Politecnico di Bari

Calendario accademico corsi Scudo 2025/2026

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DCMCEI

Course title	Advanced Transportation Accessibility-Equity Assessment
Lecturer	Simona De Bartolomeo
Scientific Discipline Sector	CEAR-03/B
Hours of instruction	20
CFU	2
Year/Semester	First/First
Tentative Calendar	11/03/2026: 14.00-19:00 25/03/2026: 14.00-19:00 15/04/2026: 14.00- 19:00 29/04/2026: 14.00-19:00
SUMMARY /GOAL	The final scope is to equip students with advanced analytical tools and critical perspectives essential for addressing the interplay between transportation systems and social equity in diverse territorial contexts.
Syllabus	This course delves into the field of Transport Accessibility and Equity Assessment, providing an in-depth exploration of key concepts, methodologies and tools. The aims of the course are: Exploring the Principles of Accessibility-Based Transportation Planning (e.g., 15 minutes city); Utilizing Evaluation Tools and Performance Indicators for Measuring Progress Toward Transportation Equity Goals (e.g., threshold measures, gravity measures, PTAL, Lorenz Curve, Gini Index); Provide with transportation policy evaluation tools that account for the costs and benefits of equitable planning (e.g. through cost-benefit analysis and multicriteria evaluations).
Bibliography	Scientific papers, slides and support material from the lecturer
Examination method	Oral exam by slide presentation on the topics of the lectures (PP presentation)
Room	On-site Please send an email to simona.debartolomeo@poliba.it to enroll in the course

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DCMCEI

Course title	Complex Network Theory: Theory, Methods and Applications
Lecturer	Antonietta Simone
Scientific Discipline Sector	CEAR-01/B
Hours of instruction	20
CFU	2
Year	First
Tentative Calendar	
SUMMARY /GOAL	The integration of both mathematical and technical tools, as well as the growing availability of data, make it possible to study and interpret an enormous number of complex systems, where the main component is topology, that is, the way in which elements are connected and interact with each other. This course offers an overview of all the Complex Network Theory tools and their use in the study and analysis of real systems from a topological perspective, starting from water systems, which represent complex networks composed of several interconnected components, structured in non-trivial configurations, whose behavior is largely influenced by their connective structure, spatial limits, and interactions between components. This course aims to address the following points: – Introduction to CNT. Euler and the problem of the Königsberg bridges. Graphical representation and adjacency matrix. Basic concepts and study of topological properties. – Centrality metrics as tools to identify the most important elements in complex real systems. Degree, Betweenness, Closeness and Harmonic. – Construction of predictive models for understanding complex real systems. How the connective structure is fundamental to determine vulnerability and robustness. Regular, random, small-world (principle of six degrees of separation) and scale-free networks. – Communities and clustering for system analysis and management. Detecting the presence of communities is essential for discovering the internal connections of

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	complex structures and facilitating practical applications in many disciplines. – Time series and their representation in CNT: Visibility algorithms. Overview of the different fields of application: social systems, road networks, distribution systems, biological organisms, technological networks, computer networks, epidemiology, etc.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DCMCEI

Course title	Innovative and recyclable methods and materials for Civil Engineering applications
Lecturer	Vincenzo Fazio
Scientific Discipline Sector	MATH-04/A
Hours of instruction	20
CFU	2
Year/Semester	First/First
Tentative Calendar	27/01/2026: 15.00-17:30 29/01/2026: 15.00-17:30 03/02/2026: 15.00-17:30 05/02/2026: 15.00-17:30 10/02/2026: 15.00-17:30 12/02/2026: 15.00-17:30 17/02/2026: 15.00-17:30 19/02/2026: 15.00-17:30
SUMMARY /GOAL	The course aims to provide PhD students with advanced knowledge and tools for the design, characterization, and modeling of innovative and recyclable materials for Civil Engineering applications. Emphasis will be placed on the multiscale nature of such materials and on the integration of physics-based and data-driven approaches to describe their thermo-hygro-mechanical behavior. Students will gain familiarity with the fundamental mechanisms governing damage and degradation processes, as well as with modern modeling strategies that combine continuum mechanics, bio-inspired design concepts, and machine learning techniques. The ultimate goal is to promote a multidisciplinary understanding of sustainable materials, enabling the development of new solutions for resilient and environmentally responsible civil engineering systems.
Syllabus	1. Multiscale methods for the design and characterization of innovative and recyclable materials; 2. Thermo-hygro-mechanical properties of innovative and bio-inspired materials for Civil Engineering; 3. Damage effects induced by temperature, mechanical stress and chemical phenomena; 4. Design and characterization of materials with complex structures based on data modelling approaches.

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Bibliography	Ashby, Michael F., and David RH Jones. "Engineering Materials 2: An introduction to microstructures." Processing and Design 3 (2005). Chapters 21 to 24. Beatty, M. F. (1987). "Topics in Finite Elasticity: Hyperelasticity of Rubber, Elastomers, and Biological Tissues—With Examples." ASME. Appl. Mech. Rev. December 1987; 40(12): 1699–1734. De Tommasi, D., Puglisi, G., & Saccomandi, G. (2015). Multiscale mechanics of macromolecular materials with unfolding domains. Journal of the Mechanics and Physics of Solids, 78, 154-172. O. Giustolisi D. A. Savic: A symbolic data-driven technique based on evolutionary polynomial regression. Journal of Hydroinformatics, 8(3):207–222, 2006
Examination method	Oral exam (presentation)
Room	On-site Room 6 DICATECh

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DCMCEI

Course title	IoT Technologies for Digital Transition
Lecturer	Adnan Rashid
Scientific Discipline Sector	IINF-03/A
Hours of instruction	20
CFU	2
Year/Semester	First/First
Tentative Calendar	12/01/2026: 09.00-12:00 15/01/2026: 09.00-12:00 19/01/2026: 09.00-12:00 22/01/2026: 09.00-12:00 26/01/2026: 09.00-12:00 29/01/2026: 09.00-12:00 02/02/2026: 09.00-11:00
SUMMARY /GOAL	The course aims to equip Ph.D. students with an in-depth understanding of the Internet of Things (IoT) ecosystem, including device design, communication protocols, data acquisition, and modern network architectures such as cloud, edge, and fog computing. It emphasizes IoT applications across diverse domains, scalability and reliability considerations, and security frameworks and standards. By the end of the course, students will be able to design, implement, and secure IoT solutions for research and real-world applications
Syllabus	**1. Introduction to IoT (3 Hours)** • Overview of Computer Networking and Internet Ecosystem • IoT Device Design and Development • IoT Communication Cycle • Applications of IoT Across Domains • Importance of Smart Infrastructure **2. Sensors and Data Acquisition (3 Hours)** • IoT Components and Scope • Role of Sensors in IoT Applications • Data Acquisition Techniques • Sensor Deployment and Monitoring Concepts **3. IoT Communication Protocols and Standards (6 Hours)** • 6LoWPAN and IoT Protocol Stack • Wireless Technologies for IoT

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	• Scalability and Reliability Considerations **4. Modern Network Architectures: Cloud, Edge, and Fog (3 Hours)** • Cloud Computing Fundamentals • Edge and Fog Computing Concepts • Cloud Services: SaaS, PaaS, IaaS • Cloud Deployment Models: Public, Private, Community, Hybrid • Cloud Architecture Standards (NIST, ITU-T) **5. IoT Security (5 Hours)** • Fundamental Security Requirements • ETSI Security Perspective • ITU-T Security and Privacy Requirements • IoT Security Framework • Cloud Security: Issues, Concerns, and Data Protection
Bibliography	1. The book you are referring to is Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud, which is authored by **William Stallings**. 2. **Computer Networking: A Top-Down Approach**, Seventh Edition, authored by **James F. Kurose and Keith W. Ross**, was published by **Pearson** 3. **Computer Networks: A Systems Approach**, authored by **Larry L. Peterson and Bruce S. Davie**, 4. **Cryptography and Network Security: Principles and Practice**, Eighth Edition is a standard textbook written by **William Stallings** and published by **Pearson**. 5. **MQTT & MQTT 5 Essentials: A comprehensive overview of** **MQTT facts and features for beginners and experts alike** is an e-book and a series of online guides produced by **HiveMQ** 6. **Pv6 Fundamentals: A Straightforward Approach to Understanding IPv6**, Second Edition, authored by Rick **Graziani** and published by **Cisco Press** in 2017. 7. **ETSI, ITU, IEEE, IETF, and other standard documentation**
Examination method	Project-based
Room	On-site / Microsoft Teams General | IoT Technologies for Digital Transition 2025-26 | Microsoft Teams

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CTI

Course title	AI and Creativity
Lecturer	Dario Costantino
Scientific Discipline Sector	CEAR-09/A
Hours of instruction	20
CFU	2
Year/Semester	First/First
Tentative Calendar	15/01/2026 14.30-16.30 22/01/2026 14:30-17.30 29/01/2026 14:30-17.30 05/02/2026 14:30-17.30 12/02/2026 14:30-17.30 19/02/2026 14:30-17.30 26/02/2026 14:30-17.30
SUMMARY /GOAL	The course aims to equip students with both theoretical and practical tools to understand and effectively control artificial intelligence, integrating it within a structured and comprehensive creative process. Midjourney will serve as the primary platform for image generation, while additional forms of AI will be examined to illustrate their diverse applications across creative fields. The course will also include hands-on 3D modeling sessions using Rhinoceros and will address the ethical implications of AI, fostering a critical and informed approach to its use in design and visual communication.
Syllabus	**PROGRAM** **AI: global framework (theoretical session)** • Basic notions (history and evolution of Artificial Intelligence in the creative field) • Types of AI, uses and experiences • AI and architectural design **Midjourney (practical session)** • What is Midjourney and comparison with other software (ChatGPT, ComfyUI, Nano Banana) • Use of the software (from basics to advanced commands) **From the 2D image to the 3D model (practical session)** • Generation and selection of the right image • Analysis and interpretation of the image (color theory and photographic composition)

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	• Realization of a 3D model starting from the selected image
Bibliography	
Examination method	
Room	Microsoft Teams General | AI and Creativity (SCUDO 2025-2026) | Microsoft Teams

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CTI

Course title	Contextual Design and Heritage: identity and material culture of the territories
Lecturer	
Scientific Discipline Sector	CEAR-08/D
Hours of instruction	20
CFU	2
Year	First
Tentative Calendar	
SUMMARY /GOAL	The course aims to explore the role of design in the enhancement of material culture as recommended by the 2003 UNESCO Convention for the Safeguarding of the Intangible Cultural Heritage, with a particular focus on Southern Contexts. The “intangible cultural heritage means the practices, representations, expressions, knowledge, skills – as well as the instruments, objects, artefacts and cultural spaces associated therewith – that communities, groups and, in some cases, individuals recognize as part of their cultural heritage”. The Heritage dimension proposed by the UNESCO Convention is a “phenomenal extension” of the field of knowledge, conservation, enhancement and re-activation of material culture in which contextual design is developing a prominent role. Contextual Design is an important field of contemporary research developed in North Europe, in the Design Academy of Eindhoven. The aim is to investigate the meaning of the material and immaterial artifacts of design in relation to the identities of the territories and to the historical and cultural stratification that distinguishes them. Contextual Design and Cultural Heritage thus become a strategic combination to face the modern challenges of enhancing territorial contexts against the current phenomena of globalization and spectacularization of culture.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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CTI

Course title	Design for Historical and Contemporary Heritage Landscapes
Lecturer	Nicola Scardigno
Scientific Discipline Sector	CEAR-09/A
Hours of instruction	20
CFU	2
Year	First
Tentative Calendar	
SUMMARY /GOAL	The Faro Convention extends the idea of heritage from the architectural dimension to the dimension of city and landscape, recognizing together with the value of the single artifact the value of the relationship between artifacts in urban or natural context. Furthermore, the Convention consider as heritage non only the “extraordinary” but also the “ordinary” architecture, not only the ancient but also the ‘modern’ architecture. The notion of heritage landscape results from this new idea of heritage. The course will deal with the themes of the project for the preservation and valorization of the heritage landscapes, both historical and contemporary, both extraordinary and ordinary. The heritage landscapes are not only the archaeological and historical landscapes but also, for example, the urban landscape of the ‘modern’ city, that of the social housing district as well as that of the disused industrial plants. In this perspective, the course will deal with theories and design techniques useful for the transformation of the heritage landscapes, necessary to preserve, valorize and resignify them.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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CTI

Course title	Generative Algorithms: digital tools for parametric design and assessment of structures
Lecturer	Saverio Spadea
Scientific Discipline Sector	CEAR-07/A
Hours of instruction	20
CFU	2
Year/First	First/First
Tentative Calendar	12/02/2026: 14:30-17:30 16/02/2026: 14:30-17:30 19/02/2026: 14:30-17:30 25/02/2026: 10:00-13:00 27/02/2026: 14:00-17:00 13/03/2026: 14:30-17:00 20/03/2026: 14:30-17:00
SUMMARY /GOAL	New technologies are changing the way engineers work within the construction sector. Newly developed software solutions have provided effective methods to explore the design space at the interface between Structural Engineering and Architecture, allowing more efficient design strategies. The course aims to explore the potentials of new digital tools based on generative algorisms. The course is organized into four main parts in which both theoretical and practical aspects will be illustrated: 1) Theoretical aspects of the Generative Scripting; 2) Introduction of the Python interpreter component for Grasshopper (Rhino 3D), which allows to execution of dynamic scripts; 3) Introduction to Structural Optimization; 4) Workshop: the students will be divided into groups, and they would be defining helpful generative algorithms in their research topic.
Syllabus	
Bibliography	
Examination method	
Room	Microsoft Teams

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	Generative Algorithms: digital tools for parametric design and assessment of structures | Generale | Microsoft Teams

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CTI

Course title	Historical research and study of the Ancient architecture
Lecturer	Antonio Fino
Scientific Discipline Sector	CEAR-11/A – ARCH-01/D
Hours of instruction	20
CFU	2
Year	First
Tentative Calendar	
SUMMARY /GOAL	Ancient architecture is almost always in a state of ruin. His study, aimed at formulation of reliable hypotheses of reconstruction of the building, must be based on integrated survey methodologies that use the detailed analysis of the ancient ruined building as an essential knowledge base. They are taken into consideration therefore, besides to the observations derived from the results of the architectural survey, also any iconographic testimonies from other sources, such as vascular painting, frescoes, bas-reliefs, images on coins, etc. The building and its construction and morphological details, as well as, when present, his architectural sculpture must then be compared with others contemporary architectures, in order to include it in its historical-geographical context. The course therefore aims to present some completed or ongoing architectural research that can effectively illustrating the research method mentioned above. In particular, the following case studies will be addressed: - The Arch of Trajan in Leptis Magna - The reconstruction of urban planning of Kos - The Curia in Leptis Magna - Architectural sculpture in the anastylosis of ancient buildings - Urban planning in Ionia and Caria between the archaism and the Hellenistic age - Architectural and decorative models in the mausoleums of the imperial age in Libya - The Hellenistic theatre in Mytilene - The townscape in the figurative culture of Greek and Roman times - The urban planning ant the agora of Byllis (Albania)

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	- The Cistern in the agora of Byllis, analysis of the typology and of the constructive aspects.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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CTI

Course title	Problems and methods of contemporary restoration
Lecturer	Rossella De Cadilhac
Scientific Discipline Sector	CEAR-11/B
Hours of instruction	20
CFU	2
Year	First
Tentative Calendar	
SUMMARY /GOAL	The educational objective of the course of Problems and methods of contemporary restoration is to illustrate the general lines of the main ways of understanding restoration and to provide PhD students with the historical-critical tools to develop an autonomous and conscious thought regarding the themes and nodes problematic of the discipline, with particular regard to the conceptual elaborations and experiences that open from the second post-war period to contemporary debate. There will be lectures and exercises, mutually complementary. Through the lectures the methods will be deepened, the knowledge of the theoretical and cultural foundations of restoration will be increased and strengthened and the ability to understand the conceptual nodes of the discipline will be developed in order to direct PhD students to achieve a capacity for critical re-elaboration of the acquired knowledge. Through the exercises the ability to apply knowledge and understanding will be developed and verified. The course is divided into two parts. The first part of the course will be divided into two thematic sections: the first will present the philosophical and cultural foundations of the discipline; in the second, some key issues of the contemporary debate will be addressed, such as the relationship between “restoration and creativity” in the “old and new” dialectic. The second part will be dedicated to exercises. These will take place in the form of discussions which, through comparison, will help PhD students acquire an autonomous ability to apply the knowledge acquired through analytical and critical tools useful for interpreting the different theoretical positions and evaluating their operational implications. The attribution of training credits will take place through a final test, aimed at verifying the acquisition

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	of knowledge and skills by the PhD student. The assessment will also take into account participation in the training activities carried out.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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CTI

Course title	Stereotomic Design. New frontiers of stone architecture
Lecturer	Ilaria Cavaliere
Scientific Discipline Sector	CEAR-09/A
Hours of instruction	20
CFU	2
Year	First
Tentative Calendar	
SUMMARY /GOAL	The course aims to show the unexpressed potential of the structural stone for contemporary architecture. The whole course will be divided into three parts: a first historical introduction and evolution of stereotomic architecture; a second part relating to the three-dimensional infographic parametric/variational modeling techniques of complex vaulted spaces; and a last part relating to the realization of design' projects by the students reviewed by the teacher. The best projects will be 3D printed or real-dimension built and exhibited in the most important trade fairs of the sector
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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CTI

Course title	Theories and methods in structural design: modeling and experimental issues
Lecturer	Raffaele Capuano
Scientific Discipline Sector	CEAR-06/A
Hours of instruction	20
CFU	2
Year	First
Tentative Calendar	
SUMMARY /GOAL	The shape of masonry constructions and the influence of the curvature in the load bearing capacity of arches, domes and vaults. Seismic actions and masonry constructions. Mechanical behavior of masonry: heterogeneity, different behavior in tension / compression, non-linear mechanical response, anisotropy, failure modes, damage. Modeling strategies: micromechanical models, FEM and DEM implementation of micromechanical models, macro-mechanical models, multiscale models, NT (No-Tension) and RNT (Rigid No Tension) models, macro-elements. Limit Analysis: static and kinematic approaches. From the static approach of Limit Analysis to the relation between shape and structures in masonry arches and vaults (and back to graphic statics).
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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CTI

Course title	Theories and methods of design for the Antique
Lecturer	Antonio Nitti
Scientific Discipline Sector	CEAR-09/A
Hours of instruction	20
CFU	2
Year	First
Tentative Calendar	
SUMMARY /GOAL	The first part will be structured into four thematic sections: the first, by investigating the contributions offered by the Masters of Architecture between the XIX° and XX° centuries and deducing their theoretical background, will try to outline the general principles underlying the main points of view that connote contemporary architectural research; the other three will be thematically articulated and focused on the relationships between "Antique and Landscape", "Antique and City", "Renovation and Museography", and will see the compositional analysis of some exemplary contemporary works, in order to recognize methods and techniques of the design for the Antique. The second part will be devoted to the exercises. They will be carried out in the modality of an intensive design workshop, dealing with and developing a project concerning the main topics of the course.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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CTI

Course title	Theories and techniques of the project for the fragile cities and territories
Lecturer	Giuseppe Tupputi
Scientific Discipline Sector	CEAR-09/A
Hours of instruction	20
CFU	2
Year	First
Tentative Calendar	
SUMMARY /GOAL	The recent disastrous phenomena, accentuated by atmospheric changes as well as by neglect and improper transformation processes, have highlighted the fragility of our cities and our territories, especially those of the so-called “inland areas”. The awareness that not only human lives and production activities are at risk but also the identity of the places is growing stronger and, for this reason, a paradigm shift for the safety and risk mitigation project is required. The course will illustrate an innovative approach aimed to combine Safety and Identity, based on the conception of the project of mitigation of risks (seismic, hydrogeological) as an opportunity of strengthening of the identity characters of fragile cities and territories. According to this approach, the safety works built in order to mitigate the hydrogeological risk can define a place in the landscape as well as “monumentalize” its natural forms. The project of mitigation of the seismic risk of the urban fabric of the Apennine cities could be an occasion to renovate the form of the city itself and its spaces. Indeed, combining safety and identity means convert the technical forms of the safety project into architectural forms, capable to exalt the characters of the places that they transform.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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CTI

Course title	Theory of Formativeness
Lecturer	Carlo Moccia
Scientific Discipline Sector	CEAR-09/A
Hours of instruction	20
CFU	2
Year	First
Tentative Calendar	
SUMMARY /GOAL	It seems lost today, in architecture as generally in arts, a unitary point of view on which to found a theory on. That civil conscience that has always been the basis of the art of building seems no longer part of the collective heritage. This condition is recognizable in the contradictory experience of contemporary architecture. For this reason, the class aims to try to outline a "classical" theory of architectural research; a classicism that does not renounce, rather it investigates, the culture of modernity, trying to measures itself against this alleged contradiction. All the architecture that we can include within the “classic” experience (that we can also define “rational experience”) is characterized by a peculiarity: the intelligibility of forms, along with we define a method of formativeness. According to this idea of architecture, there’s no advancement of forms without an advancement of knowledge - without an increasingly higher level of self-awareness. Hence the need for a theory of architectural research. The method of formativeness we want to investigate regards three major chapters of architecture: The relationship among architecture, city and landscape; The “construction issue”; The question of the project with the Ancient.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DAUSY

