Ph.D. PROGRAMMES
DIPARTIMENTO DI INGEGNERIA
UNIVERSITÀ DI PALERMO – CICLO 40

OFFERTA FORMATIVA (TERZO LIVELLO)

Code	Program Involved	Title of the Course	N° hours	Lecturer(s)	Brief Synopsis	Tentative period	Language
I.1	ICT	Mathematical tools for signal representation and optimization: Beyond Fourier transforms	15	**Prof. Fabio Bagarello** *(University of Palermo)* *Contact email: fabio.bagarello@unipa.it*	This course on advanced mathematical tools for signal representation will cover the following aspects: - Hilbert spaces: the space of signals - Frame - Coherent states - Gabor transform - Wavelet transforms	April	EN
I.2	ICT	Variational analysis and optimization	12	**Prof. Antonella Nastasi** *(University of Palermo)* *Contact email: antonella.nastasi@unipa.it*	This course will cover the following aspects: • Introduction to calculus of variations. Integral functionals. • Energy functionals. • Optimization problems. Eulero-Lagrange equations. • Direct methods of the calculus of variations. • Critical point theory. Compactness conditions and Mountain Pass Theorem. Examples and open problems.	July	EN

I.3	ICT	Biomedical signal analysis: heart rate variability assessment	10	**Prof. Riccardo Pernice** *(University of Palermo)* *Contact email:* *riccardo.pernice@unipa.it*	This course aims to introduce the most widely employed heart rate variability indexes in time, frequency and information-theoretic domain and show how they can be exploited for assessing the cardiac autonomic function. The course includes both lectures and practical sessions using MATLAB software.	November	EN
I.4	ICT	Biomedical signal analysis: Reconstructing Complex System Dynamics from Time Series Analysis	10	**Prof. Yuri Antonacci** *(University of Palermo)* *Contact email:* *yuri.antonacci@unipa.it*	The aim of this course is to provide an overview of different advanced time series methods that are at the basis of the approaches currently available to study the dynamics of very different complex systems. Different methodologies will be reviewed, ranging from model-free to model-based data-driven, to artificial neural networks inspired models, describing the basic concepts and the advantages and limitations of different methods when applied to the study of physiological and non-physiological complex systems. The effectiveness of the approaches presented will be demonstrated with applications on: (i) physiological systems; (ii) electronic chaotic oscillators; (iii) climate dynamics. The course includes both lectures and practical sessions using MATLAB software.	September/October	EN
I.5	ICT/ CEBHyME	Fundamentals of Big Data	6	**Prof. Simona Rombo** *(University of Palermo)* *Contact email:* *simonaester.rombo@unipa.it*	This course will present problems, technologies and solutions for big data and data warehousing design. It will cover the following topics. Introduction to Big Data and Data Mining, Problems and solutions on data cleaning. Technologies and practical implementation: MapReduce, Apache, Hadoop, Apache Spark	July	EN

I.6	ICT	Numerical simulations and applications: Finite element analysis	20	**Prof. Andrea Tognazzi** *(University of Palermo)* *Contact email:* *andrea.tognazzi@unipa.it*	This course is an introduction to the finite element method as applicable to a range of problems in physics and engineering sciences. The emphasis is on coding up the formulations in a modern, open-source environment that can be expanded to different applications, with a special attention to the problem of signal propagation.	June	EN
I.7	ICT	Numerical simulations and applications: Labview	15	**Prof. Valentina Cosentino** *(University of Palermo)* *Contact email:* *valentina.cosentino@unipa.it*	The course introduces to LabVIEW programming.	July	EN
I.8	ICT	Electronics for the Space: Mm-wave and THz technology	10	**Prof. Alessandro Busacca** **Prof. Salvatore Stivala** *(University of Palermo)* *Contact email:* *alessandro.busacca@unipa.it*	This course aims to introduce students to the problems of generating, guiding and detecting electromagnetic radiation in the millimeter wave (mm-waves) and at Terahertz (THz) frequency bands. Recent techniques about signal-processing functionalities in the THz range will be also addressed. In particular, the course will cover: -Fields of application of mm-waves and THz-waves -Generation techniques -Receiver types THz time-domain spectroscopy and waveguides for broadband THz signal processing	September	EN
I.9	ICT	Emerging network technologies	20	**Prof. Ilenia Tinnirello** **Prof. Daniele Croce** **Prof. Stefano Mangione** *(University of Palermo)*	This course will present some emerging trends in network technologies, and in particular open architectures for beyond-5G cellular systems and solutions for massive IoT applications. It will also present some frontier topics, such as	September	EN

				Contact email: *ilenia.tinnirello@unipa.it*	methodologies for zero-touch beyond-5g networks and quantum information.		
I.10	ICT	Deep learning applications for the analysis of biomedical data	12	**Prof. Salvatore Contino** *(University of Palermo)* *Contact email:* *salvatore.contino01@unipa.it*	The proposed PhD course will deal with the use of technologies based on Deep Learning (DL) and Machine Learning (ML) on biomedical data. Specifically, it will deal with Machine Learning and Deep Learning algorithms used at the state of the art, with particular interest in the different types of chemicals, biological and medical data. The course will be structured in 12 hours, divided as follows: 1) Lecture 1 (3h). Perspective on Machine Learning and Deep Learning. Classification, Clustering and Semantic Segmentation. 2) Lecture 2 (3h). Biomedical data (structured and unstructured data). Pre-processing algorithms for data optimisation. 3) Lecture 3 (3h). DL and ML applications in chemistry and biology (Classification and Clustering). 4) Lecture 4 (3h). DL and ML applications for image analysis (Classification and Semantic Segmentation).	September/October	IT or EN (upon request)
I.11	ICT	Privacy-Preserving Techniques for Data Analysis	12	**Prof. Vincenzo Agate** *(University of Palermo)* *Contact email:* *vincenzo.agate@unipa.it*	This course will present techniques for designing privacy-preserving systems and applications, and discuss the possibilities and limitations of their use. Topics covered in the course include secure multi-party computation techniques and related cryptographic algorithms, and in-depth discussion of specialized tools and libraries for building secure systems for analyzing user data in a privacy preserving manner.	February	EN or IT upon request

I.12	ICT	Machine Learning Techniques based on FPGA	12	**Prof. Gianluigi Chiarello** *(University of Palermo)* *Contact email:* *gianluigi.chiarello@unipa.it*	The course aims to provide the state of the art on the implementation of Machine Learning (ML) and Deep Learning (DL) techniques in FPGA-type devices. This course aims to illustrate how ML techniques can be implemented in FPGA devices from a dual point of view. First, the course will focus on the technological aspect: the software and hardware tools available on the market will be presented and development methodologies will be illustrated, discussing practical cases. Secondly, the course will show the state of the art of ML applications on FPGAs through the analysis of concrete cases and examples of applications (of varying complexity).	April	EN
I.13	ICT	Introduction to embedded system design based on SoC	21	**Prof. Gianluigi Chiarello** *(University of Palermo)* *Contact email:* *gianluigi.chiarello@unipa.it*	The course aims to introduce the design of embedded systems using Xilinx SoC and the tool Vivado. After a general description of the Xilinx SoC architecture, the functionalities offered by the Vivavdo will be analysed. The following lessons will deal with the main design and integration techniques of the main functions necessary for the design of embedded systems. There will be practical exercises on development boards based on Xilinx Zynq®-7000 All Programmable SoC.	February/March	EN
I.14	ICT	Two-dimensional semiconductor	6	**Prof. Antonio Lombardo** *(University College London, UK)* *Contact email: a.lombardo@ucl.ac.uk*	Study and analysis of two-dimensional transistors with ALFIO doping. ALFIO in two-dimensional transistors refers to "approximated local field-induced orbital", a methodology developed to describe the electronic properties of two-dimensional	March/April	EN

| | | | | | materials used in transistors. In two-dimensional transistors, which exploit materials such as graphene or transition metal dichalcogenides (TMDCs), it is critical to understand and manipulate the electronic properties to improve the performance of the device.

Two-dimensional transistors are electronic devices that use atomic-thick materials, offering advantages such as increased switching speed, energy efficiency, and the potential for extreme miniaturization. Materials such as graphene, MoS_2 (molybdenum disulfide), and other TMDCs are commonly studied for these applications.

