Course Description

Course name	**#038 - Silicon-on-Insulator Technologies from Microelectronics to MEMS**
Duration	**3 days**
Format	**Public Classroom, Inhouse Event and Online**

Overview

Professor Jean-Pierre Raskin is teaching this 3-day SEMI course. He will demonstrate the advantages of SOI technology for RF CMOS integration as well as for building thin film sensors on thin dielectric membrane and three-dimensional **Micro-Electro-Mechanical Sensors (MEMS)** and actuators co-integrated with their associated SOI CMOS circuitry. SOI is for sure today one of the most promising technologies for meeting the requirements of **More than Moore Roadmap.**

Technical Focus

This last decade **Silicon-on-Insulator (SOI) MOSFET technology** has demonstrated its potentialities for high frequency (reaching cut-off frequencies close to 500 GHz for nMOSFETs) and for harsh environments (high temperature, radiation) commercial applications. SOI also presents high resistivity substrate capabilities, leading to substantially reduced substrate losses, crosstalk and non-linearities.

Today, the demand for the newly developed **RF-SOI** is booming and it is becoming the major material adopted by all the foundries for high-performance RF applications. All new smartphones have RF-SOI inside.

More recently, SOI technology has been emerging as a major contender for heterogeneous **microsystems** applications.

In this series of lectures, we will demonstrate the advantages of SOI technology for RF CMOS integration as well as for building thin film sensors on thin dielectric membrane and three-dimensional micro-electro-mechanical (**MEMS**) sensors and actuators co-integrated with their associated SOI CMOS circuitry. SOI is for sure today one of the most promising technologies for meeting the requirements of **More than Moore** roadmap.

Besides the RF SOI and SOI MEMS thematics, two other major aspects that nanoelectronics is facing today will be covered by the lectures. The first one concerns the economic, technical, environmental, and social issues related to the development of the nanoelectronics required by the fast on-growing **digital society**. Everything seems to be fast, clean, reconfigurable, etc. but behind our screens there is an industry which requires, more than ever, space, energy and matter.

Since tens of billions of electronics objects are being disseminated all over the world in homes, buildings, cars, roads, etc., there is an urgent need to revisit the economic, technological, and societal models to develop a **sustainable electronic industry** that will care about its impact right from the design of these objects.

The second topic which will be addressed concerns the need to develop new **characterization techniques to explore the physical properties of materials** of the size that are used in today's

electronics, it means at **nanometer scale**. MEMS-based lab-on-chips to extract the (electro)-mechanical properties of thin metals, dielectrics and semiconductors will be presented.

Course Content
The primary objectives of the course are as follows:

(a) Exposing the participants to fundamentals and applications of Silicon-on-Insulator (SOI) Technology

(b) Provide in-depth content which covers wide perspective i.e. from device to microsystem in SOI technology

(c) Capability building of participants in terms of usability and maturity of SOI technology for wide-ranging real-world applications

Who should attend?
This course is for engineers working in the field of microelectronics, designers of microwaves devices and MEMS sensors.

Course Daily Schedule

DAY 1:

- Specifications of RF ICs such as RF switches, LNA, PA,… (1 hour)
- MOS capacitor over a wide frequency band (1,5 hour)
- RF interconnection lines on top of silicon-based substrate, problematic of parasitic substrate conduction (1 hour)
- Introduction of the trap-rich concept (1 hour)
- High quality interconnection lines and passives on top of trap-rich SOI (2 hours)
- Impact of temperature on passive elements integrated on Si-based substrate (1 hour)

DAY 2:

- Newly developed techniques to improve the RF performance of Si-based substrate, such as buried depletion layer between implemented PN junctions, formation of porous silicon, depletion layer induced by field effect, etc. (1 hour)
- Small-signal equivalent circuit of SOI MOSFET (1,5 hour)
- Analog and RF performances of state-of-the-art RF SOI transistors (2 hours)
- RF performance and self-heating comparison between FinFET and FD SOI transistors (2 hours)
- Urgent need for more sustainable electronics (1,5 hour)

DAY 3:

- Bulk micromachining techniques (1 hour)
- Surface micromachining techniques (1 hour)
- SOI MEMS sensors (2 hours)
- Internal stress in thin films, source of innovation for building 3D MEMS (1 hour)
- Simple lab-on-chip MEMS device to characterize the (electro-)mechanical properties of nanometer scale materials (1,5 hour)

Instructor Biography

Professor Jean-Pierre Raskin. Full Professor at Institute of Information and Communication Technologies, Electronics and Applied Mathematics (ICTEAM), Electrical Engineering Department (ELEN), Université Catholique de Louvain, Belgium

Being convinced that changes in the industry will not come if scientists and engineers are not trained to think differently, Professor Raskin established **5 years ago**, in collaboration with the NGO Louvain Cooperation, a lecture named ***IngénieuxSud*** in which **a systemic approach is taught to students** from the Sector of Science and Technology at UCL. The aim of this lecture is to encourage students to open their mind to complexity, to strengthen their capacity to commit themselves individually and collectively to a sustainable transition.

In order to achieve this ambitious objective, *IngénieuxSud* guides the students towards a better understanding of the political, social, economic, environmental and cultural stakes of our societies and stimulates changes in values, attitudes and behaviors. This **lecture changes the mindset** of students towards considering parameters related to **sustainable development, appropriable technologies and social justice** in the analysis, design and implementation of projects. Students, privileged actors of transition, must have the capability to **go beyond their areas of expertise**, to embrace the **complexity of the world** and to bring solutions that integrate parameters that go far beyond technical efficiency and economic profitability. *IngénieuxSud* encourages students to reflect on the meaning of their future career as scientists. Since September 2017, *IngénieuxSud* has been integrated in the program of Louvain School of management.

IngénieuxSud initiative recently received the **European Global Education Innovation Award 2017**.

It is worth mentioning that Prof. Raskin joined the committee of the Hoover Chair of economic and social ethics at UCL 4 years ago. His teaching commitments outside the Engineering School of Louvain aim to vanish the barriers between scientific disciplines. Today Prof. Raskin is invited to give the lecture abroad. Being well introduced and recognized in the microelectronics industry,

Prof. Raskin has established a **European consortium** grouping academics, scientists and industrials to develop together a **sustainable electronic industry**.