Course title	Deep Reinforcement Learning for Control of Autonomous Systems
Lecturer	Gaetano volpe
Scientific Discipline Sector	IINF-04/A
Hours of instruction	10
CFU	1
Year/Semester	First/First
Tentative Calendar	07/04/2026: 09.30-12:00 09/04/2026: 09.30-12:00 14/04/2026: 09.30-12:00 16/04/2026: 09.30-12:00
SUMMARY /GOAL	Reinforcement learning deals with solving sequential decision problems when minima prior information is available. Solving sequential decision problems means finding their optimal control policies. Using reinforcement learning algorithms, the optimal pol icy is learned through the cooperation between the agent (or con troller) and the system to be controlled. Deep Reinforcement Learning (DRL) is a subfield of machine learning that combines reinforcement learning (RL) and deep learning. The course will pro pose the main modeling frameworks, investigate the most relevant deep reinforcement learning techniques and show some in teresting applications.
Syllabus	This course introduces the fundamental concepts and methods of Reinforcement Learning (RL) and Deep Reinforcement Learning (DRL), focusing on sequential decision-making problems where limited prior information is available. Students will learn how agents interact with environments to learn optimal control policies and how deep learning techniques enable RL to scale to com plex, high-dimensional settings. The course presents the main modeling frameworks, key DRL algorithms, and representative ap plications in fields such as robotics, control, games, and resource management. Topics: • Reinforcement Learning basics and Markov Decision Pro cesses (MDPs) • Dynamic programming and model-free RL methods (Monte Carlo, TD learning, Q-learning) • Deep learning foundations for RL • Deep value-based methods (DQN and extensions)

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	• Policy gradient methods and actor–critic algorithms (A2C/A3C, DDPG, PPO, SAC) • Exploration strategies and stability considerations • Applications of DRL in real-world systems By the end of the course students will be able to: • Model sequential decision problems using RL frame-works • Implement and analyze major DRL algorithms • Apply DRL techniques to practical control and decision making tasks • Understand current challenges and research directions in the field
Bibliography	• Sutton, R.S., & Barto, A.G. Reinforcement Learning: An In troduction (2nd ed.). • Goodfellow, I., Bengio, Y., & Courville, A. Deep Learning. • Watkins, C., & Dayan, P. (1992). Q-Learning. • Mnih, V. et al. (2015). Human-level Control Through Deep Reinforcement Learning (DQN). • Schulman, J. et al. (2017). Proximal Policy Optimization (PPO). • Lillicrap, T.P. et al. (2016). Deep Deterministic Policy Gradi ent (DDPG). • Haarnoja, T. et al. (2018). Soft Actor–Critic (SAC).
Examination method	Final Project
Room	Microsoft Teams Generale | Deep Reinforcement Learning for Control of Au-tono mous Systems 2025-2026 | Microsoft Teams For any information, please contact: gaetano.volpe@poliba.it

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DAUSY

Course title	Dynamical stochastic models of biological systems
Lecturer	Pasquale Palumbo
Scientific Discipline Sector	IINF-04/A
Hours of instruction	10
CFU	1
Year/Semester	First/First
Tentative Calendar	24/02/2026:10.30-13:00 25/02/2026:10.30-13:00 26/02/2026:10.30-13:00 27/02/2026:14.30-17:00
SUMMARY /GOAL	This course gives the mathematical tools to model and analyze most common biological frameworks such as chemical reactions and gene transcription networks, according to the stochastic approach of the Chemical Master Equations. Note: Although Course “Modeling and simulation of biosystems” (Prof. Borri) and Course “Dynamical stochastic models of biological systems” (Prof. Palumbo) may be followed independently, they have been conceived as a single module divided into two parts, both dealing with mathematical models for biological systems: the former focuses on deterministic approaches, while the latter focuses on stochastic approaches.
Syllabus	
Bibliography	
Examination method	
Room	Microsoft Teams Dynamical stochastic models of biological systems Webex Dynamical stochastic models of biological systems For any information, please contact: pasquale.palumbo@unimib.it

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DAUSY

Course title	Modeling and simulation of biosystems
Lecturer	Alessandro Borri
Scientific Discipline Sector	IINF-04/A
Hours of instruction	20
CFU	2
Year/Semester	First/First
Tentative Calendar	11/02/2026: 11.30-13.30 12/02/2026: 11.30-13.30 13/02/2026: 11.30-13.30 16/02/2026: 10.30-13.30 17/02/2026: 11.30-13.30 18/02/2026: 11.30-13.30 19/02/2026: 11.30-13.30 20/02/2026: 11.30-13.30 23/02/2026: 10.30-13.30
SUMMARY /GOAL	This course provides mathematical tools to model, analyze, simulate, and control biological and medical systems, primarily within a deterministic framework. By the end of this course, students will be able to model such systems and implement simulation models using Matlab. Note: Although Course "Modeling and simulation of biosystems" (Prof. Borri) and Course "Dynamical stochastic models of biological systems" (Prof. Palumbo) may be followed independently, they have been conceived as a single module divided into two parts, both dealing with mathematical models for biological systems: the former focuses on deterministic approaches, while the latter focuses on stochastic approaches.
Syllabus	
Bibliography	
Examination method	
Room	Microsoft Teams Modeling and simulation of biosystems For any information, please contact: alessandro.borri@iasi.cnr.it

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DAUSY

Course title	Modeling and Simulation of Smart Energy Systems
Lecturer	Michele Roccotelli
Scientific Discipline Sector	IINF-04/A
Hours of instruction	10
CFU	1
Year/Semester	First/Second
Tentative Calendar	14/09/2026: 10.00-12.30 15/09/2026: 10.00-12.30 16/09/2026: 10.00-12.30 17/09/2026: 10.00-12.30
SUMMARY /GOAL	This course aims at providing PhD students with modeling and methodological tools for formulating and solving large-scale optimization problems with a focus on the use of duality theory. During the course several optimization problems will be formalized, particularly referred to relevant issues within management and industrial engineering. Problem definition and resolution will be also implemented in simulation and engineering software (Matlab). The final goal is to provide PhD students with the necessary background for starting research in the field of duality-based decentralized and distributed optimization techniques to be applied to large-scale systems. Each lesson consists in lectures, numerical examples, simulation and analysis of case studies.
Syllabus	
Bibliography	
Examination method	
Room	Microsoft Teams Modeling and Simulation of Smart Energy Systems For any information, please contact: michele.roccotelli@poliba.it

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DAUSY

Course title	Optimal control for Climate change and air quality
Lecturer	Claudio Carnevale
Scientific Discipline Sector	IINF-04/A
Hours of instruction	20
CFU	2
Year/Semester	First/Second
Tentative Calendar	01/07/2026: 09.30-12.30 02/07/2026: 09.30-12.30 03/07/2026: 09.30-12.30 06/07/2026: 09.30-12.30 07/07/2026: 09.30-12.30 08/07/2026: 09.30-12.30 09/07/2026: 09.30-11.30
SUMMARY /GOAL	The course will address the fundamentals of the modelling and control of real-world systems, presenting the application of control theory to climate change and air quality. Each lesson shall consist in lecture and numerical examples.
Syllabus	
Bibliography	
Examination method	
Room	Microsoft Teams For any information, please contact: claudio.carnevale@unibs.it

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DAUSY

Course title	Simulation Systems for Engineering Applications
Lecturer	Nicola Mignoni
Scientific Discipline Sector	IINF-04/A
Hours of instruction	10
CFU	1
Year/Semester	First/First
Tentative Calendar	06/05/2026: 10.00-12.30 08/05/2026: 10.00-12.30 13/05/2026: 10.00-12.30 15/05/2026: 10.00-12.30
SUMMARY /GOAL	The course shall address the basis of simulation techniques for engineering applications, with a focus on the underlying mathematical formalism. At end of this course students will be able to deal with system modeling and to implement simulation models in engineering tools (e.g., Python, Matlab). Each lesson shall consist in lecture and numerical examples.
Syllabus	
Bibliography	
Examination method	
Room	Microsoft Teams Simulation Systems for Engineering Applications For any information, please contact: nicola.mignoni@poliba.it

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DRIEI

Course title	Fundamentals of Information Security and Data Privacy
Lecturer	
Scientific Discipline Sector	IINF 05/A
Hours of instruction	10
CFU	1
Year	First
Tentative Calendar	
SUMMARY /GOAL	This course delves into the dynamic interplay between Artificial Intelligence (AI), Machine Learning (ML), and data security and privacy, highlighting both the challenges and opportunities these technologies present. The rapid advancements in Information and Communication Technologies (ICTs) are transforming society, delivering profound societal and economic benefits. This evolution is fueled by the vast availability of rich, heterogeneous data and the pervasive adoption of AI-ML approaches for data generation, analysis, and processing. However, this technological leap presents a double-edged sword in the realm of data protection. On one hand, AI-ML applications introduce new privacy and security risks, such as potential data exposure during the learning process or vulnerabilities like data poisoning attacks, which can compromise model accuracy and integrity. On the other hand, AI-ML techniques also offer transformative opportunities, enabling innovative solutions for cybersecurity and privacy-preserving data sharing. This course offers a comprehensive overview of the research issues, challenges, and opportunities at the intersection of AI-ML, data security, and privacy. Participants will explore the dual nature of AI-ML's impact, gaining insights into both the potential threats and the groundbreaking solutions it can provide for safeguarding information in the era of smart technologies. The course combines theoretical lectures with practical insights. Participants will engage with real-world case studies and hands-on sessions, enabling them to implement and

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	evaluate interpretability techniques. A final project will require students to analyze a case study using the acquired knowledge and tools.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DRIEI

Course title	Machine learning
Lecturer	Antonio Ferrara
Scientific Discipline Sector	IINF-05/A
Hours of instruction	10
CFU	1
Year	First
Tentative Calendar	
SUMMARY /GOAL	The course will provide a broad introduction to machine learning. The course will cover Supervised learning, Machine Learning systems design and evaluation, Unsupervised learning, including clustering and dimensionality reduction. By the end of the course, the course participants will be able to design and implement Machine Learning-based applications autonomously. The lessons alternate theoretical lectures and implementation examples.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DRIEI

Course title	Management of future telecommunication systems via pervasive intelligence
Lecturer	Arcangela Rago
Scientific Discipline Sector	IINF-03/A
Hours of instruction	20
CFU	2
Year/Semester	First/First
Tentative Calendar	16/01/2026: 15.30-19.00 22/01/2026: 15.30-18.30 27/01/2025: 15.30-19.00 29/01/2025: 15.30-19.00 03/02/2025: 15.30-19.00 05/02/2025: 15.30-18.30
SUMMARY /GOAL	The course illustrates the emerging technologies and methodologies based on pervasive intelligence for the management of future telecommunication systems, with particular focus on: • the context of 5G and Beyond networks and the enabling technologies, • traffic analysis at the mobile edge, • anticipatory resource allocation at the edge, • Radio Access Network slicing management, • practical examples.
Syllabus	- Course presentation, Introduction to 5G and Beyond net-works - Traffic analysis at the mobile edge - Anticipatory resource allocation at the edge, Radio Access Network slicing management - Dynamic resource provisioning via Network Digital Twin - Management of Terrestrial and Non-Terrestrial Networks - XAI in 6G Network Architectures, Practical examples, Final exams
Bibliography	Scientific papers provided by the lecturer
Examination method	PhD course work and final presentation
Room	On-site / Microsoft Teams

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	Generale | SCUDO "Management of Future Telecommunication Systems via Pervasive Intelligence" AA 2025/2026 | Microsoft Teams

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DRIEI

Course title	Mechatronic Systems
Lecturer	
Scientific Discipline Sector	IINF-04/A
Hours of instruction	20
CFU	2
Year	First
Tentative Calendar	
SUMMARY /GOAL	This class provides the PhD students with analytical tools to model and simulate interconnected multi-physical dynamic systems, with a focus on mechatronic systems and actuator applications. A generalized modeling framework will be initially presented to describe engineering systems across different physical domains (e.g., mechanical, electrical, magnetic, fluidic, thermofluidic). A port-based modeling perspective will be introduced, which exploits the concept of energy to model the physical interconnection among various subsystems in a universal and coherent way. Based on the derived framework, basic mathematical models of different types of electrostatic, electromagnetic, hydraulic, and pneumatic mechatronic systems will be derived. In parallel to model development, basic technological aspects of each class of mechatronic systems and actuators will be discussed, and the most common physical components and applications will be presented. At the end of the PhD class, the students will be able to model and simulate complex mechatronic systems consisting of the interconnection of several components with a unified thermodynamic framework, and will have a basic understanding of the operating principles of the most common types of mechatornic actuator technologies.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DRIEI

Course title	Numerical Methods for nonlinear Optimization
Lecturer	Alessandro Coclite
Scientific Discipline Sector	MATH/05/A
Hours of instruction	10
CFU	1
Year/Semester	First/First
Tentative Calendar	03/02/2026: 10.00-12:30 05/02/2026: 10.00-12:30 10/02/2026: 10.00-12:30 12/02/2026: 10.00-12:30
SUMMARY /GOAL	This course will provide an advanced-level overview of the numerical solution of partial differential equations and computational models for differential problems. Within a rigorous mathematical setting, the major classes of numerical methods will be analyzed and critically discussed. Consistency and stability will be discussed, providing essential guidelines for the choice and implementation of numerical methods for differential problems.
Syllabus	- Transport equations. Scalar transport problem, a priori estimation. System of hyperbolic linear equations. Finite difference technique, scalar equation discretization, and discretization of a system of hyperbolic linear equations. Boundary conditions. - Equivalent models for transport equations.- Kinetic BGK-like models. Kinetic models for hydrodynamics and traffic laws. Convergence and Stability. Computational aspects. - Description of parallel computing structures and strategies. Shared memory VS distributed memory.
Bibliography	- E. Godlewski, P. A. Raviart, Numerical Approximation of Hyperbolic Systems of Conservation Laws- Springer Verlag 1996. - M. Treiber and A. Kesting Traffic Flow Dynamics - Springer Verlag 2013.- Slides and support material from lecturer.
Examination method	Final examination in class
Room	Microsoft Teams Numerical Methods for nonlinear Optimization

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DRIEI

Course title	Numerical Methods for ODEs
Lecturer	Sabrina Francesca Pellegrino
Scientific Discipline Sector	MATH/05/A
Hours of instruction	10
CFU	1
Year	First
Tentative Calendar	
SUMMARY /GOAL	The course will describe the numerical methods that facilitate the analysis of mathematical real-world problems with particular reference to initial value problems. Their implementation in Matlab will be addressed, together with the use of modern Matlab toolboxes for large and sparse data; applications to the solution of real-life problems will be considered. Each lesson shall consist in lecture and numerical examples.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DRIEI

Course title	Research Methodology
Lecturer	Leonarda Carnimeo
Scientific Discipline Sector	IIET-01/A
Hours of instruction	20
CFU	2
Year/Semester	First/First
Tentative Calendar	03/02/2026: 12:30-13:30 04/02/2026: 11:00-13:30 05/02/2026: 14:30-17:00 10/02/2026: 14:30-17:00 11/02/2026: 14:30-17:00 12/02/2026: 14:30-17:00 17/02/2026: 14:30-17:00 18/02/2026: 11:00-13:30 19/02/2026: 11:00-12:30
SUMMARY /GOAL	This course aims at providing PhD students with the knowledge of fundamentals of Research Methodology and how to use them effectively in their own scientific research. Examples are inserted when necessary.
Syllabus	❖ Introduction ❖ Research Theory ❖ Ethics and Research ❖ Research Methods ❖ Research Instruments ❖ Research Project ❖ Scientific Proposal Drafting
Bibliography	
Examination method	
Room	Microsoft Teams Research Methodology-Scu.Do. prof. L. Carnimeo - leonarda.carnimeo@poliba.it - Office No.+39 0805963438 | Generale | Microsoft Teams

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DRIG

Course title	A user- centered approach to Ergonomics assessment in the Industry 5.0 paradigm
Lecturer	Vito Modesto Manghisi
Scientific Discipline Sector	IIND-03/B
Hours of instruction	20
CFU	2
Year/Semester	First/Second
Tentative Calendar	19/06/2026: 09:30-12:30 23/06/2026: 09:30-12:30 30/06/2026: 09:30-12:30 02/07/2026: 09:30-12:30 06/07/2026: 09:30-12:30 08/07/2026: 09:30-12:30 10/07/2026: 15:00-17:00
SUMMARY /GOAL	The Industry 4.0 program and the perspectives of the innovative I5.0 approach are significantly changing the role played by the operator on the smart factory shopfloor. The introduction of the mass-customization paradigm and the fast changes in the production cycle require new operators' capabilities. In particular, the I4.0 operator is requested to be a smart element in the production cycle, able to adapt to sudden changes by means of decisional capabilities. In order to strengthen such capabilities, it is necessary to optimize the working conditions so as to free operators from unnecessary tasks and allow them to use their physical and cognitive resources in an optimal manner. The Human Performance Envelope (HPE) constitutes the set of factors that define the conditions in which the operator acts and encompasses environmental, social, physical, and cognitive aspects. In order to optimize the operator's performance, it is essential to understand the processes that govern the definition of the HPE, thus allowing both designing efficient solutions and applying rigorous validation procedures. Thanks to technological innovations (e.g. low-cost tracking systems and physiological signals platforms), nowadays it is possible to apply an integrated approach for the HPE assessment using both traditional and novel methods. The course will be composed of 3 modules aiming at providing Ph.D. students with the necessary knowledge to validate in their scientific research the effec-

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	tiveness of solutions designed in order to improve the operator's performance with particular attention to the HPE. Module I. Introduction and theoretical bases. The role of the Operator in the I4.0 smart factory. Introduction to the concept of HPE and its fundamental components —the physical and the cognitive workload. Basic principles of the Cognitive Load Theory. The ISO standard 11226 Ergonomics — Evaluation of static working postures. Module II. Assessment methods for physical ergonomics. Post-hoc measures (the Borg-CR 10 scale), direct methods, observational methods (the Rapid Upper Limb Assessment metrics), and innovative applications for the observational methods (the ErgoSentinel tool). Module III. Assessment tools for cognitive ergonomics. Post-hoc measures (the NASA Task Load Index, the Multiple Resource Questionnaire), task performance measures (Completion time, Error Rate, reaction Time, the dual-task design); direct methods (the electrocardiographic signal and the Heart Rate Variability Analysis approach). By the end of the course, Ph.D. students will have a broadened knowledge in the field of the Industry 4.0 paradigm through the awareness of the new role of the operator and the knowledge of the HPE concept. Furthermore, they will be able to handle tools for physical and cognitive workload assessment and for designing an experimental setup in order to validate innovative solutions for HPE improvement.
Syllabus	The course programme will be composed of 3 modules aiming at providing Ph.D. students with the necessary knowledge to validate in their scientific research the effectiveness of solutions designed in order to improve the operator's performance with particular attention to a user centric design approach. **Module I. Introduction and theoretical bases.** The role of the Operator in the I4.0 smart factory. Introduction to the concept of HPE and its fundamental components —the physical and the cognitive workload. Basic principles of the Cognitive Load Theory. The ISO standard 11226 Ergonomics — Evaluation of static working postures. **Module II. Assessment methods for physical ergonomics.** Post-hoc measures (the Borg-CR 10 scale), direct methods, observational methods (the Rapid Upper Limb Assessment metrics), and innovative applications for the observational methods (the ErgoSentinel tool). **Module III. Assessment tools for cognitive ergonomics.** Post-hoc measures (the NASA Task Load Index, the Multiple Resource Questionnaire), task performance measures (Completion

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	time, Error Rate, reaction Time, the dual-task design); direct methods (the electrocardiographic signal and the Heart Rate Variability Analysis approach).
Bibliography	
Examination method	
Room	On-site / Microsoft Teams A user- centered approach to Ergonomics assessment in the Industry 5.0 paradigm

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DRIG

Course title	Advanced Additive Manufacturing and Reverse Engineering design and processes for the twin transition
Lecturer	Rossella Surace
Scientific Discipline Sector	IIND-04/A
Hours of instruction	20
CFU	2
Year/Semester	First/First
Tentative Calendar	14:04:2026: 14:00-19:00 21:04:2026: 14:00-19:00 28:04:2026: 14:00-19:00 05:05:2026: 14:00-19:00
SUMMARY /GOAL	The course aim to provides PhD students with the knowledge about advanced Additive Manufacturing (AM) and Reverse Engineering (RE) processes mainly for new Repairing/Remanufacturing more sustainable solutions in circular industrial economy. In fact, the new Additive Manufacturing methods offer the best value-added, resource-efficient approach to end-of-life product recovery. The course project will be articulated in different topics: 1. Direct Energy Deposition (DED) solutions for repair and life extension. Among DED processes, Laser Powder Metal Deposition will be analysed in more detail because of its enormous capabilities, flexibility and efficiency.
Syllabus	Module 1: Strategic Framework & Metrology of Data • The Twin transition & Circular industrial economy. • The digital thread. • Life Cycle Assessment (LCA). • Advanced Metrology and Reverse Engineering (RE). Module 2: Additive Manufacturing (AM) as an Enabling Technology • AM for Rapid Tooling. • Physics of AM Processes for tooling. • Systems Architecture. Module 3: Hybrid Systems & Functional Materials • Advanced injection molding: specifics of micro-molding vs. conventional molding. • Hybrid manufacturing systems: integration of AM (additive) and CNC Milling (subtractive) for mold manufactur-ing. • Advanced Materials: Developing composite structures using recycled polymers.

