EUROTRAINING

# EUROTRAINING - 316526

## D 1.3.1 – Multimedia based training

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| PROJECT | EUROTRAINING – FP7 - 316526 |
| ABSTRACT | Deliverable 1.3.1 - This document contains the description of 67 multimedia based courses and the criteria used to choose these courses |

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# 1. Executive summary

EuroTraining is a FP7 Coordination and Support Action with the aim of providing a European Training Infrastructure facilitating the provision of high calibre training in the field of nanoelectronics and micro/nanosystems across Europe.

According to recent experience, more and more web-based short courses (e.g. as short as only one hour), webcasts, videos or just slide shows and white papers are published on the internet by research institutions, equipment manufacturers and technology developers (actors from the front end of the value chain). Unfortunately they do not have sufficient effect on the activities of the application/manufacturing (back end) actors, have even less effect on SMEs, and especially no effect on SMEs in the less developed (East and South) European region by the simple lack of information on the existence of this training.

To stimulate the take-up of this training EuroTraining has elaborated a selection of relevant web-based training in the field of nanoelectronics and micro/nano systems. A clearly structured document was elaborated containing an extensive overview on 67 existing nanoelectronics multimedia based training courses such as webinars, online courses, videos, webcasts, slide shows, etc. The document classes the courses according to different selection criteria: topics, language, tutors, providers, for free or with registration fees, prerequisites, duration, etc.

All web-based courses from this document will be made available on-line on the multimedia platform of EuroTraining www.eurotraining.net and will be disseminated by e-mail to the 16'000 EuroTraining newsletter subscribers.

# 2. Multimedia based material and training

## 2.1. Objectives of the task

According to recent experience, more and more short courses (e.g. as short as only one hour), webcasts, videos or just slide shows and white papers are offered by research institutions, equipment manufacturers, technology developers (actors from the front end of the value chain), which unfortunately do not have sufficient effect on the activities of the application/manufacturing (back end) actors, have even less effect on SMEs, and especially no effect on SMEs in the less developed (East and South) European region. By the extension of the existing infrastructure of EuroTraining with a multimedia platform (T4.2) and applying a proper course promotion strategy (T4.4), these course contents of high technologies could be easily accessed by SMEs, which are short of scientific/technical information. In this way EuroTraining will strengthen the cooperation between the front end and back end actors of the value chain of smart integrated systems, will increase the awareness of Joint Assessments of (combined) equipment/metrology/process solutions for suppliers and users, will shorten the user-supplier feedback loops, and will stimulate the take-up of converging technologies by SMEs of the industrial sector. This kind of training will be well suited for the global training described in T3.2, as well.

The objective of this deliverable is a clearly structured document containing an selection of at least 25 existing nanoelectronics multimedia based training courses such as webinars, online courses, videos, webcasts, slide shows, etc. The document will class the courses according to different selection criteria: language, topics, tutors, for free or with registration fees, prerequisites, duration, etc. The information from this document will be made available on-line at the multimedia platform developed in WP4.

## 2.2. Analysis of multimedia based training

This paragraph is a short summary of the analysis of David Glance, Martin Forsey and Myles Riley.and helped to choose multimedia courses for nanoelectronics applications.

**About the authors**

Associate Professor **David Glance** is director of the University of Western Australia (UWA) Centre for Software Practice, a UWA research and development centre. His research interests include open source software, technology and society and health informatics

Associate Professor **Martin Forsey** teaches at the University of Western Australia and has written about neoliberal reform of schooling, school choice and supplementary education.**Myles Riley** is a Research Assistant at the University of Western Australia.

**Summary of the report**

In 2011, the respective roles of higher education institutions and students worldwide were brought into question by the rise of the massive open online course (MOOC). MOOC platforms Coursera (2012a), edX (2012) and Udacity (2012) have partnered with 33 universities, offering more than 200 courses to over two million students in 196 countries (Coursera, 2012b). Courses offered have attracted enrolments of up to 160,000 students (Fazackerley, 2012) lending the “massive” portion to the name MOOC. These courses are also free or “open”. Given that these courses are being offered by some of the most prestigious of universities, the potential disruptive nature of MOOCs was recognised early on. After all, if a student could take a course from Princeton University for free, why would they pay for an identical course given by their local (less famous) institution? Given the growth in availability of MOOCs, the question could be extended to why someone wouldn’t do an entire degree programme in this way. Of course, there are a number of practical issues that need to be resolved before this happens. Providing proctored examinations to students who have had their identities verified being the most salient. However, a more fundamental question has been raised on both sides of the argument. Namely, do MOOCs represent a pedagogically sound format for learning at a tertiary level? Claims for and against the pedagogical foundations of MOOCs have been made by a variety of interested parties (Association for Learning Technology, 2012; Baker, 2012; Moe, 2012) but these claims have been backed with only a scant amount of evidence or indeed agreement as to the defining characteristics of a MOOC and the pedagogical foundations it rests upon.

The pedagogical foundations claimed for MOOCs follow on from their attributes and in part are justifications for those attributes. So it has been argued that online learning is particularly effective, formative quizzes enhance learning through the mechanism of retrieval practice, short video formats with quizzes allow for mastery learning and peer and self–assessment enhance learning. Further claims have been made that short videos complement the optimal attention span of students (Khan, 2012) and that discussion forums provide an adequate replacement of direct teacher–student interactions that would be considered normal for a class delivered on campus. These attributes and their pedagogical consequences are shown in Table 1.

