ESIEE
PARIS

ESIEE PARIS

International Masters of Electronics

- **Wireless communications**
- **Micro and Nano Technologies**

Courses Curriculum – June 2013

2013/2014

1 General Description

ESIEE Paris created recently some international masters to attract and train international students toward domains of excellence within three main fields:

- « Micro- and nano- technologies »
- « Wireless communications »
- « Computer science and imaging »

The two first main topics are covered by our International Master of Electronics. This master is entirely taught in English on a two year basis (September 2013 to September 2015 for future students). Last topic is covered by our International Master of Computer Science (IMC). See http://www.esiee.fr/en/

ESIEE Paris delivers the master degree also named as *Diplome d'Ingénieur des Grandes Ecoles*.

International Master of Electronics

The applied hands-on nature of program will provide students with qualifications very sought-after in both the current industrial environment, and in academic research. Graduates are prepared to work in all economic sectors where these advanced technologies are demanded:

- intelligent transport systems,
- mobile communications,
- information and communication technologies in homes and cities,
- telecommunications,
- aeronautics,
- multi-physics sensors,
- MEMS for urbanism,
- biological sensing,
- human body monitoring and biological interfaces,
- and many others…

An important focus will also be put as well on learning the French culture and French language while still studying technical courses in English. Taking advantage of the proximity of an international master of management of technologies and information systems (MOTIS) from ESIEE Paris, students will also have access to top level management courses in an international environment (management of innovation, entrepreneurship, finance...)

Thanks to the management training included in the program, Graduates are able to develop their careers towards various managing positions such as product manager, project leader, or technical director. Further continuation by an enrolment in a PhD program is also possible, and encouraged.

Courses organization

International students have the opportunity to go for a 100% taught-in-English track, but can also follow courses taught in French if they wish. A common core of 6 courses is imposed, plus 4 courses per option (all taught in English exclusively) among a total of 32 courses to be selected in a broad range of topics over the two years of the master.

The first year of the *"100% taught-in-English track"* consists of courses focusing on fundamental scientific and technical aspects and tools, combined with a selection of management and human sciences, French language and culture courses. A one-month internal project in an R&D laboratory of ESIEE-Engineering as well as an optional internship will complement the classwork during the first year.

The second year consists of specialized courses in one of the two options (wireless communications, micro- and nano- technologies), of practical hands-on projects and of a six-month final project. The final project takes place in a company or in a research lab under the guidance of a professor from ESIEE Paris and leads to the writing of the Master thesis.

2 *"100% Taught-in-English Track"* Courses organization

2.1 E4-IME: Master 1st year courses

1st semester - Period 1

Unit Code	Course Title	Volume
IME-4101A	Review of Electronic Fundamentals	30h
IME-4101B	Material sciences	30h
IME-4101C	Optoelectronic and photonic	30h
IS-4103E	Signals and systems	30h
PR-IT-4105E	C and C++ programming	30h
FLE-1	French as a Foreign Language 1	30h
MSH-4102D	Intercultural Management	15h

1st semester - Period 2

Unit Code	Course Title	Volume
IME-4201A	Analog circuits for sensors and receivers	30h
IME-4201B	Discrete time electronics	30h
IME-4201C	Introduction to communication systems	30h
IS-4201E	Principles of MEMS Sensors and Actuators	30h
PR-IS-4202	Introduction to FPGA	25h
FLE-2	French as a Foreign Language 2	30h
MOT1-FIN	Introduction to corporate Finance	12h
MOT1-MKT	Introduction to International Marketing	12h

2nd semester- Period 3

Unit Code	Course Title	Volume
IME-4301A	Electron devices	30h
IME-4301B	Propagation technologies	30h
ELE-4301C	Modeling and simulation of MEMS (elective)	30h
IME-4301C	RF circuits (elective)	30h
IS-4304E	Analog IC design	30h
PR-IT-4303	Lab on Signal Analysis (elective)	25h
PR-IS-4301	Design of a MEMS Device (elective)	25h
FLE-3	French Language Immersion	30h
MOT2-SEM	Management seminars	30h

2nd semester- Period 4

Unit Code	Course Title	Volume
IME4-PR	Project or Internship	3 months

2.2 E5-IME: Master final year courses

1st semester

Students have to select 7 technical courses among the following list. Students might also be accepted to select other topics taught in French from ESIEE Paris.

