

This is a preliminary list of classes for the 2024-2025 academic year. We are publishing it now as some classes will begin in November 2024, allowing students to plan ahead. This document will be updated periodically. If you wish to attend a class, please contact the designated reference persons as soon as possible.

This is version 1.0, published on 18/10/2024

Consiglio Nazionale delle Ricerche (CNR-ISTC and CNR-STIIMA)

Reference person: Andrea Orlandini <andrea.orlandini@istc.cnr.it>, Nicola Pedrocchi <nicola.pedrocchi@stiima.cnr.it>

The courses can be BASIC (to establish cultural foundations), ADVANCED (advanced study of specific topics), CROSSOVER (on interdisciplinary subjects).

Name	Teacher	Ore	Class description	Available online	Time of the year (please check)	Language	Final evaluation	Level
Automated Planning	Andrea Orlandini, Alessandro Umbrico, andrea.orlandini@istc.cnr.it, umbrico.alessandro@gmail.com	10	The course presents Artificial Intelligence automated planning. It introduces models and resolution approaches for both "classic" and temporal planning. Different methodologies for the synthesis of action plans and their execution will be presented, as well as applications in relation to the control of autonomous robots.	yes	June 2025 (ask for details)	English	yes	BASIC

Istituto Italiano di Tecnologia (IIT)

Reference person: Lorenzo Natale <Lorenzo.Natale@iit.it>

The courses can be BASIC (to establish cultural foundations), ADVANCED (advanced study of specific topics), CROSSOVER (on interdisciplinary subjects).

Name	Teacher	Ore	Class description	Available online	Time of the year (please check)	Language	Final evaluation	Level
Open Science and Research Data Management (OS&RDM)	Anna Maria Pastorini, Valentina Pasquale, anna.maria.pastorini@unige.it, valentina.pasquale@iit.it	10	This training module for PhD Students aims to introduce early-career researchers to the principles of scholarly communication, Open Science and Research Data Management. Students will gain a better understanding of the available research infrastructures, tools, and services for Open Access publishing, Research Data Management and FAIR Data. Students will also learn the importance and the transformative potential of Open Science practices in research, especially to improve reproducibility and increase research integrity. They will learn what means to make data FAIR, as required by many funders, including the European Commission, and how to draft a data management plan. Finally, they will have the chance to practice on common tools for Research Data Management, like Data Stewardship Wizard, Zenodo, and Dataverse.	yes	Feb 2025 (ask for details)	English	yes	CROSSOVER
Modern C++	Marco Accame, Valentina Gaggero, Nicolò Genesisio, marco.accame@iit.it, valentina.gaggero@iit.it	30	The students will learn the new syntax and philosophy of Modern C++ (releases C++11, -14, -17, -20) with hands on the code at every lesson.	yes	May-Jun 2025	English	yes	BASIC

Mechanical Drawing Fundamentals	Diego Torazza, diego.torazza@iit.it	18	This course provides an introduction to Mechanical Technical Drawing with mention to manufacturing techniques. The aim of the course is to give a base knowledge in understanding and preparing mechanical technical drawings, so there is no need of prior background of mechanical drawing. Mechanical drawing is the main way to communicate design need to technicians, workshops, suppliers. A base knowledge of rules and methods helps the researcher, even if not directly engaged in mechanical design, to better contribute to interdisciplinary team working when involved in the design of experimental setups, scientific devices, and the writing/understanding of technical specifications.	No	Jan 2025	English	yes	BASIC
ComputerAided Design	Diego Torazza, diego.torazza@iit.it	12	The aim of the course is to gain and apply knowledge of 3D CAD concepts and techniques by using high-end CAD systems (PTC Creo).	No	Jun 2025	English	yes	ADVANCED
Perceptual systems	Monica Gori, Alessia Tonelli, monica,gori@iit.it, alessia.tonelli@iit.it	12	From birth, we interact with the world through our senses. How the brain process and transform sensory signals into perceptual outputs is one of the main questions in the field of experimental psychology. The goal of the course is to present the perceptual from the anatomical, physiological, and functional points of view. A particular focus will be on how physical stimuli are transduced into sensory signals by our peripheral sensory apparatus in a hierarchy organize complex behaviour. In the last part of the course, these topics will be described in relation with cross-sensory interaction and multisensory integration in the adult and the developing brain. Students will learn how the functioning of the main sensory systems, i.e. vision, audition, touch, smell and taste. Moreover, it will be explain the	yes	March 2025	English	yes	ADVANCED

