ESIEE PARIS

Curriculum 1st and 2nd year (E4-E5)

Major: International Master of Electronics

Courses (1st year - 1st semester – E4-S1) September-January			
Title	**Hours**	**Credits**	**Period**
Networking	30	3	Period 1 (September-October) 18 ECTS
Sensors and Conditioning Circuits	30	3	
C Programming for Electronics	30	3	
Intercultural Management and Communication	30	3	
Signal and Systems	30	3	
Programming and Computing Tools	30	3	
Analog Electronics	30	3	Period 2 (November-January) 18 ECTS MAX
Digital Communications	30	3	
Real-time Systems	30	3	
Electron Devices	30	3	
Connected Objects	30	3	
Corporate Finance and International Marketing	30	3	
Fundamentals of MEMS	30	3	
Introduction to Robotics	30	3	
Statistics with Python	30	3	
Digital Electronics	30	3	
French Language as a Foreign Language	30	4	September-January 2 ECTS min
English Electives (optional)	20	2	
Other languages (optional)	20	2	

Courses (1st year - 2nd semester – E4-S2) January-June			
Title	**Hours**	**Credits**	**Period**
Wireless networks	30	3	Period 1 (January-April) 16 ECTS MAX
Material Sciences	30	3	
Fabrication and Modeling of MEMS	30	3	
Optoelectronics and Photonics	30	3	
Digital ASIC	30	3	
IoT Prototyping	30	3	
Introduction to FPGA	30	3	
French Business Culture & Communication	30	3	
RF System Fundamentals	30	3	
Clinic Course Project	40	4	
French Language as a Foreign Language	30	4	January – April 2 ECTS min
English Electives (optional)	20	2	
Other languages (optional)	20	2	
Full Time Project (may-june)		10	Period 2 (May-June)

Courses (2nd year - 1st semester – E5-S1) September-December			
Title	**Hours**	**Credits**	**Period**
Electromagnetic Modeling for Circuits and Packages	30	3	Period 1 (September-October) 30ECTS MAX
Fundamentals of Microfluidics and Analytical Chemistry	30	3	
Energy Building modeling and case study 1 (ENE-5101A)	30	3	
Embedded Operating Systems	30	3	
Clean-room	30	3	
RF and Microwave Circuits	30	3	
Materials and Nano-materials	30	3	
Internet of Things	30	3	
Corporate Profiling	30	3	
Energy Harvesting for Autonomous Sensors	30	3	
Antennas	30	3	
Advanced Electron Devices	30	3	Period 2 (November-December) 30ECTS MAX
Localisation	30	3	
Energy Building modeling and case study 2 (ENE-5203A)	30	3	
Analog IC	30	3	
Lab-on-Chip	30	3	
Computational Fluid Dynamics (ENE-5202B)	30	3	
RF and Microwave Characterization Lab	30	3	
Project Management and Innovation Management	30	3	
Topical MEMS Design	30	3	
RF Front-end	30	3	
French Language as a Foreign Language	30	4	September-January 2 ECTS min
English Electives (optional)	20	2	
Other languages (optional)	20	2	

Courses (2nd year - 2st semester – E5-S2) Final Semester			
Title	**Hours**	**Credits**	**Period**
Internship & Master Thesis (6-month)		30	January - September

Year 1:
1st Semester at ESIEE (E4-S1): September to January

Period 1

Networking (Lynda Zitoune)
Content: OSI model, layer abstraction; Paquet switching (OSI layer 2); Routing (CISCO routers, OSI layer 3); WAN (Wide Area Network) and VPN (Virtual Private Network). **Aim:** This course provides attendees with the most essential concepts from low to mid-level networking. The most widespread networking technologies are first introduced. It is then shown how these different technologies may be abstracted in the first layers of the OSI model. Routing is considered, with concrete example given on CISCO routers. Large networks, and their administration, are explained at last. **Bibliography** [1] Tanenbaum A., "Computer Networks" [2] Kurose J. F. and Ross K. W., "Computer Networking, a Top Down Approach Featuring the Internet", Pearson Edition. [3] Stevens W. R., "TCP/IP Illustrated Protocols", Vol.1, Addison Wesley.