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	Module 4: Industrial Applications • High-Value Case Studies: Aerospace, Automotive, Tool-ing, Biomedical & Telco.
Bibliography	Scientific papers, slides and support material from the lecturer
Examination method	PPT presentation
Room	On-site / Microsoft Teams

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DRIG

Course title	Basic concepts on elliptic equations
Lecturer	Pietro D'Avenia
Scientific Discipline Sector	MATH-03/A
Hours of instruction	20
CFU	2
Year/Semester	First/First
Tentative Calendar	03/03/2026: 09:30-12:00 06/03/2026: 09:30-12:00 10/03/2026: 09:30-12:00 13/03/2026: 09:30-12:00 17/03/2026: 09:30-12:00 20/03/2026: 09:30-12:00 24/03/2026: 09:30-12:00 27/03/2026: 09:30-12:00
SUMMARY /GOAL	The aim of the course is to present some basic aspects for elliptic equations and to show how solutions of this type of equations can be obtained through optimization of suitable functionals.
Syllabus	**Introduction and preliminary tools.** **The Laplace equation.** Preliminaries. Well posedness and uniqueness. Harmonic func-tions. Fundamental solution and Green function. Kelvin transform and applications. Maximum principle. **A Variational approach.** Preliminaries. Variational formulation of an elliptic problem. Op-timization and the Weierstrass Theorem.
Bibliography	E.H. Lieb, M. Loss, Analysis, AMS, 2001. L.C. Evans, Partial differential equations, AMS, 2010. S. Salsa, G. Verzini, Partial Differential Equations in Action, Springer, 2022.
Examination method	Oral examination on a topic mutually agreed upon by the lecturer and the student.
Room	Microsoft Teams Generale | Basic concepts on elliptic equations 2026 | Microsoft Teams

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DRIG

Course title	Design and management of research projects
Lecturer	
Scientific Discipline Sector	IIND-05/A
Hours of instruction	20
CFU	2
Year	First
Tentative Calendar	
SUMMARY /GOAL	This course provides essential knowledge, methodologies, and tools for designing and managing research projects. The main learning objectives are as follows: Guide participants in crafting successful proposals and developing comprehensive plans for research projects to capitalize on available funding opportunities. Focus on the objectives, methodologies, conditions, and best practices of major research programs. Familiarize students with the EU financial framework. Equip pstudents with the principles and competencies of project cycle management. Develop the ability to precisely define the objectives, purpose, and requirements of a project. Introduce principles, techniques, and tools for the design and planning of research projects. Enhance competencies in key project monitoring and control techniques. Familiarize students with the successful dissemination principles of research projects.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DRIG

Course title	Introduction to probability and statistical inference
Lecturer	Erasmo Caponio
Scientific Discipline Sector	MATH-03/A
Hours of instruction	20
CFU	2
Year/Semester	First/First
Tentative Calendar	14/04/2026: 16:00-18:00 17/04/2026: 10:00-12:00 21/04/2026: 16:00-18:00 24/04/2026: 10:00-12:00 28/04/2026: 16:00-18:00 05/05/2026: 16:00-18:00 12/05/2026: 16:00-18:00 19/05/2026: 16:00-18:00 26/05/2026: 16:00-18:00 03/06/2026: 16:00-18:00
SUMMARY /GOAL	This course introduces the fundamental concepts of elementary probability theory and statistical inference.
Syllabus	(CDF), discrete uniform, Bernoulli, binomial, geometric, negative binomial, Poisson distributions and Poisson approximation to the binomial. Continuous random variables: probability density functions (PDF), cumulative distribution functions, uniform, exponential, normal (Gaussian), log-normal distributions, transformations of random variables, Jacobian method, central limit theorem and Gaussian approximation to the binomial. Properties of distributions: expectations, mean, mode, median, variance, higher moments, central moments, skewness, kurtosis, quantiles, percentiles, moment-generating functions, characteristic functions, cumulant generating functions. Inequalities and further distributions: Markov's and Chebyshev's inequality, weak law of large numbers, gamma, chi-squared, Student's t, Fisher-Snedecor F distributions and their relationships. Joint distributions: joint probability mass functions, joint probability density functions, marginal distributions, expected values, independent random variables, covariance, correlation, functions of multiple random variables, conditional distributions. Statistical inference:

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	sample statistics, distribution of sample mean, sampling variability, estimators and their properties (consistency, bias, efficiency), Cramer-Rao lower bound, standard errors, maximum-likelihood estimation, method of moments, Fisher information. Confidence intervals: interval estimation, pivotal quantities, confidence intervals for normal parameters and proportions, one sided confidence intervals. Regression analysis: simple and multiple linear regression, least squares estimation, properties of regression estimators, confidence intervals in regression. Hypothesis testing: principles, simple and composite hypotheses, significance levels, power, Type I and Type II errors, p-values, test statistics, tests for means and proportions, analysis of variance (ANOVA), goodness-of-fit testing.
Bibliography	• Probability and Statistics for STEM, 2nd ed. by Emmanuel N. Barron and John G. Del Greco, Springer, 2024 • Think Stats, 3rd edition, Allen B. Downey. • Lectures notes
Examination method	Oral exam on a topic related to the course or to the student's PhD thesis
Room	Microsoft Teams Generale | Introduction to probability and statistical inference AA25-26 | Microsoft Teams

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DRIG

Course title	Mathematical methods in deep learning
Lecturer	Gianluca Orlando
Scientific Discipline Sector	MATH-03/A
Hours of instruction	20
CFU	2
Year/Semester	First/First
Tentative Calendar	27/01/2026: 14.30-17:00 29/01/2026: 14.30-17:00 03/02/2026: 14.30-17:00 05/02/2026: 14.30-17:00 09/02/2026: 14.30-17:00 10/02/2026: 14.30-17:00 17/02/2026: 14.30-17:00 19/02/2026: 14.30-17:00
SUMMARY /GOAL	This course, intended for Engineering Ph.D. Students, has the objective to provide the basic mathematical concepts needed to have a clear insight of the mechanism of neural networks in deep learning. This will help engineers in exploiting neural networks as a tool in a conscious way. The theory treated in the course is the following. 1) We will start by introducing the basic architecture of a feedforward neural network defined basing on weights. For this, we shall recall some basic facts in tensor algebra. 2) We will ex-plain some examples of Universal Approximation Theorems, highlighting the ideas behind the fact that a neural network is capable to approximate any continuous function. 3) We will introduce the concept of cost in a feedforward neural network, providing some examples of nonlinear costs. Among these, we will put some stress on the cross-entropy cost, recalling some basic facts in statistics about maximum likelihood estimation. 4) We will introduce some numerical methods for nonlinear optimization: the gradient descent, stochastic gradient descent, momentum update. 5) We will explain how all the previous ingredients are combined together in the feedforward-backpropagation algorithm used for data-driven learning. In parallel with the theory, we will illustrate how to implement it using the PyTorch library in some educational examples in image recognition and language models, putting some stress on the process of

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	babysitting a neural network (initialization, normalization, checking overfitting). Projects proposed by the Ph.D. Students will be strongly encouraged.
Syllabus	The course will start with a general introduction to the objectives of data-driven machine learning and by explaining where neural networks and deep learning fit in this general framework. Then we will move on to the description of the basic building blocks of neural networks. We will introduce the concept of perceptron and of sigmoid neuron, and we will explain how these simple models can be used to build complex neural networks, with a gentle intro-duction to loss functions and the backpropagation algorithm. This will allow us to build a simple neural network that recognizes handwritten digits from the MNIST dataset with the aid of the Py-Torch library from Python. With this concrete example in mind, we will discuss in detail some of the most important key aspects of neural networks. We shall give an idea of the proof of the Universal Approximation Theorem, explaining how neural networks are able to approximate any continuous function. The proof will highlight the importance of the non-linearity in the activation functions of neural net-works. Then we will refer to some results in the literature that show the benefits of using deep neural networks over shallow ones. Next, we will move on to the choice of the loss function, discus-sing the choice of cross-entropy and log-likelihood loss functions. For this, we will recall some basic concepts of information theory and maximum likelihood estimation in statistics. After the choice of the loss function, we will discuss the optimization of weights in neural networks. We will introduce, in a general setting, the algorithm of gradient descent, explaining how it is used to minimize functions. We will discuss pros and cons of the basic gradient descent algorithm. Then we will introduce in detail the algorithm used in practice to optimize the weights of neural networks, the stochastic gradient descent algorithm. Finally, we will discuss some of the most important variants of this algorithm, such as momentum update. With these tools in hand, we will build a simple neural network from scratch.

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	We will move on to regularization techniques in neural networks, discussing the concepts of regularization and dropout. Moreover, we will discuss the problem of vanishing and exploding gradients in deep neural networks, and we will introduce the concept of batch normalization, explaining how it can be used to mitigate these problems. If time permits, we will discuss some further topics in deep learning, such as convolutional neural networks for image recognition and natural language processing. A lecture will be dedicated to the question of how neural networks represent features in the data, discussing the concept of superposition of features and the Johnson-Lindenstrauss lemma.
Bibliography	General references - M. Nielsen, Neural Networks and Deep Learning, Determination Press, 2015. - I. Goodfellow, Y. Bengio, and A. Courville, Deep Learning, MIT Press, 2016. Introduction - Prima e seconda rivoluzione industriale (in Italian) https://www.treccani.it/enciclopedia/rivoluzione-industriale/ - Timeline of Machine Learning: https://en.wikipedia.org/wiki/Timeline_of_machine_learning - J. Schmidhuber. Annotated History of Modern AI and Deep Learning. https://arxiv.org/abs/2212.11279 - M. Roser. The brief history of artificial intelligence: the world has changed fast — what might be next?. Published online at Our-WorldinData.org. Retrieved from: https://our-worldindata.org/brief-history-of-ai - F. Duarte. Amount of Data Created Daily (2024). https://explod-ingtopics.com/blog/data-generated-per-day Machine learning - A. Quarteroni. Physics-based and data-driven mathematical models for the simulation of complex problems. C.I.M.E. Course. https://sites.google.com/unifi.it/cime/c-i-m-e-courses/c-i-m-e-courses-2024/pdes-control-and-deep-learning - T. Hastie, R. Tibshirani, and J. Friedman, The Elements of Statisti-cal Learning, Springer, 2009. Linear regression - T. Hastie, R. Tibshirani, and J. Friedman, The Elements of Statisti-cal Learning, Springer, 2009. Logistic regression

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	- C. M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006. Cross-entropy - T. Cover and J. Thomas, Elements of Information Theory, Wiley, 1991. Optimization algorithms (general reference) - J. Nocedal and S. J. Wright, Numerical Optimization, Springer, 2006. Gradient descent and stochastic gradient descent - G. Garrigos, R. M. Gower. Handbook of convergence theorems for (Stochastic) Gradient Methods. https://arxiv.org/abs/2301.11235 Neural networks - M. Nielsen, Neural Networks and Deep Learning, Determination Press, 2015. - I. Goodfellow, Y. Bengio, and A. Courville, Deep Learning, MIT Press, 2016. Perceptron - F. Rosenblatt, The Perceptron: A Probabilistic Model for Information Storage and Organization in the Brain, Cornell Aeronauti-cal Laboratory, 1957. - M. Nielsen, Neural Networks and Deep Learning, Determination Press, 2015.å Universal approximation theorem - G. Cybenko, Approximation by superpositions of a sigmoidal function, Mathematics of Control, Signals, and Systems, 2(4), 303-314, 1989. - M. Nielsen, Neural Networks and Deep Learning, Determination Press, 2015. Datasets - Real estate dataset collected from https://www.kaggle.com/da-tasets/kirbysasuke/house-price-prediction-simplified-for-regres-sion - MNIST dataset collected from https://www.kaggle.com/datasets/oddrationale/mnist-in-csv - Seoul Bike Sharing Demand dataset collected from https://ar-chive.ics.uci.edu/ml/datasets/Seoul+Bike+Sharing+Demand
Examination method	Oral examination on the topics of the course or development of a project.

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Room	On-site / Microsoft Teams Aula 5 fino al 10/02/2026 Aula 3 dal 17/02/2026 Generale | SCUDO | Mathematical methods in Deep Learning | Microsoft Teams

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DRIG

Course title	Metaverse Integration for Digital Transformation of industry
Lecturer	Alessandro Evangelista
Scientific Discipline Sector	IIND-03/B
Hours of instruction	20
CFU	2
Year	First
Tentative Calendar	
SUMMARY /GOAL	This course provides an in-depth exploration of the metaverse as a fundamental catalyst for digital transformation in an increasingly evolving industrial context. Balancing theory and practice, participants are guided through a series of modules designed to provide a comprehensive and applied understanding of key concepts. The introduction will outline the fundamental importance of the Metaverse in the context of the Digital Transition. The first module will explore the history and development of metaverse technologies. A clear distinction will be made between virtual reality, augmented reality and the metaverse concept itself. The second module, through the study of successful cases and the analysis of successful implementation strategies, will explore the practical applications of the metaverse in a business context. The third module will provide an overview of enabling technologies. It will examine how Artificial Intelligence and Blockchain can empower the Metaverse and accelerate the digital transition. The fourth module is highly practical. It will guide participants in designing immersive experiences and developing a strategic plan for integrating the metaverse into the corporate environment. Hands-on experience will be provided through practical sessions using virtual reality metaverse development platforms such as the Unity game engine. The course conclusions will summarise the acquired knowledge and prepare the participants for the final project. The aim of this assignment is to develop a practical project that applies the concepts of Digital Transition through the metaverse. After completing the course, the theoretical and

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	practical learning will be reinforced by presenting and evaluating projects. The course aims to train participants as informed Digital Transition leaders, equipped with the skills to fully exploit the potential of the Metaverse in the business domain, through theoretical lectures and practical sessions.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DRIG

Course title	Smart sustainable manufacturing
Lecturer	Michele Dassisti
Scientific Discipline Sector	IIND-04/A
Hours of instruction	20
CFU	2
Year	First
Tentative Calendar	
SUMMARY /GOAL	The major issue of sustainable manufacturing activities is the management of useful information: the way we choose data to measure may strongly change the perception of its nature and influence. Thus sustainability, which is an emerging paradigm in manufacturing, is now leading the most of the scientific efforts in defining the assessment of sustainability and the collection of significant measures of transition toward actions that satisfies the economic, environmental, social and technological targets. Smartness paradigm in manufacturing, on the other hand, is deeply tied to the information management and use, provided the Digital Twins as well as Cyber Physical Systems are mostly based on data get from sensing systems and on their elaboration to predict the evolution of systems simulated. The class will bring the students to understand the main driving issues in assessing and managing sustainable manufacturing in the light of a smart transition. At the same time will put major issues to come in order to stimulate students in their scientific career to deepen open issues still remaining on the subject from a technological perspective. Contents 1CFU. Manufacturing processes and the main factors of production: material and energy. Manufacturing and sustainability. Production systems and their sustainable management. Smart manufacturing paradigms: I4.0 and 5.0. 1CFU Criteria for modeling manufacturing processes and their critical variables. Cyber Physical System and Cyber Physical Social System.

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	Measurement of the ecological footprint of a process: carbon and water footprint. Sustainability Assessment of manufacturing processes based on 1 and 2nd law of thermodynamics.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DRIG

Course title	Technological changes and transition perspective
Lecturer	Vito Albino
Scientific Discipline Sector	IEGE-01/A
Hours of instruction	20
CFU	2
Year	First
Tentative Calendar	
SUMMARY /GOAL	The technological change is continuously increasing its pace. New technologies and business models are impacting the economic and social systems in a deep and unexpected way as well as social systems are adapting and reacting to these changes. The aim of the course is firstly to adopt the epistemological point of view for the technological determinism to examine how technology, economy, and society interact each other when a change in technology occurs. Some cases will be presented and discussed (asbestos cement, iron, and automotive technologies). Then, the transition perspective is presented to explain how such changes can determine long-term and wide impact. The type and nature of the transition are discussed. The structural and ideological nature of a transition will be described to support a full understanding of the phenomena. Some tools to operationalize ideologies are introduced. The green and digital transition will be examined adopting this perspective. A specific analysis for the transitions towards the smart city and the new space economy will be discussed with students.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DRIME

Course title	Acoustics and thermoacoustics
Lecturer	Davide Laera
Scientific Discipline Sector	IIND-06/B
Hours of instruction	20
CFU	2
Year	First
Tentative Calendar	
SUMMARY /GOAL	Coupling between acoustic waves and flames has become a central issue in the development of many modern combustion systems because of both environmental issues (noise) and the destructive interactions which acoustics can generate in combustors. Numerical tools are essential in many flames/acoustics studies but a theoretical background in acoustics and especially in acoustics for reacting flows is mandatory to tackle such problems. This course presents the fundamental concepts of acoustics and thermo-acoustic instabilities together with instability control strategies. Possibilities of data-driven approach for optimal design of stable combustion chamber will be also presented. The course is an alternation of theoretical presentations and practical work. It is divided into 5 lectures and a practical hands-on. 1) Fundamental of acoustics: theory, modelling and measurement techniques. 2) The thermoacoustic combustion instabilities 3) Flames as acoustic element: Flame transfer functions/Flame describing functions 4) Controlling of thermoacoustic instabilities: passive and active control strategies 5) Data-driven methods for optimal design. 6) Simple hands-on.
Syllabus	
Bibliography	
Examination method	

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Room	On-site / Microsoft Teams

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DRIME

Course title	Conservation laws in continuum mechanics and traffic modeling
Lecturer	Giuseppe Maria Coclite
Scientific Discipline Sector	MATH-03/A
Hours of instruction	20
CFU	2
Year/Semester	First /First
Tentative Calendar	11/03/2026: 10.30-13:00 13/03/2026: 10.30-13:00 16/03/2026: 10.30-13:00 18/03/2026: 10.30-13:00 20/03/2026: 10.30-13:00 23/03/2026: 10.30-13:00 25/03/2026: 10.30-12:10 To be defined
SUMMARY /GOAL	<u>Introduction to Conservation Laws.</u> Scalar conservation laws. Hyperbolic systems of conservation laws. Euler and Burgers equations. <u>The Method of Characteristics.</u> Semilinear equations with constant coefficients. Semilinear equations with variable coefficients. Quasilinear equations: creation of shock waves. <u>Shock waves.</u> Discontinuous solutions. Rankine-Hugoniot conditions. Shock waves. Entropies and entropy fluxes for scalar equations and systems. Entropy weak solutions. Kruzkhov entropies. Change of variables. Liu conditions: entropic shock waves. Kruzkhov Theorem. Uniqueness and stability of entropy weak solutions. Change of coordinates. <u>Oleinik Estimate.</u> Oleinik estimate for conservation laws with convex fluxes. Uniqueness via Oleinik type estimates. Minimal entropy conditions.

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	<u>Riemann Problem.</u> Shock and rarefaction waves. Solution of the Riemann problem for convex fluxes. Solution of the Riemann problem for general fluxes. <u>Vanishing Viscosity.</u> Vanishing viscosity approximants. Viscous shock waves. Convergence and error estimate. Numerical schemes. Viscosity solutions for Hamilton-Jacobi equations. Legendre Trasform. Lax-Oleinik Formula. <u>Traffic Models.</u> Fluidodynamic models for vehicular traffic. LWR model: shock and rarefaction waves. Moving bottleneck. Nonlocal models. Aw-Rascle model. Two phase models. Multi-population models. Traffic on networks: shocks generated by the junctions. Stop and Go waves. <u>Continuum Mechanics.</u> Nonlinear elasticity. Gas dynamics. The p-system. Shock waves. Riemann invariants.
Syllabus	
Bibliography	1. A. Bressan. Hyperbolic Systems of Conservation Laws. The one-dimensional Cauchy problem. Oxford Lecture Series in Mathematics and its Applications, vol. 20, Oxford University Press, Oxford, 2000. 2. G. M. Coclite. Scalar Conservation Laws. Springer-Briefs in Mathematics. Springer (2024). 3. C. M. Dafermos. Hyperbolic Conservation Laws in Continuum Physics. Second edition. Grundlehren der Mathematischen Wissenschaften [Fundamental Principles of Mathematical Sciences], vol. 325, Springer-Verlag, Berlin, 2005. 4. L. C. Evans. Partial differential equations. Graduate Studies in Mathematics, vol. 19, American Mathematical Society, Providence, RI, 1998. 5. M. Garavello, K. Han, and B. Piccoli. Models for vehicular traffic on networks. AIMS Series on Applied Mathematics 9. Springfield, MO: American Institute of Mathematical Sciences (AIMS), 2016.

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	6. H. Holden and N. H. Risebro. Front tracking for hyperbolic conservation laws. Applied Mathematical Sciences, vol. 152, Springer-Verlag, New York, 2002. 7. D. Serre. Systems of conservation laws - 1 & 2. Cambridge University Press, Cambridge, 2000.
Examination method	
Room	On-site / Microsoft Teams Le lezioni saranno in presenza, trasmesse online e registrate. L'aula verrà comunicata inseguito sul canale del team. Conservation laws in continuum mechanics and traffic modeling

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DRIME

Course title	Hydraulic Turbomachines for Energy Recovery in Water Distribution Networks
Lecturer	Michele Stefanizzi
Scientific Discipline Sector	IIND-06/B
Hours of instruction	20
CFU	2
Year	First
Tentative Calendar	
SUMMARY /GOAL	Water Distribution Networks (WDNs) represent a noteworthy field for possible implementation of Small Hydropower (SHP). Indeed, WDNs experience considerable water leakages due to their age and water management authorities often divide the WDNs by inserting Pressure Reducing Valves (PRVs), which waste a potentially recoverable hydraulic head. The replacement of PRVs with turbomachines can be considered as an economically feasible solution to achieve both an effective pressure control and an energy recovery, otherwise wasted. In this framework, the course aims to provide criteria for selecting and predicting the performance of hydraulic turbomachines for energy recovery in water distribution networks. The course starts with an overview on the global scenario of renewable energy sources. In particular, hydropower sector will be deepened ranging from the large hydropower to the small/mini hydropower and its potential. Then, the available technologies to exploit hydraulic energy in water distribution networks will be illustrated (i.e., Pumps as Turbines (PaTs), Cross-flow turbines, Energy harvesting valves, etc.). Afterwards, PaTs will be investigated. After the analysis of the state of the art, the course will present performance prediction models (both theoretical and empirical). Cross-flow turbines and energy harvesting valves will be discussed in terms of performance curves and regulation techniques.

