M2RI-3EA is an international research master degree in Electronic

This Research Master entitled «Electronics, Electrical Energy, Automatic» (M2RI-3EA) is a one-year study aiming at bringing students the theoretical background required to be an expert in the field. This research oriented program is intended to form highly qualified personnel to be active in microelectronic or in acoustic and piezoelectric materials and their applications or in control engineering industries. This Research Master is managed by international high-level institutes, such as Polytech Tours, INSA CVL, the GREMAN and the PRISME Laboratory.

This Masters, taught entirely in English, aims to specialize students in the science and engineering of microelectronics, with emphasis on a variety of subjects like materials for electronics, nanotechnologies, elastic waves in solids, piezoelectric applications, design, numerical modeling, reliability, life cycle analysis, processing and instrumentation, etc.

This program will cater to the needs of both engineering and science majors.

Close contacts with the Industry will be provided through off-campus work assignments in industry.
(internships) or in academic lab. Our goal is to produce well qualified materials scientists and engineers who can function effectively in the technical arena as well as possess the skills to assume leadership roles in industry, academia, and government.

**The program's objectives are to produce graduates who are:**

- able to apply the principles of materials science for undertaking advanced engineering and/or research projects.
- knowledgeable about a variety of engineering materials (piezoelectric, microelectronics), and the relationships among processing, structure, properties, and performance.
- able to define and solve problems, especially those involving materials selection and design, and are able to develop, implement and evaluate solutions via integration of their basic scientific skills and knowledge.
- able to communicate effectively and who demonstrate the ability to function in multi-disciplinary teams.
- skilled at using modern engineering tools for characterization, analysis and design of materials.
- able to understand their responsibility towards their profession and society in a global context.

**Content**

**Semester 9**

**TU 1: Materials and Technologies for Microelectronics (I) - ECTS 4 - 20h**
This course describes the processes of fabrication of semiconductor devices. Knowledge of technologies for electronic components and microcircuits fabrication.

**TU 2: Elastic waves in solids (I) - ECTS 4 - 20h**
Fundamental knowledge of piezoelectricity. Knowledge of acoustics principles in electronic applications and piezoelectric instrumentation.

**TU 3: Automatic control (I) - ECTS 4 - 20h**
This course will allow students to master the controller and observer design for nonlinear dynamical systems. Understanding the behavior of a dynamical system. Understanding the stability of a dynamical system. Mastering algorithms of linearization of nonlinear dynamical systems.

**TU 4: Advanced Robotics (I) - ECTS 4 - 20h**
This course will enable the students to control robots in industrial applications and to discover new fields of research on humanoids and biorobotics. Unit’s goals: Being able to use the methods of dynamic modeling of robotics systems; Being able to identify and control an industrial robot and/or servicing robot; Being able to mobile robots, develop planning and localization algorithms; Being able to discover new
fields of research on humanoids and biorobotics.

**TU 5: Bibliographic Search/Seminar - ECTS 2 - 30h**
This course aims at: improving the research skills of students; helping students to plan their own research; developing critical evaluative skills in relation to the researches conducted by other scholars.

**TU 6: Preparation to Professional Activity - ECTS 1 - 10h**
Preparing the professional project, learning techniques for job search, defining a professional project and developing a networking approach, expressing personal skills in a professional vocabulary.

**TU 7: French as a Foreign Language or English - ECTS 3 - 30h**
Students attending the 3EA master program will have to succeed to an English Level Test and to French Level Test.

Each student has to choose between thematic background:

- **Power Microelectronics Background:**
  **TU 8a: Power Devices and Systems - ECTS 4 - 25h**
  Getting a better understanding of the power devices, developing specific know-how of static converters’ operation, being able to simulate the electric behavior of power devices and systems using a specific software tool (PSIM). Being able to choose a power structure depending on the application requirements.

- **TU 8b: Materials and Technologies for Microelectronics (II) - ECTS 4 - 25h**
  Microelectronics technology overview, device structures and process integration, process and equipment requirements, metallization - physical vapor deposition, growth - thermal oxidation. Surface cleaning, MOS defect chemistry, epitaxial semiconductor growth, ion implantation and diffusion, fundamental chemical processes. Thermal CVD - semicond, diel, metal, rapid thermal processing, plasma-enhanced CVD (PECVD), plasma equipment, plasma etching. Lithography, silicides, packaging and interconnect technologies, MEMS and batteries. Knowledge of technologies for electronic components and microcircuits fabrication.

- **Acoustic and Piezoelectric Background:**
  **TU 9a: Piezoelectric Materials and their applications - ECTS 4 - 25h**
  The aim of the course is to broaden the knowledge of piezoelectric materials principles, constitution and applications. This will allow students to work directly in laboratories or companies that deal with these applications. Knowledge of piezoelectric transducer constitution, Knowledge of electrical piezoelectric transducer modeling, Application to piezoelectric components, and systems for industrial and research applications.

- **TU 9b: Elastic waves for electronic system (II) - ECTS 4 - 25h**
  The aim of this course is to highlight how the fundamental knowledge acquired in the UE2[R 17] teaching unit can be applied to create acousto-electric components and to deal with electronic systems and scientific instrumentation. Application of the acoustics principles to electronic devices, Application of the acoustics principles to signal processing components. Application of the acoustics principles to electronic systems, and instrumentation in industrial as well as research applications.

- **Automatic and Robotic Background:**
  **TU 10a: Multiphysics modeling - ECTS 4 - 25h**
This course intends to help students to develop the capability of system thinking by introducing classical and advanced system engineering and multiphysics modeling theory, methods, and tools. Applying systems engineering tools (e.g., requirements development and management, robust design, Design Structure Matrix) to realistic problems.

Testing the plausibility of a solution from many perspectives (functional, structural, performances).

Finding and classifying the critical points of a designed system.

Identifying how the assumptions and constraints of each subsystem affect other subsystems.

**TU 10b: Cyber physical integrity - ECTS 4 - 25h**

Introduction to the research, analysis and attack diagnosis of cyber-physical systems - the tight integration of computing, control, and communication. Discussing applications for the CPS research such as medical devices, smart buildings, vehicle systems, and mobile computing. Modeling a simple physical system to obtain a support to analyze an attack effect. Testing the plausibility of solutions to detect a failure. Finding and classify the critical points of a physical systems. Understanding and use fluently CPS simulation.

**Semester 10**

**TU 11: Research INTERNSHIP: 4-6 month - ECTS 25**

The students have to realize a 4-6 months internship in a research laboratory or in an industrial environment. During this period, they will review the literature and work on a research project under the direction of the project supervisor. The final project report will be defended in front of the jury. The project can be carried out at one of the European partners of this program.

**Total ECTS Points: 60**

**Scientific partnership**

The Research specialty «Electronics, Electrical Energy, Automatic» is based on the skills of:

- the GREMAN, a University-based Research team of Tours and INSA-CVL Blois
- and the PRISME Laboratory (INSA-CVL Bourges)
- To these laboratories, many industrial partners of the competitiveness cluster S2E2 (Faiveley, Forclum, STmicroelectronics, Legrand, Vermon …) and industrial partners (such as Thales Avionics Vendôme, Thales air système Elancourt, EADS, …) are added.

**Contact**

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