			process of multisensory integration and cross-modal interaction.					
Robotic Virtual Prototyping Design	Ferdinando Cannella, Mariapaola D'Imperio (TA: Gabriele Marchello), ferdinando.cannella@iit.it	18	The aim of the Robotic Virtual Prototyping Design course is to give the basic knowledge about the Finite Element Analysis (FEA) and Multi-Body Simulations (MBS) applied to the robotics. These computational techniques predict the behavior of physical systems: joined together permit to study the dynamics taking in account the body flexibility, the control and optimization. It will be introduced mainly applied to the mechanical field, in particular to the robotic anthropomorphic arm. The student gets 6 credits if he/she attends the entire course and accomplishes the final project.	yes	May-Jun 2025	English	yes	CROSSOVER
Mechatronics and AI	Ferdinando Canella, Gabriele Marchello, ferdinando.cannella@iit.it	18	The aim of the Mechatronics and Artificial Intelligence (AI) course is to give the basic knowledge about AI and Deep Learning (DL) applied to mechatronics. The course will provide the students with an overview of AI, DL and the possible applications, and will focus in the last lectures on reinforcement learning (RL) techniques. AI, DL and especially RL can be adopted to control the behavior of mechatronic systems acting in complex environment, and solving tasks too hard to be tackled with traditional approaches. The student gets 6 credits if they attend the entire course and passes the final project.	yes	Jun 2025	English	yes	ADVANCED

Politecnico di Torino (Polito)

Reference person: Giuseppe Quaglia <giuseppe.quaglia@polito.it>, Carmen Visconte <carmen.visconte@polito.it>

The courses can be BASIC (to establish cultural foundations), ADVANCED (advanced study of specific topics), CROSSOVER (on interdisciplinary subjects).

Name	Teacher	Ore	Class description	Available online	Time of the year (please check)	Language	Final evaluation	Level
Advanced scientific programming in matlab	Paolo Bardella, paolo.bardella@polito.it	30	The course aims to provide advanced skills in scientific programming, and to teach sound methodologies for the development of reliable, optimized and maintainable codes. A basic knowledge of MATLAB and the C language represents a prerequisite of this course. During this course, many common methods used in Scientific Computing will be presented, with particular attention to the most recent programming techniques in MATLAB. At the end of the course, the student will have expanded his/her knowledge of MATLAB and will be able to choose the best approach for the solution of numerical problem he/she will face.	yes	Jan/Feb 2025	English	yes	ADVANCED
Development and management of data-acquisition systems	Alessio Carullo, alessio.carullo@polito.it	25	The course, open to all those who perform experimental activity and do not have specific knowledge on analogue and digital electronic circuits, is conceived to analyze and study multi-channel data-acquisition systems, to develop the know-how required for choosing and configuring the components of the measuring chain according to the requirements. Sensors and circuitry commonly employed in the industrial field to adapt the sensor output signals to the analogue-to-digital converter will be studied. Furthermore, the performance of different architectures of data-acquisition systems will be analyzed	No	Jun 2025	English	yes	ADVANCED

			(dedicated systems, data-acquisition boards for personal computer, micro-controller based boards), also revising the most common development environments. Eventually, guide lines for the estimation of the expected uncertainty will be provided. Laboratory experiments will be arranged in order to develop and analyze some case studies.					
Machine learning for pattern recognition	Sandro Cumani, sandro.cumani@polito.it	20	This course gives a broad yet rigorous introduction to machine learning and statistical pattern recognition. It focuses on supervised generative and discriminative learning models, analyzing some important topics such as model architectures, training and evaluation techniques. The course will compare different models and classification approaches on the popular MNIST digit recognition dataset. It will also discuss about the applications of the proposed machine learning approaches to image, speech, and speaker recognition. Students will be asked to apply the acquired knowledge to develop their own classification system using labeled training and evaluation data provided during the course. Each system will then be evaluated on another unlabeled and previously unseen data set.	yes	Jun 2025	English	yes	ADVANCED
Principles, materials and applications of robotics in biomedicine	Alberto Arezzo	20	Robotic technologies for minimally invasive surgery and diagnosis is the focus of this course. Clinical needs in extra-, endo- and trans-luminal access approaches are identified. Various engineering solutions are discussed and their evolution over time is presented and justified. Discussed topics, technologies and methodologies include, but are not limited to: history of surgical robots, commercial surgical robots, research robotic systems, gastrointestinal robots, advances in soft robots fabrication, sensing and actuation, cancer detection robots, perceptual human-robot interfaces,	yes	Feb 2025	English	yes	ADVANCED

			data- and AI-driven operating theatres, etc with the major scientific players worldwide in their respective fields of competence.					
Research design and methodology	Federico Bella, federico.bella@polito.it	11	This course is intended to explain to PhD students how high-quality scientific research can be carried out during the three years of the doctorate course. The lessons will address the path that goes from the assignment of the research project to the literature analysis, from the design of research activities to the interaction with other scientists, from the production of tangible results to the analysis of the metrics commonly adopted to assess the quality of research and researchers. The overall aim of the course is that of making PhD students aware of what a PhD is and which is the spirit required to face it.	No	Mar 2025	English	yes	CROSSOVER
Facing the scientific publishing world	Federico Bella, federico.bella@polito.it	12	This course is intended to introduce the world of scientific publishing to PhD students starting their academic career. The lessons will address the main pillars of this sector, from the fundamentals of journals organization to the rational construction of an article, from the peer-review process to the evaluation of research and researchers through internationally recognized metrics. The main aim of this course is to make PhD students aware of the international scientific publishing system.	No	Mar 2025	English	yes	CROSSOVER
Research communication and relationships with companies and organizations	Diana Caterina Nada Massai diana.massai@polito.it,	10	The objective of the course is to provide the PhD students the essential tools for improving their skills in communicating the scientific research to the business world, particularly focusing on the relationships with start-ups, PMIs, large companies and public organizations. By attending the course, the PhD students will increase their communication skills for interacting with professionals from the business world, with the final aims of promoting the	No	March 2025	English	yes	CROSSOVER