Material sciences (Philippe Basset)
Content: semiconductors, crystallography **Aim:** This course develops the electronic properties of materials and semiconductors. Crystallography and bands theory are exposed together with fundamentals to analyze interaction of materials with electronic, magnetic and optical wave. **Bibliography** [1] William D. Callister, David G. Rethwisch, Materials Science and Engineering: An Introduction, Wiley [2] Marius Grundmann, The Physics of Semiconductors, Springer [3] Kittel, Introduction to Solid State Physics [4] K.F. Riley, M.P. Hobson, S.J. Bence, Mathematical Methods for Physics and Engineering (Third edition), Cambridge University Press

Sensors and Conditioning Circuits (Thierry Alves)
Content: resistive sensors, OPA, strain gages, photodiodes, transimpedance amplifier. **Aim:** The aim of this lecture is to introduce analog electronic sensors as resistive sensors and passive sensors (photodiodes and piezoelectric sensors). Signal conditioning circuits are an important key in creating a complete analog circuit able to sense physical stimuli. The course finish with a 11h project with both thereotical simulations on QUCS and practical work on solder less board. **Bibliography** [1] Pallàs-Areny Ramon, Webster John G. "Sensors and Signal Conditioning", ISBN 0-471-33232-1, Wiley Publication.

C Programming for Electronics (Yves Blanchard)

Content: C, PIC µC, hardware drivers.

Aim: This course targets to train students with computer languages to interface with electronics systems. C programming will be developed mainly on a project basis toward electronics application and hardware drivers. After an introductory course, a microcontroller based platform supporting various sensors will be used to support the integration of software with hardware.

Bibliography

[1] The GNU C Reference Manual (https://www.gnu.org/software/gnu-c-manual/gnu-c-manual.html)

Intercultural Management and Communication (MSH-4102D) (D.Mainwaring) (E4 semester 1)

Content: Intercultural Management - a series of lectures and class activities on key concepts; Communication Skills 1 - making effective presentations.

Aim:

Intercultural Mgt.

- To introduce students to the main conceptual frameworks used in these fields
- To build awareness of their own cultural paradigm
- To implement and use the concepts presented in various intercultural and organisational contexts
- To develop effective strategies of intercultural management
- To develop a hands-on, eclectic approach to dealing with intercultural problems

Communication Skills 1

- To improve presentation skills
- To understand the key elements in a professional presentation

Bibliography

[1] E.T.Hall, The Silent Language, Doubleday (1959)
[2] G.Hofstede, Culture's consequences, Sage (2001-2nd.)

Signal and Systems (Arben Cela)

Content: Fourier and Laplace transforms; Theory of convolution; Sampling and reconstruction; Dynamical Systems; Integration methods (Euler, Runge -Kutta , Adams) ; Stability ; Controllability, Observability.

Aim: Introduction to necessary mathematical tools for analysis of signal and dynamic systems. Different concepts such as stability, controllability and observability are introduced through different well known application examples. Mastering of the related Matlab/Simulink toolboxes, introduced through different applications, is another objectives of this course. The course also aims at introducing the basics of continuous-time and discrete-time signals and systems, such as impulse and frequency responses, the Fourier Transform, Fourier Series, Discrete Fourier Transform, Finite Fourier Transform, as well as the Z-Transform and the Function Transfer of a system. The course also involves, as part of it, the study and design of digital filters.

Bibliography

[1] Astrom K. J., Murray R., "Feedback Systems, An Introduction for Scientists and Engineers" Princeton University Press (http ://www.cds.caltech.edu/murray/books/AM05/pdf/am08-complete 22Feb09.pdf)
[2] Oppenheim A. V., Schafer R. W., Buck J. R., Discrete Time Signal Processing, PRENTICE HALL (1999)

Programming and Computing Tools (PIM-4104) (Y. Abdeddaim)
Content: Matlab, C programming, Linux programming **Aim:** This course gives an overview of the Linux command line. It will explain how to get along with the command line interface in a larger sense, how does it all work, what can it do and what's the best way to use it. The second objective is to present the base of programming in Linux using Language C. Finally the course will cover the use of Matlab commands. **Bibliography** [1] Downey B. A., How to Think Like a Computer Scientist [2] Shotts W., The Linux Command Line

Period 2

Analog Electronics (Christophe Delabie)
Content: analog IC, MOSFET, common source/gate/drain amplifiers, differential amplifier, current sink, current mirror. **Aim:** The aim of this unit is the discovery of the basic principles that are put together in the frame of full custom analog integrated circuit design. **Bibliography** [1] Sedra Adel S., Smith Kenneth C., "Microelectronic Circuits", Oxfords series on Electrical and Computer Engineering.