Relevant option	Unit Code	Course Title	Volume
"Wireless and communications"	IME-5101C	**RF and Microwave Circuits**	**30h**
	IME5-RFE	**RF Front-End**	**30h**
	IME5-IC	**RF and millimeter wave circuits: from design to layout**	**30h**
	IME5-EM	**Electromagnetic Modeling for circuits and packages**	**30h**
	IME5-MEA	**Test and measurement**	**30h**
	IME5-ANT	**Antennas and propagation**	**30h**
	IME-5101A	**Advanced Electron Devices**	**30h**
	IME-5101B	**Optoelectronic and Photonic Applications**	**30h**
	IME5-AMT	**Advanced microfabrication technologies for ICs end MEMS**	**30h**
"Micro- and Nano-Technologies"	IME5-MEM	**Topical MEMS Design**	**30h**
	IME5-NBD	**Nano & bio-chemical technologies and devices**	**30h**
	IME5-EHS	**Energy Harvesting for Autonomous Sensor**	**30h**
	IME5-NM	**Materials and Nano-materials**	**30h**
	IME-5101A	**Advanced Electron Devices**	**30h**
	IME-5101B	**Optoelectronic and Photonic Applications**	**30h**
	IME5-AMT	**Advanced microfabrication technologies for ICs end MEMS**	**30h**

Additionally Management and language courses are:

Unit Code	Course Title	Volume
FLE-4	**French as a Foreign Language 4**	**30h**
MOT1-IPM1	**International Project Management**	**18h**
IME5-IM	**Innovation Management**	**30h**

2nd semester: Final Internship (6months minimum)

Second semester is devoted to a final master thesis Internship, either in a company or in a lab. The duration is at minimum 6months, starting mid of January.

3 Detailed Curriculum

3.1 E4-IME: Master 1st year courses

IME-4101A - Review of Electronic Fundamentals

This course aims at providing a review of electronic basics to students from different background. It provides the common terminology and consolidates competences in analog electronics, electrical circuits, electronic devices and operational amplifier.

IME-4101B - Material sciences

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 waves.

IME-4101C - Optoelectronic and photonic

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 waveguides.

IS-4103E - Signals and Systems

The objective of this course is to give an accessible introduction to signals and systems for electrical engineering, computer engineering, and computer science. **Content:**

- Fundamentals of continuous-time/discrete-time signals: Fourier and Laplace transforms; Convolution and transfer function; Sampling and reconstruction
- Essentials of feedback control: representation of dynamical systems; basic feedback loops and more abstract representations; structural properties; stability and sensitivity; control algorithms and methodologies (PID, state feedback, pole placement, observers)
- Uncertainty and systems' limitations (measurement noise, actuator saturation, process dynamics)

PR-IT-4105E – C and C++ programming

This course targets to train students with computer languages. C and C++ programming will be developed mainly in on a project basis accompanied by introduction courses. Various applications of C language to scientific and technical engineering tasks will be pursued. **Content:** Introduction courses on languages and programming of hardwares; Short Project

IME-4201A - Analog circuits for sensors and receivers

This course provides the audience with knowledge and techniques in building analog circuits for various sensing applications as well as for communication receiver devices. It develops the necessary concepts and continues with circuit design examples, including practical experiments. A strong focus is put on small-signal model of transistors and their related circuits. Noise, frequency stability and power consumption reduction issues are covered.

IME-4201B - Discrete time electronics	This course is intended to develop techniques at the interface of the digital and analog domains with acquisition chains, converters and digital filters. The subject will first be handled theoretically by studying the theory of acquisition chains, and will be continued with digital filters toward sensors and communications applications. **Content:** Description of acquisition chains and theory; A/D and D/A converters principles; Converters architectures; Digital filters.
IME-4201C - Introduction to communication systems	This course browses main communication applications with the desire to present the market, the network architecture with an insight in electronic technologies involved. At the end, design requirements will be considered derived from the system level to the individual device. **Content:** Wireless technologies and standards, RFID; Wired and Optical networks; Satellite communications.
IS-4201E – Principles of MEMS Sensors and Actuators	This course gives an introduction to fundamentals of MEMS Sensors and Actuators. Basic physical principles includes structural mechanics and electrostatic transduction. Microfabrication is introduced starting from materials to the corresponding technological processes. **Content:** Introduction to MEMS (History and applications), Fundamentals of MEMS electromechanical transducers, Material Science and microfabrication technologies.
PR-IS-4202 – Introduction to FPGA	This course focuses on digital system implementation on FPGA (Field Programmable Gate Array) using VHSIC Hardware Description Language (VHDL). Combinational and sequential circuit design will be briefly covered along with associated hardware description coding. This course will help in understanding the most important issues related to the synthesis of field programmable logic devices using Altera Quartus Software. Modelsim software will be used for a first phase of simulation test bench design. Many system design examples will be considered using an FPGA board from Altera.
IME-4301A - Electron devices	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. Their electrical modeling will be key to the design of integrated circuits. An introduction to compact circuit models topology will be provided before the end of the class.
IME-4301B - Propagation technologies	The course targets to train students in high frequency technologies and techniques. Electromagnetism and propagation fundamentals will be initially reviewed. The course will then provide the audience with the tools to manipulate high frequency signals and will describe elements of technologies such as practical transmission lines, analog filters, resonators and passive components. Applications will be for the design of circuits and systems, also including RF MEMS. **Content:** Propagation basics review; High frequency techniques fundamentals; Transmission lines technologies; Analog RF filters, passives and resonators.