**Table 1: Characteristics of MOOCs and their related pedagogical benefits.**

| **MOOC characteristic** | **Pedagogical benefits** |
|---|---|
| Online mode of delivery | Efficacy of online learning |
| Online quizzes and assessments | Retrieval learning |
| Short videos and quizzes | Mastery learning |
| Peer and self–assessment | Enhanced learning through this assessment |
| Short videos | Enhanced attention and focus |
| Online forums | Peer assistance, out–of–band learning |

## 3. Methodology for multimedia based courses choice

Before the final choice of the courses we had discussion in the EuroTraining consortium in order to identify the most important topics of the nanoelectronics.

We have chosen to classify the courses along the three categories of the integrated electronics: More Moore, More than Moore and beyond CMOS, and the below listed sub-categories:

- **MORE MOORE**
  - CMOS Overview
  - Lithography
  - Materials for Electronics
  - Low power
  - FDSOI
  - FINFET
  - Memories
  - NOC
  - Asynchronous Architectures

- **MORE THAN MOORE**
  - MEMS technologies
  - NEMS for sensing
  - 3D technologies
  - MEMS RF
  - Photonics on Silicon
  - Organic electronics

- **BEYOND CMOS**
  - TFET
  - Nanowires and Nanotubes transistors
  - Graphene and 2D transistors
  - Nanorelays
  - Molecular Electronics
  - QCA
  - Neuromorphic Architectures
  - Quantum Computing

## 4. Selection of multimedia based courses

The multimedia based courses have been selected according to following criteria:

- Course topic in one of the identified categories of the integrated electronics (More Moore, More than Moore and beyond CMOS)
- Highly skilled and experienced lecturers
- High notoriety and reputation of the providing institution (e.g. IMEC, Berkeley, IMT, IEEE)
- Easy course accessibility. Free access courses are chosen in priority.

A clear difference is made between fundamental courses addressing in priority undergraduates and generally extracted from websites of universities and courses or seminars addressing graduate students or researchers working in research or industries. These courses are generally short videos (between 1 hour and 3 hours) and different providers may be identified as speakers in conferences, or professors working in research centers (IMEC academy for instance).

Totally 67 multimedia courses in nanoelectronics and micro/nanosystems have been selected.

For the final classification, the categories mentioned in the previous chapter have slightly been extended for more clarity, adding a chapter on the *Fundamentals* and by subdividing the *More Moore* chapter.

Finally, the 67 selected courses have been classified according to the following categories:

- Fundamentals-Technology and Physics
- More Moore-Technology
- More Moore-Design
- More than Moore- Technology and Design
- Beyond CMOS-Technology and Design

The detailed tables are on the next pages.

## 4.1 FUNDAMENTALS- Technology and Physics

| Course title | level | duration | fees | provider | tutor | abstract |
|---|---|---|---|---|---|---|
| **Driving the future with nanotechnology** http://www.youtube.com/watch?v=mGT4taikc6Y | undergraduate | 1/2 | free | | Kota Murali | Introduction to nanotechnology applications |
| **How Computers Work: Information** http://www.youtube.com/watch?v=AtqjxyV9t1I | undergraduate | 1/2 | free | | Joshua Hawcroft | Introduction to computer science |
| **Quantum Mechanics** http://www.youtube.com/watch?v=Nv1_YB1IedE | undergraduate | 1 | free | | Joshua Hawcroft | Introduction to quantum mechanics |
| **Vibrations and Waves** http://www.youtube.com/watch?v=Nv1_YB1IedE | undergraduate | 1 | free | MIT | SHO | Principles of waves propagation |
| **Characteristic Time and Length, Simple Kinetic Theory** http://www.youtube.com/watch?v=XfWkgDLc4xA | undergraduate | 1 | free | MIT | Gang Chen | Main principles of physics of transport |
| **Solutions to Schrödinger Equation, Energy Quantization** http://www.youtube.com/watch?v=bESVLOTvijk | undergraduate | 1 | free | MIT | Gang Chen | Basic elements of quantum mechanics |
| **Crystal Bonding & Electronic Energy Levels in Crystals** http://www.youtube.com/watch?v=rfgaLeHq5f0 | undergraduate | 1 | free | MIT | Gang Chen | Basic elements of solid state physics |
| **Phonon Energy Levels in Crystal and Crystal Structures** http://www.youtube.com/watch?v=lcVaTjSpn7Y | undergraduate | 1 | free | MIT | Gang Chen | Basic elements for understanding vibrations and phonons in solids |
| **Microfabrication Technology** http://www.youtube.com/watch?v=nAaweyqtqlo&index=1&list=PL-XXv-cvA_iCUd5HQso6RFO_CApbpdXjW&t=0s | undergraduate | 30 | free | Berkeley | Clark Tu-cuong Nguyen | Full course about fabrication of microelectronic components and integrated circuits |
| **Electrical Engineering** https://www.youtube.com/view_play_list?p=-XXv-cvA_iDy-rACIy-kh40XJJDp3Y0X | undergraduate | 30 | free | Berkeley | Sayeef Salahuddin | This course covers the fundamental circuit and device concepts needed to understand analog integrated circuits. |
| **Integrated Circuit Design** http://webcast.berkeley.edu/playlist#c,d,Electrical_Engineering,-XXv-cvA_iDFmJmdSEKx40kOsMHePEXU | undergraduate | 30 | free | Berkeley | Tsu-Jae King Liu | Integrated-Circuit Devices - Overview of electronic properties of semiconductor. Metal-semiconductor contacts, pn junctions, bipolar transistors, and MOS field-effect transistors. |
| **Advanced Analog Integrated Circuits** | undergr | 30 | free | Berkeley | Elad Alon | Analysis and optimized design of monolithic operational amplifiers and wide-band |