Digital Communications (Geneviève Baudoin)
Content: FSK, PSK, ASK QAM, OFDM **Aim:** This course is designed with more emphasis on the most relevant concepts related to digital communication. It can be considered as an introduction to the broad topic of single and multicarrier digital modulations. Several digital modulation schemes including QAM and OFDM are studied. The baseband and passband representation of signals and systems are thus covered. The performance of the different modulation techniques at the transmission and receiver sides will be addressed and compare. **Bibliography** [1] Haykin, Proakis, Sklar, "Digital Communications".

Real-Time Systems (Yasmina Abdeddaïm)
Content: Real time scheduling algorithms; Feasability analysi ; Optimality analysis ; Resource sharing ; Real-time Linux (RTAI). **Aim:** This course is an introduction to scheduling for hard real-time systems. We introduce the task model, the classical scheduling algorithms, and feasibility analysis based on this model. Scheduling algorithms will be tested in practice on a real-time kernel. **Bibliography** [1] Buttazzo G. C., Hard Real-time Computing Systems : Predictable Scheduling Algorithms And Applications (Real-Time Systems Series) Springer-Verlag TELOS Santa Clara, CA, USA,2004 [2] rtai : https //www.rtai.org/

Electron Devices (Jean-Luc Polleux)

Content: Semiconductor physics, PN diode currents and energy bands, bipolar transistor, Schottky diodes, MOS capacitor.

Aim: The aim of this course is to deal with the elementary electron devices that are commonly used in all integrated circuits, and to develop an understanding of relevant physical effects and their modeling. The focus will be on bipolar structures on one hand, such as PN diodes and bipolar transistors on Silicon, and on unipolar devices on the other hand with Schottky diodes and MOS transistors.

Bibliography

[1] The Physics of Semiconductors, Marius Grundmann, 2010
[2] Physics of Semiconductor Devices, S.M. Sze

Connected Objects (Olivier Venard)

Content: IoT, hardware and architectures, communication protocols, energy consumption and autonomy

Aim: The aim of this course is to present the Internet of Things in its two main technical aspects: system and hardware.

Bibliography

[1] Zach, Shelby, Carsten, Bormann, "6LoWPAN the wireless embedded internet", Wiley

Corporate Finance and International Marketing (MSH-4202D) (D.Mainwaring)

Content: Introduction to Corporate Finance; Introduction to International Marketing

Aim:
An Introduction to Corporate Finance - Understanding financial statements and their utility for financial analysis
Understanding financial market, corporate financing, capital structure and risk
An Introduction to International Marketing - What is marketing? Basics of International Marketing. Marketing of Innovation

Fundamentals of MEMS (T. Bourouina)

Content: Electromechanical Transducers, electrostatic, piezoelectric, piezoresistive, electro-thermal, structural mechanics, Ansys

Aim: MEMS (Micro Electro Mechanical Systems) is the technology of microscopic sensors and actuators having moving parts. This course introduces basics on related physical principles, including structural mechanics. MEMS nonlinear behavior and transduction mechanisms will be presented so as to facilitate sensor design.

Bibliography

[1] S. D. Senturia, Microsystem design, Kluwer Academic Publishers (2001)

Introduction to Robotics (Ting Wang)

Content: motion planning, kinematics, inverse kinematics, sensors and actuators. It will also expose students to some of the contemporary happenings in robotics

Aim: Understanding the structure of robotic systems and the modelling and simulation of robotic systems in MATLAB/Simulink

Bibliography

[1] Cubero S., Industrial Robotics: Theory, Modelling and Control

Digital Electronics (Hadj Daoud Mouselmal)

Content: Boolean algebra, Karnaugh maps, combinatory logic, sequential logic.

Aim: This course introduces the students to digital electronics and provides a broad overview of many important concepts, components, and tools. Students will get up-to-date coverage of digital fundamentals-from basic concepts to programmable logic device.

