Co-funded by the Erasmus+ Programme of the European Union

Course	Knowledge	Skills	Competences
'learning outcomes' means statements of what a learner knows, understands and is able to do on completion of a learning process, which are defined in terms of knowledge, skills and competence;	'knowledge' means the outcome of the assimilation of information through learning. Knowledge is the body of facts, principles, theories and practices that is related to a field of work or study.	'skills' means the ability to apply knowledge and use know-how to complete tasks and solve problems.	'competence' means the proven ability to use knowledge, skills and personal, social and/or methodological abilities, in work or study situations and in professional and personal development
Microelectronics for ICT (TUS)	Basics knowledge on registers, processors, memories, displays for computer hardware	Ability to apply the theoretic concepts to the design and implementation of novel computer devices.	Ability to manage the design of computer hardware and to apply the innovative approaches to the study of a not standard solution for the realisation of new computer architectures.
Design of Nanoscale MOS ICs (TUS)	Highly specialised knowledge on CMOS integrated circuit layout, basic technology, IC design and modelling and specific physical effects in short channel transistors.	Ability to design submicron CMOS ICs using CADENCE and solving problems with modelling of submicron devices behaviour.	Demonstrate innovation, autonomy, scholarly to the development of new modelling and design rules at the forefront of work or study contexts including research in nanoelectronics design.
Nanomaterials (TUS)	Advanced knowledge of a field of materials for nanoelectronics and their use in nanodevices fabrication, involving a critical understanding of theories and principles of their physical and chemical properties.	Advanced skills, demonstrating mastery and innovation in the use of new materials for the fabrication of new submicronic devices.	Manage complex technical and professional activities and projects in using new materials for nanoelectronics.
Nano Materials and Nanotechnology (UM)	Basic knowledge on the structure, theories and properties of nanomaterials	Ability to apply the learned skills on nanomaterials in nanoelectronics and other related applications	Demonstrate the proficiency in selecting suitable nanomaterials by designing them for appropriate methods
Materials Characterisation (UM)	Basic operation, sample preparation and interpretation of data	Ability to conduct analysis of materials using different characterization equipment.	Capable of producing new nanomaterials and characterization tools

Carbon nanotube and applications (UTAR)	Specialized knowledge on nano diamond particles and diamond like carbon films	Ability to analyze and synthesize carbon nanotubes	Apply carbon nanotubes in real life applications.
Graphene Nanoelectronics: From synthesis to device applications (UTAR)	Specialization in the area of graphene nanomaterials and its application	Synthesis and characterization of graphene material	Development of graphene based electronic devices
Top-Down ASIC Design Flow (CTBU)	Fundamental knowledge of ASIC top-down design methodology, with an introduction to practical tools, languages and optimization techniques adopted in the abstraction levels of VLSI designs.	Ability to design, optimize and simulate digital systems at RTL, at logic level and at circuit level. Ability to estimate area, power and latency at RTL level and at logic level.	Acquire a top-down design methodology to master complexity of convoluted large systems. Demonstrate innovation and autonomy in the development of digital designs.
Bio-sensing microsystems (CTBU)	Fundamental knowledge on bio-sensing systems, from each individual building block to a general system overview, with emphasis on the design abstraction levels in bio-sensing systems, transducing principles and data acquisition systems.	Ability to model and simulate a bio-sensing system. Perform metrological analysis and estimations on uncertainties and errors. Design data acquisition systems.	Combine knowledge from multiple scientific disciplines (biology and electronics) to acquire a complete overview in an interdisciplinary research field.
Advanced electronic devices (TAU)	Upon successful completion of this class, the student will be able to comprehend the basic electrical parameters of passive and active components for advanced Micro and Nano scale circuits.	The student will be able to perform the following operations: • Analyze metal oxide silicon capacitors. • Design and analyze passive components: diodes, capacitors, resistors. • Extract MOS transistor parameter	The student will be able to simulate electrical circuits using SPICE model, including parameter extraction. The student will be able to Compile a complete parameter set for any conventional semiconductor device.
Introduction to VLSI circuits (TAU)	Upon successful completion of this class, the student will have the full understanding of the basic principles of very large scale integration (VLSI) integrated circuit	The student will be able to perform the following operations: • Simulate small to medium level VLSI circuits and systems. • Verify small to medium digital	The student will be able to design, analyze complete building blocks of digital integrated VLSI circuits, and integrate them onto a system.