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	Subsequently, the course will focus on methods for the selection of the proper machine for a specific WDN. Then, different case studies will be analyzed in terms of energy production and economic feasibility. The last part of the course will be focused on how to experimentally investigate a Pump as Turbine. In particular, the hydraulic turbomachinery lab (PoliBa) will be described. Then, the experimental characterization of a PaT selected for a WDN will be illustrated.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DRIME

Course title	Hydrogen for Sustainable Transportation Systems
Lecturer	Gianmarco Saponaro
Scientific Discipline Sector	ING-IND/08
Hours of instruction	20
CFU	2
Year	First
Tentative Calendar	
SUMMARY /GOAL	Hydrogen can play a significant role in the decarbonization process of hard-to-abate transport sectors such as heavy and long-distance road transport and maritime mobility, where electrical transportation is not technically viable. Hydrogen may be used either to feed fuel cells (FCs) or burned inside ICE. The current state hydrogen FC technology is expensive and requires pure hydrogen. Furthermore, large batteries are needed to cope with the transient nature of power demands for vehicle applications, reducing the overall efficiency. ICEs can be fueled with non-purified hydrogen, resulting in significantly lower production cost of hydrogen fuel. Furthermore, they can take advantage of the existing advanced combustion and engine control technologies. The course proposes an overview of both technologies, considering their pros and cons. The course delves into the aspects related to the configuration of propulsion systems, power management systems, storage systems, as well as the problems of deterioration of fuel cells and hydrogen embrittlement.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DRIME

Course title	Introduction to fluid-structure interaction
Lecturer	Alessandro Nitti
Scientific Discipline Sector	IIND-01/F
Hours of instruction	20
CFU	2
Year	First
Tentative Calendar	
SUMMARY /GOAL	The objective of this course is to deliver the key topics concerning Fluid-Structure Interaction (FSI) problems for biophysical and engineering applications. The students are expected to understand the mechanisms underlying the fluid-elastic effects in microscopic and human-scale applications, with the respective modelling approaches. The course will focus on simplified, low-dimensional models containing key aspects of real-world problems. Reference applications include bacterial locomotion, aeroelastic phenomena on airfoils, flow-induced vibrations of bridge decks, vibrations of conveying pipes. Numerical solutions will be addressed by means of a Matlab implementation.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DRIME

Course title	Introduction to Partial Differential Equations and Applications
Lecturer	Alessio Pomponio
Scientific Discipline Sector	MATH-03/A
Hours of instruction	20
CFU	2
Year/Semester	First/First
Tentative Calendar	04/03/2026 8.30-11.00 06/03/2026 8.30-11.00 09/03/2026 8.30-11.00 11/03/2026 8.30-11.00 13/03/2026 8.30-11.00 16/03/2026 8.30-11.00 18/03/2026 8.30-11.00 20/03/2026 8.30-11.00
SUMMARY /GOAL	Aim of this course is the introduction to the study of partial differential equations. The three main types of linear second order partial differential equations will be considered: parabolic (diffusion equation), elliptic (Laplace equation), and hyperbolic (wave equation), underling their theoretical and applied features.

Syllabus	<u>Preliminary Calculus tools</u>
	• Differential Calculus
	  ○ Sobolev Spaces
	  ○ Differential and integral relationships
	• · Function sequences and function series
	  ○ Pointwise and uniform convergence
	  ○ Fourier Series
	Partial Differential Equations
	• · Introduction and classification
	• · Transport Equation o Physical model
	  ○ Solving the initial value problem
	  ○ Transport equation with damping
	  ○ Transport equation with concentrated source
	• · Heat Equation o Linear diffusion model
	  ○ Separation variables
	  ○ Maximum principle
	• · Laplace Equation
	  ○ Harmonic functions
	  ○ Separation variables

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	○ Maximum principle • · Wave Equation ○ d'Alembert's formula ○ Vibrating string ○ Energy conservation
Bibliography	• L.C. Evans, Partial differential equations, American Mathematical Society, 2010. • S. Salsa, Equazioni a derivate parziali, Metodi, modelli e applicazioni, Springer, 2010. • S. Salsa, G. Verzini, Equazioni a derivate parziali, Complementi ed esercizi, Springer, 2005. • F. Tomarelli, Mathematical analysis tools for engineering, Società Editrice Esculapio, 2024.
Examination method	Oral presentation
Room	On-site / Microsoft Teams Generale | 2025/2026 - Introduction to Partial Differential Equa-tions with Applications | Microsoft Teams

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DRIME

Course title	Offshore Wind Technologies
Lecturer	Sergio Mauro Camporeale
Scientific Discipline Sector	IIND-06/A
Hours of instruction	20
CFU	2
Year	First
Tentative Calendar	
SUMMARY /GOAL	Offshore wind energy has the potential to integrate a large part of the renewable electric energy that will be produced in the coming Years to meet the objectives of reducing global CO2 emissions. For Italy in particular, interest is focused on floating turbine technologies, which can play an important role in industrial development, with the integration of blue economy activities in ports and at sea. However, floating wind turbines still require fundamental research on platforms, turbines and mooring technologies to make them fully competitive for use in the Mediterranean, where wind speeds and sea states are lower than in northern Europe. The course provides an overview of floating turbine technologies, considering their advantages and disadvantages and their possible integration with other offshore power generation systems such as wave energy converters and floating photovoltaic platforms. The course covers aspects related to digital tools for identifying areas suitable for the development of marine renewable energy sources, tools for performance analysis and simulation, ranging from simplified models based on BEM to more accurate CFD simulations.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DRIME

Course title	Optimization theory
Lecturer	
Scientific Discipline Sector	MATH-03/A
Hours of instruction	20
CFU	2
Year	First
Tentative Calendar	
SUMMARY /GOAL	Mathematical Formulation. Control of production and consumption. Reproductive strategies in Social Insects. Pendulum. Moon lander. Rocket railroad car. Controllability of Linear Systems. Observability. Bang-Bang Principle. Time Optimal Control. Calculus of Variations and Hamiltonian Dynamics. Pontryagin Maximum Principle. Control of production and consumption. Linear Quadratic Regulator. Maximum Principle with transversality conditions. Distance between two sets. Commodity trading. Hamilton-Jacobi-Bellmann equation. Dynamic programming. Connections between dynamic programming and the Pontryagin Maximum Principle. Differential games. Isaacs equations. Games and the Pontryagin Maximum Principle. War of attrition and attack.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DRISA

Course title	Coding Theory
Lecturer	Angela Aguglia
Scientific Discipline Sector	MATH-02/B
Hours of instruction	10
CFU	1
Year/Semester	First/First
Tentative Calendar	11/03/2026: 10.30-13:00 18/03/2026: 10.30-13:00 25/03/2026: 10.30-13:00 02/04/2026: 10.30-13:00
SUMMARY /GOAL	The aim of the course is to present the theory of error correcting codes and the mathematical principles they rely on, with special regard to their application to deep-space communications.
Syllabus	Finite Fields. Linear Codes and their parameters. Cyclic Codes. BCH, Reed Solomon Codes, Post-quantum codes (mentions) and some applications to deep-space probe communications.
Bibliography	Luca Giuzzi, Codici Correttori, Springer (2006) Scott A. Vanstone, Paul C. van Oorschot, An introduction to error correcting codes with Applications, Kluwer Academic Publishers (1989)
Examination method	Oral discussion
Room	Microsoft Teams Generale | Coding Theory 2025-2026 | Microsoft Teams

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DRISA

Course title	DoE and Robust Design applied to setup optimization for numerical and experimental testing
Lecturer	Francesca Di Carolo
Scientific Discipline Sector	IIND-03/A
Hours of instruction	20
CFU	2
Year/Semester	First/Second
Tentative Calendar	09/06/2025 14:00-17:00 11/06/2025 14:00-17:00 16/06/2025 14:00-17:00 18/06/2025 14:00-17:00 23/06/2025 14:00-17:00 25/06/2025 14:00-17:00 26/06/2025 14:00-16:00
SUMMARY /GOAL	The aim of the course is to provide skills in the definition of statistically robust setup and analysis of experimental and/or numerical plans in order to reduce the impact of the noise.
Syllabus	1. **Basics of statistics** a. Descriptive statistics and inferential statistics b. Hypothesis testing c. ANOVA (Analysis of Variance) 2. **DoE via Factorial Design** a. Full factorial design.(single factor experiments and Multi-factor experiments) b. Fractional factorial design c. Response Surface Methodology (RSM) 3. **Robust Design** a. Taguchi method b. System definition and classification of factors (signal, noise, control) c. Orthogonal array design (internal matrix and external matrix) d. Application of robust setup definition (either numerical or experimental) 4. **Case Studies** 5. **Guided Implementation of an Individual Case Study and Evaluation**
Bibliography	Atkinson, A. C.; Donev, A. N.; Tobias, R. D. (2007). Optimum Experimental Designs, with SAS. Oxford University Press. pp. 511+xvi. ISBN 978-0-19-929660-6

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	Taguchi Methods: Design of Experiments. Amer Supplier Inst (1 novembre 1993). ISBN-10 ： 0941243184 Statistical Quality Control: A Modern Introduction Hand outs from the lecturer
Examination method	Personal project with oral presentation
Room	Microsoft Teams Generale | DoE and Robust Design applied to setup optimization for numerical and experimental testing - SCUDO 2025/2026 | Microsoft Teams

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DRISA

Course title	Mathematical Models for High Frequency Analysis
Lecturer	Francesco Maddalena
Scientific Discipline Sector	MATH-03/A
Hours of instruction	10
CFU	1
Year	First
Tentative Calendar	
SUMMARY /GOAL	The main goal of this course relies in introducing some mathematical models related to the study of wave propagation in continuous media in the regime of high frequency. Some arguments of asymptotic analysis will be discussed. Particular emphasis will concern the study of thin elastic structures in high frequency vibrations.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DRISA

Course title	Spatio-Temporal dynamics of lasers: modelling and applications
Lecturer	Massimo Brambilla
Scientific Discipline Sector	PHYS-03/A, PHYS-04/A
Hours of instruction	20
CFU	2
Year/Semester	First/First
Tentative Calendar	09/04/2026: 10.00-12:00 16/04/2026: 10.00-12:00 30/04/2026: 10.00-12:00 07/05/2026: 10.00-12:00 14/05/2026: 10.00-12:00 21/05/2026: 10.00-12:00 28/05/2026: 10.00-12:00 04/06/2026: 10.00-12:00 11/06/2026: 10.00-12:00 18/06/2026: 10.00-12:00
SUMMARY /GOAL	The objectives of the course are: i) ability to describe the dynamics of lasers (and nonlinear optical devices) including coherent effects; ii) understanding spatiotemporal field dynamics in the paraxial approximation; iii) understand applications to pulse generation, multimode coherent dynamics, mode-locking, solitons and optical frequency comb (OFC) formation; iv) understand applications of gathered knowledge to modern semiconductor lasers of remarkable relevance (e.g. quantum dot lasers, quantum cascade lasers).
Syllabus	Derivation of fully coherent radiation/medium (Maxwell-Bloch) model. Coherent laser dynamics: Rabi oscillations, photon echo, self-induced transparency. Dynamical regimes in different classes of lasers: relaxation oscillations, giant pulses, Q-switching, optical chaos, mode-locking. Semiconductor laser modelling, applications to Quantum Dot/Quantum Cascade Lasers and optical frequency comb formation.
Bibliography	- Course material provided by instructor Other partially referenced texts: - L.L.Lugiato, F.Prati, M.Brambilla “Nonlinear Optical Systems”, Cambridge Un. Press (2015)

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	- W.W.Chow, S.W.Koch, “Semiconductor Laser Fundamentals”, Springer (99) - O.Svelto, “Principles of Lasers”, V ed., Springer (2009)
Examination method	Powerpoint presentation concerning treatment and possibly elaboration of a topic of the course, mutually agreed upon between instructor and student
Room	Microsoft Teams Generale | Ph.D. Course S-T dynamics of lasers | Microsoft Teams Code : 0rq9m1b

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DRISS

Course title	Construction safety: legal and administrative aspects, technical standards (part one of three)
Lecturer	Mario Daniele Piccioni
Scientific Discipline Sector	CEAR-06/A – GIUR-14/A
Hours of instruction	30 (10 Modulo A: STRUCTURAL ENGINEERING CEAR-06/A)0
CFU	3 (1 Modulo A: STRUCTURAL ENGINEERING CEAR-06/A)
Year	First
Tentative Calendar	
SUMMARY /GOAL	Nowadays, the structural safety of constructions is a key problem, especially for critical infrastructures like bridges, industrial and energy production plants, etc.. Indeed, eventual collapses may involve risks not only for human lives but also for the preservation of the environment. This course proposes a multidisciplinary approach for giving effective answers to the safety of construction problems, involving different points of view, coming from the fields of structural engineering, technical standards, and legal aspects.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DRISS

Course title	Construction safety: legal and administrative aspects, technical standards (part two of three)
Lecturer	Roberto Scaravaglione
Scientific Discipline Sector	CEAR-06/A – GIUR-14/A
Hours of instruction	30 (10 Modulo B: TECHNICAL STANDARDS CEAR-06/A)
CFU	3 (1 Modulo B: TECHNICAL STANDARDS CEAR-06/A)
Year	First
Tentative Calendar	
SUMMARY /GOAL	Nowadays, the structural safety of constructions is a key problem, especially for critical infrastructures like bridges, industrial and energy production plants, etc.. Indeed, eventual collapses may involve risks not only for human lives but also for the preservation of the environment. This course proposes a multidisciplinary approach for giving effective answers to the safety of construction problems, involving different points of view, coming from the fields of structural engineering, technical standards, and legal aspects.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DRISS

Course title	Construction safety: legal and administrative aspects, technical standards (part three of 3)
Lecturer	Francesco Paolo Sisto
Scientific Discipline Sector	CEAR-06/A – GIUR-14/A
Hours of instruction	30 (10 Modulo C: LEGAL ASPECTS GIUR-14/A)
CFU	3 (1 Modulo C: LEGAL ASPECTS GIUR-14/A)
Year	First
Tentative Calendar	
SUMMARY /GOAL	Nowadays, the structural safety of constructions is a key problem, especially for critical infrastructures like bridges, industrial and energy production plants, etc.. Indeed, eventual collapses may involve risks not only for human lives but also for the preservation of the environment. This course proposes a multidisciplinary approach for giving effective answers to the safety of construction problems, involving different points of view, coming from the fields of structural engineering, technical standards, and legal aspects.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DRISS

Course title	Energy Production: Storage, Emerging Technologies & Social Challenges
Lecturer	Valeria Selicati
Scientific Discipline Sector	IIND-07/A– IEGE-01/A
Hours of instruction	20
CFU	2 (Modulo A: 1 IIND-07/A+ Modulo B: 1 IEGE-01/A)
Year/Semester	First/Second
Tentative Calendar	08/09/2026: 9.30-12:00 10/09/2026: 9.30-12:00 15/09/2026: 9.30-12:00 17/09/2026: 9.30-12:00 22/09/2026: 9.30-12:00 24/09/2026: 9.30-12:00 28/09/2026: 9.30-12:30 30/09/2026: 9.30-12:30
SUMMARY /GOAL	This SCUDO course will deepen the fundamentals of distributed energy production and distribution of energy. The course aims to provide PhD students with methodologies to support a renewable energy transition for renewable energy communities (REC) looking at investigated in three different modules, emerging technologies for energy production (1), the energy storage opportunities and technologies (2) and social aspects behind the implementation of practices of (REC). The course will provide the tools to carry out an evaluation of the use of energy resources, making the PhD students aware of the methodologies for carrying out an energy production and management systems. The course therefore aims to provide specific technical knowledge on the application and use of the main renewable energy sources, encouraging critical development towards a path aimed at the efficient use of energy resources. During the course, through case studies, the ability to propose both managerial and technological-system interventions will be developed, and advanced tools for visualizing energy consumption will be presented, facilitating its monitoring.
Syllabus	The course provides an overview of distributed and renewable energy production, storage technologies, and the social

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	dimensions of energy transition. It is structured into three macro-areas: 1. **Emerging Technologies** – renewable sources, hydrogen, e-fuels, and innovative energy conversion systems; 2. **Energy Storage** – electrical, thermal, and chemical storage technologies and their role in balancing renewable generation; 3. **Social & Economic Challenges** – community engagement, social acceptance, behavioral change, governance models, and policy frameworks for Renewable Energy Communities (RECs). Through lectures and case studies, PhD students will develop analytical and critical skills to design sustainable energy systems integrating technical innovation with societal needs.
Bibliography	Scientific papers, slides and support material from the lecturer
Examination method	Oral presentation of the project work
Room	On-site / Microsoft Teams

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DRISS

Course title	Innovative devices for seismic risk protection
Lecturer	Armando La Scala
Scientific Discipline Sector	CEAR-07/A
Hours of instruction	10
CFU	1
Year	First
Tentative Calendar	
SUMMARY /GOAL	This course will introduce the use of innovative devices for seismic risk protection of Reinforced Concrete (RC) structure. In particular, the retrofitting of the latter will made using hybrid technological systems based on laminated timber panels. The main goals will be the evaluation of the structure's response and the consequent reduction of seismic risk.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DRISS

Course title	Numerical and experimental modelling of heat transfer
Lecturer	Aminhossein Jahanbin
Scientific Discipline Sector	IIND-06/A – IIND-07/B
Hours of instruction	20
CFU	2 (Modulo A: 1 IIND-06/A + Modulo B: 1 IIND-07/B)
Year/Semester	First/First
Tentative Calendar	21/01/2026: 15:00 – 17:00 23/01/2026: 14:00 – 17:00 26/01/2026: 14:00 – 17:00 29/01/2026: 14:00 – 17:00 02/02/2026: 14:00 – 17:00 04/02/2026: 14:00 – 17:00 06/02/2026: 14:00 – 17:00
SUMMARY /GOAL	This course introduces advanced numerical models for solving heat transfer problems across a range of thermal engineering applications, emphasizing model formulation, validation, and procedures for conducting high-fidelity simulations. It also familiarizes students with state-of-the-art computational tools and software for numerical heat transfer analysis. The experimental component covers measurement techniques and instrumentation required for thermal system characterization, enabling integration of numerical and experimental approaches for comprehensive model verification.
Syllabus	
Bibliography	
Examination method	Presentation and discussion on a selected topic
Room	Microsoft Teams Numerical and experimental modelling of heat transfer

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DRSATE

Course title	Adaptive Building Technologies for the Mitigation of Local and Global Climate Change
Lecturer	Ludovica Maria Campagna
Scientific Discipline Sector	CEAR-08/A
Hours of instruction	20
CFU	2
Year	First
Tentative Calendar	
SUMMARY /GOAL	The aim of the course is to provide students with the knowledge of the effects of climate change and Urban Heat Island (UHI) on built environment. The course will also provide detailed knowledge on the techniques and technologies to adapt the building fabrics to the effects of climate change and UHI and to counterbalance the temperature increase. The first part of the course will explore in detail the major issues of urban climatology, helping in defining the interaction between environmental variables, outdoor surfaces and building fabrics. In the second part of the course detailed students will investigate in detail adaptive technologies to mitigate the temperature effects of climate change-related phenomena. Examples from successful real case studies will be shown. Finally, the third part of the course will provide students with a hands-on experience of modelling techniques and tools to simulate the thermal characteristics of cities and buildings and assess the impact of adaptation technologies. The assessment will be based on the modelling of a selected case study and on the analysis of the effects of different adaptation technologies.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DRSATE

Course title	Analysis and representation techniques for building research
Lecturer	Domenico Pastore
Scientific Discipline Sector	CEAR-10/A
Hours of instruction	10
CFU	1
Year	First
Tentative Calendar	
SUMMARY /GOAL	The course introduces the theoretical and practical knowledge necessary for conducting three-dimensional surveys of built structures (buildings, infrastructures, monuments, urban systems, and cities) and the territory using the most modern digital photogrammetric techniques. The following topics will be covered by proposed course: - Introduction to digital surveying with a focus on aerial and terrestrial photogrammetry. - Overview of basic mathematical tools for stereoscopic restitution and potential errors. Coordinate systems used in photogrammetry. - Notes on photographic techniques and color theory. Digital images: acquisition and geometric and radiometric characteristics, image processing and analysis techniques. - Camera orientation procedures. - Introduction to terrestrial laser scanning, a complementary technique to photogrammetry for creating 3D surveys in construction, architectural, and industrial contexts. - Survey campaign design for buildings with simple and complex geometry. - Reconstruction of 3D surface models. - Visualization and management of point clouds and generation of meshes, textures, and derived products. - Possibilities for integrating digital photogrammetry with other techniques. - Photogrammetry applications to real case studies.
Syllabus	
Bibliography	

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Examination method	
Room	On-site / Microsoft Teams

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DRSATE

Course title	Bio-residues and geomaterials for sustainable engineering: from multiscale characterisation to mechanical improvement
Lecturer	Rossella Petti
Scientific Discipline Sector	CEAR-05/A
Hours of instruction	20
CFU	2
Year	First
Tentative Calendar	
SUMMARY /GOAL	The sustainable use of resources is a crucial aspect in a scenario of exponential increase in their consumption, driven by a growing global population and a continually accelerating global economy. It is therefore a duty for today's researchers to find out new strategies that enable such development while minimizing the consumption of the planet's primary resources. This approach, inspired by principles of circular economy and sustainability, can be applied to various fields of engineering. Specifically, scientific approaches will be presented to implement more sustainable management of different residues, mainly of marine origin, such as shells, dredged soils, algae, and seagrass. Dredged sediments, for example, are one of the most environmentally impactful natural materials to be managed nowadays due to the massive amounts that are dredged periodically in Europe (approximately 200 million m3 per Year), both to ensure the effective functioning of activities in port areas and, when contaminated, for remediation of polluted sites. In this context, various studies anticipate their mechanical improvement using traditional binders, such as cement that is the source of about 8% of the world's carbon dioxide (CO2) emissions. The course will showcase recent approaches paving the way to transform these residues into new secondary raw materials useful for various industrial sectors. In detail, the geo-chemo-hydro-mechanical characterisation at multiple investigation scales of both the residues to be treated and the new geomaterials produced will be presented, in order to identify the reuse potential of the waste soils beforehand and the geo-mechanical performance of the new geomaterial afterward, depending on the intended use.