			collaboration between academia and industry and supporting the technology transfer. A dedicated webpage will be available with news, alerts, materials, links, and useful information for the course attendance and work progress. The course is limited in number to 50 participants: registration is required in the manner indicated by the Nucleo Dottorato di ricerca.					
Writing research proposal and EU projects		10	The figure of the researcher has become more complex. In addition to knowing how to do research and translate the results of their efforts into scientific papers, the researcher must possess project management skills that include knowing how to monitor European, national, and regional funding opportunities, as well as how to write project proposals in response to such calls. The ongoing European programming 2021-2027 offers considerable opportunities for the researcher who aspires to obtain more funds to finance its own research. Although only an introduction, this course aims to help PhD candidates develop certain project management skills, i.e., the search of funding opportunities, the analysis of the essential elements and requirements of the calls, and the preparation of a project proposal.	No	Nov 2024	English	yes	CROSSOVER
Innovation management	Francesca Montagna, francesca.montagna@polito.it	8	Innovation Management is nowadays a recognized discipline that concerns scientific knowledge and professional skills. In the current economic environment, the transfer of technological development results into products and services, which must be both profitable for businesses and useful to society, is in fact not immediate and requires special capabilities. These required capabilities and skills are transversal and common to the different expressions of technology, as well as to	No	Nov 2024	English	yes	CROSSOVER

			<p>various disciplines and industrial sectors. In this sense, they constitute a fundamental professional and cultural background for Engineers, Architects and Designers. Innovation management covers both strategic and technical-operational decisions, as well as the definition of those core competences for the management and support of innovation processes and product and service development. The course mainly aims at blending a managerial perspective, so to make the doctoral student capable of understanding the innovation process, to the more traditional perspectives from the specific design disciplines. It also provides indications on the main current research questions and on the work being carried out by researchers in the field. The course is based on lessons, with wide use of cases drawn from experience and empirical research and case studies where students are required to analyse information in a quantitative manner. At the end of the course, students will have acquired a concrete ability to analyze and manage business and design decisions related to technological innovation in both strategic and operational terms. They also acquire full mastery of approaches for the management of R&D and innovative processes, product and service development.</p>					
Intellectual Property Rights and Innovation	Federico Caviggioli, federico.caviggioli@polito.it	6	<p>This course aims to provide students with fundamental knowledge on the Intellectual Property Rights (IPRs) that are available to protect creativity and innovation. The definitions and the main characteristics of patents, trademarks, copyrights, designs, creative commons, etc. will be examined. Students will be introduced to some of the sources of IPR data which can be searched to perform preliminary prior art analyses.</p>	No	Mar 2025	English	yes	CROSSOVER

			In particular, the course will focus on patent data as a source of information which could help the researchers in developing new technical developments from a scientific perspective and improve their understanding of a technological field. The definition of such a technology landscape can be also useful for supporting the communication of technology trends and their socio-economic impact, in particular for project funding.					
Creativity and idea generation techniques	Buiatti Eleonora, eleonora.buiatti@polito.it	20	The main objective of this course is the generation and development of new and creative ideas by specific techniques and psychological models. The first part of the course will be dedicated to theoretical aspects related to the main mechanisms of the human mind involved in mostly automated and recursive processes: mental models, heuristics and automatisms. The sensory aspects of human perception will also be studied to show how the strategic actions are possible, during the meta-project and the design phase, in order to specifically convey particular characteristics of any artifact, interface or environment. At the same time, during the course, the main Tools through which it is possible to measure perceptual aspects will be shown (Eyetracking and SounBe). Finally, the second part of the course will see students to apply creative models using innovative device based on the holographic principle. The main idea will be to create a prototype of innovative learning, taking as a specimen a course devoted to physical topics (Structural mechanics aspects), in order to apply the communicative 10etworks10ic language to the students. The learners will generate the images, the 3D contents they will traduce them in holograms and they will project with the teacher a learning path for an innovative pilot course.	No	Mar 2025	English	yes	CROSSOVER

Scuola Superiore Sant'Anna (SSSA)

Referenti: Arianna Menciacchi <arianna.menciacchi@santannapisa.it> e Calogero Oddo <Calogero.Oddo@santannapisa.it>

The courses can be BASIC (to establish cultural foundations), ADVANCED (advanced study of specific topics), CROSSOVER (on interdisciplinary subjects).