Statistics with Python (Arben Cela)

Content: An introduction to statistics by using Python. Basic notions of Python: datatypes, including vectors and arrays, indexing, functions writing, plotting data, visualization of data. Basic notions of statistical populations, samples, distributions, expected value, variance, covariance, sensitivity, specificity, tests of means of numerical data, confidence intervals, regression.

Aim: At the end of this course, the students will be capable of using Python in order to conduct basic statistical analysis: they will be able to use input data (text file, Excel file, Matlab file etc.) in Python routines, to extract information from the input data and to visualize it. They will be able to use common statistics terminology and to implement it into Python programs by themselves or by using Python
packages (such as stasmodels)

Bibliography

[1] Haslwanter T., An introduction n t o Statistics with Python with applications in the life sciences, Springer (2016)
[2] Good P. L., Hardin J. W., Common errors in statistics an how to avoid them, Willey (2002)
[3] Unpingo J., Python for probability, statistics, and machine learning, Springer (2016)

2st Semester at ESIEE (E4-S2): January End to June

Period 1

Wireless Networks (Najib ait Saadi)
Content: Wireless LAN: IEEE 802.11 (WiFi); Wireless PAN: IEEE 802.15.1 (Bluetooth) and IEEE 802.15.4 (ZigBee); Wireless MAN : EEE 802.16 (WiMAX), 3GPP (2G / 3G / 4G / 5G), SigFOX and Laura ; Wireless RAN : IEEE 802.22 and Satellite. **Aim:** In this course, we will address the main wireless communication standards. The objective is to allow the students to understand the Pros & Cons of each wireless technology in terms of i) bandwidth, ii) energy consumption, iii) range, iv) bit error rate, etc. In doing so, the students will be able to choose the best wireless standard fitting the i) requirement of the flows, ii) hardware constraints and iii) environment.

Fabrication and Modelling of MEMS (P. Basset)
Content: MEMS fabrication, clean-room, Coventorware, Ansys **Aim:** This course provides fundamentals on microfabrication of CMOS and MEMS components. It includes a first practice in ESIEE cleanroom and the introduction to the most widespread MEMS simulation tools. **Bibliography** [1] M. Madou, Fundamentals of Microfabrication, CRC Press (2011, 3rd edition)

Optoelectronics and Photonics (Jean-Luc Polleux)
Content: optical waveguides, laser, photodetectors. **Aim:** Along this course, semiconductor based photodetectors and lasers will be developed. Optical interactions with the semiconductor are detailed, as well as waveguiding properties into fibers and integrated optical waveguide. **Bibliography** [1] Semiconductor Optoelectronics, M.A. Herman, John Wiley & Sons Editions [2] High-speed Electronics and Optoelectronics (Devices and circuits), S.Prasad, H.Schumacher, A.Gopinath [3] Fundamentals of Photonics, G. Lifantes, Wiley, 2003

Digital ASIC (Anne Exertier)
Content: synthesis, static timing analysis, design for test, place&route, power analysis, ASIC design flow. **Aim:** This course focuses on digital designs implementation on ASIC (Application Specific Integrated Circuit). During this module, you will implement a digital ASIC on AMS 0,35µm technology. You will synthesize the design with RTL Compiler, insert scan respecting DFT (Design For Test) rules, impose timing constraints (with SDC script), verify the constraints are met, export your design for the back-end methodology. Using Encounter Design Implementation, you will place and route the design checking at every step the design constraints are still met.

IoT Prototyping (Olivier Venard)

Content: 6LoWPAN, MQTT, IoT Thingsworx platform

Aim: This course is an introduction to IoT prototyping based on the different technological blocks of the connected objects : sensors, embedded systems, protocols, software, network, cloud,...

Introduction to FPGA (Yves Blanchard)

Content: FPGA, VHDL

Aim: This course focuses on digital system implementation on FPGA (Field Programmable Gate Array) for non specialist. The main specifities of this kind of circuits will be covered. Two kind of methodologies will be presented, fast prototyping and design using an Hardware Description Language.
Why FPGA, Field-Programmable Gate array?
It is one of the most powerful general-purpose programmable digital circuits today!!
It is used to implement complex digital computations for signal processing or systems control.
A project is proposed in which all design steps will be seen through the realization of a digital system for machine control.