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	Examples of products and applications in different industrial fields. Case studies and ongoing- EU projects related to the specific topic
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DRSATE

Course title	Complex Knowledge Management and Intelligent Systems for Territorial Engineering
Lecturer	Mauro Patano
Scientific Discipline Sector	CEAR-12/A
Hours of instruction	10
CFU	1
Year	First
Tentative Calendar	
SUMMARY /GOAL	The course aims to provide theoretical foundations and practical tools necessary for the utilization of advanced methods in constructing digital twins and computational models increasingly prevalent in the field of engineering in general, particularly in current territorial engineering and urban planning contexts. The theoretical presentation of methodologies and hands-on experience with innovative digital tools will be complemented by reflections on emerging scenarios in both research and practice within engineering domains, driven by new technologies (big data, grid and cloud computing, iaas, paas, and saas services). This aims to enrich students' cultural background with new project development possibilities, from conceptualization to practical and detailed realization. The course will consist of two parts: theoretical and practical.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DRSATE

Course title	Deep learning applications for Engineering Geology
Lecturer	Angelo Doglioni
Scientific Discipline Sector	GEOS-03/B
Hours of instruction	20
CFU	2
Year/Semester	First/First
Tentative Calendar	02/03/2026: 10.00-13:00 04/03/2026: 10.00-13:00 09/03/2026: 10.00-13:00 11/03/2026: 10.00-13:00 16/03/2026: 10.00-13:00 18/03/2026: 10.00-13:00 23/03/2026: 10.00-12:00
SUMMARY /GOAL	The course introduces deep learning techniques for Engineering Geology, focusing on recognizing landslide-prone areas and modeling aquifer responses to rainfall. It will use convolutional neural networks to identify landslide areas through geological and geomorphological data and orthophotos, training algorithms to detect and delineate susceptible regions. For aquifer recharge modeling, Multi-Objective Evolutionary Polynomial Regression will formulate responses to rainfall, alongside evolutionary neural networks. Goals: Equip doctoral students with AI knowledge for modeling engineering geology phenomena to prevent environmental risks. Knowledge and Understanding: Students will gain insights into advanced modeling paradigms in environmental geology, enhancing the understanding of complex geological and hydrogeological phenomena beyond traditional methods. Application Skills: Students will apply deep learning and machine learning techniques to comprehend and mitigate environmental risks.

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	Expected Outcomes: Students will become familiar with AI-based data modeling techniques and will be able to implement basic deep learning paradigms using pre-developed tools for geological-environmental modeling
Syllabus	
Bibliography	
Examination method	Oral exam
Room	On-site / Microsoft Teams Room will be chosen when the number of PhD students will be known. Microsoft Teams if needed.

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DRSATE

Course title	How to build an ontology that lasts for design matters: Theory.
Lecturer	Maria Rosaria Stefano Melone
Scientific Discipline Sector	CEAR-12/A
Hours of instruction	20
CFU	2
Year	First
Tentative Calendar	
SUMMARY /GOAL	'Applied Ontology' is an approach developed within Artificial Intelligence and aimed to build symbolic representations of (a fragment of) reality. The use of applied ontology ensures that the result is conceptually coherent, semantically clear and computationally robust. In this course we introduce the motivations and methodology of applied ontology focusing on (a) the distinction between data and information; (b) the DOLCE ontology; (c) the conceptual analysis of simple scenarios of urban and social interest; (d) methodologies for ontology-based model construction; and (e) the use of software (e.g., Protege) for ontology construction.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DRSATE

Course title	Lab-and-field data acquisition and analysis for studying Hydraulic Processes
Lecturer	Diana De Padova
Scientific Discipline Sector	CEAR-01/A
Hours of instruction	20
CFU	2
Year	First
Tentative Calendar	
SUMMARY /GOAL	Aim of this course is the introduction to the study of partial differential equations. The three main types of linear second order partial differential equations will be considered: parabolic (diffusion equation), elliptic (Laplace equation), and hyperbolic (wave equation), underling their theoretical and applied features. The course provides the basic concepts necessary to carry out measurements, process data and derive hydrodynamic and physical meanings form large data sets. The following topics are studied, combining theory and practical examples: Measurement definition and concept. Measurement instrumentation and sensors. Sources of error. Measurement uncertainty. Measurement in static and dynamic conditions. Instrument calibration. How to get a calibration curve from laboratory data. Sensitivity, accuracy and precision. Measurement range and frequency response. Instrument precision. Measurement error. Theory of errors. How to carry out a measurement. Nyquist theorem. Sampling duration. Signal analysis in time and frequency domain. FFT and IFFT. How to obtain a spectrum of the measured signal with FFT technique. Acquisition signal chain. Control and management of remote measuring stations, with sensors sampling hydrodynamic parameters. Acoustic and laser signal sources. Doppler effect. Measuring flow velocity with LDA and ADV sensors. Practical trials at the Coastal Engineering Laboratory – LIC of the DICATECh and analysis of acquired data.

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Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DRSATE

Course title	Materials for the ecological transition
Lecturer	Biagia Musio
Scientific Discipline Sector	CHEM-06/A
Hours of instruction	10
CFU	1
Year/Semester	First/Second
Tentative Calendar	15/06/2026: 10:00 12:30 22/06/2026: 10:00 12:30 29/06/2026: 10:00 12:30 06/07/2026: 10:00 12:30
SUMMARY /GOAL	The course aims to provide an overview of some progress in the development of innovative materials applicable to a more sustainable energy production, the reduction of environmental contaminants, and a more sustainable waste disposal. In particular, the following topics will be covered: environmental sustainability, carbon neutrality, circular economy vs. linear economy, innovative materials for technological applications and energy production.
Syllabus	
Bibliography	
Examination method	
Room	Microsoft Teams Materials for the ecological transition A.A. 2025-26 | Microsoft Teams In case of any queries, please contact the teacher at biagia.musio@poliba.it.

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DRSATE

Course title	Mathematical models for transportation systems
Lecturer	Aleksandra Colovic
Scientific Discipline Sector	CEAR-03/B
Hours of instruction	10
CFU	1
Year/Semester	First/Second
Tentative Calendar	13/07/2026: 10.00-13:00 16/07/2026: 09.00-13:00 20/07/2026: 10.00-13:00
SUMMARY /GOAL	Mathematical models of transportation systems represent, for a real or hypothetical transportation system, the demand flows, the functioning of the physical and organizational elements, the interactions between them, and their effects on the external world. Mathematical models and the methods involved in their application to real, large-scale systems are thus fundamental tools for evaluating and/or designing actions affecting the physical elements and/or organizational components of transportation systems. The goal of this course is to provide the Ph.D. students the theoretical background and knowledge necessary to analyze and manage transportation systems. The course will be focused on mathematical models that represent transportation supply systems (these models combine traffic flow theory and network flow theory models) and transportation demand/supply interactions.
Syllabus	Introduction to transportation systems Supply models Random Utility theory Four-step model Traffic assignment models
Bibliography	Cascetta, E., 2009. Transportation systems, Springer Optimization and Its Applications, Transportation Research
Examination method	Application of the obtained theoretical background for solving certain problem of your choice (e.g., small-sized example) and presenting obtained results in a Power Point presentation (maximum 10 minutes)
Room	On-site MaaS Control room

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DRSATE

Course title	Multiscale models for material science
Lecturer	Giuseppe Florio
Scientific Discipline Sector	MATH-04/A
Hours of instruction	20
CFU	2
Year/Semester	First/First
Tentative Calendar	02/02/2026: 8.30-11:00 03/02/2026: 8.30-11:00 09/02/2026: 8.30-11:00 10/02/2026: 8.30-11:00 16/02/2026: 8.30-11:00 17/02/2026: 8.30-11:00 23/02/2026: 8.30-11:00 24/02/2026: 8.30-11:00
SUMMARY /GOAL	The purpose of the course is the presentation of models methods based on Statistical Mechanics to describe the multiscale behaviour of materials.
Syllabus	Elements of Statistical Mechanics Thermo-mechanical methods for multistable materials Single-molecule models Rate effects Network models
Bibliography	*) K. Huang, Statistical Mechanics, Wiley (2008) *) J. H. Weiner, Statistical mechanics of elasticity, Dover (2012) *) R. K. Pathria and P. D. Beale, Statistical Mechanics (4th ed.), AcademicPress (2021) *) J. P. Sethna, Statistical Mechanics: Entropy, Order Parameters and Complexity (2nd ed.), Oxford University Press (2021) *) M. Rubinstein, R. H. Colby, Polymer Physics, Oxford University Press (2003) *) A. Marantan and L. Mahadevan, Mechanics and statistics of the worm-like chain. American Journal of Physics 86, 86 (2018) *) P. Hanggi,P. Talkner and M. Borkovec, Reaction-rate theory: fif-ty years after Kramers, Reviews of modern physics 62, 251 (1990)

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	*) H. Kleinert, Path integrals in quantum mechanics, statistics, polymer physics, and financial markets (5th ed.), World Scientific (2009)
Examination method	Oral examination. Seminar about the topics of the course.
Room	On-site (room to be fixed) Microsoft Teams Multiscale models for material science

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DRSATE

Course title	Research in Architecture and Engineering Aided by Information Models: From BIM to Digital Twin for the Built Environment
Lecturer	Silvana Bruno
Scientific Discipline Sector	CEAR-08/B
Hours of instruction	10
CFU	1
Year	First
Tentative Calendar	
SUMMARY /GOAL	In architecture, engineering and construction (AEC) research, information modelling methods and technologies have been further investigated to enhance design, assessment, execution and management of the built environment. Among these methods, Building Information Modelling (BIM) research is still evolving from data collection, information integration and knowledge management for new buildings and assets. The approach has also been developed for refurbishment / restoration of historic buildings and tangible Cultural Heritage, turning it into HBIM (Heritage or Historic BIM). In both the research directions, BIM is recently used to create the parametric virtual twin of the real entity to support the creation of the Digital Twin Framework, able to support decisions before the project stage through simulations, and during operation and maintenance activities through monitoring and analysing performance data. This course will provide theoretical and practical reference about current and future research about and with BIM methodology and tools, underling potential research in different construction engineering domains. Fundamentals in data structure and data types will be provided aiming at interoperable pipelines with further Information Systems, according to different application domains.
Syllabus	
Bibliography	
Examination method	

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Room	On-site / Microsoft Teams

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DRSATE

Course title	Sustainable Mobility and Shared Mobility in a Smart Cities framework: optimization models and applications
Lecturer	Margherita Mascia
Scientific Discipline Sector	CEAR-03/B
Hours of instruction	10
CFU	1
Year	First
Tentative Calendar	
SUMMARY /GOAL	Shared mobility is one of the possible solutions for reducing the traffic congestion problem following the sustainable mobility perspective. It offers the potential to enhance the efficiency, competitiveness, social equity, and quality of life in large cities. The goal of this course is to provide the Ph.D. students the theoretical background and knowledge necessary to manage optimization models for solving shared mobility problems considering environmental aspects. Moreover, basic knowledge in using IBM ILOG CPLEX and MATLAB software for solving Integer Linear Programming models is carried out. The lectures will be structured into two parts. The first part of the course will be focused on the introduction to shared mobility and recent technologies applied to reach the Mobility-as-a-Service concept. Furthermore, a short introduction about optimization models, e.g., Vehicle Routing Problem, for solving transportation issues. The second part of the course will deal with exercises of Integer Linear Programming models through the usage of IBM ILOG CPLEX and MATLAB software.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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SSI

Course title	Advanced Fiber Optic Technologies for Biosensing
Lecturer	Saha Nabarun
Scientific Discipline Sector	IINF-01/A
Hours of instruction	20
CFU	2
Year/Semester	First/First
Tentative Calendar	16/01/2026: 8.30-13:30 23/01/2026: 8.30-13:30 30/01/2026: 8.30-13:30 06/02/2026: 8.30-13:30
SUMMARY /GOAL	The goal of this course is to provide a theoretical and simulation- oriented introduction to biosensing with advanced optical fiber technologies. After a brief introduction to the optical fiber's characteristics, the course will focus on a few fiber optic architectures and their working principle for biosensing. This course will also introduce the basic parameters to assess the fiber optic sensors' performance with real-world applications. A few demonstrations of the sensor design will be performed through the simulation tool Comsol Multiphysics and Matlab coding to guide the students for the final project.
Syllabus	1) Introduction to the optical fibers from the Maxwell equations to provide basic concepts including vector and scalar modes. 2) Standard optical fiber materials and working principle of optical fibers for Biosensing. 3) Different fiber optic sensors e.g. photonic crystals, ring resonators and surface plasmon resonance will be introduced with the sensing enhancement principle. 4) The important parameters will be introduced to assess the sensing performance with real world application e.g. protein detection, remote sensing. 5) Few demonstrations will be performed with Comsol and Matlab to provide hands-on experience to the students and prepare them for the final project.
Bibliography	Slides will be provided during the lessons
Examination method	Final project

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Room	On-site / Microsoft Teams Room will be informed once registration is complete Advanced Fiber Optic Technologies for Biosensing

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SSI

Course title	Fundamentals of Radio Localization and Sensing
Lecturer	Alessio Fascista
Scientific Discipline Sector	IINF-03/A
Hours of instruction	20
CFU	2
Year/Semester	First/First
Tentative Calendar	14/01/2026: 10.00-13:00 21/01/2026: 10.00-13:00 28/01/2026: 10.00-13:00 04/02/2026: 10.00-13:00 11/02/2026: 10.00-13:00 18/02/2026: 10.00-13:00 25/02/2026: 10.00-12:00
SUMMARY /GOAL	The course is designed to deliver to PhD students' knowledge on various aspects of radio localization and sensing using terrestrial wireless systems, from more traditional scenarios (e.g., WSN) up to the new emerging contexts of 5G and 6G cellular systems.
Syllabus	• Course overview and fundamentals of terrestrial wireless positioning systems: Introduction of the participants and the course; The role of terrestrial radio positioning as a complementary solution to GNSS. • Localization approaches based on time and signal strength information in single-input single-output systems: RSS-based methods; TOA-based methods; Hybrid RSS and TOA-based localization. • Localization using antenna arrays in sub-6 GHz systems: cooperative schemes and advanced signal processing approaches for dynamic multipath environments: Basics of antenna arrays for positioning; Dynamic Applications. • Localization in 5G mmWave multiple-input single-output systems - accurate low-complexity channel estimation and simultaneous localization and mapping: Sub-6GHz vs mmWave; SISO, MISO, SIMO, MIMO Systems; Array architectures; Channel parameter estimation in MISO 5G Systems; Positioning in MISO 5G Systems; Simultaneous localization and mapping in MISO 5G Systems. • Joint localization and synchronization using reconfigurable intelligent surfaces in 6G systems: Ingredients of 6G;

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	Going deeper into RIS; RIS for localization and synchronization; Advanced channel models.
Bibliography	- D. Dardari, E. Falletti, M. Luise, "*Satellite and Terrestrial Radio Positioning Techniques – A Signal Processing Perspective*", London, U.K, Elsevier, 2011. - C. Gentile, N. Alsindi, R. Raulefs, and C. Teolis, "*Geolocation Techniques: Principles and Applications*", New York, NY, USA, Springer-Verlag, 2013. - Yu, K., Lohan, E., & Oppermann, I. (2025). *Handbook of Wireless Positioning*. Springer Nature Singapore.
Examination method	PhD students will be required to demonstrate their knowledge and understanding of fundamentals radio positioning and sensing via a final presentation (10/15 minutes) on selected scientific articles dealing with the topics covered by the course. Quality of presentation as well as way of conducting discussion will also be assessed by the lecturer. Successful completion of the test will grant 2 CFU to students.
Room	On-site: Laboratorio Didattico Telematics (Celso Ulpiani) / Microsoft Teams: Generale | PhD Course: Fundamentals of Radio Localization and Sensing (A.A. 25/26) | Microsoft Teams

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SSI

Course title	Nuclear Techniques and Innovative Sensors for Medical Applications
Lecturer	Dayron Ramos Lopez
Scientific Discipline Sector	PHYS-01/A , PHYS-03/A– PHYS-06/A
Hours of instruction	20
CFU	2
Year	First
Tentative Calendar	
SUMMARY /GOAL	The course introduces basic concepts of nuclear physics applied in medicine, reaching advanced radiotherapies and modern tools of particle simulation studies. The additional goal is to provide a deep understanding of sensor technologies and contribute to the field by developing and implementing innovative dosimetry sensors. Graduates should be capable of conducting cutting-edge research, advancing the field, and addressing challenges in areas such as medical, environmental, and industrial applications of radiation. The program aims to foster critical thinking, research skills, and a strong sense of ethical responsibility in the domain of dosimetry.
Syllabus	• Introduction to the interaction of radiation with matter and dosimetry • Radio isotopes in medical diagnosis • Gamma Camara, Computational tomography basics • PET/SPECT imaging techniques • Innovative radiation therapy with hadrons: HT and BNCT • Monte Carlo on medical physics, Tool for Particle Simulation (TOPAS) • Introduction to Dosimetry • Sensor Technologies • Radiation Detection Techniques • Use of innovative sensors in medical radiation therapy
Bibliography	- Physics in Nuclear Medicine, 4th Edition 2012, Simon R. Cherry, James A. Sorenson, Michael E. Phelps. - Radiation Detection and Measurements, 4th Edition 2010, Glenn F. Knoll.

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	- TOPAS User Guide (http://topas.readthedocs.org/) - Ciofani, G., Genchi, G. G., Liakos, I., & Athanassiou, A. (2018). "Innovative materials for sensors in radiation dosimetry." Journal of Materials Chemistry C, 6(16), 4374-4396. - Attix, F. H. (1986). "Introduction to Radiological Physics and Radiation Dosimetry." John Wiley & Sons.
Examination method	Oral exam by seminary (PP presentation)
Room	On-site / Microsoft Teams

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SSI

Course title	Physical Layer Security for wireless communication
Lecturer	Giovanna Calò
Scientific Discipline Sector	IINF-02/A
Hours of instruction	20
CFU	2
Year	First
Tentative Calendar	
SUMMARY /GOAL	The course will address different security techniques based on the physical layer, which are suitable to improve data security in wireless networks and in IoT (Internet of Things) applications. The course participants will gain knowledge of Physical Layer Security techniques. The course will consist of theoretical lectures and numerical hands-on examples.
Syllabus	- Introduction to Physical Layer Security (PLS) and applications - Secrecy notions - Secure array synthesis, beam forming and beam steering - Electromagnetic propagation models in indoor and outdoor environments - PLS keyless approaches - PLS key-based approaches
Bibliography	Scientific papers, slides and support material from the lecturer.
Examination method	Oral or project work
Room	On-site / Microsoft Teams

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Course title	Gender studies
Lecturer	Floriana Bernardi, Chiara De Santis
Scientific Discipline Sector	IEGE-01/A
Hours of instruction	20
CFU	2
Year	First
Tentative Calendar	16/02/2026: 10:00-11:00 19/02/2026: 09:30-13:30 20/02/2026: 19:00-20:30 09/03/2026: 09:30-11:45 30/03/2026: 09:30-11:45 13/04/2026: 09:30-11:45 27/04/2026: 09:30-11:45 11/05/2026: 09:30-11:45 18/05/2026: 09:30-11:45
SUMMARY /GOAL	The course aims to provide students with the theoretical and operational tools to understand the concept of gender in its historical evolution and in its social, political and economic implications. At the end of the course the students and teachers will have acquired knowledge regarding feminist theories, women's studies, men's and masculinity studies relating to the social construction of male and female identities, and will be able to identify and critically analyse the different factors that contribute to generate any inequality and discrimination based on gender.
Syllabus	
Bibliography	Lectures, Discussions, Guest speakers (e.g., women in STEM fields, gender studies experts, …), Film screenings, Case study analysis, Group works. Visione del Film Club: “Il diritto di contare” (2017)
Examination method	Students may choose to develop and present projects that address a specific gender and technology issue.
Room	On-site / Microsoft Teams On-site: 19-20/02/2026 We would be pleased to learn about your interest in this course before its start, so feel free to write us an email with your name and surname and area of study (Architecture, Design, Engineering, …). Thank you! floriana.bernardi@poliba.it ; chiara.desantis@poliba.it

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DCMCEI

Course title	Elements of digital transition in civil engineering
Lecturer	Daniele Biagio Laucelli
Scientific Discipline Sector	CEAR-01/B
Hours of instruction	20
CFU	2
Year/Semester	Second/First
Tentative Calendar	09/02/2026: 08:30-12:30 19/02/2026: 08:30-12:30 20/02/2026: 08:30-12:30 26/02/2026: 08:30-12:30 27/02/2026: 08:30-12:30
SUMMARY /GOAL	The course is designed to provide a solid foundation for applying key machine learning and data modelling techniques within the civil and environmental engineering sectors. It introduces the history and defining features of the digital transition, along with its main tools, such as complex network theory, artificial intelligence, and multi-objective optimization, that underpin modern machine learning approaches. These concepts will be presented to equip students with practical insights for real-world applications in civil engineering. Participants will gain hands-on experience with machine learning methods, focusing on ANN-MOGA and EPR-MOGA. The course will also cover essential steps for building databases that support data-driven modelling, as well as techniques for data interpretation and analysis. The ultimate goal is to enable PhD students to develop effective, transferable solutions that implement efficient processes for addressing diverse technical challenges. Advanced case studies in civil and environmental engineering may be used in class as reference points, actively engaging students in the application of ANN-MOGA and EPR-MOGA to real-world problems. **Students are strongly encouraged to bring input–output datasets from physical phenomena relevant to civil engineering for use in the in-class exercises.**
Syllabus	
Bibliography	

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Examination method	The dates for the exams will be agreed during the course, matching the needs of teacher and students.
Room	On-site / Microsoft Teams Classroom 6 at DICATECh Elements of digital transition in civil engineering Registration for the course will be closed by February 8, 2025. Participating students will be contacted by the teacher to organise the installation of the software necessary to carry out the course, and to communicate the classroom at Poliba. The dates for the exams will be agreed during the course, matching the needs of teacher and students.