Name	Teacher	Ore	Class description	Available online	Time of the year (please check)	Language	Final evaluation	Level
Neuromorphic Computing	Calogero Maria Oddo, Calogero.Oddo@santannapisa.it	20	The course will explore computational and physical models that emulate the neural dynamics and the efficiency of biological neurons of peripheral and central nervous system.	Yes	Dec 2024/Jan 2025	English	yes	CROSSOVER
Graphical programming for measurement, test, and control systems in bioengineering	Calogero Maria Oddo, Calogero.Oddo@santannapisa.it	20	The main competences developed will be fundamentals and technical abilities of graphical programming for biomedical engineering. The main software used will be LabVIEW (Core 1 module), with the aim to address the following detailed topics: introduction to graphical programming; navigating the graphical programming environment; what is graphical programming; project explorer; parts of a Virtual Instrument (VI); front panel; block diagram; searching for controls, Vis, and functions; selecting a tool; dataflow; building simple Vis; troubleshooting and debugging Vis; implementing a VI; data types; documenting code; while and for loops; timing a VI and data feedback in loops; plotting data; case structures; developing modular applications; data structures: arrays and clusters; managing file and hardware resources; introduction to data exchange via UDP; Euler method for discrete fixed-step solution of differential equations and graphical implementation; hands on examples with graphical programming.	Yes	Oct 2025	English	yes	BASIC

Neural Networks and Deep Learning: Theoretical Foundations	Giorgio Buttazzo, giorgio.buttazzo@santnapisa.it	20	The objective of the course is to provide key concepts and methodologies to understand neural networks, explaining how to use them for pattern recognition, image classification, signal prediction, system identification, and adaptive control. Topic will include fully connected networks, unsupervised learning, self-organizing maps, clustering algorithms, autoencoders, reinforcement learning, supervised learning, multi-layer networks, Backpropagation, radial basis function networks, recurrent networks, attention mechanism.	Yes	Starts on 7th January 2025	English	yes	BASIC
Neural Network and Deep Learning: Deep Networks	Giorgio Buttazzo, giorgio.buttazzo@santnapisa.it	20	This module presents the foundations for understanding deep neural networks and deep learning algorithms. Topics include convolutional networks for classification, detection and segmentation, deep reinforcement learning, generative adversarial networks and transformers.	Yes	Starts of 4 th February 2025	English	Si	CROSSOVER
Neural Network and Deep Learning: Advanced Topics	Giorgio Buttazzo, giorgio.buttazzo@santnapisa.it	20	This module presents recent techniques proposed to improve neural models and overcome their limitations. Topics include model compression, semi-supervised learning, anchor-free object detection, neural object tracking, adversarial attacks and defense methods, methods for explainable AI and anomaly detection.	Yes	Starts of 4 th February 2025	English	Si	ADVANCED
Neural Networks and Deep Learning: Implementation Issues	Giorgio Buttazzo, giorgio.buttazzo@santnapisa.it	30	The objective of the course is to present practical and implementation issues useful to deploy neural networks on a variety of embedded platforms using different languages and development environments. Topics include implementing neural networks from	Yes	Starts on 1 st April 2025	English	yes	ADVANCED

			scratch in C, TensorFlow, Keras, and PyTorch. Neural networks for autonomous driving. Model optimization for embedded platforms. Accelerating deep networks on GPGPUs and FPGA.					
Fundamentals of Surgical and Interventional Robotics	Arianna Menciassi, arianna.menciassi@santannapisa.it	10	<p>The course will be focused on methodologies and guidelines related to robotic technologies for minimally invasive therapy, diagnosis and surgery. Lectures will introduce different solutions for targeted therapies both minimally invasive and non-invasive, e.g. which exploit external generators of therapeutic actions. At the end of the course the student will be able to identify the most appropriate targeting/therapeutic solutions for the different human body districts, at different scales, and for different pathologies. Competence to be acquired along the course:</p> <ul style="list-style-type: none"> • the design principles behind robotic technology for MIS; • different technologies and paradigms for autonomous, teleoperated, hand held robots for minimally invasive surgery; • actuation technologies for robotic tools for minimally invasive surgery. 	Yes	Feb-Apr 2025	English	yes	CROSSOVER

Università di Firenze (UNIFI)

Reference person: Benedetto Allotta <benedetto.allotta@unifi.it>

The courses can be BASIC (to establish cultural foundations), ADVANCED (advanced study of specific topics), CROSSOVER (on interdisciplinary subjects).