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| https://www.youtube.com/view_play_list?p=EC2253E580A37DDC66 | aduate | | | | | amplifiers; methods of achieving wide-band amplification, gain-bandwidth considerations; analysis of noise in integrated circuits and low noise design. Precision passive elements, analog switches, amplifiers and comparators, voltage reference in NMOS and CMOS circuits, Serial, successive-approximation, and parallel analog-to-digital converters. Switched-capacitor and CCD filters. Applications to codecs, modem. |
| **Electrical Engineering**<br>https://www.youtube.com/view_play_list?p=EC5198B4B55A37C1AB | | 30 | free | Berkeley | Ian Rabbey | CMOS devices and deep sub-micron manufacturing technology. CMOS inverters and complex gates. Modeling interconnect wires. Optimization of designs with respect to a number of metrics: cost, reliability, performance, and power dissipation. Sequential circuits, timing considerations, and clocking approaches. Design of large system blocks, including arithmetic, interconnect, memories, and programmable logic arrays. |
| **Introduction to Digital Integrated Circuits**<br>https://www.youtube.com/view_play_list?p=ECD4C75518947B4347 | | 30 | free | Berkeley | Borivoje Nikolic | Optimization of analog and digital integrated circuits |
| **Advanced Topics in Circuit Design**<br>https://www.youtube.com/view_play_list?p=EC81E2F15D026EEA81 | | 30 | free | Berkeley | Elad Alon | Design and optimization of digital functions and filters |

## 4.2. MORE- MOORE- technology

| Course title | Level | Duration | Fees | Provider | Tutor | Abstract |
|---|---|---|---|---|---|---|
| **CMOS Device Scaling - Past, Present, and Future** http://eds.ieee.org/webinars.html | graduate | 1 | IEE member | IEEE | Yuan Taur | This tutorial reviews the history of CMOS devices and projects their future prospects |
| **Working Successfully in the Semiconductor Industry** http://eds.ieee.org/webinars.html | graduate | 1 | IEE member | IEEE | Doug P. Verret | In this webinar you will not hear about the results of a rigorous sociological or anthropological study on the semiconductor industry workplace, but rather a personal perspective of someone who has worked in the industry for three and a half decades. You will hear about the characteristics of the industry as a whole and how it affects the work life of a typical engineer. |
| **Packaging Challenges in a World Driven by the Internet of Things and Migration to the Cloud** http://eds.ieee.org/webinars.html | graduate | 1 | IEE member | IEEE | W. R. "Bill" Bottoms | The semiconductor industry growth was driven first by government requirements with mainframe computing as the primary platform, the second phase of growth came from desktop computers for both business and consumer applications. Today mobile consumer devices are the primary drivers of increasing transistor count. Packaging requirements change as the primary drivers of industry growth change. The relative importance of performance, power, latency, size, weight and cost are different in each application. |
| **The FinFET 3D Transistor and the Concept Behind It Abstract** http://eds.ieee.org/webinars.html | graduate | 1 | IEE member | IEEE | Chenming Hu | The concepts of "ultra-thin-body (UTB) MOSFET" and of the body thickness as a new scaling parameter (as gate oxide thickness used to be) will be illustrated with FinFET and UTB-SOI. |
| **Modeling and Analysis of Single Event Effects** http://www.silvaco.com/webinar/modeling_and_analysis_of_single_event_effects_webinar_bn.html | graduate | 1 | free | SILVACO | Christopher Nicklaw | This webinar will provide a discussion of the methods used by radiation effects engineers to model the impact of Single Event Effects (SEE) and some of their effects on devices and circuits. The remarkable advances in modern device technology creates specific challenges for high–fidelity radiation effects modeling of these phenomena, while the reduction of feature sizes has made the accurate modeling of SEE and other radiation effects of critical importance. |
| **Enabling 20nm for multimedia convergence** http://synopsys1.http.internapcdn.net/synopsys1/icc-stmicroelectronics-dac-2012/main.htm | graduate | 1 | free | ST | Philippe Magarshack | On June 4, 2012, Synopsys hosted an IC Compiler luncheon during the Design Automation Conference (DAC) where Mr. Philippe Magarshack of STMicroelectronics spoke about enabling 20nm for multimedia convergence |
| **On-chip Networks Presentation** http://sonicsinc.com/resources/presentations/future-soc-design/ | graduate | 1 | free | ST | John Bainbridge | Analysis and performances of networks on chip |
| **Reliability modeling of deeply scaled CMOS technologies & impact on design** https://imec.csod.com/LMS/catalog/Welcome.aspx?tab_page_id=-67&tab_id=-1 | graduate | 1 | Free on request | IMEC | Francky Catthoor | In the coming technology nodes beyond 28 nm severe reliability challenges are becoming manifest. Unavoidably designers will have to adapt to these challenges. In order to understand this approaching situation, it is essential to first understand the models underlying the heavily reduced life time expectations and especially the impact on parametric reliability issues. |