ELE-4301C – Modeling and Simulation of MEMS (elective)	This course provides knowledge about advanced topics which relate to MEMS behavior. Numerical simulation methods are introduced for the purpose of immediate practice of the most widespread MEMS simulation tools, for the purpose of being able to proceed to MEMS Design. Content: Advanced topics related to MEMS behavior; More transduction mechanisms; Numerical methods and related simulation tools.
IME-4301C - RF circuit fundamentals (elective)	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.
IS-4304E - Analog IC design	This course provides an extensive study of the use of transistors within analog ICs but also digital fundamental circuit blocks. The first part of the course will focus on high-speed differential stages, extending the knowledge of students from analog circuits to higher speed and sensitive amplifier scheme. The second will be deal with noise limitations within circuits at the device level. The third part of the course will consider the specific topic of the switched-capacitor circuits, giving another example of the full custom methodology to design original and efficient circuits.
PR-IT-4303 – Lab on Signal Analysis (elective)	The objectives of this unit are to present some useful operators in signal processing and to illustrate the art of programming under Matlab. The unit will mix presentation of the main concepts followed by matlab experiments. We will deal with the spectrum estimation for random signals, multivariate beamforming, optimum Wiener filtering, algebraic noise cancellation, programmation of a GUI (Graphical User Interface). Students will have to work by their own on a project and defend it.
PR-IS-4301 – Design of a MEMS Device (elective)	The objective of the project is to define a given MEMS architecture, to simulate its physical behavior and to provide the corresponding layout, which could be used in a given technological process. MEMS simulation and Design tools will be extensively used during this project. A defense of the project will be organized at the end of the project period.
MSH-4102D – Organisational Behavior: Managing Diversity	Intercultural Management: This course aims to: • Identify some of the factors that influence how decisions are made in cross-cultural management contexts • Describe key models and concepts used for comparing/contrasting cultures • Implement and use them appropriately in different cultural & organisational contexts Content includes: Managing Diversity Living in a multi-cultural environment: notions of time, space & environment Hofstede's dimensions of culture Other approaches to the analysis of cultures "Snapshots" of cultures

MOT1-FIN & MKT – **Corporate Finance** **International Marketing**	Corporate Finance At the end of this course students will be able to : • Understand the most important accounting principles used to prepare financial statements • Measure and analyse working capital requirement, net long-term financing, net short-term financing and net working capital • Prepare and interpret a cash-flow statement • Measure a firm's profitability • Calculate the net present value (NPV) of a stream of future cash flows and how to apply it to investment decisions Introduction to International Marketing When you have completed this course you will be able to: • Understand the key role of marketing, particularly with the influence of ICTs • Understand how a marketing strategy is established. • Comprehend the difference between B to B and B to C marketing policy • Implement and use the different tools of marketing analysis appropriately • Assess your own skill for marketing • Identify specificities of international marketing • Be capable of doing a marketing plan • Be capable of taking the right decisions concerning segmentation, targeting, branding, price and promotion
MOT2-SEM - Management seminars	"Management in a Changing World" Change Management, Risk Management, Creative Management, International Financial Markets, etc.
FLE1 – Français Langue Étrangère 1	Understanding and communicating in French in normal speech. (Work on pronunciation, intonation, gestural)
FLE2 – Français Langue Étrangère 2	Acquire techniques for an oral speech during a meeting (presentations, talks, discussions…). Enhance intercultural relations to enable social integration at school or on a public place.
FLE3 – Français Langue Étrangère 3	Through an intensive period, students develop more ease in the oral language with colleagues and friends. Every day life French is developed to gain autonomy in the environment. A focus is put on the cultural exchange as well.