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DCMCEI

Course title	Innovation of business models in the civil infrastructure sector
Lecturer	Ilaria Mancuso
Scientific Discipline Sector	IEGE-01/A
Hours of instruction	20
CFU	2
Year	Second
Tentative Calendar	
SUMMARY /GOAL	This module aims to provide concepts, approaches and techniques for the generation, management, analysis and innovation of business models in the civil infrastructure sector. Specifically, during the course the main reference frameworks for the definition of a business model will be presented as well as the patterns of existing business models with particular focus on the civil infrastructure sector. The innovation dynamics of business models will also be explored in depth, providing useful elements for structuring the evolution process, especially in reference to the adoption of the most recent digital technologies enabling a digital innovation path in the civil infrastructure sector. The module will include alternating theoretical lessons with practical sessions (examples, case studies and project work). Below is the summary structure of the module: – Business models (definitions and frameworks). – Business model patterns (with focus on the civil infrastructure sector). – Innovation of business models and digital innovation in the sector.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DCMCEI

Course title	Innovative approaches and digital tools for ecological land planning
Lecturer	Domenico Camarda
Scientific Discipline Sector	CEAR-12/A
Hours of instruction	20
CFU	2
Year	Second
Tentative Calendar	
SUMMARY /GOAL	The contribution of land planning to climate adaptation and mitigation strategies: – The challenges of climate change to land planning; – The role of cities in adaptation and mitigation policies; Approaches and tools for ecological planning: – Different interpretations of the ecological transition in the plans: modernization vs. capitalization; – Nature-based solutions in city planning; – The urban bioregion: eco-territorial approach, ecosystem services, multifunctionality; Potential and critical elements of the digital transition to support ecological planning: – GIS/webgis, open data, social networks, etc. to support inclusive approaches to planning, coordination between Public Administration sectors dealing with territorial governance, sharing and transparency of decisions and monitoring systems; – Digital divide, difficulty in involving users in the creation and use of digital systems, data updating.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DCMCEI

Course title	Innovative evaluation techniques to support the implementation and management of civil constructions
Lecturer	
Scientific Discipline Sector	CEAR-03/C
Hours of instruction	20
CFU	2
Year	Second
Tentative Calendar	
SUMMARY /GOAL	The course aims to provide an essential overview of the main evaluation techniques to support decisions in local interventions, also with reference to public-private partnership models. Contents in summary form: – Estimate and innovative tools for the construction of civil works; – Financial analysis and economic analysis (ACB) for the evaluation of investments and the estimate of the impact on the community; – Multi-Criteria Decision Analysis (MCDA) to support decisions in complex contexts: the construction of multidimensional indicators for the implementation and management of civil works.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DCMCEI

Course title	Innovative techniques and methodologies for the reuse of materials in road, railway and airport constructions
Lecturer	Stefano Coropulis
Scientific Discipline Sector	CEAR-03/A
Hours of instruction	20
CFU	2
Year/Semester	Second/First
Tentative Calendar	12/01/2026: 14:00-18:00 13/01/2026: 15:00-19:00 14/01/2026: 14:00-18:00 15/01/2026: 15:00-19:00 16/01/2026: 14:00-18:00
SUMMARY /GOAL	The course aims to illustrate the current techniques and technological innovations relating to the management and use of recycled materials in the construction of mobility infrastructures: – construction of road embankments; – recycling of milled asphalt; – use of materials from other production chains (used tyres, plastics, ...) for the production of road construction materials; – techniques and technologies for maximizing the use of excavated earth and rocks; – platform water management for traffic and environmental safety; – alternative materials for complementary works.
Syllabus	Introduction to materials used for road, railway, and airport infra-structures. Procedures and Tests on materials for transportation infra-struc-tures Life Cycle Assessment: a new approach towards building materials Innovative materials for asphalts: Case studies and practical exam-ples Innovative materials for subgrades: Case studies and practical ex-amples Innovative water management strategies: case studies
Bibliography	Slides of the course and referenced articles and scientific papers included in the slides

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Examination method	Each attendant is invited to develop a concise project proposal about one of the discussed topics during the class to be discussed at the exam by a Power Point presentation.
Room	Microsoft Teams Innovative techniques and methodologies for the reuse of materials in road, railway and airport constructions | Generale | Microsoft Teams

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DCMCEI

Course title	Low carbon structural design and retrofitting of concrete infrastructures using advanced composites
Lecturer	Saverio Spadea
Scientific Discipline Sector	CEAR-07/A
Hours of instruction	20
CFU	2
Year/Semester	Second/Second
Tentative Calendar	08/06/2026: 14:30-17:30 12/06/2026: 14:30-17:30 15/06/2026: 14:30-18:00 19/06/2026: 14:30-18:00 22/06/2026: 14:30-18:00 26/06/2026: 14:30-18:00
SUMMARY /GOAL	The main contents of the course are: – Introduction to low-carbon structural design. – Fibre-Reinforced Materials in civil engineering construction. – Innovative reinforcement for resilient concrete structures. – Retrofitting concrete structures using advanced composites.
Syllabus	
Bibliography	
Examination method	
Room	Microsoft Teams Low carbon structural design and retrofitting of concrete infrastructures using advanced composites | Generale | Microsoft Teams

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DCMCEI

Course title	Meteomarine forcing and design of maritime constructions
Lecturer	Maria Francesca Bruno
Scientific Discipline Sector	CEAR-01/B
Hours of instruction	20
CFU	2
Year/Semester	Second/First
Tentative Calendar	20/01/2026: 14.00-18:00 27/01/2026: 14.00-18:00 03/02/2026: 14.00-18:00 10/02/2026: 14.00-18:00 24/02/2026: 14.00-18:00
SUMMARY /GOAL	The course aims to provide the first basic preparatory knowledge of the marine environment (study of waves, currents, transport, sediments, etc.) and the elements necessary for the design of maritime works, both port and coastal defense against erosion. During the course, the interaction between the fundamental physical phenomena and their description through analytical models, long-term statistical analysis for the evaluation of extreme events and the numerical approaches used in the field of coastal engineering to evaluate the environmental loads on structures induced by waves, currents and wind. The course will also deal with the resilience of coastal structures to climate change (e.g., sea level rise and increase in extreme sea storms), with reference to current design criteria and future research developments.
Syllabus	➢ **Lesson 1** Wave mechanics and wave transformation processes from deep water to shallow water ➢ **Lesson 2** Design principles of coastal and port structures (statistical analysis of extreme events - calculation of loads for the design of structures - wave/structure interaction) ➢ **Lesson 3** Effects of climate change on the design and management of coastal and port structures. ➢ **Lesson 4** Advanced mathematical models and numerical approaches in coastal engineering ➢ **Lesson 5** Hands on Coastal Modelling
Bibliography	Coastal Engineering Manual

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Examination method	Practical test (case study on a coastal model).
Room	Lectures in hybrid mode: in-person classes (classroom 5 – DICATECh,) and/or online via the Microsoft Teams group Meteomarine forcing and design of maritime constructions

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DCMCEI

Course title	Open Source and Innovative tools for simulating transport systems
Lecturer	Nadia Giuffrida
Scientific Discipline Sector	CEAR-03/B
Hours of instruction	20
CFU	2
Year/Semester	Second/First
Tentative Calendar	18/02/2026: 09.00-14:00 11/03/2026: 09.00-14:00 18/03/2026: 09.00-14:00 25/03/2026: 09.00-14:00
SUMMARY /GOAL	The aim of this course is to equip participants with a good under standing of innovative and Open-Source tools specifically de signed for simulating transport systems to analyse performances of new technologies and digitalization of transport infrastructure and systems.
Syllabus	The course will delve into: – the role of digital twins in simulating real-world transport scenarios. – advanced methodologies for harnessing and analysing extensive datasets (Big data) to understand mobility phenomena. – command-line interface (CLI) tools, primarily controlled by typing commands (e.g. SUMO, Python, R). – graphical user interface (GUI) tools, primarily controlled by point and clicking (e.g. AequilibraE, QGIS). – web application programming interfaces (API) and web user interface (WUI) tools During the course participants will gain knowledge on these tools to mapping and simulate transport system, fostering a good grasp of their application in achieving efficiency and sustainability within the mobility planning sector.
Bibliography	Scientific papers, slides and support material from the lecturer.
Examination method	Oral exam by slide presentation on the topics of the lectures
Room	On-site Please send an email to nadia.giuffrida@poliba.it to enroll in the course

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DCMCEI

Course title	Practical Course in physical modelling for coastal engineering
Lecturer	Matteo Gianluca Molfetta
Scientific Discipline Sector	CEAR-01/B
Hours of instruction	20
CFU	2
Year/Semester	Second/Second
Tentative Calendar	12/05/2026: 10.30-14:30 14/05/2026: 10.30-14:30 19/05/2026: 10.30-14:30 21/05/2026: 10.30-14:30 26/05/2026: 10.30-14:30
SUMMARY /GOAL	The Practical Course in Coastal Engineering gives Ph.D. students an insight into physical experiments related to coastal engineering research. The focus is on the planning, implementation and evaluation of physical experiments in maritime laboratories on both 2d and 3d small scale models. Scaling criteria of both hydrodynamic and morpho dynamic quantities, measurement techniques, data acquisition, analysis and post processing will be the main contents of the course
Syllabus	– Introduction to measurement and experimental techniques in coastal engineering. – Planning and execution of model tests - Scaling criteria. – Acquisition and analysis of measurement data using ultrasonic and resistive wave gauges, pressure transducers, ADV, bed profiler, load cells, laser scanner, lidar, photogrammetry, etc.; – Statistical description of the generated waves in time domain. – Parameterization using characteristic wave parameters and analysis of sediment transport processes in scaled physical models.
Bibliography	*Coastal Engineering Manual (CEM 2000)* - US Army Corps of Engineers
Examination method	The exam will consist of a practical test on wave motion data acquisition and processing, to be held at the Coastal Engineering Laboratory of the Polytechnic University of Bari.
Room	On-site / Microsoft Teams

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	The lectures will be held in hybrid mode, both on site in a physical DICATECh classroom (to be defined) and via the Microsoft Teams groupOn Practical Course in physical modelling for coastal engineering

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DCMCEI

Course title	Road infrastructure for intelligent mobility
Lecturer	Stefano Coropulis
Scientific Discipline Sector	CEAR-03/A
Hours of instruction	20
CFU	2
Year/Semester	Second/First
Tentative Calendar	19/01/2026: 09:00-13:00 20/01/2026: 15:00-19:00 21/01/2026: 09:00-13:00 22/01/2026: 15:00-19:00 23/01/2026: 14:00-18:00
SUMMARY /GOAL	The course aims to illustrate the main techniques and technolo-gies for the construction and management of road infrastructures in the presence of connected, automatic and semi-automatic vehicles (Smart roads, Smart tunnels, ITS, C ITS, adaptive lanes, etc.). The problems linked to the technological transition will also be il-lustrated with reference to both the existing road heritage and the coexistence of vehicles with different technological capabilities.
Syllabus	Introduction: Smart Roads and Smart Mobility. Smart Roads' Regulations and Characteristics of a Smart Road Connected and Autonomous Vehicles (CAVs) Road Safety in presence of CAVs Road Safety Assessment Examples in presence of CAVs
Bibliography	• Le Smart Road: stato dell'arte e scenari futuri (10.1007/978-3-031-96144-1)
Examination method	Each attendant is invited to develop a concise project proposal about one of the discussed topics during the class to be discussed at the exam by a Power Point presentation.
Room	Microsoft Teams Road infrastructure for intelligent mobility | Generale | Microsoft Teams

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CTI

Course title	Analysis and representation techniques for architectural research
Lecturer	Massimo Leserri
Scientific Discipline Sector	CEAR-10/A
Hours of instruction	20
CFU	2
Year	Second
Tentative Calendar	
SUMMARY /GOAL	The course aims to stimulate a critical attitude in the study of the city and architecture, providing to the young researcher a repertoire of analysis techniques and representation models to support research. The techniques of survey of the existing, laser scanner and photo-modeling, are joined to those of the inexistent, graphic analysis and graphic reconstruction, providing the tools and methods for a research of architectures in praesentia that can be studied and analyzed also metrically, that those in absentia designed and never realized. The course aims to analyze and graphically return the different components of architecture and the city, and with the tools of drawing and modeling investigate the historical / evolutionary process or the ideation / composition process too. These are fundamental cognitive moments for the study of an architecture or a part of the city and at the same time to analyze the complex personality of its author. Practical exercises alternate with lectures encouraging young researchers to use the techniques of analysis and graphic representation, articulating and stimulating their critical skills in reading an architecture and / or the city or a portion of it.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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CTI

Course title	Historical research and study of the Ancient architecture
Lecturer	Antonio Labalestra
Scientific Discipline Sector	CEAR-11/A – ARCH-01/D
Hours of instruction	20
CFU	2
Year	Second
Tentative Calendar	
SUMMARY /GOAL	Ancient architecture is almost always in a state of ruin. His study, aimed at formulation of reliable hypotheses of reconstruction of the building, must be based on integrated survey methodologies that use the detailed analysis of the ancient ruined building as an essential knowledge base. They are taken into consideration therefore, besides to the observations derived from the results of the architectural survey, also any iconographic testimonies from other sources, such as vascular painting, frescoes, bas-reliefs, images on coins, etc. The building and its construction and morphological details, as well as, when present, his architectural sculpture must then be compared with others contemporary architectures, in order to include it in its historical-geographical context. The course therefore aims to present some completed or ongoing architectural research that can effectively illustrating the research method mentioned above. In particular, the following case studies will be addressed: - The Arch of Trajan in Leptis Magna - The reconstruction of urban planning of Kos - The Curia in Leptis Magna - Architectural sculpture in the anastylosis of ancient buildings - Urban planning in Ionia and Caria between the archaism and the Hellenistic age - Architectural and decorative models in the mausoleums of the imperial age in Libya - The Hellenistic theatre in Mytilene - The townscape in the figurative culture of Greek and Roman times - The urban planning ant the agora of Byllis (Albania)

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	- The Cistern in the agora of Byllis, analysis of the typology and of the constructive aspects.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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CTI

Course title	The architecture of construction
Lecturer	Tiziano De Venuto
Scientific Discipline Sector	CEAR-08/C
Hours of instruction	20
CFU	2
Year/Semester	Second/Second
Tentative Calendar	04/05/2026: 16.00-18:30 07/05/2026: 16.00-18:30 11/05/2026: 16.00-18:30 15/05/2026: 16.00-18:30 25/05/2026: 16.00-18:30 29/05/2026: 16.00-18:30 05/06/2026: 16.00-18:30 10/06/2026: 16.00-18:30
SUMMARY /GOAL	The didactic project of the course assumes the relationship between space and the constructive forms of architecture as a problematic core, through a point of view that recognizes construction as the most powerful expressive resource for the representation of the spatial character of buildings. The thought on the structure, therefore, seems to be problematized in a dialectical tension between the disciplines of architecture and engineering, whose common language is that of matter and its possible formal definitions. The purpose of the course is to develop a particular approach to research on architectural design that is able to recognize, problematically, the relationship between space and the design of its structural systems, from type to construction. By declining the constructive paradigms of history and their cultural areas of reference, it is possible to identify some interpretative lines that feed the most recent structural experiments on matter, between the definition of its possible forms and the search for their own figurative identity. Just think of the research on the forms of reinforced concrete carried out in Switzerland since the beginning of the twentieth century, where the technical forms of the structure (also in the construction of bridges and infrastructure works) exceed their aesthetic autonomy, interpreting the relationship with the landscape in which they are located.

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	Between Architecture and the Art of structures.
Syllabus	• Character and Construction. The Bridge as the Invention of a New Place; • Rooting in the earth: The desire to contemplate the horizon. For a modern idea of living; • Rooting in the earth: nature and geography in the experience of the Paulista house; • The construction of the Hall; • Isostatic Ribbed Floors. From Pier Luigi Nervi to Livio Vacchini; • Architecture and engineering in the era of "Structural conception": the order of the new Italian industrial architecture; • The construction of the suspended building: ancient, modern Broletto.
Bibliography	AA. VV., The Engineer and the Architect, a cura di Flury A., Birkhäuser, Basel 2012. CONZETT Jürg, Architettura nelle opere d'ingegneria, a cura di Chiorino M. A., Umberto Allemandi, Torino 2007. DE VENUTO Tiziano, Livio Vacchini. Architettura come costruzione, Libria, Melfi 2023. DE VENUTO Tiziano, Case in Ticino, Libria, Melfi 2023. EMERY Nicola, Progettare, costruire, curare. Per una deontologia dell'architettura, Casagrande, Bellinzona 2007. FRAMPTON Kenneth, Tettonica e architettura. Poetica della forma architettonica nel XIX e XX secolo, Milano, Skira editore. GARGIANI Roberto, "Perret, Le Corbusier, Mies van der Rohe: nuovi ordini architettonici", in Fanelli Giovanni, e Gargiani Roberto, Storia dell'architettura contemporanea, Roma-Bari, Giuseppe Laterza &figli, 2004. HAN Byung-Chul, La salvezza del bello, trad.it. di V. Tamaro, Nottetempo, Milano 2019. MARTÍ ARÍS Carlos, La centina e l'arco. Pensiero, teoria, progetto in architettura, a cura di Pierini O. S., Marinotti, Milano 2007. MUTTONI Aurelio, L'Arte delle strutture. Introduzione al funzionamento delle strutture in architettura, a cura di Minazzi F., Mendrisio Academy Press, Mendrisio 2006. NERVI Pier Luigi, Scienza o arte del costruire? Caratteristiche e possibilità del cemento armato, a cura di Neri G., Milano, CittàStudi 2014. VACCHINI Livio, Capolavori. 12 architetture fondamentali di tutti i tempi, Melfi, Libria 2017. SALVADORI Mario, Perché gli edifici stanno in piedi, Milano, Bompiani 2016.
Examination method	Oral discussion

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Room	Microsoft Teams Generale | The architecture of structural forms A. A. 2025/2026 | Microsoft Teams

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CTI

Course title	The architecture of structural forms
Lecturer	
Scientific Discipline Sector	CEAR-09/A
Hours of instruction	20
CFU	2
Year	Second
Tentative Calendar	
SUMMARY /GOAL	The didactic project of the course assumes the relationship between space and the constructive forms of architecture as a problematic core, through a point of view that recognizes construction as the most powerful expressive resource for the representation of the spatial character of buildings. The thought on the structure, therefore, seems to be problematized in a dialectical tension between the disciplines of architecture and engineering, whose common language is that of matter and its possible formal definitions. The purpose of the course is to develop a particular approach to research on architectural design that is able to recognize, problematically, the relationship between space and the design of its structural systems, from type to construction. By declining the constructive paradigms of history and their cultural areas of reference, it is possible to identify some interpretative lines that feed the most recent structural experiments on matter, between the definition of its possible forms and the search for their own figurative identity. Just think of the research on the forms of reinforced concrete carried out in Switzerland since the beginning of the twentieth century, where the technical forms of the structure (also in the construction of bridges and infrastructure works) exceed their aesthetic autonomy, interpreting the relationship with the landscape in which they are located. Between Architecture and the Art of structures
Syllabus	
Bibliography	
Examination method	

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Room	On-site / Microsoft Teams

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CTI

Course title	The post-growth paradigm in planning research
Lecturer	Mariella Annese
Scientific Discipline Sector	CEAR-12/B
Hours of instruction	20
CFU	2
Year/Semester	Second/First
Tentative Calendar	05/03/2026: 15:00-to be defined 09/03/2026: 13:30-to be defined 20/04/2026: 10:30-to be defined To be defined
SUMMARY /GOAL	Gli ultimi quarant'anni hanno segnato radicalmente la città e la disciplina urbanistica. A partire da una lettura critica della lunga stagione di studi che ha chiuso il secolo scorso decretando la fine del progetto urbano e, guardando a come i temi emergenti sono trattati nelle ricerche più recenti, il corso cerca di capire quanto e in che modo siano cambiati il discorso sulla città contemporanea, con ciò tentando di chiarire come le interpretazioni aggiornate del fenomeno urbano possano aprire nuove strade al progetto. Il corso approfondirà i temi del paradigma della post-crescita contemporanea, delle sue cause e delle sue manifestazioni materiali; verranno inoltre delineati i percorsi della ricerca contemporanea nelle direzioni di un rinnovato rapporto con l'esistente, della valorizzazione del patrimonio territoriale, dell'integrazione e della contaminazione con le discipline che affrontano i temi della sostenibilità e del cambiamento climatico, della società. L'obiettivo formativo del corso è quello di offrire ai dottorandi gli strumenti per comprendere la complessità del mondo contemporaneo e acquisire la capacità di sviluppare un pensiero autonomo e consapevole rispetto ai nodi problematici e alle sfide che esso pone. Il corso si propone quindi di approfondire le principali fenomenologie del paradigma della post-crescita nella città e nel territorio, e allo stesso tempo di discutere le linee di ricerca che le discipline del territorio hanno avviato negli ultimi decenni.
Syllabus	Sono previste lezioni frontali e seminari, strettamente integrati, che si avvalgono anche del contributo di docenti esperti italiani con un punto di vista rilevante sui temi del corso, per

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	permettere un'ampia riflessione tra dottorandi e relatore sui temi trattati.
Bibliography	
Examination method	L'attribuzione dei crediti formativi avverrà attraverso la valutazione di una relazione, volta a verificare l'acquisizione di onoscenze e competenze da parte del dottorando. Nella valutazione si terrà conto anche della partecipazione alle attività formative svolte.
Room	On-site / Microsoft Teams

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DAUSY

Course title	Control and Security of Cyber Physical Systems
Lecturer	Ruotian Liu
Scientific Discipline Sector	IINF-04/A
Hours of instruction	10
CFU	1
Year/Semester	Second/First
Tentative Calendar	17/03/2026: 15.00-17:30 18/03/2026: 15.00-17:30 24/03/2026: 15.00-17:30 25/03/2026: 15.00-17:30
SUMMARY /GOAL	The aim of the course is to show the importance of control and security in Cyber Physical Systems (CPSs). CPSs are systems where a decision making(cyber/control)component is tightly integrated with a physical system(with sensing/actuation) to enable real-time monitoring and control. Therefore, control and security are crucial issues for commissioning these systems and for improving competitiveness of companies. In this context, the study of opacity is a fundamental notion to determine if an industrial "secret" can be discovered by a malicious observer (intruder).
Syllabus	
Bibliography	
Examination method	
Room	Microsoft Teams Control and Security of Cyber Physical Systems For any information, please contact: ruotian.liu@poliba.it

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DAUSY

Course title	Data-driven fault diagnosis and fault prognosis
Lecturer	Riccardo Felicetti
Scientific Discipline Sector	IINF-04/A
Hours of instruction	10
CFU	1
Year/Semester	Second/Second
Tentative Calendar	05/05/2026: 10.30-13:00 07/05/2026: 10.30-13:00 12/05/2026: 10.30-13:00 14/05/2026: 10.30-13:00
SUMMARY /GOAL	This module aims at providing PhD students with the main concepts of data-driven fault diagnosis and fault prognosis which are at the base of modern condition-based and predictive maintenance. During the module, the students will learn how to apply a data-driven workflow to solve real case studies and to adapt it to the specific cases of fault diagnosis and fault prognosis. The workflow will include data processing, feature extraction and model training, with some insights on deployment complexity; problem resolution will also be implemented by using a common engineering software (MATLAB). The final goal is to provide PhD students with the necessary background to process sensors data and use them to monitor the condition of a physical system, classify possible undesired behaviours and eventually estimate the remaining useful life of specific components. Each lesson consists in lectures, numerical examples and analysis of case studies.
Syllabus	-Motivating examples: from industry to robotic applications. -Nomenclature: fault, maintenance and supervision. -Reliability and safety. -Limit checking, trend checking and hypothesis testing. -Data types and data normalization. -Filtering (signal processing). -Signal features in the time and frequency domain. -Features selection and dimensionality reduction. -Fault diagnosis: features extraction and classification. -Bias-variance trade-off. -Overfitting and cross validation.