	(IC) design process.	circuits including data path and memories. • Estimate the performance of large VLSI circuits, using manual calculations	
Fabrication methodology for micro and nanosystems (TAU)	Upon successful completion of this class, the student will understand the various processes steps required to design and produce Micro and Nano integrated systems.	The student will be able to: 1. Analyze any Micro and Nano fabrication process flow; 2. Model process modules using basic physics and chemistry principles,	The student will be able to analyze or synthesize new Process modulus, and integrate them onto a device or systems.
Bio-Nano Electronics and BioMolecular Computing (Polito)	Basics of quantum mechanics useful for the modelling, design and use of bio-nanodevices, in particular bio-nanosensors. Knowledge of device fabrication techniques of bio-nanosystems.	Modelling of biomolecules. Design of nanosystems for sensing and computing, choosing the needed interfaces for reading the signals and transferring the information, from the nanolevel to the user interface.	The students will reach a sufficient knowledge and skill for being able of choosing novel solutions in terms of bio-nanodevices and bio-nanosensors, with the capability of guiding the strategical choices for the implementation of nanoelectronic devices and systems based on biomolecules.
Memristor Technology for Cognitive Computing (Polito)	Basics of physics for circuit modeling, analysis and design, in particular nonlinear circuit theory. Knowledge of nonlinear differential ordinary equations and nonlinear analysis.	Modelling of nanoelectronic devices and circuit analysis. Qualitative analysis on nonlinear dynamical systems (equilibrium points, periodic/chaotic attractors and bifurcation phenomena).	Students will reach a sufficient knowledge and skill for being able to analyze and design nonlinear circuits with memristors. In addition, students will acquire the fundamental principles of neural networks and machine learning algorithms.
Sensing at the Nanoscale (BIU)	Fundamentals of sensing techniques at the nanoscale, and their current applications in nano-electronics and nano-medicine	Students will be able to select the appropriate probe to their research.	Students will be able to work with important applications in wide range of topics, from bio-sensors to nano-electronics

Nanoelectronic Device (BIU)			
MEMS Design (HSN)	The student will be able to describe the working principles of a range of MEMS devices and identify methods that can be used to analyse their performance.	The student will be able to apply analytical and numerical methods to predict the behavior of a variety of MEMS sensors and actuators and evaluate their performance. The student will be able to relate design parameters to performance in order to reach design goals.	The student will have knowledge and insight into MEMS design that can also be applied to other electromechanical systems. The student will have hands-on experience with conducting a design under the constraints of a given process, as well as to report and discuss the results.
Sensor Interface (HSN)	The student should be able to: • Verify different sensor front-end techniques • Explain different interface circuits for MEMS sensors • Design front-end and signal conditioning circuits for sensors	Students will be able to design, simulate and do calculations on electronic front-end circuits for MEMS (Micro Electro Mechanical Systems) sensors. Students will also learn how to search for the latest publications in the field.	The students will be familiar with the use of microsensors and their applications in practical life. Students will be able to present their work in a scientific way by written report and oral presentation.
Raw materials for Nanobio-structures (MU)	Basic knowledge on the structure, theories and properties of biological nano/materials	Introduction to selected biopolymers and their potential substitution to synthetic polymers and their applications. The Neuronal structure, network and functioning would also be introduced to the learners along with the study of special senses like taste, hearing and vision and the role of nanostructures in the relay of this information.	To understand biological macromolecular structures and cellular organization, special sense. The nano and micro-structure correlated to their functions.
Socio-ethical and environmental aspects (MU)	Socio-ethical and environmental concerns and obligations towards use of nanotechnology	To understand need to develop technologies with due concern and respect to health and environment. Development of regulatory policies in Nano-sciences in the world as well as their country of origin.	The course intends to educate its learner that progress and sustenance of any science or technology depends on its longer term impact on society and environment.