At the end of this module:
- you will be able to define the specifications of the needed digital circuit
- you will acquire a methodology to design it,
- write the corresponding VHDL code
- evaluate your design behaviour through simulations
- and implement it on FPGA for validation.

The DE1-SoC board will be used to this end.

Bibliography

[1] Pedroni, V. A., Circuit design and simulation with VHDL, MIT Press (2010)
[2] Rushton A., VHDL for logic synthesis / 3rd ed., Wiley (2011)

French Business and Culture (MSH-4303D) (D.Mainwaring) (E4 semester 2)

Content: Decision in French Management Context; Social Culture; Internship French context; Skills in looking for an internship

Aim:

1. French Business Culture: The key or salient features of French culture related to the world of work and business
   - To enable you to work more effectively in a French company
   - To compare the French business environment to others
2. Communication Skills 2: Interview skills.
   - To make your CV as impressive as possible
   - To write an effective cover letter

RF System Fundamentals (Shermila Mostarshedi)
Contents: S-parameters, IP3, filters, link budget, noise figure, RF architecture **Aim:** This course aims to provide students with the description of standard communication systems architecture. It will then describe how those topologies lead to individual requirements for the system itself as well as for individual sub-systems and devices. Several critical sub-systems will then be analyzed in detailed such as non-linear continuous wave amplifier and filters. From this approach, complete linear and non-linear budget of the communication link will be established. At the end of this course your skills will : To be able to analyse the gain of a complete RF chain To be able to analyse the impact of each block on the noise of the link To manipulate scattering parametes to analyse components and systems from MHz to GHz (and more) To be able to optimize the architecture of complete RF and wireless systems in terms of gain, noise and non-linearities **Bibliography** [1] Egan W. F., Practical RF System Design, Wiley [2] Ludwig R., Bogdanov G., RF Circuit Design: Theory & Applications (2nd Edition) [3] Pozar D. M., Microwave and RF wireless system, Wiley [4] Gu Q., RF System design of transceivers for wireless communications, Springer

Clinic Course Project (E4 semester 2)
Contents: Half a day per week project in parallel to 2nd semester courses (from February to April)

Period 2

Full time Project (E4 semester 2)
Contents: Two-month full time project from May to June

Year 2:
1st Semester (E5-S2): September to December

Period 1

Electromagnetic Modeling for Circuits and Packages (Elodie Richalot)
Content: EMC, HFSS. **Aim:** This course introduces electromagnetic modeling applied to the integration of a system into its package. This aspect is a key challenge that is crucial to solve in the industry and to which development of numerical tools turned on. Attendees will also investigate system-on-chip and system-in-package integration techniques. Content: Numerical tools; Passives electromagnetic modeling; EMC and Packaging; System on chip (SoC) and in Package (SiP) integration.

Fundamentals of microfluidics and analytical (T. Bourouina)
Content: Microfluidics, analytical chemistry, environment monitoring. **Aim:** The objective of this course is to introduce a new class of miniaturized devices at the interface between physics, chemistry and biology. These devices take advantage of merging several key technologies including nanomaterials, microfluidic lab-on-chip, micro-optics and surface treatment. While those devices have numerous applications in biology and medecine, a special focus is put on the field of environment, including air quality and water quality monitoring. **Bibliography** [1] H. Bruus, Theoritical Microfluidics, Oxford Master Series in Physics, 2007 [2] Microfluidics and sensors https://en.wikibooks.org/wiki/Microtechnology/Microfluidics_and_Sensors [3] Chromatography - The Most Versatile Method of Chemical Analysis – Open access: https://www.intechopen.com/books/chromatography-the-most-versatile-method-of-chemical-analysis [4] Developments in Near-Infrared Spectroscopy – Open access : https://www.intechopen.com/books/developments-in-near-infrared-spectroscopy [5] Progresses in Chemical Sensor – Open access : https://www.intechopen.com/books/progresses-in-chemical-sensor