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| **A scalable SoC for energy-efficient biomedical signal processing**<br>https://imec.csod.com/LMS/catalog/Welcome.aspx?tab_page_id=-67&tab_id=-1 | graduate | 1 | Free on request | IMEC | Maryam Ashouei | We are working on the application of wireless sensor nodes (WSN) for ambulatory monitoring of physiological signals. To reach this goal, the wireless sensor nodes should be small with very low power consumption. Adding more intelligent to the WSN via on-node signal processing not only helps in reducing the radio power consumption, which is dominant in the node total power consumption, but also provides extra functionality and diagnosis capability; |
| **Leakage physics and modeling**<br>https://imec.csod.com/LMS/catalog/Welcome.aspx?tab_page_id=-67&tab_id=-1 | graduate | 3 | Free on request | IMEC | Wieslaw Kuzmicz | In deep submicron CMOS static gates static power consumption is no longer negligible due to large static currents that flow in the devices in their " off " state. This lecture discusses the origins of these currents: sub threshold current, gate tunneling current, junction tunneling currents and other static currents. The goal is to explain how these currents depend on the device design (process and layout) and its operating conditions (such as VDD and body bias). |
| **OI and multiple gate transistors**<br>https://imec.csod.com/LMS/catalog/Welcome.aspx?tab_page_id=-67&tab_id=-1 | graduate | 3 | Free on request | IMEC | Thierry Poiroux | Description of the Silicon On Insulator technology and the application for designing multiple gate transistors. |
| **Low power CMOS 65 and 45 nm industrial technologies**<br>https://imec.csod.com/LMS/catalog/Welcome.aspx?tab_page_id=-67&tab_id=-1 | graduate | 3 | Free on request | IMEC | Thomas Skotniky | Description and comparison of the 65 and 45 nm low power CMOS technologies. |

## 4.3. MORE MOORE-Design

| Course title | level | duration | fees | provider | tutor | abstract |
|---|---|---|---|---|---|---|
| **Leading the Way to 20nm Design with IC Compiler**<br>http://www.synopsys.com/cgi-bin/dac2012ms/videos/reg1.cgi?file=20nm-icc-dac-2012 | graduate | 1 | Free on request | SYNOPSIS | SYNOPSIS | On June 4, 2012, Synopsys hosted an IC Compiler luncheon presentation during the Design Automation Conference (DAC). Attendees heard from industry experts in foundry, processor, wireless and consumer electronics companies, such as GLOBALFOUNDRIES, Oracle, Samsung and STMicroelectronics who shared how they have successfully met the 20nm design enablement challenge using IC Compiler. This video gives you a chance to hear from the trail blazers themselves. |
| **Reliability modeling of deeply scaled CMOS technologies & impact on design**<br>https://imec.csod.com/LMS/catalog/Welcome.aspx?tab_page_id=-67&tab_id=-1 | graduate | 3 | Free on request | IMEC | Francky Catthoor | In the coming technology nodes beyond 28 nm severe reliability challenges are becoming manifest. Unavoidably designers will have to adapt to these challenges. In order to understand this approaching situation, it is essential to first understand the models underlying the heavily reduced life time expectations and especially the impact on parametric reliability issues. |
| **A scalable SoC for energy-efficient biomedical signal processing**<br>https://imec.csod.com/LMS/catalog/Welcome.aspx?tab_page_id=-67&tab_id=-1 | graduate | 3 | Free on request | IMEC | | We are working on the application of wireless sensor nodes (WSN) for ambulatory monitoring of physiological signals. To reach this goal, the wireless sensor nodes should be small with very low power consumption. Adding more intelligent to the WSN via on-node signal processing not only helps in reducing the radio power consumption, which is dominant in the node total power consumption, but also provides extra functionality and diagnosis capability. |
| **Ultra low power low voltage re-configurable SoC for bio-medical applications**<br>https://imec.csod.com/LMS/catalog/Welcome.aspx?tab_page_id=-67&tab_id=-1 | graduate | 3 | Free on request | IMEC | Mario Konijnenburg | Energy efficient digital signal processing is an essential component in autonomous wireless sensor nodes. In many sensor nodes the required performance accommodating bio-medical applications may vary a lot between standby state, low-voltage and low-speed operation up to full performance at nominal supply. |
| **A guided tour of the Interconnect road map**<br>https://imec.csod.com/LMS/catalog/Welcome.aspx?tab_page_id=-67&tab_id=-1 | graduate | 3 | Free on request | IMEC | Roberto Suaya | First talk: The technology components:<br>The technology generations (90 nms down to 45 nms and beyond). Side effects on Interconnects. Maximum signal frequency, Increased role of CMPs, Rough surface effects, the role of scattering on Resistance, ITRS limits, larger process variations<br>Second talk: The basic physical components: |
| **Advanced circuit design in ermerging 2D & 3D SOI technologies**<br>https://imec.csod.com/LMS/catalog/Welcome.aspx?tab_page_id=-67&tab_id=-1 | graduate | 3 | Free on request | IMEC | Thierry Poiroux | The objective of this course is to explain advantages of SOI technology for low power integrated circuits design. Models of SOI transistors will be detailed and applications to 2D and 3D applications will be introduced. |
| **Asynchronous logic: from principles to** | graduate | 3 | Free on | IMEC | Alex Yakovlev | The objective of the proposed course on asynchronous logic is to give a large overview of the un-clocked logic, the so- |