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	-Loss functions and performance indicators. -Hyperparameters optimization. -Fault prognosis: condition indicators and remaining useful life estimation. -Data-driven fault diagnosis and fault prognosis workflows. -MATLAB Predictive Maintenance Toolbox. -Case studies and benchmarks.
Bibliography	Recommended books: • Isermann, Rolf. Fault-diagnosis systems: an introduction from fault detection to fault tolerance. Springer Science & Business Media, 2005. • Bishop, Christopher M., Pattern Recognition and Machine Learning (Information Science and Statistics), 2006, Springer-Verlag. • G. Pillonetto, T. Chen, A. Chiuso, G. D. Nicolao, and L. Ljung, Regularized System Identification. Springer, 2022. Slides and supporting material from lecturer.
Examination method	End-course examination based on a project work.
Room	Microsoft Teams Data-driven fault diagnosis and fault prognosis For any information, please contact: r.felicetti@univpm.it

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DAUSY

Course title	Distributed/Decentralized Control and Optimization of Large-Scale Systems
Lecturer	Raffaele Carli
Scientific Discipline Sector	IINF-04/A
Hours of instruction	10
CFU	1
Year/Semester	Second/First
Tentative Calendar	23-01-2026: 15:30-18:00 26-01-2026: 08:30-11:00 28-01-2026: 09:30-12:00 28-01-2026: 14:30-17:00
SUMMARY /GOAL	This course aims at providing PhD students with modeling and methodological tools for formulating and solving large-scale optimization problems with a focus on the use of duality theory. During the course several optimization problems will be formalized, particularly referred to relevant issues within management and industrial engineering. Problem definition and resolution will be also implemented in simulation and engineering software (Matlab). The final goal is to provide PhD students with the necessary background for starting research in the field of duality-based decentralized and distributed optimization techniques to be applied to large-scale systems. Each lesson consists in lectures, numerical examples, simulation and analysis of case studies.
Syllabus	
Bibliography	
Examination method	
Room	Microsoft Teams Distributed/Decentralized Control and Optimization of Large-Scale Systems For any information, please contact: raffaele.carli@poliba.it

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DAUSY

Course title	Game Theory for Controlling Autonomous Systems
Lecturer	Paolo Scarabaggio
Scientific Discipline Sector	IINF-04/A
Hours of instruction	10
CFU	1
Year/Semester	Second/Second
Tentative Calendar	23/06/2026: 13.30-16:00 24/06/2026: 13.30-16:00 25/06/2026: 13.30-16:00 26/06/2026: 13.30-16:00
SUMMARY /GOAL	This course is designed to provide PhD students with the necessary modeling and methodological tools for analyzing and designing algorithms to solve game equilibrium problems. . The course will include lectures, numerical examples, simulations, and analysis of case studies.
Syllabus	1. Introduction and motivation 2. Background a. Convex Optimization: Convex sets and functions. Set-valued mappings. Normal cone and tangent cone operators. Projection and proximal operators. Lagrangian duality and KKT conditions. b. Monotone Operator Theory: Fixed points, zeros, and contraction mappings; averaged and nonexpansive mappings; fixed point theorems and algorithms. 3. Nash equilibrium a. Nash equilibrium problem, and best response mapping. b. Applications and models: Linear complementarity problems and variational inequalities. c. Existence and uniqueness of equilibria. d. Algorithms. 4. Generalized Nash equilibrium a. Background, Generalized Nash equilibrium problem. b. Applications and models: Quasi-variational inequalities and mixed complementarity problems. c. Existence and uniqueness of equilibria. d. Algorithms.

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Bibliography	[1] Boyd, Stephen P., and Lieven Vandenberghe. Convex optimization. Cambridge University Press, 2004. [2] Bauschke, Heinz H., and Patrick L. Combettes. Convex analysis and monotone operator theory in Hilbert spaces. Vol. 408. Springer, 2011. [3] Facchinei, Francisco, and Jong-Shi Pang, eds. Finite-dimensional variational inequalities and complementarity problems. Springer, 2003. [4] Osborne, Martin J. An introduction to game theory. Vol. 3. No. 3. New York: Oxford University Press, 2004. [5] Basar, Tamer, and Georges Zaccour, eds. Handbook of dynamic game theory. Berlin: Springer, 2018. Slides and supporting material from lecturer.
Examination method	End-of-course examination based on a written test or a project, work. Evaluation of class participation, including active engagement in lectures, discussions, and case study analysis.
Room	Microsoft Teams Game Theory for Controlling Autonomous Systems For any information, please contact: paolo.scarabaggio@poliba.it

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DAUSY

Course title	Gaussian processes for modeling and control of robotics systems
Lecturer	Alberto Dalla Libera
Scientific Discipline Sector	IINF-04/A
Hours of instruction	20
CFU	2
Year/Semester	Second/First
Tentative Calendar	27-01-26: 14:00-16:00 29-01-26: 14:00-16:00 30-01-26: 14:00-16:00 02-02-26: 14:00-16:00 04-02-26: 14:00-16:00 06-02-26: 14:00-16:00 11-02-26: 14:00-16:00 13-02-26: 14:00-16:00 16-02-26: 14:00-16:00 18-02-26: 14:00-16:00
SUMMARY /GOAL	The course shall address the basis of Gaussian Process Regression applied to modeling and control of robotic manipulators. At end of this course, students will be able to apply Gaussian Process Regression to the following problems: ▪ Inverse dynamics identification; ▪ Estimation of forward dynamics model to simulate the evolution of a robotic system; ▪ Use such models to derive a controller. Lesson shall consist in lecture and numerical examples in MATLAB and Python.
Syllabus	
Bibliography	
Examination method	
Room	Microsoft Teams Gaussian processes for modeling and control of robotics systems For any information, please contact: alberto.dallalibera@unipd.it

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DAUSY

Course title	Human autonomous system interaction
Lecturer	Sabrina Iarlori
Scientific Discipline Sector	IINF-04/A
Hours of instruction	10
CFU	1
Year/Semester	Second/First
Tentative Calendar	17-04-26: 10:00-12:00 24-04-26: 10:00-12:00 08-05-26: 10:00-12:00 15-05-26: 10:00-12:00 22-05-26: 10:00-12:00
SUMMARY /GOAL	The course aims at providing PhD students with the main concepts of the well-known technology for improving human-autonomy interaction with a special focus on autonomous systems. It is especially focused on technology and case studies relevant to complex, applied environments in which people interact with autonomous systems regularly, particularly in the context of ambient assisted living. The course focuses on approaches that include task inputs from humans: how to model humans and their tasks and at what level of details. Moreover, the human in-the loop approach will be introduced as a new scenario to facilitate the goal achievement, to reduce the anomalies and the unexpected responses from the system or inappropriate responses by the human to enhance human safety. New human-system engineering techniques are needed to ensure autonomous systems will be smoothly and readily adopted into society. Autonomous systems that work together in the environment should integrate the connections and interactions between them, over networks, with the physical environment, and with humans must be assured, resilient, productive, and fair in the autonomous future. Autonomous systems should be analysed including concept, context, requirements, design, integration, operationalization, validation, testing and evaluation. During the course, the students will learn how the human-autonomous system interaction is achieved and how it is articulated. The workflow will include data processing, feature extraction and model training for human-robot in-

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	teraction tasks, with some insights on deployment complexity; problem resolution will also be proposed by using a common engineering software (MATLAB), and the ROS (Robot Operating System). Each lesson consists in lectures, numerical examples and analysis of case studies.
Syllabus	
Bibliography	
Examination method	
Room	Microsoft Teams Human autonomous system interaction For any information, please contact: s.iarlori@staff.uni-vpm.it

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DAUSY

Course title	Intelligent Supervisory Systems
Lecturer	Silvio Simani
Scientific Discipline Sector	IINF-04/A
Hours of instruction	20
CFU	2
Year	Second
Tentative Calendar	
SUMMARY /GOAL	This course aims to offer a foundation of intelligent supervisory system techniques and their application in various real-world domains and how to implement a solution with “intelligent” functionality. Students will learn to judge when intelligent functionality and artificial intelligence may be a good solution for a problem and be able to choose suitable artificial intelligence methods and techniques. Students will also acquire knowledge enabling them to develop the necessary skills to design and implement an intelligent supervisory system.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams For any information, please contact: silvio.simani@unife.it

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DAUSY

Introduction to autonomous systems	Introduction to autonomous systems
Lecturer	Nicola Mignoni
Scientific Discipline Sector	IINF-04/A
Hours of instruction	10
CFU	1
Year/Semester	Second/First
Tentative Calendar	06/04/2026: 10.00-12:30 08/04/2026: 10.00-12:30 10/04/2026: 10.00-12:30 13/04/2026: 10.00-12:30
SUMMARY /GOAL	The course aims at providing PhD students with the fundamental principles, technologies, and applications related to autonomous systems.
Syllabus	
Bibliography	
Examination method	
Room	Microsoft Teams Introduction to autonomous systems For any information, please contact: nicola.mignoni@poliba.it

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DAUSY

Course title	Learning in multi-agent systems
Lecturer	Nicola Bastianello
Scientific Discipline Sector	IINF-04/A
Hours of instruction	20
CFU	2
Year/Semester	Second/First
Tentative Calendar	13/04/2026: 14.00-16:00 14/04/2026: 14.00-16:00 20/04/2026: 14.00-16:00 21/04/2026: 14.00-16:00 27/04/2026: 14.00-16:00 28/04/2026: 14.00-16:00 04/05/2026: 14.00-16:00 05/05/2026: 14.00-16:00 11/05/2026: 14.00-16:00 12/05/2026: 14.00-16:00
SUMMARY /GOAL	The aim of the course is to provide a thorough overview of learning and optimization in multi-agent systems. At the end of the course, students will be familiar with applications, with the challenges of decentralized learning, and the current state-of-the-art solutions. Additionally, they will have an overview of current research trends and opportunities. Lessons will merge theoretical lectures and numerical examples (using Python).
Syllabus	
Bibliography	
Examination method	
Room	Microsoft Teams Learning in multi-agent systems For any information, please contact: nicolba@kth.se

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DAUSY

Course title	Linear algebra for control applications
Lecturer	Matthias Pezzuto
Scientific Discipline Sector	IINF-04/A
Hours of instruction	20
CFU	2
Year/Semester	Second/Second
Tentative Calendar	09/06/2026: 10.00-12:00 10/06/2026: 10.00-12:00 11/06/2026: 10.00-12:00 16/06/2026: 10.00-12:00 17/06/2026: 10.00-12:00 18/06/2026: 10.00-12:00 23/06/2026: 10.00-12:00 24/06/2026: 10.00-12:00 25/06/2026: 10.00-12:00 30/06/2026: 10.00-12:00
SUMMARY /GOAL	The course will introduce advanced linear algebra tools that are commonly used in many applications in Control and System Theory. The course will address this topic from different perspective: 1. Theory with formal proofs of many results, 2. Algorithms to understand the most common algorithms used in MATLAB or Python for linear algebra, 3. Implementation via MATLAB of algorithms and performance evaluation on large data sets.
Syllabus	
Bibliography	
Examination method	
Room	Microsoft Teams Linear algebra for control applications For any information, please contact: matthias.pezzuto@unipd.it

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DAUSY

Course title	Linear and nonlinear Kalman filtering: theory and applications
Lecturer	Marco Todescato
Scientific Discipline Sector	IINF-04/A
Hours of instruction	20
CFU	2
Year/Semester	Second/First
Tentative Calendar	27/04/2026: 10.30-12:30 04/05/2026: 09.30-12:30 11/05/2026: 09.30-12:30 18/05/2026: 09.30-13:30 25/05/2026: 09.30-13:30 01/06/2026: 09.30-13:30
SUMMARY /GOAL	This course aims to provide both theoretical and practical tools to tackle estimation problems encountered in several areas of engineering and science. In particular, it is shown how to formulate such estimation problems as instances of a general dynamical system state estimation problem and how to derive the mathematical solution of the latter problem. Then it is shown that, for a linear Gaussian system, such a solution yields the well-known Kal-man filter. Further, approximate techniques (e.g. extended and unscented Kalman filters, particle filter, etc.) are presented for the case of nonlinear and/or non-Gaussian systems, for which an ex-act closed-form solution cannot be found. To conclude the theoretical part, theoretical limitations (i.e. the Cramer-Rao lower bound) on the quality of estimation are discussed. In the final part of the course, we illustrate some applications of linear/nonlinear Kalman filtering (e.g., tracking, robotic navigation, environmental data assimilation).
Syllabus	Refer to summary/goal.
Bibliography	Scientific papers in addition to slides and supporting material from lecturer.
Examination method	Software project work plus presentation of the results.
Room	Microsoft Teams Linear and nonlinear Kalman filtering: theory and applications Meeting ID: 389 555 689 053 48 Passcode: dR69ST3U

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	For any information, please contact: marco.todescato@fraunhofer.it

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DAUSY

Course title	Non-integer order systems and controllers
Lecturer	Guido Maione
Scientific Discipline Sector	IINF-04/A
Hours of instruction	10
CFU	1
Year/Semester	Second/First
Tentative Calendar	09/02/2026: 15:00-17:00 10/02/2026: 15:00-17:00 11/02/2026: 15:00-17:00 12/02/2026: 15:00-17:00 13/02/2026: 15:00-17:00
SUMMARY /GOAL	The course concerns non-integer-order systems. These systems can propose engineering solutions to modeling and control problems that often improve those based on integer-order calculus. Basic tools of fractional calculus are introduced, and some methods and models are described for different engineering fields. Models for practical applications are proposed. Moreover, approaches to design and realize non-integer-order (fractional-order) controllers are described. These controllers show higher flexibility, increased robustness, and ability to obtain a better trade-off between stability and dynamic performance with respect to widespread PID controllers. As case-studies, the course uses applications in automotive and mechatronic systems.
Syllabus	Fractional calculus, non-integer-order systems and non-integer-order controllers. Design of non-integer-order controllers and case studies. Realization by approximation of non-integer-order controllers. Case studies, exercises, simulation of non-integer-order controllers, discussion. Application: control of an automotive system.
Bibliography	R. Caponetto, G. Dongola, L. Fortuna, I. Petráš, Fractional Order Systems: Modeling and Control Applications. Singapore: World Scientific, 2010. C. A. Monje, Y. Q. Chen, B. M. Vinagre, D. Xue, V. Feliu, Fractionalorder Systems and Controls: Fundamentals and Applications. London, UK: Springer-Verlag, 2010. Some reference scientific papers.
Examination method	Discussion of a modeling or control problem, also by simulation software tools (Matlab/Simulink).

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Room	Microsoft Teams Non-integer order systems and controllers For any information, please contact: guido.maione@poliba.it

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DAUSY

Course title	Non-linear Control
Lecturer	Karl Dietrich Von Ellenrieder
Scientific Discipline Sector	IINF-04/A
Hours of instruction	20
CFU	2
Year/Semester	Second/Second
Tentative Calendar	08/06/2026: 10:00-12:00 09/06/2026: 10:00-12:00 10/06/2026: 10:00-12:00 11/06/2026: 10:00-12:00 12/06/2026: 10:00-12:00 15/06/2026: 10:00-12:00 16/06/2026: 10:00-12:00 17/06/2026: 10:00-12:00 18/06/2026: 10:00-12:00 19/06/2026: 10:00-12:00
SUMMARY /GOAL	The course introduces analytical tools for the analysis and design of nonlinear control systems. At the end of the course students will understand how to analyze the stability of nonlinear dynamic systems and knowledge of some of the main approaches for designing nonlinear controllers. Basic engineering examples and Matlab exercises are provided.
Syllabus	
Bibliography	
Examination method	
Room	Microsoft Teams Non-linear Control For any information, please contact: karl.vonellen-rieder@unibz.it

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DAUSY

Course title	Variable Structure Control
Lecturer	Elio Usai
Scientific Discipline Sector	IINF-04/A
Hours of instruction	10
CFU	1
Year/Semester	Second/First
Tentative Calendar	23/02/2026: 15.00-17:00 24/02/2026: 15.00-17:00 25/02/2026: 15.00-17:00 26/02/2026: 15.00-17:00 27/02/2026: 15.00-17:00
SUMMARY /GOAL	Variable Structure Control (VSC) is a control technique who force a dynamical system to behave as a Variable Structure System (VSS) whose characteristics satisfy the required performance, in spite of a class of uncertainties in the system dynamics and external disturbances. In particular the system is forced to reach and remain constrained onto a properly chosen surface of the state space such that the movement on such a surface, i.e., the Sliding Mode (SM), is invariant and corresponds to specifications. The lectures will present the general theoretic and applicative framework of VSC with SMs, presenting it in the more general vision of the control systems. Some of the mathematical tools to analyze and design a VSC with SM will be presented and discussed, also by means of simple examples. The limits of the resulting switching control, the tools to analyze the approximate behavior and the approaches to mitigate the so-called chattering phenomenon will be presented and discussed. Finally, some applications of VSC to real systems and to observer design will be presented.
Syllabus	
Bibliography	
Examination method	
Room	Microsoft Teams For any information, please contact: elio.usai@unica.it

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DRIEI

Course title	Antenna Technology for 5G communications: propagation arrays and integration
Lecturer	Ilaria Marasco
Scientific Discipline Sector	IINF-02/A
Hours of instruction	10
CFU	1
Year/Semester	Second/Second
Tentative Calendar	01/07/2026: 10.30-13:00 03/07/2026: 10.30-13:00 08/07/2026: 10.30-13:00 10/07/2026: 10.30-13:00
SUMMARY /GOAL	The course aims to introduce the fundamental concepts of antenna technologies for new generation telecommunication systems with a particular focus on beam steering and beam forming. The course includes the study of numerical methods and laboratory experiences for testing and characterizing antennas and antenna arrays.
Syllabus	The course will be organized as follows: -Introduction; -Antenna elements and types: smart and reconfigurable configurations; -Implementation of antennas with CST Studio; -Characterization and test of antenna and array performance; -Radiopropagation, beam steering and beam forming for communication systems
Bibliography	Scientific papers and books on the selected arguments will be used as reference
Examination method	A synthetic report on a chosen topic or PP presentation
Room	On-site / Microsoft Teams The course will be online on Teams with some activies in the Integrated Optics Lab (DEI II floor) Generale | 2025/26 - PhD Course:Antenna technology for 5G Communications: propagation, arrays and integration | Microsoft Teams

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DRIEI

Course title	Design of optical fiber devices with Finite Element Method
Lecturer	Francesco Anelli
Scientific Discipline Sector	IINF-02/A
Hours of instruction	10
CFU	1
Year/Semester	Second/First
Tentative Calendar	03/11/2025: 9.00-11:30 04/11/2025: 9.00-11:30 05/11/2025: 9.00-11:30 06/11/2025: 9.00-11:30
SUMMARY /GOAL	The course proposes an overview of some professional softwares such as CST Studio Suite for the design of electromagnetic devices. Both antennas and microwave devices will be proposed for design and study, with particular focus millimeter and sub-millimeter wave antennas. The participants will learn how to design and sim ulate electromagnetic devices with many practical examples.
Syllabus	Basic mathematical and physical concepts; Fundamentals of light propagation in optical fibers; Introduction to the Finite Element Method (FEM); General structure of a FEM problem (mesh, bound ary conditions, solvers); Optical waveguides: modeling principles; FEM modeling of fiber-optic devices; Numerical simulation exam ples (guided modes, losses, dispersion); Study of advanced application cases: fiber-optic sensors; Guided exercises; Multiphysics anal ysis applied to optical devices (optical-thermal and optical-mechanical coupling); Development of a mini numerical project by the stu dents.
Bibliography	Optical Fiber Communications Principles and Practice, Third Edi tion, JOHN M. SENIOR, ISBN: 978-0-13-032681-2.
Examination method	Brief presentation on course topics.
Room	Microsoft Teams Design of optical fiber devices with Finite Element Method

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DRIEI

Course title	Electric power system markets and planning
Lecturer	Francesca Marasciuolo
Scientific Discipline Sector	IIND-08/B
Hours of instruction	10
CFU	1
Year	Second
Tentative Calendar	
SUMMARY /GOAL	The aim of the course is to provide information about the organization of electric power system planning and operation with different levels of electricity markets for the provision of energy and services. The classroom activities will deal with: • Power system evolution • Power system development planning and scenario approach • Power system regulation services and reserves • Structure of electricity markets, coupling, grid models, and new regulation services Scientific papers and books on the selected arguments will be used as reference The examination method is represented by a synthetic report on a chosen topic.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DRIEI