Energy Building modeling and case study 1 (ENE-5101A) (E. Nefzaoui)
Content: Basics of building energy needs and consumption modeling and projects on renewable energy and energy efficiency **Aim:** Buildings are responsible for 30% of global energy consumption. Tremendous efforts are spent to reduce this large share. Building energy modeling (BEM) is a powerful tool to reach this goal. This course provides the basics of BEM using wide use software such as Matlab or BEM specific software. In addition to the priority challenge of energy efficiency in Buildings, students attending this lecture will be invited to solve wider energy efficiency and renewable energy problems largely inspired from those addressed by industry engineering departments, consultancy agents and researchers in the field. **Bibliography** [1] J. Clarke, Energy Simulation in Building Design, 2 edition. Oxford: Routledge, 2001. [2] General renewable energy and energy efficiency textbooks

Embedded Operating Systems (Yasmina Abdeddaïm)

Content: The different tools used on the target system: kernel, uboot, rootfs, busybox ; Native compilation of a program on the target machine ; The tools used for Cross-compilation ; Develop/deploy an application to be used on the board ; Construction of a minimal image for a Raspberry Pi ; Customization of the image.

Aim: This course aims to present the methods and tools needed to build a GNU/Linux operating system using the source code. During the practical, students have to build their own Linux operating system embedded on a Raspberry-pi 2.

Clean Room (O. Francais)

Content: Fundamentals of semiconductor materials and processing - Typical process flows of IC and MEMS foundry services - Keynote advanced Lab session: Fabrication and test of a MicroDevice in clean-room

Aim: This course is intended to give the knowledge of fundamental semiconductor processing, including micro- fabrication of both integrated electronic circuits as well as MEMS devices. The most conventional technology steps will be detailed. Typical process flows will be discussed as well. The courses will be organized around experimental clean room sessions in which the students in the clean room of ESIEE-Paris will achieve classical microelectronic process.

Bibliography

[1] S.M. Sze, VLSI Technology, McGraw-Hill, 1983.
[2] Madou, M.J., Fundamentals of Microfabrication: The Science of Miniaturization, 2nd ed. CRC Press, Boca Raton, FL, 2002.

RF and Microwaves Circuits (Shermila Mostarshedi)

Content: filters, LNA, mixer, RFPA.

Aim: This course is the following of the “RF circuit fundamental” course and will focus on the design of every typical Radio-Frequency (RF) integrated circuits, from amplifiers to filters and A/D or D/A converters. Finally selection criteria for IC technologies will be given to optimize circuit performances. Content: RF and microwave circuits fundamentals; Design of low-noise and high-power amplifiers; Design of mixers and oscillators; Filter technologies; Selection criteria for IC technologies versus performances.

Materials and Nanomaterials (Y. Leprince / P. Basset)

Content: Nanomaterials, Synthesis methods, Characterization methods, Carbon nanotubes & Graphene.

Aim: The objective of this course is to introduce the fundamental knowledge for nanomaterials: elaboration, characterization, proprieties, and applications. Content: The fundamental of the materials science: different types of materials and their characteristics; Introduction on the nanoscience and the nanotechnologies; Different methods for nanomaterials fabrication and characterization; Various properties (physical, chemical, mechanical and multi applications of the nanomaterials). Keynote advanced Lab Session: Polluted water purification by photocatalysis process using ZnO nanowires.

Bibliography

[1] Springer Handbook of Nanotechnology | Bharat Bhushan | 3rd revised and extended edition, 2010.
[2] Nanomaterials: An Introduction to Synthesis, Properties and Applications | Dieter Vollath | 2nd Edition, Wiley-VCH, 2013.
[3] Nanostructures & Nanomaterials: Synthesis, Properties, & Applications | G.Cao, Y.Wang | 2nd edition, World Scientific, 2011.

Internet of Things (Olivier Venard)

Content: various technologies and architectural principles of the Internet of Things (Consumer IoT and Industrial IoT); the transmissions protocols, data concentration and processing; the market structures related to these technologies, LWPAN radio transmission technologies

Aim: The aim of this course is to present the IoT solution architectures and the different protocols implemented in IoT applications and their properties and to be able to understand the structure of IoT markets

Corporate Profiling (MSH-5104D) (D.Mainwaring)

Content: Profiling an unknown company. The basics of business analysis.