The ALFIO methodology helps describe how local electric fields, induced by the application of external voltages, affect the electronic orbitals of two-dimensional materials. These changes in the electronic orbitals directly affect the electronic transport properties of the material, such as electron mobility and drain current in the transistor. Understanding and controlling local electric fields is important because they affect electronic orbitals, which allows to optimize the performance of two-dimensional transistors, improving parameters such as switching speed, energy dissipation and operational stability. This is essential for the development of advanced electronic devices, including next-generation processors and memories. | | |

| I.15 | ICT | Navigation and Control of Unmanned Aerial Vehicles (UAVs): a comprehensive approach. | 10 | **Prof. Kimon Valavanis**

(University of Denver, US)

Contact email:
kimon.valavanis@du.edu | The course objective is twofold: i.) Provide a comprehensive study of unmanned fixed-wing and rotorcraft navigation and control techniques, including a review of kinematics, dynamics and equations of motion, sensors, identification, controller design and implementation, as well as advances in unmanned aviation technology. When focusing on multi-rotor UAVs, a detailed modeling approach based on Lagrange formulation is followed, which also accounts for rotor dynamics, gyroscopic effects, all types of drag, disturbances, and abrupt changes of mass. A comprehensive presentation of linear, linearized, nonlinear and soft-computing based controller designs are discussed, the focus being on helicopter, rotorcraft, and fixed-wing navigation and control designs. A comparison of advantages and limitations of implemented techniques follows, subsequently introducing a generalized 'one-fits-all' flight control system (FCS) in which the specific controller design approach is a plug-in-plug-out module. Implementation details and how to guarantee task execution given strict timing requirements is detailed. Case studies include simulation and experimental results for several prototype UAVs. ii.) Present a detailed methodology for designing and navigating/controlling a new type of fixed-wing aircraft with enhanced aerodynamic performance based on the concept of Circulation Control, which allows for lift enhancement, | April | EN |

					reduced takeoff and landing distance, delayed stall and increased effective payload. CC based aircraft design is followed by controller design that also includes identification of stability and control derivatives. Simulation results, experimental/wind-tunnel and flight tests validate and verify the proposed methodology. Consequently, a general framework for controller design of a class of nonlinear systems with unstructured, time-varying uncertainties (aerodynamic uncertainties) is proposed, supported by obtained results. Prerequisites: Knowledge of feedback control systems is required. Knowledge of fundamentals of robotics is desirable, but not necessary. All required background information will be presented in class.		
I.16	ICT	Qubit and entanglement: theory and applications	6	**Prof. Rosario Lo Franco** *(University of Palermo)* *Contact email:* *rosario.lofranco@unipa.it*	This course introduces qubits, entanglement, and their practical applications in quantum computing and quantum communication. Participants will delve into the foundational principles of qubits, explore the intriguing phenomenon of entanglement, and gain insights into how these concepts are harnessed in cutting-edge technologies such as quantum cryptography and quantum teleportation. Through a combination of theoretical discussions, mathematical formalism, and practical examples, this course aims to equip learners with a basic understanding of quantum phenomena,	June	EN

					such as coherence and entanglement, and their real-world implications.		
I.17	ICT	Advanced material investigations by Electron Microscopy: theoretical and experimental hints	12	**Prof. Simona Boninelli** *(IMM – CNR, Catania)* *Contact email: simona.boninelli@ct.infn.it*	Electron Microscopy has emerged has a crucial characterization technique in material science, providing highly resolved evidence of chemical, optical and morphological structure of matter from micron to atomic scale. In this course I will give an overview of physical fundamentals and electro-optical alignment lying at the basis of both Scanning Electron Microscope (SEM) and (Scanning)-Transmission Electron Microscope (S-TEM), equipped with spectroscopic tools such as Energy Dispersive X-ray Spectroscopy and Electron Energy Loss Spectroscopy. Analogies and differences between these two techniques will be emphasized. The morphology and chemical mapping of nanomaterials (nanowires, metal-oxides and metallic nanoalloys, nanobelts) and thin films (Si, Ge, SiC) will be presented pointing at their specific practical applications, spanning from microelectronics to power devices. Moreover, we will remote connect with the the Beyond nano Electron Microscopy Lab located at IMM-CNR in Catania, to follow live a S-TEM session to investigate the crystallographic atomic arrangement at the nanoscale and beyond. The tentative program is: 1st lesson: EM to overcome the resolution limit of light	February	EN

					2nd lesson: Conventional S-TEM techniques for defects characterization 3rd lesson: Spectroscopic analyses form chemical mapping 4th lesson: Remote controlled STEM analysis		
I.18	ICT	Computer-Aided Design of electronic circuits and systems	12	**Prof. Daniele Sciré** *(University of Palermo)* *Contact email: daniele.scire@unipa.it*	il corso propone di fornire le competenze di base sulla progettazione e analisi di circuiti e sistemi elettronici tramite l'ausilio di software gratuiti di simulazione basati su SPICE (es. Microcap, LTSpice). Nel corso verranno trattati gli algoritmi e i metodi numerici usati dai software di simulazione circuitale sia nel dominio del tempo che della frequenza, i modelli dei dispositivi a stato solido più comunemente usati e l'applicazione di metodi statistici e di ottimizzazione alla progettazione di circuiti elettronici. Le lezioni frontali saranno integrate da esercitazioni sull'applicazione dei concetti visti a lezione sul software di simulazione. Al termine del corso gli allievi dottorandi avranno acquisito le conoscenze operative per utilizzare adeguatamente ed in modo accurato più comuni software di simulazione SPICE.	March	EN
I.19	ICT	Machine learning techniques for cyber threat detection in distributed systems	12	**Prof. Federico Concone** *(University of Palermo)* *Contact email: federico.concone@unipa.it*	This 12-hour course will focus on the use of machine learning to detect attacks in relevant cybersecurity domains. Topics covered in the course will include intelligent data analysis techniques for discovering critical events raced by the spread of false information, as well as the	March	IT or EN (upon request)

					detection of malicious activities performed by humans in the internal perimeters of data centers.		
I.20	ICT	Robot Consciousness	12	**Prof. Antonio Chella** *(University of Palermo)* *Contact email: antonio.chella@unipa.it*	Robot consciousness focuses on attempts to apply AI, robotics, and computer science methods to various ways of understanding consciousness and examining consciousness's possible role in robot systems. The course will present the current state of research and discuss both the theoretical foundations and the experimental results of the emerging field of robot consciousness. The student will be able to apply the methodologies studied in different contexts and learn analysis and synthesis processes related to robot consciousness, including advanced methods.	March	EN
I.21	ICT	Quantum Devices and Circuits for metrology	6	**Prof. Emanuele Enrico** **Dr. Luca Fasolo** *(Istituto Nazionale di Ricerca Metrologica)* *Contact email: e.enrico@inrim.it*			EN
I.22	ICT	Microwave Quantum Sensing for target detection	10	**Prof. Patrizia Livreri** *(University of Palermo)* *Contact email: patrizia.livreri@unipa.it*	The state of the art of microwave quantum radar (MQR) based on quantum illumination (QI) protocol and exploting Josephson Traveling Wave Parametric Amplifier as a quantum source of broadband entangled photons will be describe. The quantum receiver, as joint measurement, will be addressed, as well.		EN

I.23	ICT	Microwave and Millimeter-waves Solid State Power Amplifiers: Design, Fabrication, and Characterization	20	**Prof. Patrizia Livreri** *(University of Palermo)* *Contact email: patrizia.livreri@unipa.it*	Microwave and Millimeter-wave Solid State Power Amplifiers are ubiquitous in communications, radar, automotive, and instrumentation applications. This course will cover principles of operation, structures, characteristics, classes of operation, and solid state power amplifier state of the art benchmarks. The art of power amplifier design is approached from a historical perspective. Power amplifiers utilizing Si LDMOS, PHEMT, InP HEMT/MHEMT, and GaN HEMT are described. Future trends are highlighted and summarized.		
M.1	M3AI	Computational Modelling of Composite and Heterogeneous Materials	8	**Prof. Ivano Benedetti** **Prof. Alberto Milazzo** *(University of Palermo)* *Contact email: ivano.benedetti@unipa.it*	The course will introduce some recent developments on computational modelling of composite and polycrystalline materials, with a focus on the analysis of damage and fracture problems. Some specific concepts and techniques, such as the Generalised Unified Formulation for multilayered composites modelling and Cohesive Zone Modelling for the analysis of damage and fracture initiation in heterogeneous materials, will be introduced and recent and perspective applications will be discussed. Applications to low- and high-cycle fatigue, hydrogen embrittlement, multifunctional materials will be discussed.	May	EN
M.2	M3AI	Introduction to causal analysis	8	**Dott. Salvatore Marcantonio** *(University of Palermo)* *Contact email: salvatore.marcantonio@unipa.it*	The Course aims at introducing causal analysis through graphical models according to Judea Pearl's methodology. It will cover: preliminaries, statistical and causal models, graphical models and their applications, the Effects of interventions,	May	IT

					counterfactuals and their Applications. Theoretical M.3arguments will be M3AI shown along withM.4 excerces and software presentation.		
M.3	M3AI	Fundamentals of Life Cycle Engineering techniques	8	**Prof. Giuseppe Ingarao** *(University of Palermo)* *Contact email: giuseppe.ingarao@unipa.it*	The course aims at providing skills concerning products environmental impact analysis. The whole product life cycle as well as the inventory techniques for each phase life will be analyzed. The concept of material embodied energy, as well as the idea of dominant phase of a product/component life cycle will be analyzed. Life Cycle engineering (LCE) techniques will be presented as means to identify environmentally friendly solution while designing products/components. Comparatives industrial case studies will be thoroughly analyzed. Also, the Circular Economy paradigm will be analyzed; specifically, several Circular Economy strategies concerning the case of aluminum alloys Reuse/Recycle will be presented.	May	EN
M.4	M3AI	Non-Destructive Evaluation for Industry 4.0	8	**Prof. Carmelo Mineo** *(University of Palermo)* *Contact email: carmelo.mineo01@unipa.it*	This course will discuss the evolution of Non-Destructive Evaluation (NDE) for the assessment of industrial production in the landscape of Industry 4.0. As it has happened in the history of industrial development, NDE will be critical for the success of the fourth industrial revolution, by providing the database needed for feedback in a networked production environment. This course will present a review of the recent scientific literature and of several current-day challenges	March	EN