Name	Teacher	Ore	Class description	Available online	Time of the year (please check)	Language	Final evaluation	Level
Current Trends in Marine Robotics	Alessandro Ridolfi, alessandro.ridolfi@unifi.it	3	The course describe the state of the art of research in Marine Robotics and suggests hot fields of investigation	yes	Autumn/Winter 2024	English	sì	BASIC
Maneuverability Analysis of Underwater Vehicles	Benedetto Allotta, benedetto.allotta@unifi.it	3	The course describes how to evaluate the dynamic maneuverability of underwater vehicles starting from the vehicle dynamic model and the thruster model	yes	Spring/Summer 2025	English	sì	ADVANCED

Università degli studi di Genova (UNIGE)

Reference person: Giorgio Cannata <giorgio.cannata@unige.it>, Antonio Sgorbissa <antonio.sgorbissa@unige.it>

To be defined

Università degli studi di Milano Bicocca (UNIBM)

Reference person: Domenico Giorgio Sorrenti <domenico.sorrenti@unimib.it>, Dimitri Ognibene <dimitri.ognibene@unimib.it>

To be defined

Università degli Studi di Napoli Federico II (UNINA)

Reference person: Silvia Rossi <silrossi@unina.it>

The courses can be BASIC (to establish cultural foundations), ADVANCED (advanced study of specific topics), CROSSOVER (on interdisciplinary subjects).

Name	Teacher	Ore	Class description	Available online	Time of the year (please check)	Language	Final evaluation	Level
Social Robotics	Silvia Rossi, Alessandra Rossi, silrossi@unina.it	16	In this module, students will learn the key aspects of designing and developing robots' behaviours that are accepted and familiar to people. Particular attention will be given to robotics applications and scenarios where robots are expected to have close interactions with people and support therapists and caregivers. Students will be provided with an overview of the multidisciplinary aspects to consider in order to design a human-robot interaction (HRI) by discussing and learning aspects and techniques from different relevant fields, such as robotics, computer science, engineering, psychology, and artificial intelligence (AI). Students will learn how to design and conduct a HRI study, and how to choose subjective and objective measures to evaluate the interaction with the robot, and people's perception of the robot's behaviours and their effect on users. Students will also be exposed to different robots, such as Pepper and Furhat, that are used in human-centred scenarios, such as assistive robots in private homes, care facilities and hospitals, robotic companions in home environments, and robots in rehabilitation centers.	yes	Spring/Summer 2025	English	yes	CROSSOVER

Università degli Studi di Padova (UNIPD)

Reference person: Giulio Rosati <giulio.rosati@unipd.it>

The courses can be BASIC (to establish cultural foundations), ADVANCED (advanced study of specific topics), CROSSOVER (on interdisciplinary subjects).

Name	Teacher	Ore	Class description	Available online	Time of the year (please check)	Language	Final evaluation	Level
Python programming for Data Science and Engineering	Stefano Tortora, stefano.tortora@unipd.it	20	<p>Aim: Python is an easy-to-learn and powerful high-level language and it is becoming more and more popular for scientific applications such as machine learning, statistics, manipulating and transforming data, but also computer vision and robotics. The first objective of the course is to become familiar with Python syntax, environments and basic libraries. Secondly, the learner will be guided in performing basic inferential data analyses and introduced to the application of common machine learning algorithms.</p> <p>Topics:</p> <p>1- Introduction to the Python Programming Language</p> <ul style="list-style-type: none">○ What is different in Python?○ The Python Language Syntax○ Basic and advanced data structures <p>2- Modules and Packages</p> <ul style="list-style-type: none">○ NumPy and SciPy: Numerical and Scientific Python○ Pandas: Labeled Column-Oriented Data	yes	Mar/Apr 2025	English	yes	BASIC

			<ul style="list-style-type: none">○ Matplotlib: MATLAB-style scientific visualization○ Scikit-learn: Basics of Machine Learning in Python					
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Università degli Studi di Palermo (UNIPA)

Reference person: Adriano Fagiolini <adriano.fagiolini@unipa.it>

The courses can be BASIC (to establish cultural foundations), ADVANCED (advanced study of specific topics), CROSSOVER (on interdisciplinary subjects).

Name	Teacher	Ore	Class description	Available online	Time of the year (please check)	Language	Final evaluation	Level
Robot Consciousness	Antonio Chella	12	Robot Consciousness is a seminal field placed at the crossing between technical disciplines (AI, Robotics, Computer Science and Engineering), theoretical disciplines (Philosophy of Mind, Linguistic, Logic), and empirical disciplines (Psychology and Neuroscience). Robot consciousness focuses on attempts to apply the methods of AI, robotics and computer science to various ways of understanding consciousness and to examine the possible role of consciousness in robot systems. The course will present the current state of research and will discuss both the theoretical foundations and the experimental result of the emerging field of robot consciousness.	yes	Mar/Apr 2025	English	yes	CROSSOVER

Sapienza Università di Roma (UNIROMA1)

Reference person: Alessandro De Luca <deluca@diag.uniroma1.it>

The courses can be BASIC (to establish cultural foundations), ADVANCED (advanced study of specific topics), CROSSOVER (on interdisciplinary subjects).