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| **applications**<br>https://imec.csod.com/LMS/catalog/Welcome.aspx?tab_page_id=-67&tab_id=-1 | | | request | | And<br>Pascal Vivet | called asynchronous logic. In the course, it will be presented what are the basic principles and advantages of this type of logic, the high level modeling and synthesis related aspects, as well as system level issues such as architecture, arbitration, de-synchronization techniques. The course will also present the Globally Asynchronous Locally Synchronous (GALS) design style, |
| **Component matching: Best practice and fundamental limits**<br>https://imec.csod.com/LMS/catalog/Welcome.aspx?tab_page_id=-67&tab_id=-1 | graduate | 3 | Free on request | IMEC | Marcel Pelgrom and Maarten Vertregt | Circuit operation greatly depends on the ability to control and reproduce component parameters, such as resistances, capacitances, transistor currents. Variation in processing was in the past countered by defining process corners: boundaries in parameter variation that accounted for process tolerances. With the improved control over processing, this batch-to-batch variation is largely under control. However, now a new class of phenomena has appeared: statistical variations. |
| **CMOS front-end design at Millimetre Wave frequencies**<br>https://imec.csod.com/LMS/catalog/Welcome.aspx?tab_page_id=-67&tab_id=-1 | graduate | 3 | Free on request | IMEC | Alexandre Siligaris | Models of CMOS transistors for RF applications are given in this course. A few examples of front-end RF will be detailed at millimeter Wave frequencies |
| **Integrated LC oscillators**<br>https://imec.csod.com/LMS/catalog/Welcome.aspx?tab_page_id=-67&tab_id=-1 | graduate | 3 | Free on request | IMEC | Piero Andreani | This tutorial will go through the fundamental of LC oscillator and LC VCO design, such as basic phase-noise theory, design for low power, low phase noise and large tuning range (including varactor choice), but will also include other key issues such as supply pushing, LDO-VCO co-design, routing/buffering the oscillator signals in large SoCs, and PLL-VCO co-design for fully integratable frequency synthesis. |
| **Millimeter-wave Design in Silicon Technologies**<br>https://imec.csod.com/LMS/catalog/Welcome.aspx?tab_page_id=-67&tab_id=-1 | graduate | 3 | Free on request | IMEC | Didier Belot | This presentation will cover the different aspects of the design, from the applications to the implementations in silicon technologies. |
| **Low power digital design in advanced CMOS technologies**<br>https://imec.csod.com/LMS/catalog/Welcome.aspx?tab_page_id=-67&tab_id=-1 | graduate | 3 | Free on request | IMEC | Wim De Haene | In this course is shown how low power design is still possible when scaling goes beyond 90 nm. First a short review of classic power reduction techniques at technology, circuit and architectural level is given. Then it explains why technology scaling is no longer living up to its classical promises when it comes to power and energy reduction. |
| **Ultra-Low voltage analog circuit design**<br>https://imec.csod.com/LMS/catalog/Welcome.aspx?tab_page_id=-67&tab_id=-1 | graduate | 3 | Free on request | IMEC | Christian Enz | At very low voltage many problems have to be solved for analog applications. Electrical models of transistors are explained and detailed for analog applications. Rules and limits of ultra-low power analog design will be detailed with examples. |
| **Ultralow-power MEMS-based Radio for WBAN**<br>https://imec.csod.com/LMS/catalog/Welcome.aspx?tab_page_id=-67&tab_id=-1 | graduate | 3 | Free on request | IMEC | Christian Enz | Transceivers for wireless body area networks (WBAN) and wireless sensor networks (WSN) require both extreme miniaturization and ultra low-power dissipation in order to be seamlessly integrated virtually everywhere and enable ubiquitous connectivity among persons, objects, machines and the environment. |

## 4.4. MORE than MOORE-Technology and design

| Course title | Level | Duration | Fees | Provider | Tutor | Abstract |
|---|---|---|---|---|---|---|
| **Planar Nanowire-based Transistors and Vertical Nanowire-based Solar Cells: Performance and Manufacturability**<br>http://eds.ieee.org/webinars.html | graduate | 1 | IEEE members | IEEE | Xiuling Li | This talk will focus on two semiconductor nanowire nanotechnologies developed at Illinois. First, I will introduce a method to realize scalable 3D III-V transistors using MOCVD grown planar nanowire arrays. Planar nanowires represent a new nanowire paradigm that is self-aligned, transfer-printable, and compatible with planar processing technologies. Monolithically grown HEMTs using GaAs planar nanowire array as the channel material, will be shown with record $f_T/f_{max}$. I will then discuss heterogeneous integration of vertical III-V nanowires on silicon and graphene by direct epitaxy for solar cell applications. |
| **Circuits on Cellulose: From Transistors to LEDs, from Displays to Microfluidics on Paper Abstract**<br>http://eds.ieee.org/webinars.html | graduate | 1 | IEEE members | IEEE | Andrew Steckl | The drive to improve the performance and reduce the cost of electronic, photonic and fluidic devices is starting to focus on the use of materials that are exotic for these applications but actually readily available in other fields. In this talk the use of paper as a substrate will be reviewed for a variety of applications, including transistors, light emitting diodes, displays, microfluidics. Paper is a very attractive material for many device applications: very low cost, available in almost any size, versatile surface finishes, portable and flexible. From an environmental point of view, paper is a renewable resource and is readily disposable (incineration, biodegradable). |
| **Emerging Memory Webinar Abstract**<br>http://eds.ieee.org/webinars.html | graduate | 1 | IEEE members | IEEE | Victor Zhirnov | This lecture is intended to provide an expository, physics-based, framework for the estimation of the performance potential and physical scaling limits for emerging memory devices. The approach taken seeks to provide physical insight into those parameters and those physical effects that define device performance and scaling properties. |
| **Organic Electronics – where are we, where do we go?**<br>http://eds.ieee.org/webinars.html | graduate | 1 | IEEE members | IEEE | Karl Leo | Organic semiconductors with conjugated electron system are currently being intensively investigated since they offer the possibility for novel, flexible, low-cost, ubiquitous electronics. Possible applications are for logic and memory devices and for optoelectronic devices such as organic light-emitting diodes (OLED) and organic solar cells. |
| **From Deep Trenches to Skyscrapers-- Orthogonal Scaling Abstract**<br>http://eds.ieee.org/webinars.html | graduate | 1 | IEEE members | IEEE | Subramanian S. Iyer | The absence of cost effective lithography and patterning schemes is predicted to make the historical expectations of the cost –performance benefits of scaling (popularly known as Moore's "Law") difficult to sustain. In this talk we introduce the concept of orthogonal scaling. Orthogonal scaling refers to features that can be added to the technology which significantly enhance the technology and which are sustainable over several generations of technology. |
| **Introduction to Physics and Technology of Solar Cells Abstract**<br>http://eds.ieee.org/webinars.html | graduate | 1 | IEEE members | IEEE | Prof. Dalal | Direct conversion of solar energy into electricity using solar cell technology has now become a major industry, with over 16 GW of solar cell panels being produced in 2010 almost cost competitive with peaking power in suitable locations. This webinar will focus on the basic physics of solar cells, the material properties, manufacturing technologies, and methods for increasing the conversion efficiency. The physics and status of advanced solar cell technologies will be discussed in the upcoming webinar. |
| **Fully autonomous Tire Pressure Monitoring** | graduate | 1 | IEEE | IEEE | Stefano | The objective of this work is to increase car safety with an autonomous Tire Pressure |