					(informatization, digitalization, standardization, networking, etc.) that are being tackled to adapt NDE to the requirements of the rising industrial revolution.		
M.5	M3AI	Research Methods	8	**Prof. Giovanni Battista Dagnino** *(Lumsa University, Palermo)* *Contact email: g.dagnino@lumsa.it*	The PhD course in research methods is aimed to buttress students in achieving an insightful appreciation of the essence and unfolding mechanisms underlying the research process and engender the fundamental preconditions to develop the skills required to conduct inquiry and write scholarly research publishable in top-level academic journals. The targeted knowledge to achieve is concerned with the ability to execute separate parts of 'normal science' projects within professional standards including the basic guidelines for understanding theory construction and development, literature review and qualitative design.	June/July	EN
M.6	M3AI	Multi-sided platform business models	8	**Prof. Paolo Roma** *(University of Palermo)* *Contact email: paolo.roma@unipa.it*	The PhD course will provide an overview of the logic of multi-sided platforms and their business models. In a world where more and more businesses have been re-organized as multi-sided (platform) markets, the main purpose of the course is to offer PhD students a broad understanding of how multi-sided platforms can generate a competitive advantage and enhance marketability of new products and technologies. By exploring several important types of economy/business models enabled by Internet and organised as multi-sided	June	ENG

					platforms, such as sharing economy, app market, crowdfunding, the course will offer a set of guidelines on how to take advantage of multi-sided platforms in different fields of application to support innovation.		
M.7	M3AI	Sustainability Management	8	**Prof.ssa Erica Mazzola** *(University of Palermo)* *Contact email: erica.mazzola@unipa.it*	The PhD course aims to provide PhD students with the knowledge and skills necessary to critically analyze sustainability initiatives within companies and contribute to the development of robust sustainability management practices. Through theoretical discussions and practical case studies, students will delve into the reasons why companies today are increasingly aware of sustainability issues. This awareness is driven, in part, by the prevalence of greenwashing scandals and the increasingly evident impacts of climate change. Furthermore, students will explore the motivations behind companies' desires to disclose their sustainability efforts to stakeholders. Additionally, the PhD course aims to examine the various tools and strategies available to companies for sustainability disclosure, and will learn how to analyze a sustainability report.	February	ENG
M.8	M3AI	Sailing Tomorrow	8	**Prof. Antonio Mancuso** *(University of Palermo)* *Contact email:* *antonio.mancuso@unipa.it*	The PhD course will provide an overview of the design methodology in the field of sailing yacht particularly concerning high speed boats. The new opportunities provided by the use of lifting surfaces (the so-called foils) changes the design paradigm dramatically. An intensive use of advanced software aimed to improve both	February	ENG

			8		aero/hydro dynamics and structural performances become mandatory. During the course will be faced problems as far as shape, structures and rigging of a regatta sailing yacht are concerned. Will be show how the integration of CAD, FEM and CFD software allows designer to reach the final result in a faster way.		
M.9	M3AI	Computer Modeling of Cardiovascular Problems	8	**Prof. Salvatore Pasta** *(University of Palermo)* *Contact email:* *salvatore.pasta@unipa.it*	Computational modeling can revolution the way we diagnose and treat cardiovascular diseases. While medical drugs can reduce the risk of heart diseases, biomedical devices play a key role in managing cardiovascular problems. Just as in other industries, the efficacy of biomedical device and treatments can be greatly improved by using computer aided engineering (CAE). However, when compared with other industries, the biomedical engineering has been lagging in its adoption of CAE, in part due to the challenges in modeling the complexity human system and in the absence of published standards. In this course, the numerical challenges in the development of computer models for simulating the heart mechanics under normal and pathological conditions will be addressed. The role of patient-specific segmentation from medical images, the adaptation of constitutive models for simulating the electro-fluid-mechanical interaction of the myocardium and the selection of boundary conditions will be presented. Simulations of structural heart valve diseases and aneurysm physiopathology will be shown.	July	IT or EN upon request

					The need for verification and validation of computer models according to the recent ASME VV40 will be presented.		
M.10	M3AI	Concept of measurement and related qualification in terms of uncertainty in engineering processes	8	**Prof. Francesco Scardulla** *(University of Palermo)* *Contact email: francesco.scardulla@unipa.it*	No measurement provides an exact number and thus, several measurements performed in identical conditions provide different results. Hence the importance of the correct quantification of uncertainty in the technological, scientific and commercial fields, which calculation is regulated by international agreements and procedures. In this course, you will learn what information you need to calculate uncertainty, how to identify contributors to uncertainty, and how to evaluate your calculations to prevent overestimating or underestimating uncertainty. This course is highly recommended for all students who have never faced the concept of measurement uncertainty.	June	IT or EN upon request
M.11	M3AI	Innovation in measurements: from the concept of the device to the design of a business model	8	**Prof. Francesco Scardulla** *(University of Palermo)* *Contact email: francesco.scardulla@unipa.it*	During a PhD course or after its conclusion, it is possible to come up with an idea/technology that is believed to be innovative or revolutionary. Unfortunately, the only idea is not enough to bring it to the market through the launch of a startup. People don't know the steps and they are often intimidated by the whole process, letting the ideas die without any chance. In this course you will learn how to evaluate your business idea and protect it from potential competitors and what are all the first steps to take to found a start-up and let investors believing in it. The main topics that will be covered are: how to write an	April	IT or EN upon request

					executive summary and a business model, how to build a pitch and how to present it, investments options, how to properly write a patent. The last lession will be devoted to a practical pitch session.		
M.12	M3AI	Sustainable Logistics and Transportation	12	**Prof. Simona Mancini** *(University of Palermo)* *Contact email: simona.mancini@unipa.it*	The course will present the main issues arising in green and sustainable logistics and will analyze viable solutions to this issue, which include both the exploitation of more sustainable resources (such as electric vehicles) and a smarter usage of available resources. We will discuss the main advantages and disadvantages of exploiting electric vehicles, the issues to manage when dealing with such vehicles (en-route recharging planning, recharging slots reservation, recharging stations location) both in freight delivery and in public transport. The impact of different incentives, such as the introduction of toll zones or restricted areas for fuel-engine vehicles, will be discussed in details. Furthermore, open challenges and latest advances in City Logistics (multi-echelon distribution systems for long-haul transportation, collaboration among carriers, closed loop supply chains) will be discussed. Hints about reverse logistics will be provided. The course will integrate lectures with discussion of recent journal papers reporting latest advances in the literature.	February/March	EN
M.13	M3AI	Advanced Mathematical	12	**Prof. Simona Mancini** *(University of Palermo)*	The aim of the course is to give the students advanced modelling skills that can allow them to be able to provide	April/May	EN

		Modeling for complex decision problems		Contact email: simona.mancini@unipa.it	mathematical formulations for decision problems they can face in their research field. The first part of the course will provide the needed knowledge to transform a textual description of a decision problem into a mathematical formulation. The second part will address specific problems such as production and scheduling problems, packing problems and vehicle routing problems. Given a single problem, different formulations will be provided and analyzed. Techniques to provide smarter formulation (i.e. formulations that can solve quicker the problems to the optimality) will be presented. Hints about formulations strengthening techniques and exact solving methods will be provided.		
M.14	M3AI	New trends in future metrology: measurements of non-physical quantities (measuring the unmeasurable)	8	**Prof. Leonardo D'Acquisto** *(University of Palermo)* Contact email: leonardo.dacquisto@unipa.it	The measurement of quantities according to perception is of great interest for the optimal characterization of the interaction of persons with their living and working environment. It formally conflicts with the definition of physical quantity (PQ): " A physical quantity is a physical property of a material or system that can be quantified by measurement". Despite that, there is growing interest to a new approach to the development of a theory of measurements for non-physical quantities (NPQs). For these measurements it is not possible to ensure traceability because of their exclusive nature as substantiated by the subject. NPQs exist in the immaterial world in the sense they exist only in the mind of people either as a reflection of properties	February	IT or EN upon request

					of real material world or as a personal understanding of the subject. Measurements of PQs and NPQs have clearly different fields of application. So, NPQ) have different fields of application. Measurements of NPQ are: a way to perceive the material world through its reflection in human minds and a way to perceive the immaterial world of each person through its understanding (or lack of understanding) by other people.		
M.15	M3AI	Sensors 4.0 - smart sensors and measurement approach for Industry 4.0	8	**Prof. Leonardo D'Acquisto** *(University of Palermo)* Contact email: leonardo.dacquisto@unipa.it	Industrial Internet of Things (IIoT) or its related denomination Industry 4.0 are two widespread used terms to indicate the actual revolution in the industrial approach involving automation and control. On the ground of data generated at all levels of the production processes, disruptive improvements are made possible in terms of process quality, efficiency, productivity and flexibility. Smart sensors are the basic step providing added value to the measurement information which enables new process functionality in terms of self monitoring and self-configuration to condition monitoring of complex processes. Today's smart sensors, in this sense, are the fourth measurement revolution moving from the basic mechanical and thermal sensors like dynamometer spring scale and liquid expansion thermometer.	June-July	IT or EN upon request
M.16	M3AI	The Power of Many: Advancing Innovation	8	**Prof. Mariangela Piazza** *(University of Palermo)*	The course delves into the theory, methods, and implications of crowdsourcing for innovation. It equips	May	EN