Name	Teacher	Ore	Class description	Available online	Time of the year (please check)	Language	Final evaluation	Level
Least Squares optimization on Factor Graphs, an overview	Giorgio Grisetti, Barbara Bazzana, Luca di Giammarino	20	<p>Factor Graphs are graphical models that can represent a wide range of problems including, but not limited to SLAM, Visual and Lidar Odometry, Calibration, Structure from Motion, and Model Predictive Control. Effective methods to solve factor graphs are nowadays available.</p> <p>The aim of this course is to provide the students with a basic background on the formalism and on the techniques that can be used to solve these models.</p> <p>We plan to present several worked out examples, with small projects covering: Calibration, Point-Cloud Registration and Pose-Graph Optimization. https://sites.google.com/diag.uniroma1.it/onfactorgraphs/home</p>	yes	May 2025	English	yes	ADVANCED
An introduction to PDEs and their applications in robotics	Andrea Cristofaro, Marilena Vendittelli	16	<p>The scope of the course is to provide the basic knowledge to handle dynamical systems characterized by spatial distributed phenomena and governed by partial differential equations. After reviewing the needed theoretical background material, stability analysis and control design tools will be illustrated. Finally, in the second part of the course, applications to robotics and biomedical engineering will be considered, such as manipulation of flexible</p>	yes	<p>Monday 18/11/2024 ore 14:00-18:00</p> <p>Wednesday 20/11/2024 14:00-18:00</p> <p>Monday 25/11/2024 09:00-13:00</p>	English	yes	ADVANCED

			<p>materials or control of heat transfer in organic tissues.</p> <p>Detailed Program:</p> <p>1) Introduction: motivations and practical examples. Background tools: recalls on finite-dimensional systems, Banach and Hilbert spaces, functional spaces, linear functionals and linear operators.</p> <p>2) Semigroup theory and infinite-dimensional linear dynamical systems. Well-posedness. Examples of classical PDEs: reaction-diffusion equation, wave equation, beam equation. Spectral analysis: eigenvalues and eigenfunctions. Stability and stabilization based on modal decomposition.</p> <p>3) Lyapunov based stability analysis. Boundary control. Observer design. Coupling with ODEs at the boundary: example of a flexible robot arm. Approximations and simulations: finite elements, spectral decomposition.</p> <p>4) Applications: non-invasive internal temperature estimation in superficial hyperthermia, haptic interaction with virtual deformable structures.</p>		<p>Wednesday 27/11/2024 12:00-16:00</p>			
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Università degli Studi di Siena (UNISI)

Reference person: Domenico Prattichizzo <dprattichizzo@unisi.it>

The courses can be BASIC (to establish cultural foundations), ADVANCED (advanced study of specific topics), CROSSOVER (on interdisciplinary subjects).

To be defined

Università degli Studi di Trento (UNITN)

Reference person: Daniele Fontanelli luigi.palopoli@unitn.it Luigi Palopoli Daniele Fontanelli <daniele.fontanelli@unitn.it>

The courses can be BASIC (to establish cultural foundations), ADVANCED (advanced study of specific topics), CROSSOVER (on interdisciplinary subjects).

Name	Teacher	Ore	Class description	Available online	Time of the year (please check)	Language	Final evaluation	Level
Fundamentals of statistical estimation theory	Daniele Fontanelli, daniele.fontanelli@unitn.it	18	<p>The course provides an overview of estimation algorithms that are most commonly applied in engineering problems. The course will improve the background knowledge to model, analyse and solve estimation problems. The course has theory and practical sections, mainly simulative. Depending on the availability of actual components, practical examples on actual software/hardware solutions are foreseen.</p> <p>The course covers the following topics:</p> <ul style="list-style-type: none"> - Background on stochastic processes and random variables - Minimum Variance Unbiased Estimators - Cramer-Rao lower bound - Best linear unbiased estimator - Maximum Likelihood estimation - Weighted least squares solutions - Bayesian estimators <p>All the treated topics will be given with examples and hands-on problems.</p>	No	First or second week of September 2025	English	The final exam consists of a multiple-choice test or a project for the interested students.	BASIC
Legged Robot Control	Andrea Del Prete, andrea.delprete@unitn.it	12	<p>The course provides an overview of state-of-the-art techniques for the dynamic control of robotic systems, with a specific focus on legged robots (bipeds and quadrupeds). The course covers both theory and implementation, relying on the Python language and some existing libraries for robot visualization, multi-body</p>	yes	July 2025	English	Students are required to write a report, which is evaluated with pass/no pass.	BASIC

			dynamic computation, and trajectory optimization.					
Robot learning from demonstration	Matteo Saveriano, matteo.saveriano@unitn.it	20	The course provides an overview of state-of-the-art approaches for robot learning from human demonstration. The course will focus on approaches that allow the robot to learn stable (in the sense of Lyapunov) discrete (point-to-point) and periodic (limit cycle) trajectories evolving in the Euclidean space. We then move to more complex space structures and introduce the concept of Riemannian manifold with a special focus on orientation and symmetric and positive definite matrices that are of interest in robotics. The presented mathematical tools will be then used to perform learning of motion patterns evolving on Riemannian manifolds. The course covers both theory and implementation of presented algorithms relying on existing, open-source implementations.	yes	September 2025	English	Project and report	BASIC
Factor Graphs for SLAM	Marco Camurri, marco.camurri@unitn.it	18	The course will introduce factor graphs as a general tool to solve optimization problems and how to apply them to robot perception, with particular application to Simultaneous Localization and Mapping (SLAM) and other correlated problems such as path planning	Yes	First two weeks of June 2025	English	Oral Examination	ADVANCED