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| **System (TPMS) powered by a vibrational electrostatic energy harvester**<br><br>http://eds.ieee.org/webinars.html | | | members | | Stanzione | Monitoring System (TPMS) that is located on the inner-liner of a car tire. A large effort is done to replace the nowadays used non-rechargeable batteries with small and long lasting power sources like energy harvesters. |
| **Electrochemical sensors**<br><br>https://imec.csod.com/LMS/catalog/Welcome.aspx?tab_page_id=-67&tab_id=-1 | graduate | 1 | Free on request | IMEC | Marcel Zevenbergen | Electrochemical sensors are extremely versatile, intrinsically low power and can be applied in many areas. Illustrating this, I will discuss the basic functioning and performance of two electrochemical sensors developed at imec. First, we developed a multi-ion generic sensing platform based on miniaturized ion-selective electrodes fabricated by photolithography or screen printing techniques. These sensors have been applied as pH sensors for perishable monitoring (meat and milk) and incorporated in a wearable, flexible sweat patch, |
| **Energy harvesting for wireless sensor nodes: principles, applications and outlook**<br><br>https://imec.csod.com/LMS/catalog/Welcome.aspx?tab_page_id=-67&tab_id=-1 | graduate | 1 | Free on request | IMEC | Ruud Vullers | Wireless Sensor Nodes (WSN's) are expected to play an increasing role in multiple application areas. These application areas vary from networks around the human body (BAN), sensors in tires (Intelligent Tires), sensor networks that can control the safety and comfort levels throughout buildings (Smart Buildings), sensors that monitor the necessity for maintenance (predictive maintenance) and sensors that track the conditions of food throughout the distribution chain (Smart Packaging). |
| **Architectural simulations for hardware software codesign in life sciences research**<br><br>https://imec.csod.com/LMS/catalog/Welcome.aspx?tab_page_id=-67&tab_id=-1 | graduate | 1 | Free on request | IMEC | Wilfried Verachtert | At imec, the ExaScience Life lab is doing research on the application of high performance computing in the area of life sciences. This is a collaboration between Janssen Pharmaceutica, Intel, imec and all Flemish universities. Since we are targeting future exascale computer systems – planned to become available around 2020 – in our lab, we also work on fast hardware simulators. Our current simulator – Sniper (http://snipersim.org/) – is substantially faster than current cycle accurate simulators and has good predictive value. |
| **A silicon microfluidic platform for lab-on-a-chip applications**<br><br>https://imec.csod.com/LMS/catalog/Welcome.aspx?tab_page_id=-67&tab_id=-1 | graduate | 1 | Free on request | IMEC | \| Paolo Fiorini | The term Lab-on-a-chip (LoC) refers to microsystems capable of performing complex diagnostic analysis. LoC based on silicon, although considered more expansive than polymers, offer clear advantages in terms of robustness, minimum critical dimensions, possibility of integration. In the last few years a silicon microfluidic platform has been developed at imec, it combines on the same substrate structures with mm and um size, thus allowing large design freedom and versatility. |
| **Stretchable electronics**<br><br>https://imec.csod.com/LMS/catalog/Welcome.aspx?tab_page_id=-67&tab_id=-1 | graduate | 1 | Free on request | IMEC | \| Paolo Fiorini | First developments on stretchable electronic circuits date from about 10 years ago. Pioneering work was done mainly in the USA (Princeton University, Johns Hopkins University, Lawrence Livermore Nat. Labs.). Nowadays R&D developments on the subject are going on worldwide. Groups at imec (CMST, REMO) also are taking part in this research domain. Fraunhofer-IZM (Germany) and imec are the two institutes which have developed technologies, which are quite close to standard printed circuit board (PCB) technologies, and which therefore have the highest potential for future industrialization. |
| **Sensing the world with millimeter-waves**<br><br>https://imec.csod.com/LMS/catalog/Welcome.aspx?tab_page_id=-67&tab_id=-1 | graduate | 1 | Free on request | IMEC | Wim Van Thillo | Millimeter-wave (mmWave) radars operating at 79GHz offer higher range, angular and Doppler resolution than at lower frequency bands. The automotive industry is migrating to this band for short-range radar systems, next to the long-range systems operating at 77GHz. Beyond cars, high-resolution radar systems are applied in industrial sensing, medical monitoring of vital signs and infrastructure applications such as building automation or security systems. Even consumer electronics will employ radar |