		Through Crowdsourcing		Contact email: mariangela.piazza@unipa.it	students with a comprehensive understanding of how crowdsourcing leverages collective intelligence to tackle complex problems and drive innovation across various domains. Through case studies and discussions, students will explore the intricacies of designing, managing, and analyzing crowdsourcing initiatives. By the end, students will be adept at harnessing diverse crowds to generate novel ideas, solve challenges, and pioneer groundbreaking innovations.		
M.17	M3AI	Engineering applications of the CFD analisys	12	Dr. Antonino Cirello (University of Palermo) Contact email: antonino.cirello@unipa.it	The course will introduce some engineering applications of CFD analysis focusing even on specific hints to conduct consistent fluid dynamics analysis. Turbulence models, mesh characteristics and correct modeling of the boundary conditions will be introduced. Examples of these applications will be presented.	November	IT or EN upon request
M.18	M3AI	Prosthetic Implants and Design Methods: from clinical requirement to manufacturing	12	Dr. Agostino Igor Mirulla (University of Palermo) Contact email: agostinoigor.mirulla@unipa.it	The proposed course aims to provide the workflow in the design and development of prosthetic limb, upper and lower limb implants that takes into consideration clinical, biocompatibility, and static and dynamic stress resistance requirements. The course will include theoretical notions pertaining to bone remodelling and osseointegration, surface finishes for the interaction of metallic and/or polymeric materials with biological tissues. In addition, image recognition, CAD modelling and numerical simulation	November	IT

					software will be used for practical application of the knowledge gained.		
M.19	M3AI	R&D financing	**16**	**Prof. Fabrizio Micari** *(University of Palermo)* *Contact email: fabrizio.micari@unipa.it*	Strategie ed opportunità di finanziamento della ricerca e sviluppo in ambito industriale ed accademico, con particolare riferimento ai progetti europei ed ad Horizon Europe con particolare focus su ERC	June/July	IT or EN upon request
S.1	ESI	**Sicurezza strutturale di elementi in c.a. e c.a.p soggetti a degrado**	**8**	**Prof. Giuseppe Campione** *(University of Palermo)* *Contact email: giuseppe.campione@unipa.it*	Scopo del corso è quello di fornire gli strumenti di calcolo di verifica allo stato limite di esercizio ed ultimo di strutture in cemento armato ordinario e precompresso soggette a fenomeni di degrado indotti da carbonatazione e dall'attacco cloridrico (corrosione generale e localizzata). Sulla base di evidenze e studi sperimentali si propongono legami costitutivi di natura fenomenologica da impiegare nelle verifiche di sicurezza in cemento armato ordinario e precompresso, fornendo anche degli esempi di calcolo di strutture esistenti.	December 2024	IT or EN upon request
S.2	ESI	**GIS based analysis**	**8**	**Dr. Gabriele D'Orso** *(University of Palermo)* *Contact email: gabriele.dorso@unipa.it*	L'obiettivo del corso è quello di presentare agli allievi uno strumento versatile ed utilizzabile per effettuare analisi spaziali inerenti ai diversi campi dell'ingegneria civile. Per le analisi si utilizzerà un software GIS open-source, QGIS. Attraverso la presentazione di casi studio, verranno fornite ai partecipanti del corso breve delle conoscenze su tale software, evidenziandone le potenzialità e i limiti come mezzo di supporto alle decisioni nei processi progettuali e pianificatori.	January 2025	IT or EN upon request

S.3	ESI	**Virtual Experiments: Why?**	**8**	**Prof. Antonella Pirrotta** *(University of Palermo)* *Contact email: antonina.pirrotta@unipa.it*	Modeling and simulation are becoming increasingly important enablers for the analysis and design of complex systems. The connection between mathematics and reality is just experimental tests. The latter makes the difference between mathematical method and scientific method, that is experimental tests for validation is an important step of the scientific method.	March 2025	IT or EN upon request
S.4	CEBHyME/ ESI	**Corso breve su Elementi di Matlab per l'ingegneria**	**12**	**Prof. Alberto di Matteo** *(University of Palermo)* *Contact email: alberto.dimatteo@unipa.it*	Il corso si pone l'obiettivo di introdurre gli elementi basilari della programmazione in linguaggio MATLAB e le sue applicazioni in problemi tipici dell'Ingegneria Civile. La trattazione dei vari argomenti avviene in maniera graduale anche attraverso esempi applicativi. Si parte dalle nozioni elementari sui fondamenti dell'ambiente e del linguaggio MATLAB per pervenire all'uso in applicazioni non banali	April 2025	IT or EN upon request
S.5	ESI	**Metodi di valutazione delle prestazioni operative e di sicurezza delle infrastrutture stradali nell'attuale contesto e nella transitione al futuro**	**8**	**Prof. Anna Granà** *(University of Palermo)* *Contact email: anna.grana@unipa.it*	Il corso si propone di fornire gli strumenti conoscitivi, interpretativi e applicativi per svolgere valutazioni di efficienza operativa e di sicurezza delle infrastrutture stradali. In questa prospettiva, i modelli di micro-simulazione del traffico consentono di prevedere e di esaminare gli impatti indotti da soluzioni progettuali nuove o da soluzioni alternative all'assetto viario esistente, e di concettualizzare scenari what-if in presenza di tecnologie di guida cooperativa. Sulla base di recenti studi e ricerche, il corso presenta non solo approcci tradizionali, ma anche metodi avanzati per l'analisi di sicurezza e di	May 2025	IT or EN upon request

					efficienza operativa delle infrastrutture stradali urbane ed extraurbane, fornendo anche esempi utili e di supporto decisionale nella transizione verso sistemi viari efficienti e sicuri a servizio della mobilità.		
S.6	ESI	**Progetto e simulazione di un modello di rete in Aimsun Next [Designing and simulating a road network model in Aimsun Next]**	**8**	**Dr. Maria Luisa Tumminello** *(University of Palermo)* *Contact email: marialuisa.tumminello01@unipa.it*	Il corso, composto da 2 lezioni di 4 ore, verrà svolto in modo interattivo con i partecipanti, al fine di renderlo particolarmente efficace e fruibile per i nuovi utenti, oltre che significativamente produttivo per utenti con conoscenze base precedentemente acquisite.	June 2024	IT or EN upon request
S.7	ESI	**Nonconservative problems of dynamic stability**	**8**	**Prof. Massimiliano Zingales** *(University of Palermo)* *Contact email: massimiliano.zingales@unipa.it*	Nonconservative problems of dynamic stability	July 2024	IT or EN upon request
S.8	ESI	**Vulnerabilità sismica e tecniche di intervento**	**8**	**Prof. Piero Colajanni** *(University of Palermo)* *Contact email: piero.colajanni@unipa.it*	Scopo del corso è quello di fornire gli strumenti per la verifica della vulnerabilità sismica, il progetto di interventi di adeguamento/miglioramento, e il progetto di nuove strutture attraverso l'analisi statica non lineare di edifici a struttura intelaiata in c.a e di ponti in c.a. e c.a.p. Partendo dalle formulazioni dei metodi pr4esenti in normativa, verranno analizzate l'efficacia di metodi avanzati per la valutazione della risposta di strutture irregolari, in pianta e in elevazione. I risultati forniti dalle diverse tecniche di analisi statica non lineare verranno	September 2024	IT or EN upon request

					confrontati con risultati di analisi dinamiche non lineari al passo.		
S.9	ESI	**Elementi di modellazione FEM per la meccanica strutturale mediante ADINA, ABAQUS e FEAP. 28 ore primo anno**	16	**Prof. Francesco Parrinello** *(University of Palermo)* *Contact email: francesco.parrinello@unipa.it*	ADINA, ABAQUS e FEAP sono codici di calcolo multi fisico ad elementi finiti che operano in campo lineare e non-lineare per la risoluzione di numerose applicazioni nell'ambito dell'ingegneria civile, meccanica, idraulica e dei materiali.	October 2024	IT or EN upon request
S.10	ESI	**Modern strategies of seismic vulnerability mitigation and seismic design of structures**	8	**Prof. Liborio Cavaleri** *(University of Palermo)* *Contact email: liborio.cavaleri@unipa.it*	Modern strategies of seismic vulnerability mitigation and seismic design of structures	November 2024	IT or EN upon request
S.11	ESI/ CEBHyME	**Introduction to Python for scientific computing**	12	**Prof. Emma la Malfa Ribolla** *(University of Palermo)* *Contact email: emma.lamalfaribolla@unipa.it*	Il corso introduce all'organizzazione, elaborazione e gestione di ampi volumi di dati. Sarà possibile apprendere i principi di base del linguaggio di Programmazione Python, uno dei linguaggi più diffusi per l'analisi dei dati. Saranno altresì approfondite le ultime tecnologie per la Big Data Analytics con Python, linguaggio multiparadigma ricco di librerie e facilmente integrabile nei sistemi reali. Gli argomenti includono: i tipi di dato in Python e le operazioni e i metodi di conversione, gli algoritmi e i diagrammi di flusso, le istruzioni per il controllo del flusso, input dati, gestione delle errori, cicli while e for, funzioni, variabili globali e locali, i moduli della Standard Library.	December 2024	IT or EN upon request
S.12	ESI	**Il ruolo di indagini mirate per la corretta definizione del**	8	**Prof. Maurizio Ziccarelli** *(University of Palermo)*	Il ruolo di indagini mirate per la corretta definizione del modello geotecnico di sottosuolo e per la interpretazione e	January 2025	IT or EN