Nanotechnology for Solar Energy Utilization (NCNST)	Fundamental knowledge on nanotechnology for efficient utilization of solar energy, with an introduction to optical properties of nanomaterials and nanostructures, with emphasis on the conversion of photon energy into electric energy via different approaches.	Ability to design and estimate a device that can convert photon energy into electric energy.	Acquire a complete overview in nanotechnology for efficient utilization of solar energy. Demonstrate innovation in the development of the semiconductor devices.
Nanoelectronic Materials (NCNST)	Fundamental chemical and physical phenomenon at nanoscale, general knowledge on nanoelectronic materials, including atomic structure, synthesis and properties.	Ability to explain quantum confinement effect and related phenomenon at nanoscale, and ability to design experiments to synthesis, characterization and measurement of nanoelectronic materials	Combine knowledge from multiple scientific disciplines to acquire a complete overview in structure, synthesis methods, structure characterization and physical property measurement of nanoelectronic materials.
Functional Nanostructures: Synthesis, Characterizations and Device Applications (NCNST)	Fundamental knowledge on nanoscience and technology; from basic introduction of some typical nanomaterials along with their synthesis and characterization methods to potential device applications.	Ability to select suitable functional nanostructures for a given application, design a synthesis method, determine the basic characterization techniques, measure pertinent parameters for device applications and interpret the results.	Acquire a complete understanding on the role of nanostructured materials toward various academic, research and technological aspects.
Introduction to Nanoelectronics: Science & Technology Basics (NIIT)	Demonstrate a working knowledge of nanotechnology principles and industry applications. Explain the nanoscale paradigm in terms of properties at the nanoscale dimension.	Apply key concepts in materials science, chemistry, physics, biology and engineering to the field of nanotechnology. Search, read and present current nanotechnology literature applied to a particular problem domain.	Identify current nanotechnology solutions in design, engineering and manufacturing.
Nanoelectronics: Processes, Computation and Design (NIIT)	Engineering science basics of nanoelectronics with potential of silicon technology, MEMS and biology-inspired concepts.	After completion of this course student will able to deal with N Nanoelectronics and computational techniques, and will be covering biochemical and	After completion of this course student will able to deal with parallel architectures, computing and softcomputing systems for nanoelectronics, complex integrated

		quantum-mechanical computers.	systems and their properties.
Nanoelectronics Systems: Future Nanoelectronic Devices and Manufacturing processes (NIIT)	Concepts of microelectronics to nanoelectronics with VLSI techniques and their limits; future nanoelectronic devices in detail.	By the end of this course, student will be able to appreciate the importance of paradigm shift of science & technology in case of nanoelectronics vis-à-vis the present day VLSI technology.	The students will be able to solve complex problems in the design and fabrication of nanoelectronics systems: manufacturing processes and applications.
Nanoelectronics Systems: Applications- Quality living with Smart Future, Present to Future Business Systems (NIIT)	Explain the history of nanoelectronics and where the field may evolve over the next 10 to 15 years.	After completion, of course student may identify societal and technology issues that may impede the adoption of nanotechnology.	Identify career paths and requisite knowledge and skills for career change toward nanoelectronics.

Definitions

For the purposes of the RECOMMENDATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL
of 23 April 2008 on the establishment of the European Qualifications Framework for lifelong learning, the definitions which apply are the following:
(a) 'qualification' means a formal outcome of an assessment and validation process which is obtained when a competent body determines that an individual has achieved learning outcomes to given standards;
(f) 'learning outcomes' means statements of what a learner knows, understands and is able to do on completion of a learning process, which are defined in terms of knowledge, skills and competence;
(g) 'knowledge' means the outcome of the assimilation of information through learning. Knowledge is the body of facts, principles, theories and practices that is related to a field of work or study. In the context of the European Qualifications Framework, knowledge is described as theoretical and/or factual;
(h) 'skills' means the ability to apply knowledge and use know-how to complete tasks and solve problems. In the context of the European Qualifications Framework, skills are described as cognitive (involving the use of logical, intuitive and creative thinking) or practical (involving manual dexterity and the use of methods, materials, tools and instruments);
(i) 'competence' means the proven ability to use knowledge, skills and personal, social and/or methodological abilities, in work or study situations and in professional and personal development. In the context of the European Qualifications Framework, competence is described in terms of responsibility and autonomy.