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| | | | | | | technology, for instance in man-machine interaction and sports monitoring of speed, distance and position. |
| **Design and characterization of a biocompatible packaging concept for implantable electronic devices**<br>https://imec.csod.com/LMS/catalog/Welcome.aspx?tab_page_id=-67&tab_id=-1 | graduate | 1 | Free on request | IMEC | Maaike Op de Beeck | Packaging of electronic implants for biomedical applications it typically done by the use of a T-box, sealed very well to avoid any negative interaction between the implant and the body. With respect to biocompatibility and safety, this Ti-based packaging is a suitable solution, but it has several important disadvantages: the packaged implant is big, and the rigid box is not matching well with the soft tissue, causing a pronounced foreign body reaction (FBR). The incompatibility with MRI scanning is also an important issue. |
| **Micromechanical resonators for electronic nose applications**<br>https://imec.csod.com/LMS/catalog/Welcome.aspx?tab_page_id=-67&tab_id=-1 | graduate | 1 | Free on request | IMEC | Sywert Brongersma | Smart systems that are also aware of chemical changes in their environment remain elusive due to challenges in obtaining a satisfactory combination of sensitivity and chemical selectivity with compact low-power devices. One of the promising approaches to identification of complex vapor mixtures is to analyze signals from partially-selective sensing elements in arrays, essentially forming an “electronic nose”. |
| **Heterogeneous Design**<br>https://imec.csod.com/LMS/catalog/Welcome.aspx?tab_page_id=-67&tab_id=-1 | graduate | 3 | Free on request | IMEC | Nicolas Delorme | The design of heterogeneous microsystems (e.g. MEMS & readout electronics) has become an increasingly complex task mainly because of the variety of disciplines involved and the level of performance needed on the applications side. This seminar covers the methodologies, tools and techniques needed for the design of heterogeneous microsystems. Several practical design cases in the fields of MEMS sensing, actuating and energy harvesting are presented and the results compared to the state of the art in terms of readout resolution, bandwidth and power consumption |

## 4.5. Beyond CMOS-Technology and Physics

| Course title | level | duration | fees | provider | tutor | abstract |
|---|---|---|---|---|---|---|
| **Performance modeling for interconnects for emerging post-CMOS switches** https://imec.csod.com/LMS/catalog/Welcome.aspx?tab_page_id=-67&tab_id=-1 | graduate | 1 | free on request | IMEC | Azad Naeemi | In this talk, the potential performances of various interconnect technologies such as Cu/low k, carbon nanotube, and graphene interconnects used in conjunction with various conventional and emerging field effect transistors will be modeled. |
| **From salad dressing to nano-patterning** https://imec.csod.com/LMS/catalog/Welcome.aspx?tab_page_id=-67&tab_id=-1 | graduate | 1 | free on request | IMEC | Roel Gronheid | Find out how the smallest structures we make at imec relate to oil and vinegar and what we can do to manipulate them The lithography process is the step in which patterns are fabricated on a wafer. Directed Self-Assembly (DSA) is the new-kid-on-the-block in lithography. Traditionally, lithography has been done with an optical process that works much like a slide projector. |
| **Studying neural circuits in a small genetically tractable model organism** https://imec.csod.com/LMS/catalog/Welcome.aspx?tab_page_id=-67&tab_id=-1 | graduate | 1 | free on request | IMEC | Emre Yaksi | Understanding how the sensory world is represented in the brain and how these representations generate behaviors that are essential to the life of an organism is the fundamental challenge of sensory neuroscience. The activity of single neurons and the function of synapses have been investigated in great detail. Yet, information processing at the level of the neural circuits is less well understood. |
| **Neural circuits of vision** https://imec.csod.com/LMS/catalog/Welcome.aspx?tab_page_id=-67&tab_id=-1 | graduate | 1 | free on request | IMEC | Karl Farrow | A key function of the visual system is to extract behaviourally relevant features about the visual scene from the barrage of incoming photons. This process begins in the retina, a powerful image processor that separates the incoming information into ~20 distinct neural representations. |
| **Atomic scale modeling of nanoelectronic devices with Atomistix ToolKit** http://www.youtube.com/watch?v=1YF27lF8GwU | undergraduate | 1 | free | | Anders Blom | Introduction to nanoelectronic modeling |
| **The Integrated Circuit of Biology** http://www.youtube.com/watch?v=IgGFfxILoMQ | undergraduate | 1 | free | CALTECH | Stephan Quake | Nanotechnology and biology |
| **- Nanoelectronics and Quantum Computation** http://www.youtube.com/watch?v=5Uh6b3CDRaA | undergraduate | 1 | free | CALTECH | Charlie Marcus | Nanotechnology and quantum computing, introduction |
| **Nanotechnology and Energy** http://www.youtube.com/watch?v=1GFst2IQBEM | undergraduate | 1 | free | | Wade Adams | Nanotechnology and energy challenges, introduction |
| **Quantum Computing, what it is** http://www.youtube.com/watch?v=QISiAtWwbXg | undergraduate | 1 | free | | | Simple introduction to quantum computing |
| **Quantum Computations on a Topologically** | undergrad | 1 | free | | Rainer | Introduction to Qubit concept |

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| **Encoded Qubit**<br>http://www.youtube.com/watch?v=2iXGNqNdAwU | uate | | | | Blatt | |
| **Image Recognition with an Adiabatic Quantum Computer**<br>http://www.youtube.com/watch?v=vMvC-wv1ayo | undergraduate | 1 | free | | | Example of quantum computing application |
| **Molecular Electronics**<br>http://www.eurotraining.net/webinars.php | undergraduate | 3 | free | COREP | Danilo Demarchi | In this section, shared by courtesy of the Erasmus EU Project NanoEl, Prof. Danilo Demarchi introduces to the concept of using molecules inside nanocontacts, the nanogaps.<br>In this section, shared by Courtesy of the Erasmus EU Project NanoEl, Prof. Danilo Demarchi presents the methods for analyzing a molecule, simulating its behavior out of equilibrium too.<br>In this lecture, shared by Courtesy of the Leonardo EU Project NanoSkills, Prof. Mariagrazia Graziano gives an introduction to Quantum Cellular Automata (QCA) for building novel computational nanodevices. |

# 5. Conclusion and Further Steps

The objective of this deliverable was that 25 multimedia based training courses in the field of nanoelectronics and micro/nanosystems will be identified and included on www.eurotraining.net.