Aim:
After participating in this part of the course (12hrs) students should be able to:
- Find out basic information about any company, enterprise or organization
- Be able to use basic tools of Business Analysis, such as SWOT, PEST, Ansoff matrix, BCG analysis, Porter's 5 Forces etc.
- Use these tools and techniques during their post-graduation job search

Energy Harvesting for Autonomous Sensors (P. Basset)

Content: Kinetic Energy Harvesting (KEH), piezoelectric and electrostatic transduction, conditioning electronic, LT Spice, Internet of Things (IoT), Wireless Sensor Network (WSN)

Aim: Ambient energy harvesting has recently emerged as a solution to power autonomous sensors. The objective of this course is to study various technics for power generation used in small systems in order to increase the lifetime of abandoned sensors. Special attention will be given to vibration energy harvesting technologies but photovoltaic, thermoelectric and RF waves energy conversion will be also considered.

Bibliography

[1] Danick Briand, Eric Yeatman and Shad Roundy (Editors), Micro Energy Harvesting, Wiley
[2} Philippe Basset, Elena Blokhina and Dimitri Galayko, Electrostatic Kinetic Energy Harvesting, Wiley

Antennas (Jean-Marc Laheurte and Thierry Alves)

Content: small antennas, directive antennas, Yagi, dipole, monopole, NEC2.

Aim: The aim of this course is to train students toward the techniques of antenna design. Content: Integrated antennas; Small antennas; Multi-antenna systems. An introduction and training to antenna design with NEC is also an important part of this course. Finally a design and build of a four band antenna will be done by the student.

Bibliography

[1] Kraus J. D., Marhefka R. J., Antennas for all applications, McGraw-Hill Edition (1988)

Period 2

Advanced Electron Devices (Jean-Luc Polleux)
Content: semiconductor physics, HBT, HFET, LED, Laser, photodiode, phototransistor, CMOS transistor **Aim:** The purpose of this course is to describe the physics and the electrical modeling of the most advanced technologies used nowadays in all digital, analog and optoelectronic applications. The course will also provide description of advanced compact-circuit models that are mandatory for any circuit design. The proper choice of this model with respect to the designed circuit is a critical point. Finally, an overview of available industrial technologies will be provided with an insight on how to select the technology of choice regarding the targeted application requirements. Content: Advanced CMOS technologies; Heterojunction materials and devices (HBT, HFET, Optoelectronic); Advanced Compact-circuit-models; Overview of industrial technologies (RF IC and MMIC). At the end of the course the student will be able to : - to select an appropriate semiconductor - to design an HBT for high frequencies - to design an HFET for high frequencies or sensor applications - to developp a compact circuit model for HBT, HFET and advanced CMOS technologies - to understand the design of an optoelectronics semiconductor devices based on heterojunctions

Localisation (Geneviève Baudoin)
Content: GPS, Zigbee, localisation algorithm. **Aim:** This course will teach to the student the general principals of indoor and outdoor localisation systems. Thanks to a mini-project some interesting aspects can be introduced to the student : -development of an android app for indoor/outdoor localisation. -development of an indoor localisation system based on zigbee modules (deployment of the system, measurements, study of the measurements). -localisation algorithm development on Matlab. -deployment of an indoor/outdoor localisation system with a special develoment on software or hardware parts.

Energy Building modeling and case study 2 (ENE-5203A) (E. Nefzaoui) (E5 semester 2)
Content: Basics of building energy needs and consumption modeling and projects on renewable energy and energy efficiency (Requires ENE-5101A) **Aim:** Buildings are responsible for 30% of global energy consumption. Tremendous efforts are spent to reduce this large share. Building energy modeling (BEM) is a powerful tool to reach this goal. This course provides the basics of BEM using wide use software such as Matlab or BEM specific software. In addition to the priority challenge of energy efficiency in Buildings, students attending this lecture will be invited to solve wider energy efficiency and renewable energy problems largely inspired from those addressed by industry engineering departments, consultancy agents and researchers in the field. **Bibliography** [1]J. Clarke, Energy Simulation in Building Design, 2 edition. Oxford: Routledge, 2001. [2] General renewable energy and energy efficiency textbooks

Analog IC (Thierry Alves)

Content: MOSFET, Miller effect, cascode, serie peaking, shunt peaking, LNA, inductive degeneration, negative resistance, PLL, QUCS.