Università della Calabria (UNICAL)

Reference person: Giuseppe Carbone <giuseppe.carbone@unical.it>

The courses can be BASIC (to establish cultural foundations), ADVANCED (advanced study of specific topics), CROSSOVER (on interdisciplinary subjects).

Name	Teacher	Ore	Class description	Available online	Time of the year (please check)	Language	Final evaluation	Level
Advanced scientific programming applied to process optimization using Matlab	Alessio Caravella, alessio.caravella@unical.it	16	The course deals with parametric optimization of processes of interest for engineers. In particular, the Students will acquire the ability of formalizing and solve problems dealing with minimization of objective functions depending on parameters to optimize. For this purpose, the commercial software MATLAB® will be used.	Ask the teacher	Jan/Feb 2025	English	No	ADVANCED
Introduction to stochastic and mathematical modelling of discrete systems	Vittorio Astarita, vittorio.astarita@unical.it	12	The course begins with some introduction to probability theory and its applications to engineering problems. This will provide the foundation for the subsequent discussion of Markov chains. The course will then focus on the theory of Markov chains, including their definition, properties, and applications. Students will learn about discrete-time Markov chains and continuous-time Markov chains, as well as methods for analyzing these chains, such as the stationary distribution, and the limiting behavior of Markov chains. The course will also cover game theory and its application to engineering problems. Students will learn about the basics of game theory, including the concept of Nash equilibrium. In addition, the course will introduce students to the Monte Carlo method, a powerful tool for solving complex engineering problems. Students will learn how to simulate random events using	Ask the teacher	Feb 2025	English	No	BASIC

			<p>Monte Carlo simulations and will apply this technique to a range of problems. Finally, the course will introduce students to Blockchain systems and digital currencies. Students will learn about the basics of Blockchain technology, including distributed ledgers and smart contracts, and will explore the potential applications of this technology to engineering problems. Throughout the course, students will be exposed to representative case studies that demonstrate the application of the aforementioned theories to real-world engineering problems. By the end of the course, students will have a better understanding of probability theory and its applications to engineering, as well as a general view on practical toolkits for solving complex engineering problems.</p>					
Introduction to Python	Vittorio Astarita, vittorio.astarita@unical.it	12	<p>This course is designed to provide an introduction to the fundamental concepts of the Python programming language. Students will learn the syntax and semantics of Python, including variables, data types, and control structures. The course will cover basic data structures such as lists, dictionaries, and tuples, as well as functions and modules. Students will also learn about file input/output, error handling, and debugging techniques. By the end of the course, students will have gained a solid foundation in Python programming, which they can use to solve real-world problems.</p>	Ask the teacher	Feb/Mar 2025	English	No	BASIC
How to conduct a Systematic Literature Review: design, methods and supporting tools	Salvatore Ammirato, Marilena De Simone salvatore.ammirato@unical.it, marilena.de	8	<p>Topics: Motivation and goals of a systematic literature review (SLR); Methodology; Literature search, Exclusion and inclusion criteria, Metadata Analysis, Synthesis and results presentation. Applications: Designing a SLR; Paper location and selection; Paper analysis; Results synthesis; Digital tools for SLR; The</p>	Ask the teacher	Nov/Dec 2024	English	No	CROSSOVER

	simone@uni cal.it		MySLR digital platform; How to conduct a review with MySLR; Project works					
Spin-off creation: key fundamentals for a good plan	Gianpaolo lazzolino, gianpaolo.ia zzolino@uni cal.it	8	The course describes the main steps for constructing a business plan also referred to projects arising from results obtained in research. The main areas of a business plan are described with reference to the s.c. technology firms. The course proposes insights deriving from cases of spin-offs at the University of Calabria	Ask the teacher	May 2025	English	No	CROSSOVER

Università Politecnica delle Marche (UNIVPM)

Reference person: Massimo Callegari <m.callegari@univpm.it>, David Scaradozzi <d.scaradozzi@univpm.it>