		modello geotecnico di sottosuolo e per la interpretazione e soluzione di problemi di ingegneria geotecnica		*Contact email: maurizio.ziccarelli@unipa.it*	soluzione di problemi di ingegneria geotecnica		upon request
S.13	ESI	**Modellazione agli elementi finiti di opere e sistemi geotecnici mediante Plaxis**	12	**Dr. Marco Rosone** *(University of Palermo)* *Contact email: marco.rosone@unipa.it*	Modellazione agli elementi finiti di opere e sistemi geotecnici mediante Plaxis	February 2025	IT or EN upon request
S.14	ESI/CEBHyME	**Building your reputation through research products: Planning, Drafting, Revising, Publishing and Disseminating your scientific papers**	8	**Prof. Davide Lo Presti** *(University of Palermo)* *Contact email: davide.lopresti@unipa.it*	Il corso di scrittura creativa introduce i dottorandi/e alle questioni connesse all'impostazione di un articolo scientifico, alla sua organizzazione in paragrafi, alla presentazione e alla discussione dei risultati in relazione alle domande aperte che letteratura tecnico scientifica presenta in relazione al problema di ricerca descritto e affrontato	March 2025	IT or EN upon request
S.15	ESI	**Theory of linear viscoelasticity applied to concrete bridges**	8	**Prof. Michele Fabio Granata** *(University of Palermo)* *Contact email: michelefabio.granata@unipa.it*	Il corso fornirà i principi fondamentali della teoria della viscoelasticità lineare nel calcestruzzo e gli effetti sulle strutture a schema variato come i ponti in calcestruzzo armato e precompresso. In particolare si approfondiranno i modelli di viscosità raccomandati in letteratura, l'influenza sul comportamento strutturale dei ponti, le cadute di precompressione e le fasi costruttive.	April 2025	IT or EN upon request
S.16	ESI	**Biomedical signal anlalysis**	8	**Dr. Emanuela Bologna** *(University of Palermo)*	Gli argomenti del corso includono: - analisi del segnale biomedico per la valutazione della vulnerabilità della frequenza cardiaca; - ricostruzione dinamiche	May 2025	IT or EN

				Contact email: emanuela.bologna@unipa.it	all'analisi delle serie temporali; elaborazione e analisi di immagini biomediche.		upon request
S.17	ESI	**Innovative materials for shear and flexural strenghtening of masonry structural members**	8	**Prof. Lidia La Mendola** *(University of Palermo)* Contact email: *lidia.lamendola@unipa.it*	Il breve corso si propone di fornire agli studenti una sintesi delle ricerche più attuali sul rinforzo di elementi strutturali in muratura, quali: - maschi murari, fasce di piano, volte, ecc. Il rinforzo costituito da materiali innovativi, leggeri e rimovibili, funziona generalmente a flessione e taglio o, nel caso delle volte, per assorbire gli sforzi di trazione che si generano nelle sezioni in cui si formano le cerniere. Affinchè il rinforzo possa funzionare è di fondamentale importanza la trasmissione degi sforzi all'interfaccia muratura-rinforzo. Questo problema è stato oggetto di studi condotti con altre università italiane e straniere nell'ambito di progetti di ricerca e tesi di dottorato di ricerca. Sarà presentata una indagine sperimentale condotta da UniPa oltre che nell'ambito di un Round-robin Test e un modello analitico-numerico proposto.	June 2025	IT or EN upon request
S.18	ESI	**Uso di CFRM nel rinforzo strutturale delle muratrure**	8	**Dr. Jennifer D'Anna** *(University of Palermo)* Contact email: *jennifer.danna@unipa.it*	Uso di CFRM nel rinforzo strututrale delle muratrure	September 2025	IT or EN upon request
S.19	ESI	**Nonlinear Porous media mechanics as a basis for a wide class of multiphysics problems**	8	**Prof. Guido Borino** *(University of Palermo)* Contact email: *guido.borino@unipa.it*	The proposed course, starting from the basis of finite displacements continuum mixture theory, will show the fundamental relations in terms of generalized kinematics and statics, together with	November 2025	IT or EN upon request

				generalized constitutive relations. Conservation laws and thermodynamics principles will be also developed in the appropriate form for the considered problems. Finally, a few simple applications will be proposed.		
C.1	CEBHyME	Preparation and characterization of (bio)polymer-based micro- and nanostructured systems	18	**Prof. Roberto Scaffaro** **Dr. Emmanuel Fortunato Gulino** *(University of Palermo)* *Contact email:* *roberto.scaffaro@unipa.it* *emmanuelfortunato.gulino@unipa.it*	L'obiettivo del corso è fornire una conoscenza di base sugli ultimi progressi nel campo dei sistemi micro e nanostrutturati basati su (bio)polimeri. Recentemente, la scienza e la tecnologia dei micro/nano-compositi a base di (bio)polimeri sta emergendo come uno degli ambiti di ricerca di maggior impatto, soprattutto a causa della crescente domanda di materiali avanzati. Verranno quindi introdotti e discussi i principali metodi di fabbricazione e caratterizzazione dei materiali compositi, insieme alla costruzione di una mappa generica delle relazioni processo-struttura-proprietà, utile per progettare materiali multifunzionali per applicazioni avanzate, tra cui trattamento acqua/aria, sensori , biomedicina, somministrazione di farmaci, accumulo/conversione di energia.	February 2025	EN
C.2	CEBHyME	Nanoscience & nanomaterials: pushing the boundaries of technology	8	**Prof. Clelia Dispenza** **Dr. Emanuela Muscolino** *(University of Palermo)* *Contact email:* *clelia.dispenza@unipa.it*	Il corso mira a fornire un'introduzione alle nanoscienze e alle nanotecnologie, spiegando perché i materiali ridotti alla nanoscala possono improvvisamente mostrare proprietà molto diverse rispetto a ciò che mostrano su una macroscala, comprendendo alcuni sviluppi attuali e sfide non affrontate. La partecipazione a questo corso frantuma il termine	February – March 2025	EN

					monolitico "nanotecnologia" nella miriade di sfaccettature che è in realtà.		
C.3	CEBHyME	Critical issues and new perspectives in environmental remediation technologies	10	**Prof. Michele Torregrossa** **Prof. Giorgio Mannina** **Prof. Alida Cosenza** **Prof. Santo Fabio Corsino** **Prof. Daniele Di Trapani** *(University of Palermo)* *Contact email:* *michele.torregrossa@unipa.it* *santofabio.corsino@unipa.it*	Il corso presenta le principali criticità emerse negli ultimi anni nell'ambito delle tecnologie consolidate per la tutela ambientale e le nuove proposte che possono essere attuate per garantire il raggiungimento di obiettivi di recupero ecosostenibile.	July 2025	EN
C.4	CEBHyME	Peculiar hydro-morphodynamic processes in rivers	8	**Prof. Donatella Termini** *(University of Palermo)* *Contact email:* *donatella.termini@unipa.it*	Lo scopo del corso è quello di fornire le informazioni di base per comprendere i principali processi di evoluzione nei fiumi naturali. L'evoluzione morfologica del fiume avviene a seguito di processi di "adattamento spontaneo" che si verificano a causa di azioni naturali (come quelle indotte dai cambiamenti climatici) e/o di origine antropica. Nei fiumi si possono generare forme diverse e complesse a seconda delle caratteristiche cinematiche del flusso e dei fenomeni di erosione/deposizione indotti. I diversi scenari che si presentano durante i processi evolutivi influenzano fortemente l'habitat del sistema fluviale e le aree limitrofe.	July 2025	EN
C.5	CEBHyME	New hydropower systems and applications	8	**Prof. Tullio Tucciarelli** *(University of Palermo)* *Contact email:* *tullio.tucciarelli@unipa.it*	New paradigms in water and energy management make energy management more and more connected to the water management in dams, as well as in transport and distribution pipe networks (water-energy nexus). In the course inter-disciplinary basis will be provided for the	July 2025	

					knowledge of the emerging design methodologies in the field of hydraulic plants including pumps and turbines. The following topics will be covered: Kinematics and dynamics of rotomachinery, Eulero theorem. Overview of turbine and pump types. Electric management of pumps and turbines. Guide-vanes and regulation systems in turbines. Hydropower production with Pump As Turbines (PATs) Hydropower production and hydraulic regulation in pipes with turbines Cross-Flow and PRS turbine design Similarity theory for pumps and turbines Inverter design for pumps Research topics		EN
C.6	CEBHyME	Salinity Gradient Power: Fundamentals, main technologies and applications	8	**Prof. Alessandro Tamburini** **Prof. Giorgio Micale** **Prof. Andrea Cipollina** *(University of Palermo)* *Contact email:* *alessandro.tamburini@unipa.it*	L'obiettivo del corso è quello di consentire ai dottorandi di avere un primo contatto con questa nuova forma di energia rinnovabile e le relative tecnologie. Più precisamente, le lezioni saranno suddivise in tre argomenti principali: (i) Fondamenti di Salinity Gradient Power, (ii) principali tecnologie SGP con focus sull'elettrodialisi inversa, (iii) applicazioni e prospettive. Il corso aiuterà gli studenti ad apprendere la termodinamica oltre l'SGP e i fondamenti delle tecnologie in grado di sfruttarlo, a padroneggiare le basi dei fenomeni di trasporto rilevanti e a fare semplici calcoli per stimare l'energia teorica disponibile in uno scenario specifico e le relative importo effettivamente recuperabile.	July 2025	EN

