of the course is specifically dedicated to preparing for the LabVIEW first level certification: the CLAD. This certification demonstrates a student's solid working knowledge of the LabVIEW environment, a basic understanding of good coding and documentation practices, and the ability to understand and interpret existing code.

Objectives

- Using variables to modify front panel controls or stop parallel loops
- Applying common design models that use queues and events
- Manipulating user-interface objects
- Evaluating file-based I/O formats and use them in applications
- Modifying existing code to make it easier to use
- Take the LabVIEW First Level Certification Examination "CLAD".

Coursework

Using variables = This lesson explains how to use local variables to change the value of front panel controls, stop parallel loops, and bypass data flow restrictions.

Data communication between parallel loops = This lesson describes asynchronous communication techniques for creating code that is controlled by the UI and synchronizes data between parallel loops.

Implementing design models = This lesson introduces students to design models; the benefits and features specific to design models and how they can be used to reduce development time. Two categories of design models are studied: single-loop and multi-loop design models.

User interface controls = This lesson introduces methods for controlling the attributes of front panel objects via programming, such as temporarily disabling a command. Students learn how to use the VI Server to access the properties and methods of the objects on the front panel.

File-based I/O techniques = This lesson describes various file formats for data collection and recording, and how to select the appropriate format for applications. Students will practice implementing modular code that reads or writes measurement data.

Improving an existing VI = This lesson focuses on methods of refactoring legacy LabVIEW code and how to optimize the reuse of existing code. Re-factoring is the process of editing the software to make it more readable and easier to maintain without altering its observable behavior.
Creating and distributing applications = This lesson describes the process of creating standalone executables and installers for LabVIEW applications. You will learn how to use the Application Builder in LabVIEW.
CLAD certification test preparation =Review LabVIEW courses 1 and 2as well as practice tests to prepare for the certification exam

EP *(Électifs Partagés*)

(EP 04-F) MicroElectroMechanical Systems (MEMS): 8 hours lecture, 6 hours class, 6 hours laboratory

Objectives

- Understand the different technologies in the fields of micro and nanotechnologies allowing integration of electronic functions. This course will cover the links between electronics and materials and will present MEMS (Micro Electro Mechanical Systems) technologies.

Coursework

- Introduction: The need for integrating electronic functions in consumer, space, military, biomedical, and other applications
- Microelectronic technologies currently being used and emerging uses
- Introduction to manufacturing methods used in clean rooms, packaging, and experimental measurements
- Micrometric technologies with high integration potential: MEMS (Micro Electro Mechanical Systems)
- General presentation of MEMS
- The special case of MEMS-RF (Radio Frequencies)
- Labwork with MEMS: Using electrical and electromagnetic simulation software