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Name	Teacher	Ore	Class description	Available online	Time of the year (please check)	Language	Final evaluation	Level
Design of research: European Projects	Nicola Paone, n.paone@univpm.it	24	<ol style="list-style-type: none"> 1. Introduction to instruments and funding agencies for research. 2. European research <ol style="list-style-type: none"> a. European frame-work programmes and Horizon Europe b. Financial instruments in support of research. 3. The role of industry in framework programmes. Technology platforms. 4. Steps in project proposal preparation <ol style="list-style-type: none"> a. analysis of Call for Proposals and Workprogramme b. definition of objectives c. definition of partnership d. definition of impact e. the work-programme f. state of art g. budget and resources 5. Project proposal evaluation 6. Marie Curie actions for mobility of researchers 7. Project management, progress and scientific reporting. (Project meeting, deliverables, reports, etc.) 8. Administrative/financial management: <ol style="list-style-type: none"> a. financial reporting b. audit 9. Examples of projects. 10. Tutorial sessions. 	yes	Jan/Feb 2025	English	yes	CROSSOVER

Tools and methods for process representation and management	Ferruccio Mandorli, f.mandorli@univpm.it	24	<p>Formal tools for process representation: definition of IDEF0 diagrams and their use for the AS-IS and TO-BE representation of processes; definition of IDEF3 diagrams for the representation of sequences of tasks; definition of Gantt diagrams for task planning and resources allocation.</p> <p>Process management tools: introduction to Microsoft Project; basic concepts; definition of the tasks planning; resources allocation; assessment of the scheduling of the tasks.</p> <p>Data elaboration tools: advanced use of Excel; advanced query and selection functions; advanced filters; pivot tables; how to use the solver; introduction to the VBA framework for macro development and use of ActiveX controls.</p> <p>Tools for data storing, query and presentation: brief introduction to MS Access and MS Visio.</p>	yes (also e-learning)	Jan/Feb 2025	English	yes	CROSSOVER
Project management techniques	Filippo Ciarapica, f.e.ciarapica@univpm.it	24	Understanding Project Life Cycle and Project Portfolio Management Processes. Project Scope Management. WBS: creating the Work Breakdown Structure. Resource planning and estimating. Time estimating techniques. Cost estimating techniques. Project Business Plan. Risk management planning: qualitative and quantitative risk analysis.	yes	Jan/Feb 2025	English	yes	CROSSOVER
Virtual instruments (LabView) for monitoring and management of industrial systems	Milena Martarelli, m.martarelli@univpm.it	24	<ul style="list-style-type: none"> ● General approach to G programming ● Troubleshooting and debug ● Implementation of a virtual instrument ● Development of modular applications ● Arrays ● Hardware e software resources ● Data Acquisition ● Data Flow 	yes	Jan/Feb 2025	English	yes	BASIC

Mathematical programming and graph theory	Fabrizio Marinelli, fabrizio.marinelli@staff.univpm.it	24	<p>Decision Problems</p> <ul style="list-style-type: none"> • Elements and taxonomy • Solution of a decision problem • Easy and hard problems, exact and heuristic algorithms: hints of computational complexity theory • Multi-objective problems: goal programming and pareto-optimality <p>Mathematical Programming</p> <ul style="list-style-type: none"> • Declarative languages: AMPL • Decision problems and math. prog. • Integer Linear Programming: features and solution methods <p>Modelling techniques</p> <ul style="list-style-type: none"> • binary variables for selection: covering, packing and partitioning models • binary variables for association: assignments and permutations. • Logic variables: fixed costs, semi-continuous sets, conditional constraints, logical predicates • Linearization techniques: absolute values, piecewise linear functions, exponential functions <p>An introduction to Graph Theory</p> <ul style="list-style-type: none"> • Terminology and basic properties • Isomorphisms and classes of graphs: paths, cycles, trees, eulerian, hamiltonian, bipartite and planar graphs • Independent sets and covers • Greedy algorithm and matroids • Combinatorial Optimization and graphs • Mathematical prog. for optimization problems on graphs 	yes	Mar/Apr 2025	English	yes	ADVANCED
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			Applications <ul style="list-style-type: none">• Scheduling, routing and packing problems					
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Università Cattolica Milano (UNICATT)

Reference person: Antonella Marchetti <antonella.marchetti@unicatt.it>

The courses can be BASIC (to establish cultural foundations), ADVANCED (advanced study of specific topics), CROSSOVER (on interdisciplinary subjects).

Name	Teacher	Ore	Class description	Available online	Time of the year (please check)	Language	Final evaluation	Level
Developing In Human-Robot Interaction	Antonella Marchetti, Cinzia Di Dio, Federico Manzi & Giulia Peretti, antonella.marchetti@unicatt.it	16	Social robots represent the new frontier of interactions. We are looking at a future in which these entities will be included and integrated within many types of everyday activities, where they will be our new friends, collaborators, educators, and care assistants. In this course we will therefore offer a look at the state of the art in the development of robots as socially effective agents in psychology, highlighting their strengths, and trying to project our thinking into a future where these entities can be perceived as social partners. We will approach to the main psychological developmental steps in early infancy (e.g., gaze, imitation, action understanding), embodied cognition, social cognition (i.e., Theory of Mind) with respect to social and educational robotics. These will help to better understand the role of developmental psychology in AI and Human-Robot Interaction.	yes	June/July 2025	English	yes	BASIC