Aim: The student is introduced to the MOSFET transistor as an electrical device with its DC and AC (small signal) model. Then the basic amplifiers (common source, common drain and common gate) are reviewed. Basic principles of RF amplifier design are explained taking into account the MOSFET stray capacitors and all the problems related to that : Miller effect, bandwidth, impedance alteration,... After this introduction, LNA design is presented. The student will also be introduced to oscillator and PLL design. Three to four hours lab are also included for each parts of this course (lab on Miller effect, lab on LNA design, lab on oscillator design, lab on PLL). Most of this labs will be done on QUCS, an open source analog/digital electronics simulator.

Bibliography

[1] Lee Thomas H., The Design of CMOS Radio-Frequency Integrated Circuits, Cambridge Press, 2004.
[2] Razavi B., RF Microelectronics, Pearson, 2014.

Lab On Chip (Bio-5103C) (O. Francais)

Content: Introduction to Lab On Chip and application. Microfluidics design. Sensors for fluids and biological species. Labwork for design, simulation and fabrication in clean room (molding process and lift off process).

Aim: This course is intended to give the knowledge of fundamental lab on chip designing. Particular attention is given concerning the scaling laws and its benefits or drawbacks within microfluidic devices. Project around different lab-on-chip topics will be developed by the students and concluded by an oral presentation. Team work will be developed.

Bibliography

[1] H. Bruus, Theoritical Microfluidics, Oxford Master Series in Physics, 2007
[2] B.J. Kirby, Micro-and Nanoscale Fluid Mechanics, Cornell University, NY, 2010

Computational Fluid Dynamics (ENE-5202B) (X. Guo)

Content: Fundamentals of fluid dynamics and heat transfer, Navier Stokes equations, finite difference method (FDM), finite volume method (FVM), ANSYS

Aim: The aim of this module is to i) understand basic theories of numerical methods in fluid dynamics and heat and mass transfer, ii) learn to use commercial CFD tools such as Fluent, CFX and COMSOL and iii) conduct a transfer/flow analysis to a different problems chosen by each team.

[1] ANSYS FLUENT Tutorial Guide, ANSYS, Inc. release 14.1, November 2011
[2] Numerical Heat Transfer and Fluid Flow, Hemisphere/McGrawHill, New York., Patankar, S. V. (1980)

RF and Microwave Characterization Lab (Jean-Luc Polleux)
Content: VNA, spectrum analyser **Aim:** This course will focus on the measurement techniques to be involved in the characterization of components, devices, circuits and systems in the various field of the high-frequency domains: from the RF to the millimeter waves and up to the digital communications system level. Automation of measurement will also be dealt to optimize the performance of measurements setup. Content: Test of Analog, RF and Microwave communications circuits; Microwave measurement techniques. Automation techniques and data acquisition ; Keynote advanced Lab sessions: Courses completely turned on Lab sessions practice.

Project Management and Innovation Management (MSH) (D.Mainwaring)
Content: Project Management and Innovation Management **Aim:**

Topical MEMS Design (P. Basset)
Content: MEMS quasi-static accelerometer, MEMS resonant gyroscope, conditioning electronic, MEMS+, Ansys, Matlab **Aim:** This course is dedicated to the design and simulation of inertial MEMS, including their conditioning electronic. Two case studies will be developed, dealing with the design of a accelerometer and a gyroscope. We will use CAD softwares for the simulation of multi-physics components using a specific design-kit of a MEMS foundry. **Bibliography** [1] S. D. Senturia, Microsystem design, Kluwer Academic Publishers (2001) [2] V. Kaajakari, Practical MEMS, Small Gear Publishing (2009)

RF Front-end (Geneviève Baudoin) (E5 semester 1)
Content: zero IF, heterodyne, image frequency, image rejection, non-linearities, receiver sensitivity, filter, LNA, mixer, oscillator, RFPA **Aim:** This course presents different aspects of transceiver architecture for radiocommunications systems. Choices and trade-off on the architecture optimisation are explained according to the system constrains, modulation BER and defaults of principal RF system architectures. The course finish on opening about SDR, Software Defined Radio. **Bibliography** [1] Baudoin, Bercher, Berland, Brossier, Courivaud, Jardin, Lissorgues, Ripoll, Venard, Villegas, Radiocommunications numériques, Dunod, 2002