C.7	CEBHyME	Neural Network for Machine Learning: Introduction to Artificial Neural Network, design and implementation in Matlab	8	**Prof. Dario Pumo** *(University of Palermo)* *Contact email: dario.pumo@unipa.it*	La rete neurale artificiale (ANN) è una branca dell'intelligenza artificiale che cerca di imitare la capacità del cervello umano di elaborare rapidamente le informazioni in entrata in modo semplificato e di imparare dall'esperienza. In particolare, le ANN sono sistemi di calcolo di ispirazione biologica, che svolgono vari compiti (ad es. elaborazione del segnale, riconoscimento di modelli, regressione, classificazione, raggruppamento, previsione, ecc.). Le ANN sono modelli basati sui dati non lineari maturi, flessibili e potenti che sono stati applicati con successo per risolvere compiti complessi nel campo della scienza e dell'ingegneria. Lo scopo del corso è fornire le basi per la progettazione e l'implementazione di ANN (utilizzando il software MATLAB), mostrando le potenzialità ei vantaggi di questo approccio di modellazione.	7-11 July 2025	EN
C.8	CEBHyME	Combined processing for the preparation of biopolymeric porous structures for biomedical applications	18	**Dr. Elisa Capuana** *(University of Palermo)* *Contact email: elisa.capuana@unipa.it*	Il corso introduce ai biopolimeri porosi, che stanno ricevendo un crescente interesse in diversi campi tecnologicamente avanzati, compresi i dispositivi biomedici. In questo contesto, l'ingegneria dei tessuti dell'interfaccia (ITE) è un campo in rapido sviluppo che mira alla produzione di dispositivi progettati per riparare o rigenerare zone malate o danneggiate all'interfaccia di diversi tipi di tessuto. Il corso illustrerà lo sviluppo dei dispositivi porosi bio-ispirati su misura con proprietà meccaniche simili ai tessuti naturali	February 2025	EN

					combinando diversi approcci di elaborazione.		
C.9	CEBHyME	Theory and practice of electrochemical impedance spectroscopy	10	**Prof. Monica Santamaria** **Prof. Francesco Di Franco** **Dr. Andrea Zaffora** *(University of Palermo)* *Contact email:* *monica.santamaria@unipa.it*	Il corso introdurrà la spettroscopia di impedenza elettrochimica (EIS) e la sua applicazione allo studio dei processi elettrochimici e non. Verranno discussi i dettagli relativi al metodo corretto di acquisizione e analisi dei dati. Di seguito i contenuti principali: 1) Background (Variabili complesse, Equazioni differenziali, Statistica, Circuiti elettrici, Elettrochimica); 2) Considerazioni sperimentali (Strumentazione Elettrochimica, Disegno Sperimentale); 3) Modelli di processo (analoghi di circuiti equivalenti, modelli cinetici, impedenza di diffusione, dispersione a tempo costante, funzioni di trasferimento generalizzate). Il corso prevede sia lezioni frontali che sessioni numeriche e pratiche.	July 2025	EN
C.10	CEBHyME	Sensor and Biosensors	8	**Prof. Rosalinda Inguanta** **Dr. Bernardo Patella** *(University of Palermo)* *Contact email:* *rosalinda.inguanta@unipa.it*	Lo scopo di questo breve corso è fornire le nozioni di base per comprendere i principi di funzionamento delle principali tipologie di sensori e dare uno sguardo allo sviluppo della ricerca in questo settore. Verranno inoltre presentati e discussi casi di studio su sensori per l'analisi degli alimenti, per l'analisi degli inquinanti ambientali (nelle acque, nei suoli) e per l'identificazione di biomarcatori utili alla diagnosi precoce di malattie specifiche, come ad esempio malattie neurodegenerative e respiratorie. Sei ore saranno dedicate alla didattica frontale e due ore saranno di attività pratica in laboratorio su apposito sensore.	June 2025	EN

C.11	CEBHyME	Water depollution by Advanced Oxidation Technologies	**10**	**Prof. Vittorio Loddo** *(University of Palermo)* *Contact email: vittorio.loddo@unipa.it*	Il corso presenta i trattamenti delle acque mediante processi di ossidazione avanzati (AOP) basati su reazioni chimiche e fotochimiche. Vengono descritti i processi più utilizzati e per ciascuno di essi verranno analizzati i principali meccanismi di reazione, principi, vantaggi, svantaggi, prestazioni, formazione di sottoprodotti, accoppiamento con altre tecnologie e applicazioni al disinquinamento delle acque e delle acque reflue riportandone i principali risultati di studi pubblicati nella letteratura di riferimento.	July 2025	EN
C.12	CEBHyME	Degradation and stabilization of polymers, biopolymers and composites towards sustainability and materials circularity	**8**	**Prof. Nadka Tz. Dintcheva** **Dr. Giulia Infurna** *(University of Palermo)* *Contact email: nadka.dintcheva@unipa.it*	The module provides basic knowledge on natural ageing, controlled degradation and stabilisation of polymers, biopolymers and composites for sustainable applications such as green composites, biomedical devices and photovoltaic modules. It attempts to provide points for reflection on the importance of understanding degradation, which is directly related to the failure of polymers, biopolymers and composites in service conditions. It also briefly discusses the application of a controlled degradation strategy to solve the negative environmental impact of polymers, biopolymers and composites and to implement an integrated circular approach for material recovery.	February 2025	EN
C.13	CEBHyME	Polymeric materials and resource efficiency	**10**	**Prof. Giada Lo Re** *(Chalmers University of Technology – Sweden)* *Contact email: giadal@chalmers.se*	Premessa e obiettivo: è in corso una forte discussione sullo sviluppo ecologicamente sostenibile, che influenza fondamentalmente tutte le attività della società odierna e che si prevede continuerà nel prossimo futuro. Una parte importante e fondamentale dello sviluppo sostenibile sembra essere l'impegno a fare un uso corretto e deliberato delle risorse	Apr-Jun 2025	

					disponibili, ad esempio combinando il riutilizzo dei prodotti, il riciclo dei materiali e il recupero dell'energia. In questo ambito, i materiali polimerici hanno un ruolo importante da svolgere, ad esempio per quanto riguarda la riduzione dell'uso di plastiche sintetiche e la loro sostituzione con bioplastiche, l'aumento e il miglioramento dei mezzi per il riciclaggio delle plastiche senza perdere le proprietà funzionali dei materiali e la promozione del riutilizzo multiplo dei prodotti in plastica. I limiti di tutte queste ambizioni possono essere discussi da una prospettiva scientifica.		EN
C.14	CEBHyME	Organ-on-Chip: a potential alternative to traditional animal testing	8	**Prof. Francesco Lopresti** *(University of Palermo)* *Contact email: francesco.lopresti@unipa.it*	Otto candidati farmaci su nove che entrano nella fase di sperimentazione clinica falliscono, principalmente a causa della scarsa sicurezza ed efficacia. Questo è dovuto al basso valore predittivo dei modelli animali utilizzati nello sviluppo dei farmaci. Sebbene esistano metodi tradizionali di analisi *in vitro*, questi non offrono la complessità necessaria per imitare i processi fisiologici olistici che si verificano nel corpo umano, in particolare le interazioni organo-organo. Pertanto, sono necessari metodi predittivi più avanzati per studiare l'efficacia dei farmaci nella fase preclinica. I recenti sviluppi nei modelli dinamici *Organ-on-Chip* (OoC) sono molto promettenti. Un OoC si basa sullo sviluppo di una coltura di uno o più sistemi cellulari in una piccola camera o bioreattore irrorato con un flusso laminare	February 2025	EN

					di terreni di coltura, in grado di fornire livelli adeguati di nutrienti e di stress di taglio. Questo corso breve offre una panoramica dei sistemi disponibili e viene discusso il difficile percorso verso un sistema pienamente convalidato.		
C.15	CEBHyME	Green hydrogen production, storage and end uses across the energy system	9	**Prof. Rosalinda Inguanta** **Dr. Roberto Luigi Oliveri** *(University of Palermo)* *Contact email: rosalinda.inguanta@unipa.it*	Scopo del corso è di fornire le informazioni di base sui metodi di produzione di idrogeno, con particolare attenzione all'idrogeno verde, e sui principali metodi di storage. Saranno inoltre discussi alcuni casi studio di microgrid e isole energetiche con accoppiamenti fonti rinnovabili-idrogeno. Il corso sarà suddiviso in tre sessioni: due (6 ore) di didattica frontale e una (3 ore) di attività pratica in laboratorio.	June 2025	EN
C.16	CEBHyME	Microalgal biotechnology: from reactor design to industrial applications	6	**Dr. Serena Lima** *(University of Palermo)* *Contact email: serena.lima@unipa.it*	Le microalghe sono microorganismi fotosintetici di grande interesse processistico. Esse sono in grado di crescere rapidamente fissando la CO_2 e di produrre un'ampia gamma di composti ad alto valore aggiunto che sono ampiamente sfruttati nell'industria cosmetica, nutraceutica e alimentare. Inoltre, la biomassa microalgale presenta alti contenuti di oli che possono essere sfruttati come combustibile. L'obiettivo del Corso è di fornire una visione approfondita delle possibili applicazioni della biomassa microalgale affrontandone la diversità, le potenzialità di sfruttamento e le modalità di coltivazione. Inoltre, ci si soffermerà sul reactor design e su specifici esempi di processi che interessano le microalghe.	March 2025	EN
C.17	CEBHyME	Project Planning	8		This short module gives the basic elements on how to design a project including:	March	