3.2 E5-IME: Master final year courses

IME-5101A - Advanced Electron Devices	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
IME5-AMT - Advanced Microfabrication Technologies for ICs and MEMS	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. This course will be concluded by an experimental lab session in which MOS circuits will be fabricated and tested. **Content:** Fundamentals of semiconductor materials and processing; Introduction to MEMS fabrication technologies; Polymer materials and related technologies; Typical process flows of IC and MEMS foundry services. **Keynote advanced Lab session:** Fabrication and test of MEMS in clean-room
IME-5101B - Optoelectronic and photonic	This course covers the application of optoelectronic and photonic devices along two main domains: sensors and communications. The first part will be devoted to Optical MEMS systems and sensors especially in the Gaussian approximation. Second part will cover high speed electronics for communications, microwave photonic, application of photonic in radars and systems, etc. Talks will be mostly given by top leading industrial partners. Electronic and photonic convergence will be a key point.
IME-5101C - RF and microwave circuits	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; High speed D/A and A/D converters; Filter technologies; Selection criteria for IC technologies versus performances.
IME5-RFE - RF Front-ends	The aim of this course is to develop on the fundamentals of digital communication standards with a special focus on the advanced standards in next generation communication systems. Design of complete RF front-ends will be browsed from both theory and practical point of view through an important training session on OFDM front-ends design. Content: Digital communication standards ; Multi-carrier modulation format (OFDM…); Transceivers for new wireless standards; Keynote advanced Lab sessions: Training on OFDM front-ends design

IME5-IC - From RF to millimeter circuits-design	This course is an intensive and practical training on complete RF and millimeter wave monolithic ICs design. Clear hand-ons will be given to attendees with the highly enriching and exciting occasion to work on the most advanced CMOS or BiCMOS technologies internationally available. Students will design their own circuits and will processed them in real in a multi-project-wafer run. Testing will be provided through the "test and measurement" course. **Content:** Si-based and III-V technologies; Practical design training on RF IC / MMIC; **Keynote advanced Lab sessions:** Training on Europractice Technologies
IME5-EM - Electromagnetic Modeling	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
IME5- MEA - Test and measurement	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
IME5-ANT - Antennas and propagation	The aim of this course is to train students toward the techniques of antenna design. Channel modeling will allow to derive most of the constraint to be used in the further integration of single and multi-antenna systems. **Content:** Channel modeling; Integrated antennas; Multi-antenna systems
IME5-MEM – Topical MEMS Design	This course is dedicated to the design and simulation methods and tools for multi-physics components including MEMS. Important parts will be dedicated to using major CAD software packages, and to device implementation according to a specific design-kit of a MEMS foundry. **Content:** Design Methodologies and flow; Practice of ANSYS and COVENTOR; Detail of the Design-kits used for MUMPS foundry; Structural simulation and Coupled simulation case studies; **Keynote advanced Lab Session:** Design of MEMS inertial sensor for fabrication in MUMPS foundry

IME-NBD - Nano & bio-chemical technologies and devices	The objective of this course is two-fold: Part 1 - Give a general introduction to the techniques of nanofabrication, including top-down approaches and Bottom-up self-assembly techniques. Part 2 - Introduce principles and technologies for chemical and biological sensors and interfaces as well as problems of their implementation on a micro-chip. **Content:** Top-down nanotechnology (e-beam and ion-beam writing, soft lithography and nanoimprint, Atomic probe techniques, Nanotubes and Nanowires); Emerging Bottom up techniques: block copolymer nanotechnology and DNA self-assembly; Background on surface science and chemistry. Scaling laws in (bio)chemical process. Fundamentals of molecular biology, biochemistry, and cell biology; Electrochemical sensors, functionalized-surface chemical and biochemical sensors; Optical spectroscopy techniques, Chromatography and Mass spectrometry; The Lab-On-Chip implementation: Bio-chips, Bio-Sensors and Bio-MEMS Background on semiconductor physics.
IME5-EHS – Energy Harvesting for autonomous Sensors	Ambient energy harvesting has recently emerged as a solution to power autonomous sensors. The objective of this course is to study various techniques 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 also be considered. **Content:** - Basics of energy harvesting; - Vibration energy harvesting: transduction techniques, nonlinear phenomena, behavioral modeling; - Introduction to photovoltaic cell, thermoelectric harvesters and RF energy conversion; - Energy harvesting in healthcare applications
IME5-NM – Materials and nano-materials	The objective of this course is to introduce the fundamental knowledge for nano-materials: 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:** Elaboration of ZnO nanowire arrays by chemical route.
MOT1-IPM1 **International Project Management**	International Project Management When you have completed this course you will be able to: • formulate a project vision statement • identify project risks and opportunities • submit a project proposal • construct a work breakdown structure • devise a project dashboard • pilot the project • carry out a post project review.
FLE4 – Français Langue Étrangère 4	Develop written and oral languages structures. Increase French vocabulary.

Other courses available:

Digital circuits, Mixed Analog-Digital Electronics, Communications Systems, Transport Systems, Embedded Systems, Computer Sciences, etc

See http://www.esiee.fr/en/