The investigations of the consortium showed that a considerable number of web based courses in this field exists on the internet so that, in the end, it was possible to select and classify 67 relevant web based courses.

Together with the traditional course brokerage providing access to more than 500 annual courses, the described action has contributed to strengthen EuroTraining's position as a unique one-stop-shop for EU based training in subjects related to micro-/nanoelectronics and micro-/nanosystems.

To make the identified multimedia based courses available to European universities and industry, they will be published in the multimedia section of the project website www.eurotraining.net. They will be searchable by the "SEARCH" function on the main page (see below print screen, figure 1).

The courses will also be announced by e-mail to the 16'000 EuroTraining newsletter subscribers (see example of EuroTraining newsletter, figure 2 below).

Furthermore, the information will be disseminated by posters and/or presentations at related international conferences.

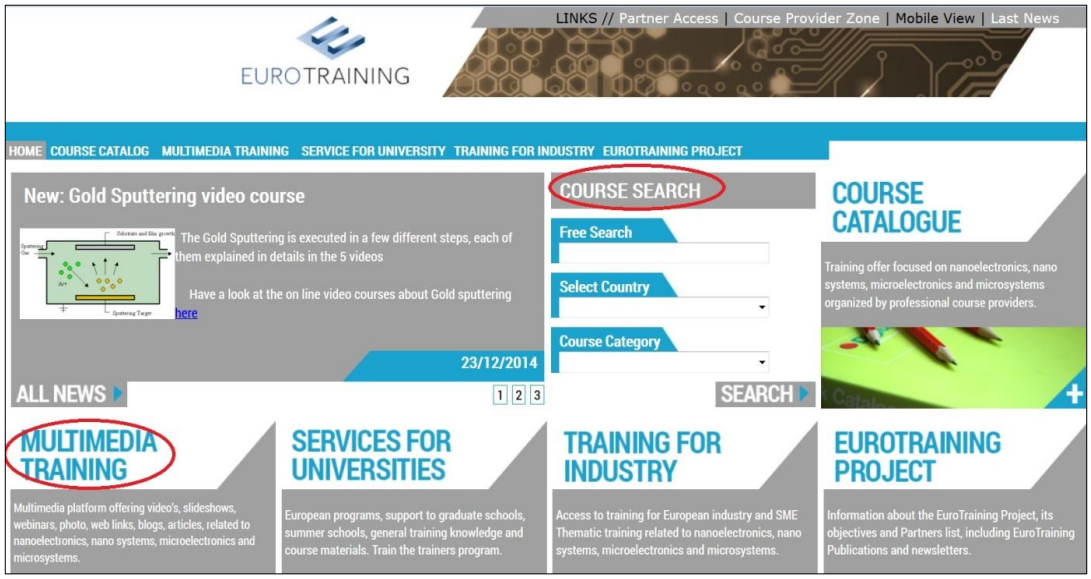


Figure 1: Top of page www.eurotraining.net with the "Multimedia Training" section and the central "Search" function providing access to the newly introduced multimedia courses.

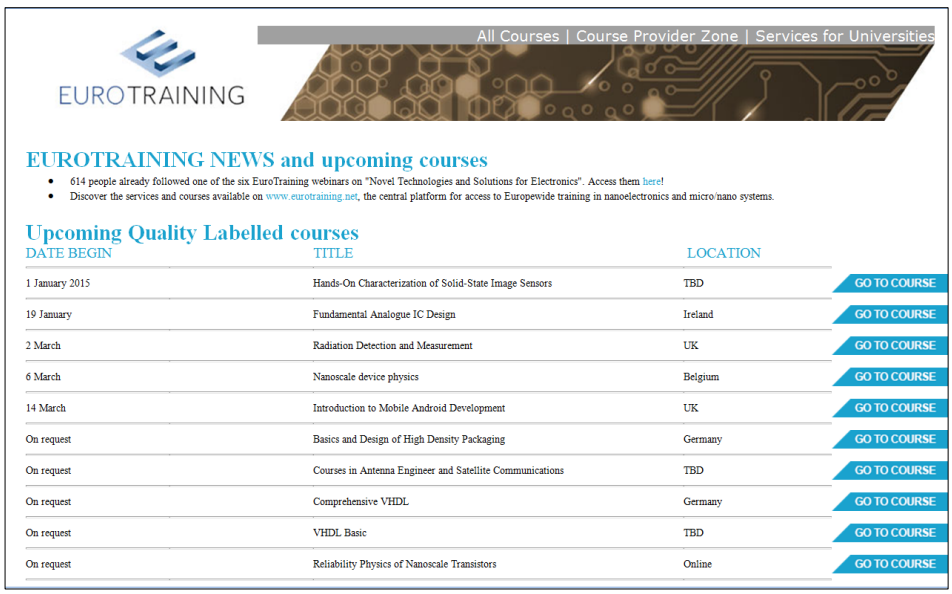


Figure 2: Example and top of the EuroTraining newsletter sent by e-mail to 16'000 subscribers monthly. The February edition will announce the multimedia courses.