				Prof. Gianluca Li Puma *(University of Palermo)* *Contact email:* *gianluca.lipuma@unipa.it*	Project network diagram; Critical path analysis; Project flexibility using floats and slacks; Resource loading histogram; Project uncertainty; Minimum cost of Expediting; and Overall project optimisation.	2025	EN
C.18	CEBHyME	Preparation and submission of a manuscript to a high impact journal	6	**Prof. Gianluca Li Puma** *(University of Palermo)* *Contact email:* *gianluca.lipuma@unipa.it*	This short module gives key skills on the preparation of high-quality manuscripts for publication in high-impact, international peer-review journals, including: How to structure and write an impactful research article, the Title, an effective and succinct Abstract, how to structure the Introduction, the Material and Methods, the Results and Discussion, the Conclusions and the References sections. It also comprises the article submission procedure, the peer-review process and post publication tips to increase the visibility and impact of the published article.	March 2025	EN
C.19	CEBHyME	Advanced Reaction Engineering	14	**Prof. Gianluca Li Puma** *(University of Palermo)* *Contact email:* *gianluca.lipuma@unipa.it*	The emphasis of this module is on computer aided design and modeling of chemical reactors. The module includes: Review of Mole Balances, Rate Laws and Stoichiometry. The Chemical Reaction Engineering Algorithm for reactor design. Isothermal and non-isothermal reactions. Multiple reactions in PFR, PBR and CSTR. Non-ideal reactor design and computer aided reactor design and modeling.	May 2025	EN
C.20	CEBHyME	Theory and practice of electrochemical impedance spectroscopy	10	**Prof. Monica Santamaria** **Prof. Francesco Di Franco** **Dr. Andrea Zaffora** *(University of Palermo)* *Contact email:* *monica.santamaria@unipa.it*	Photo-electrochemical technologies are promising solutions for solar fuel (e.g. hydrogen) production and involve a large number of physical and chemical phenomena. We provide an overview of chemical phenomena including photo-induced electron transfer, charge separation, recombination, equilibrium reactions between species in solutions and	July 2025	

					adsorption reactions. On the other hand, we focus on the transport of photocarriers in semiconductors as well as of both non-ionic and ionic species in solution. In this respect, we critically review macroscale continuum models for transport phenomena combined with kinetic descriptions including their possible coupling with models at even lower scales. A special attention will be paid to the case of water photo-splitting for green hydrogen production.		
C.21	CEBHyME	Electrochemistry for the environmental sustainability.	9	**Dr. Federica Proietto** *(University of Palermo)* *Contact email:* *federica.proietto@unipa.it*	The reduction of GHGs emissions and the remediation of contaminated sites are two of the main global concerns. This module gives the insight elements on: i) the electrochemical valorization of CO_2-waste gaseous stream into value-added chemicals, such as formic acid and syngas (CO2_Valorsation); ii) the remediation of contaminated soils and marine sediments with phenolic compounds, total petroleum hydrocarbons, polycyclic aromatic hydrocarbons as well as heavy metals (Soil/Sediment_Remediation) The module will be divided in three times: 1. CO2_Valorisation: interactive lecture of 3 hours; 2. Soil/Sediment_Remediation: interactive lecture of 3 hours; 3. Activities in laboratory of 3 hours.	November 2024	EN
C.22	CEBHyME	Sostenibilità dei processi industriali, verso la transizione dall'economia lineare a quella circolare	9	**Dr. Claudia Prestigiacomo** *(University of Palermo)* *Contact email:* *claudia.prestigiacomo01@unipa.it*	La trasformazione dell'economia lineare in economia circolare e la crescita sostenibile delle società moderne è una delle più grandi sfide attuali. L'integrazione di fonti rinnovabili di energia nei processi chimici industriali e la valorizzazione delle matrici residuali prodotte si pongono al centro di questa diatriba.	Novembre 2024	

					L'obiettivo di questo corso è quello di formare gli studenti sui recenti progressi tecnologici nelle seguenti aree: - Tecnologie di valorizzazione dei rifiuti biogenici e non biogenici: carbonizzazione idrotermale, liquefazione idrotermale, gassificazione idrotermale, carbonizzazione, pirolisi, gassificazione, processi biologici; - Processi di produzione di biodiesel da olio vegetale; - Integrazione di tecnologie solari a concentrazione in processi chimici industriali di interesse		EN
C.23	CEBHyME	Crystallization technology for mineral recovery from brines	15	**Prof. Giuseppe Battaglia** *(University of Palermo)* *Contact email:* *giuseppe.battaglia03@unipa.it*	This short course will strengthen knowledge of (reactive) crystallization fundamentals through real-world applications for the recovery of minerals from concentrated waste solutions (brines). The course will cover fundamentals relating to (i) crystallization phenomena (e.g. nucleation, growth, aggregation, agglomeration phenomena), (ii) the influence of the mixing on particles characteristics, (iii) the influence of zetapotential on particle agglomeration, (iv) the influence of supersaturation on crystal habits. Real applications will be covered: the reactive crystallization of $Mg(OH)_2$, the crystallization of Li_2CO_3 and the crystallization of $MgCO_3$ as a CO_2 storage approach. The scale-up study from lab- to pilot-scale of the crystallization of $Mg(OH)_2$ compounds will encompass all fundament knowledge in view of industrial commercialization of minerals.	January-February 2025	EN
E.1	Energy	Technologies for smart grids	8	**Dr. Giuseppe Sciumè** *(University of Palermo)*	The course will present various technologies for smart grids, among which: Vehicle-to-X, IoT applications to buildings and grids, BAC and TBM systems, energy	01/2025 - 01/2026	EN

				Contact email: *giuseppe.sciume01@unipa.it*	blockchain, Renewable Energy Communities.	
E.2	Energy	Inductive Power Transfer Systems for EV charging	6	**Dr. Filippo Pellitteri** **Dr. Nicola Campagna** *(University of Palermo)* *Contact email:* *filippo.pellitteri@unipa.it*	The class will cover: - State of the art on the wireless charging - Resonant Inductive Power Transfer Systems - Coils design and simulation through Matlab/Simulink - Compensation topologies - Bifurcation phenomenon - Dynamic wireless charging - Energy management and supervision strategies - Foreign Object Detection algorithms	03/2025 - 03/2026	EN
E.3	Energy	Multilevel power converters: Part 1	6	**Prof. Antonino Oscar Di Tommaso** **Dr. Giuseppe Schettino** *(University of Palermo)* *Contact email:* *antoninooscar.ditommaso@unipa.it*	Multilevel Power Inverters represent an innovative and promising technology in the power conversion field. They are gradually finding applications both in the field of energy transmission and distribution, and in the field of electric drives, thanks to their improved performance, if compared with traditional inverter. The course covers the following topics: - state of the art of multilevel power converters; - applications fields; - topology structures; - mathematical model and implementation;	07/2025 - 07/2027	EN
E.4	Energy	E-mobility: energy scenarios	8	**Dr. Massimo Caruso** **Dr. Claudio Nevoloso**	The class introduces the e-mobility concept and deals with the electric automotive market development, the	06/2026 – 06/2027	EN

					(University of Palermo) *Contact email: massimo.caruso16@unipa.it*	evolution of EV charging systems and the concept of vehicle-to-grid.	
E.5	Energy	Sustainable energy systems based on the rational uses of energy sources and the integration of solar-concentrating technologies	9		**Dr. Pietro Catrini** **Dr. Stefania Guarino** *(University of Palermo)* *Contact email: pietro.catrini@unipa.it*	The course will provide an overview of methods for the assessment of the rational use of energy and the promotion of energy-saving measures in real systems. Moreover, the course will focus on fundamentals, modeling, optimization, and innovative applications of solar concentrators for renewable energy generation.	09/2026 – 09/2027	EN
E.6	Energy	Energy modelling and sustainability assessment of Positive Energy Districts	9		**Dr. Francesco Guarino** *(University of Palermo)* *Contact email: francesco.guarino@unipa.it*	The class will be based on the concept of Positive Energy Districts with a specific focus on the available definitions and the their scientific implications, technical feasibility as well as a description of the most effective technologies to be used in different geographical contexts. Fundamentals of positive energydistricts energy modeling will follow with general considerations as well as applications to specific tools packages. Lastly, the sustainability perspective (including environmental, economics and social) of Positive Energy Districts performance assessment will be investigated. This part of the class deals with energy modelling and sustainability assessment of PEDs.	06/2025	EN
E.7	Energy	Passive building envelope systems for	5		**Prof. Giorgia Peri** *(University of Palermo)*	The course aims to address the following aspects: • Energy efficiency and thermal comfort;	12/2024 – 12/2025	EN

		climate change resilience		Contact email: giorgia.peri@unipa.it	• Climate Change and extreme metereological events; • Retrofit of buildings with regard to energy effciency and thermal comfort in the light of climate change and extreme metereological events taking place; Contribution made by the use of green roofs and cool roofs to climate change resilience.		
E.8	Energy	Innovative Applications of Heat Pumps in Renewable Energy Systems	4	**Dr. Maurizio La Villetta** *(University of Palermo)* Contact email: email: maurizio.lavilletta@unipa.it	The course will provide an overview of the main procedures for designing air conditioning systems based on air-to-water heat pumps. The course will start on defining the current diffusion of heat pumps considering the regulatory framework in Europe and Italy. The course will analyse the classification of heat pumps based on operating principles, thermodynamic cycles and performance indicators for innovative Renewable Energy Systems. Also, the potential benefits of Demand Response using heat pumps and thermal energy storage in buildings will be analysed by considering the thermal comfort of the occupants using a dynamic simulation model.	11/2024 - 11/2025	EN
E.9	Energy	Computational Fluid-Dynamics of Conjugate Heat Transfer Problems	12	**Dr. Andrea Quartararo** *(University of Palermo)* Contact email:	The class will cover: • General description of conjugate heat transfer problems. • Simulation workflow for conjugate heat transfer problems with finite-volume numerical codes.	02/2025 – 02/2026	EN

				andrea.quartararo@unipa.it	Practical application on high heat flux heat sink components.		
E.10	Energy	Data Acquisition Lab	8	**Dr. Giovanni Artale** *(University of Palermo)* *Contact email:* *giovanni.artale@unipa.it*	The course will present advanced applications of Labview.	05/2025 – 05/2027	EN
E.11	Energy	Multilevel power converters: Part 2	6	**Prof. Antonino Oscar Di Tommaso** **Dr. Giuseppe Schettino** *(University of Palermo)* *Contact email:* *antoninooscar.ditommaso@unipa.it*	The part 2 of the course on multilevel power inverters will cover: - modulation techniques; - innovative modulation algorithms; - impact of multilevel power converters in electrical drive applications	07/2025	EN
E.12	Energy	Definitions, fundamentals and technologies of Positive Energy Districts	6	**Dr. Francesco Guarino** *(University of Palermo)* *Contact email:* *francesco.guarino@unipa.it*	The class will be based on the concept of Positive Energy Districts with a specific focus on the available definitions and the their scientific implications, technical feasibility as well as a description of the most effective technologies to be used in different geographical contexts. Fundamentals of positive energy districts energy modeling will follow with general considerations as well as applications to specific tools packages. Lastly, the sustainability perspective (including environmental, economics and social) of PositiveEnergy Districts performance assessment will be investigated. This part of the class deals with definitions, fundamentals and technologies of PEDs.	03/2025 – 03/2027	EN
E.13	Energy	Fundamentals of dynamic simulations	8	**Dr. Rossano Musca**	The course will focus on fundamental theory, algorithms, and software tools to	11-12/2025	

		and co-simulations for electric systems		*(University of Palermo)* *Contact email: rossano.musca@unipa.it*	perform dynamic simulations and co-simulations of electric systems. Part of the course will be based on the development of suitable simulation models in Neplan and Simscape Electrical of Matlab/Simulink.		EN
E.14	Energy	New challenges in HVDC systems	8	**Prof. Pietro Romano** **Dr. Antonino Imburgia** *(University of Palermo)* **Dr Giuseppe Rizzo** *(Prysmian electronics)* *Contact email: pietro.romano@unipa.it*	The aim of the course is to present the salient characteristics that future high-voltage DC connections will have to possess in relation to the use of new materials for the construction of cables and accessories and the use of new technologies for monitoring the operating state. The most modern technologies for detecting the main causes of cable ageing, such as partial discharge and space charge, will be presented.	09/2025 – 09/2026	EN
E.15	Energy	Matlab and Arduino laboratory for solving electrical circuits	8	**Prof. Guido Ala** **Prof. Fabio Viola** **Dr. Giuseppe Schettino** *(University of Palermo)* *Contact email: fabio.viola@unipa.it*	The course is based on the use of advanced systems such as Matlab and Arduino for the solution of electrical problems. The objectives are multiple: 1) learn how to use a virtual lab like simscape / simulink 2) The course uses the Matlab grader platform to define innovative methods of self-assessment and management of tasks in the classroom 3) The arduino laboratory aims to start the first basic knowledge on the programming of microcontrollers for diagnostics on systems and machines	12/2024 – 12/2025	EN
E.16	Energy	Engineering challenges of Nuclear Fusion Reactor	12	**Prof. Pietro Alessandro Di Maio** **Dr. Gaetano Bongiovì**	Fundamentals of nuclear fusion reactors based on closed magnetic confinement systems for the conversion of nuclear	01/2025 – 01/2026	

				(University of Palermo) *Contact email:* *pietroalessandro.dimaio@unipa.it*	fusion energy into electric energy to be delivered to the grid Overview of the main reactors components and systems (plasma facing components, blanket, divertor, magnets, vessel) and survey of the most critical engineering challenges in the their design and operation		EN
E.17	Energy	Energy transition and decarbonization	**5**	**Prof.ssa Sonia Longo** *(University of Palermo)* *Contact email: sonia.longo@unipa.it*	Research activities and policy goals and actions on energy transition and decarbonization. Background and fundamentals on the energy transition, the definition of decarbonization and circular strategies, tools for measuring effective reduction of GHGs emissions with a specific policy/action.	06/2025 – 06/2027	EN
E.18	Energy	Electric Powertrain: Structure and Design	**7**	**Dr. Massimo Caruso** **Dr. Claudio Nevoloso** *(University of Palermo)* *Contact email:* *massimo.caruso16@unipa.it*	The course covers the following topics:a) Introduction to electric powertrain b) Electric motors in the automotive field c) power electronic converters for automotive d) storage systems for automotive e) The design phase	02/2025 – 02/2027	EN
E.19	Energy	Optimization of energy systems	**12**	**Dr. Francesco Montana** *(University of Palermo)* *Contact email:* *francesco.montana@unipa.it*	The course will provide an overview of optimization algorithms with a specific focus on energy applications. The first part of the course will be focused on a brief theoretical background on main concepts – convex and non-convex problems, duality, linearity, simplex algorithm, genetic algorithms, simulation-based optimization, single and multi-objective optimization, optimal planning. The second part of the course will be based	11/2024 – 01/2026	EN

					on many examples and exercises performed on the following platforms: MS Excel, MATLAB, MOBO. The exercises will concern the following topics: renewable energies, building energy demand, microgrids and distributed energy resources.		
E.20	Energy	Energy Performance Certification of Buildings	6	**Prof. Giuseppina Ciulla** *(University of Palermo)* *Contact email: giuseppina.ciulla@unipa.it*	The course aims to provide, with reference to the legislation in force in Italy, all the tools necessary for the analysis of energy performance of buildings. Tools, procedures, methodologies and practical examples will be described.	02/2025 - 02/2026	EN
E.21	Energy	Specialized software for network analysis in static and short-circuit conditions	12	**Dr. Antony Vasile** *(University of Brescia)* *Contact email: antony.vasile@unibs.it*	Specialized software plays a crucial role in modern electrical engineering. This course will provide insight about design, analysis, and optimization of electrical networks in static conditions, with power flow simulations of complex systems and a dedicated module on safety and coordination of protections devices.	12/2024 – 12/2025	EN
E.22	Energy	Methods and tools for the assessment of indoor environmental quality	10	**Dr. Marina Bonomolo** *(University of Palermo)* *Contact email: marina.bonomolo@unipa.it*	The class will be focused on the study of assessment of indoor environmental quality and, in particular, on methods and technologies for optimize efficient and smart systems design and for the post-occupancy evaluation. Furthermore, the course will introduce innovative methods (such as digital twin and predictive methods).	04/2025 – 04/2027	EN
E.23	Energy	Energy and environmental resilience to climate	8		The course will cover the following aspects: - Global, European, and national policies and regulatory frameworks regarding the	02/2025 – 02/2026	EN

		change in the built environment		**Dr. Laura Cirrincione** *(University of Palermo)* *Contact email:* *laura.cirrincione@unipa.it*	concepts of sustainability and resilience in the built environment - Similarities and distinctions between the concepts of energy and environmental sustainability and resilience in the built environment - Up to date smart solutions and technologies to improve energy and environmental resilience to climate change in the built environment (indoor and outdoor) - Assessment of buildings resilience to climate change using ad hoc selected indicators - Simulative applications for the evaluation of alternative mitigation scenarios to optimize decision processes.		
E.24	Energy	Fundamentals of the Monte Carlo Method for engineering	12	**Prof. Pierluigi Chiovaro** *(University of Palermo)* *Contact email:* *pierluigi.chiovaro@unipa.it*	The class will cover: - Elements of probability theory and statistics. - Monte Carlo integration. - Sampling from probability density functions and cumulative functions; transformations of probability density functions. - Neutron transport integral equation and random walk. Monte Carlo methods applied to the problem of thermal conduction.	01/2025 – 01/2027	EN
E.25	Energy	Thermal-hydraulic System Codes for Nuclear Power Plants	12	**Dr. Eugenio Vallone** *(University of Palermo)* *Contact email:*	The course will cover the following topics: the balance of plant of a nuclear power plant;	04/2025 – 04/2027	EN

				eugenio.vallone@unipa.it	• system codes and their role in the design and safety assessment of a nuclear power plant; • basic theory of thermal-hydraulic system codes; fundamentals of nuclear power plant modelling.		