Course title	Electromagnetic design via professional softwares
Lecturer	Antonella Maria Loconsole
Scientific Discipline Sector	IINF-02/A
Hours of instruction	10
CFU	1
Year/Semester	Second/First
Tentative Calendar	09/02/2026, 11:00-13:00 10/02/2026, 11:00-13:00 11/02/2026, 11:00-13:00 12/02/2026, 11:00-13:00 13/02/2026, 11:00-13:00
SUMMARY /GOAL	The course proposes an overview of some professional software such as CST Studio Suite for the design of electromagnetic devices. Both antennas and microwave devices will be proposed for design and study, with particular focus millimeter and sub-millimeter wave antennas. The participants will learn how to design and sim-ulate electromagnetic devices with many practical examples.
Syllabus	• Overview of electromagnetic devices • Introduction to antenna design with CST Studio Suite • Recall on scattering parameters and antenna parameters • Simulation of a horn antenna • Simulation of a patch antenna • Thermal analysis of patch antenna
Bibliography	Slides and supporting material from lecturer.
Examination method	Oral exam
Room	Microsoft Teams PhD course: Electromagnetic design via professional softwares | Generale | Microsoft Teams

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DRIEI

Course title	Green Photonics for a sustainable economy
Lecturer	Muhammad Khalid
Scientific Discipline Sector	IINF-02/A
Hours of instruction	10
CFU	1
Year/Semester	Second/First
Tentative Calendar	23/01/2026: 10.00-12:30 26/01/2026: 10.00-12:30 28/01/2026: 10.00-12:30 30/01/2026: 10.00-12:30
SUMMARY /GOAL	The course aims at introducing some fundamental photonic technologies for sustainable energy generation, for energy saving, and for environmental monitoring. The topics of the course will be mainly introduced through hands-on computer simulations That will deal with green photonic devices such as solar cells, sensors, and new photonic technologies for communication.
Syllabus	Introduction to green photonics. Introduction to numerical simulation of photonic devices. Sustainable energy generation: nanostructures for photovoltaics. Photonic devices for reduced energy consumption. Photonic sensors for environmental monitoring.
Bibliography	Scientific papers, slides and support material from lecturer.
Examination method	Oral presentation or project work
Room	Microsoft Teams Green photonics for a sustainable economy | Microsoft Teams | General

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DRIEI

Course title	Inertial sensors
Lecturer	Francesco Dell'Olio
Scientific Discipline Sector	IINF-01/A
Hours of instruction	20
CFU	2
Year	Second
Tentative Calendar	
SUMMARY /GOAL	The course aims to introduce the general concepts and applications of inertial sensors, as well as the technologies for their implementation, starting with the well-established ones and moving on to the most innovative with mid-low TRL. The course will start with an introduction to the fundamentals, operating principles, performance parameters, and main applications of inertial sensors. MEMS inertial sensors will be analyzed, showing also the most recent achievements at the state-of-the-art. The different configurations and operating principles of photonic gyroscopes will be discussed with a specific focus on miniaturization strategies. Some selected emerging technologies, including quantum inertial sensors, will be presented.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DRIEI

Course title	Matlab recipes for measurement signal processing
Lecturer	
Scientific Discipline Sector	IMIS-01/B
Hours of instruction	20
CFU	2
Year	Second
Tentative Calendar	
SUMMARY /GOAL	The aim of the course is to present, with a “hands on” approach, a number of useful techniques to acquire and process measurement data, with actual implementation in Matlab. The programme of the course is intended to be adjusted on-the-fly, according to the actual background of the students (in order to avoid too simple or too advanced topics), and to meet actual topics of interest for their Ph.D. work.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DRIEI

Course title	Micromagnetic modeling
Lecturer	Davi Rohe Salomon Da Rosa Rodrigues
Scientific Discipline Sector	IIET-01/A
Hours of instruction	10
CFU	1
Year	Second
Tentative Calendar	
SUMMARY /GOAL	This course provides an introduction to the micromagnetic modeling, from an interdisciplinary perspective focused on electrical engineering and physics, and gives the key-concepts for the following course on Spintronics Applications. Micromagnetic modeling is a major theoretical framework to analyze magnetic materials at the micrometer scale and below. Students will be introduced to basic concepts of nanomagnetism and micromagnetics. They will learn how the competing micromagnetic energies affect the magnetic state and the equations which govern the dynamics of the magnetization. They will also learn the fundamentals of the numerical implementation of micromagnetism and perform numerical simulations by means of a micromagnetic solver, using MATLAB for post-processing the output data. Each lesson shall consist in a lecture with numerical examples.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DRIEI

Course title	Numerical Methods for Big Data
Lecturer	Marina Popolizio
Scientific Discipline Sector	MATH-05/A
Hours of instruction	20
CFU	2
Year/Semester	Second/First
Tentative Calendar	13/01/2026: 11:00-13:00 15/01/2026: 11:00-13:00 20/01/2026: 11:00-13:00 22/01/2026: 11:00-13:00 27/01/2026: 11:00-13:00 29/01/2026: 11:00-13:00 02/02/2026: 11:00-13:00 09/02/2026: 11:00-13:00 16/02/2026: 11:00-13:00 18/02/2026: 11:00-13:00
SUMMARY /GOAL	The course will describe the numerical methods that facilitate the analysis of big data, network analysis and many machine learning applications. Their implementation in Matlab will be addressed, together with the use of modern Matlab toolboxes for large and sparse data; applications to the solution of real-life problems will be considered. Each lesson shall consist in lecture and numerical examples.
Syllabus	Numerical methods for Large Linear Systems (Iterative methods and Preconditioning) Singular Value Decomposition and Compression Methods Principal component analysis and dimensionality reduction
Bibliography	*Lars Elden, Matrix Methods in Data Mining and Pattern Recognition*, Philadelphia, SIAM, 2019 *Saad Yousef, Numerical Methods for Large Eigenvalues Problems*, Philadelphia, SIAM, 2011. Revised Edition S.L. Brunton, J.N. Kutz, *Data-Driven Science and Engineering*: *Machine Learning, Dynamical Systems, and Control*, 2019

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	Slides and support material from lecturer
Examination method	Project-Based Exam: • Development (or revision) and presentation of a project (or a research article) applying one or more techniques studied in the course to a real-world problem. • The project topic may be proposed either by the instructor or by the student (especially if it connects to ongoing research). • The final presentation should include: – Description of the problem – The applied method and its theoretical background – Implementation using MATLAB or Python – Numerical experiments and results – Comments and analysis of the obtained result
Room	On-site / Microsoft Teams General | 2025-26 Numerical methods for Big Data | Microsoft Teams

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DRIEI

Course title	Numerical Methods for Multidimensional Differential Problems
Lecturer	
Scientific Discipline Sector	MATH-05/A
Hours of instruction	10
CFU	1
Year	Second
Tentative Calendar	
SUMMARY /GOAL	This course will provide an advanced level overview on the numerical solution of partial differential equations and computational models for differential problems. Within a rigorous mathematical setting, the major classes of numerical methods will be analyzed and critically discussed. Consistency and stability will be also accounted providing essential guidelines for the choice and implementation of numerical methods for differential problems. The course syllabus follows: • Transport equations. Scalar transport problem, a priori estimation. System of hyperbolic linear equations. Finite difference technique, scalar equation discretization and discretization of a system of hyperbolic linear equations. Boundary conditions. • Equivalent models for transport equations. • Kinetic BGK-like models. Kinetic models for hydrodynamics and traffic laws. Convergence and Stability. Computational aspects. • Description of parallel computing structures and strategies. Shared memory VS distributed memory.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DRIEI

Course title	Power Systems Simulation Tools
Lecturer	Gioacchino Tricarico
Scientific Discipline Sector	IIND-08/B
Hours of instruction	20
CFU	2
Year	Second
Tentative Calendar	
SUMMARY /GOAL	The aim of the course is to provide information on the data management and results interpretation of power system simulation tools for the different analysis of load flow, continuation load flow, short circuit, small signal stability, dynamic stability. The classroom activities will deal with: • Operation of power systems • Models of regulation • Explication of data for different analysis • Building of a co-simulation environment • Examples Scientific papers and books on the selected arguments will be used as reference. The examination method is represented by a synthetic report on a chosen topic.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DRIEI

Course title	Spintronics applications
Lecturer	Andrea Meo
Scientific Discipline Sector	IIET-01/A
Hours of instruction	10
CFU	1
Year	Second
Tentative Calendar	
SUMMARY /GOAL	This course follows the introduction provided in the course of Micromagnetic Modeling and deals with basic concepts of Spintronics, from an interdisciplinary perspective focused on electrical engineering and physics. Spintronics represents an emerging research frontier with the potential to impact a broad range of applications. Students will use micromagnetic models to study and design spintronic devices for applications such as storage, microwave oscillators and detectors. They will also perform numerical simulations by means of a micromagnetic solver and use MATLAB for post-processing the output data. Each lesson shall consist in lecture and numerical examples.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DRIEI

Course title	Supervision and monitoring of renewable energy systems
Lecturer	Jamel Riahi
Scientific Discipline Sector	IIET-01/A
Hours of instruction	10
CFU	1
Year	Second
Tentative Calendar	
SUMMARY /GOAL	The course aims to introduce the fundamental concepts for the monitoring of the electrical and energy performance of plants/systems based on Renewable Energy Sources (RES), notably photovoltaic systems, and for the diagnostics of anomalies or failures. 1) Supervision and monitoring systems for RES 2) Statistical tools for performance analysis of RES 3) Infrared analysis for the fault detection of RES
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DRIG

Course title	Business models for circular supply chains
Lecturer	Giovanni Francesco Massari
Scientific Discipline Sector	IEGE-01/A
Hours of instruction	20
CFU	2
Year	Second
Tentative Calendar	
SUMMARY /GOAL	This course will introduce the concept of circular supply chain and the the role played by business models to achieve a transitions towards a sustainable economy
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DRIG

Course title	Empirical research on sustainable innovation and resilience Modulo 1 (part one of two)
Lecturer	Rosa Maria Dangelico
Scientific Discipline Sector	IEGE-01/A
Hours of instruction	10
CFU	1
Year/Semester	Second/First
Tentative Calendar	12/02/26: 9:00-14:00 20/02/26: 9:00-14:00
SUMMARY /GOAL	This module will deal with empirical research in the fields of sustainable innovation and consumer behavior, with a specific focus on surveys (questionnaire development, administration, and statistical data analysis) as well as main approaches and tools firms can consider in assessing and managing supply chain risks in order to achieve resilience in their supply chains.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams Aula Q Generale | Empirical Research on Sustainable Innovation and Resilience (part 1) | Microsoft Teams

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DRIG

Course title	Empirical research on sustainable innovation and resilience Modulo 2 (part two of 2)
Lecturer	Roberta Pellegrino
Scientific Discipline Sector	IEGE-01/A
Hours of instruction	10
CFU	1
Year/Semester	Second/First
Tentative Calendar	17/02/25: 9:00-14:00 24/02/25: 9:00-14:00
SUMMARY /GOAL	Supply chain risk assessment has become a priority on the agenda of supply chain managers and purchasing departments. Multifarious unforeseen supply chain vulnerabilities and disruptions that have affected organizations in last decade have caused losses of hundreds of millions of dollars in industries ranging from pharmaceuticals and consumer goods to electronics and automotive. The ongoing changes and transformations in economic, social, technological and environmental contexts can create new challenges for businesses and generate new sources of vulnerability. At the heart of all these issues there is a common challenge, namely the lack of robust processes to manage supply chain risk, that can support decision making process under the uncertainty in a world becoming even more interconnected and complex. Effective tools that can be used to model and manage supply chain risk exist, but they are still limited. Borrowing risk assessment models from large companies without adapting to the specific context of the firm may be dangerous because the realities in which companies operate are different. Also, the business environment changes at a very fast rate, thus constantly posing new challenges in managing supply chains. Considering that there is not a one-fit-all solution to risk assessment, the aim of this module is to provide an overview of main approaches and tools of empirical research that may be used to support firms in assessing and managing supply chain risks in order to achieve resilience in their supply chains. To this end, lectures will be accompanied by practical exercises.
Syllabus	

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Bibliography	
Examination method	
Room	On-site / Microsoft Teams Aula Q Generale | Corso Scudo 2025/26 Empirical research on sustainable innovation and resilience (Part 2) | Microsoft Teams

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DRIG

Course title	From qualitative to quantitative methods in business research
Lecturer	Daniele Sandro Rotolo
Scientific Discipline Sector	IEGE-01/A
Hours of instruction	20
CFU	2
Year/Semester	Second/First
Tentative Calendar	10/03/2026: 08:30-10:30 17/03/2026: 08:30-10:30 24/03/2026: 08:30-10:30 31/03/2026: 08:30-10:30
SUMMARY /GOAL	The aim of the course is to provide PhD students with a set of building blocks for conducting, at the academic level, both quantitative and qualitative research in the areas of management, economics, and policy. As quantitative research, the course addresses three main issues of qualitative research. First, the course provides theoretical insights into different quantitative research methodologies and designs. Second, the course introduces PhD students to various methodologies for gathering data, observations, and evidence and for organising them in ways that can be used for quantitative analysis. Third, the course introduces PhD students to various quantitative methodologies – from regression analysis to text mining –to support PhD students in the development of practical skills as well as critical thinking for interpretation purposes. As to the qualitative research, PhD students will be introduced to the basic ideas behind the qualitative research in social science. Students will learn about data collection, description, analysis and interpretation in qualitative research. Qualitative research often involves an iterative process. The course will focus on the ingredients required for this process: data collection and analysis.
Syllabus	
Bibliography	
Examination method	

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Room	On-site / Microsoft Teams From qualitative to quantitative methods in business research

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DRIG

Course title	Human-based Smart Manufacturing Systems
Lecturer	Andrea Lucchese
Scientific Discipline Sector	IIND-05/A
Hours of instruction	20
CFU	2
Year/Semester	Second/First
Tentative Calendar	08/01/26 h. 09:00-13:00 09/01/26 h. 09:00-13:00 23/01/26 h. 09:00-13:00 05/02/26 h. 09:00-13:00 06/02/26 h. 09:00-13:00
SUMMARY /GOAL	The course aims to provide students with a deep understanding of the principles and applications of Industry 5.0, emphasizing the integration between human in-telligence and smart technologies within modern manufacturing systems. It fo-cuses on the transition from Industry 4.0's automation and digitalization para-digm to a human-centric, resilient, and sustainable production model, enhancing both competitiveness and social value.
Syllabus	Rationale The fifth industrial revolution, known as Industry 5.0 (I5.0), encompass a vision for a human-centred, innovative, resilient, and competitive industry. I4.0 moved the focus from a traditional product-driven (mass) industrial production towards a "demand-driven" market that requires the fully-integrated systems able to adapt, in real-time, the production system to the demand change. The I5.0 ap-proach re-introduces the human-centred dimension as the key resource of a smart production systems adopting I4.0 technologies. In the transition from traditional to new production systems, two critical elements arise: the companies' "readiness degree", that is, the assessment of the potential benefits from the adoption of I4.0 technologies and the "human component". With the aim of successfully imple-menting ICT technologies allowing 'thing', 'services' and 'human' to be contin-uously remotely connected by i-cloud centralized systems, a reliable evaluation of both the potential increasing of the competitiveness degree and a reliable de-scription of

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	the behaviour and of the knowledge and skills of the human compo-nent in the new work environment are required. Program: • **08 January 2026** Human Centric Impact of Assistive Technologies in Produc-tion and Logistics Systems • **09 January 2026** TPM & Industry 5.0 in FMCG (Fast-Moving Consumer Goods) Manufactur-ing • **23 January 2026** Industry 4.0, Internet of Things and Lifecycle Management. Digital Integra-tion of the Factory: towards the I5.0 Para-digm • **05 February 2026** Towards a holistic approach to measuring operators' well-being within the Industry 5.0 paradigm: Tools and methods • **06 February 2026** Human centric collaborative workplace: the human robot interaction system perspective
Bibliography	Scientific papers, slides and support material from lecturer.
Examination method	The final assessment consists of a multiple-choice written test (graded in 30/30) evaluating students' comprehension of Industry 5.0 concepts, human-centred production sys-tems, and smart manufacturing technologies.
Room	Microsoft Teams Microsoft Teams code **sfgnqys**

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DRIG

Course title	Lean production in the digital factory
Lecturer	Claudio Sassanelli
Scientific Discipline Sector	IIND-05/A
Hours of instruction	20
CFU	2
Year/Semester	Second/First
Tentative Calendar	16/02/26: 09:30 – 12:30 18/02/26: 09:30 – 12:30 19/02/26: 09:30 – 12:30 26/02/26: 09:00 – 12:00 26/02/26: 15:00 – 17:00 12/03/26: 15:00 – 17:30 13/03/26: 15:00 – 17:30 16/03/26: 10:00 – 12:00
SUMMARY /GOAL	The course provides PhD students with the core knowledge they need: i. to understand the concept of Lean Production (principles, models and tools); j. ii. to learn how to manage the process of continuous improvement of a smart production system; iii. to enable the Lean Transformation in the digital factory, product development process, and supply chain
Syllabus	
Bibliography	
Examination method	
Room	Microsoft Teams Code **snyb79y**

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DRIG

Course title	Management and Business research
Lecturer	Antonio Messeni Petruzzelli
Scientific Discipline Sector	IEGE-01/A
Hours of instruction	20
CFU	2
Year/Semester	Second/First
Tentative Calendar	20/03/2026: 09:30-13:30 13/04/2026: 09:30-13:30 28/04/2026: 09:30-13:30 22/05/2026: 09:30-13:30 17/06/2026: 09:30-13:30 To be defined
SUMMARY /GOAL	This course aims to introduce PhD students to a scientific approach to the study of management and business issues. The focus is on equipping students with the fundamental knowledge and skills for undertaking research in managemen and business and to critically evaluate research conducted by others. The course is divided into four interrelated segments: problem formulation/conceptualisation, implementation, analysis, publication, and communication of research findings. Ethic issues will be further discussed
Syllabus	Lezione n. 1 Problem Formulation & Conceptualizaion Lezione n. 2 Research Design Lezione n. 3 Research Implementation Lezione n. 4 Publication Strategies Lezione n. 5 Communication of Research Findings
Bibliography	
Examination method	
Room	On-site / Microsoft Teams Management and Business research

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DRIG

Course title	Smart and sustainable last-mile logistics
Lecturer	Bartolomeo Silvestri
Scientific Discipline Sector	IIND-05/A
Hours of instruction	20
CFU	2
Year	Second
Tentative Calendar	
SUMMARY /GOAL	The aim of the course is to provide the basic knowledge and advances on the principles and methods of freight and people last-mile logistics design and management in urban areas through innovative Industry 4.0 technologies.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DRIME

Course title	Adjoint methods for gradient-based optimisation and control of energy systems
Lecturer	
Scientific Discipline Sector	IIND-06/A
Hours of instruction	20
CFU	2
Year	Second
Tentative Calendar	
SUMMARY /GOAL	The course then aims at providing PhD students with the fundamental knowledge and the main techniques for the optimization and control of energy systems using adjoint methods. Adjoint methods are powerful mathematical tools that play a crucial role in sensitivity analysis, gradient computation, and optimization of complex systems. In this course, we will focus on their application in energy systems, covering both theoretical foundations and practical implementation. The student will understand the fundamentals of adjoint methods and their relevance to optimization and control. He will be able to apply adjoint methods to: (a) perform sensitivity analyses on linear and nonlinear partial differential equation; (b) explore optimization techniques using adjoint methods for energy system design and control; (c) gain hands-on experience in implementing adjoint methods through practical examples and exercises; (d) investigate real-world applications of adjoint methods in propulsion systems, power systems, and other energy domains. Syllabus: 1. Introduction to adjoint methods a. Importance in optimization and control b. Historical context and development c. Mathematical Foundations 2. Review of calculus and differential equations a. Introduction to variational calculus b. Linear algebra and optimization concepts c. Sensitivity Analysis 3. Computing gradients using adjoint methods a. Numerical aspects and implementation

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	b. Gradient-based optimization algorithms 4. Formulation of optimization problems in energy systems a. Constrained and unconstrained optimization b. Case studies in energy systems 5. Introduction to control theory a. Optimal control using adjoint methods b. Feedback control and stability analysis 6. Hands-on exercises with MATLAB a. Implementation of adjoint methods b. Simulation and analysis of real-world energy systems 7. Automatic differentiation and adjoint methods
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DRIME

Course title	Contact Mechanics
Lecturer	Nicola Menga
Scientific Discipline Sector	IIND-02/A
Hours of instruction	20
CFU	2
Year/Semester	Second/First
Tentative Calendar	23/03/2026: 09:00-14:00 24/03/2026: 09:00-14:00 25/03/2026: 09:00-14:00 26/03/2026: 09:00-14:00
SUMMARY /GOAL	The course focuses on the contact mechanics of smooth and rough deformable solids. The effects of interfacial interactions, such as adhesion and friction, on the contact behavior are also studied. Probability theory for rough surface analysis is also briefly discussed.
Syllabus	
Bibliography	
Examination method	
Room	Microsoft Teams Contact Mechanics

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DRIME

Course title	Design of User Experience to exploit Extended Reality for the enhancement of research activities
Lecturer	Michele Gattullo
Scientific Discipline Sector	IIND-03/B
Hours of instruction	20
CFU	2
Year	Second
Tentative Calendar	
SUMMARY /GOAL	The course aims to provide PhD students with the fundamental knowledge of all these technologies, presenting both opportunities and threats. The course will start with the presentation of success stories about the use of XR in industrial research. Then, during the course, the main theoretical and methodological issues in the design of an XR application will be covered. Great relevance will be given to the practice: PhD students will be provided with tools to design User Experiences to exploit XR for the enhancement of their research activities. They will also be introduced to the use of the software Unity, a game engine commonly used to develop XR scenes. Finally, the course will teach how to evaluate the XR applications designed and developed.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DRIME

Course title	Digital Manufacturing for Biomedical Applications
Lecturer	Alexandra Morvayova
Scientific Discipline Sector	IIND-04/A
Hours of instruction	20
CFU	2
Year/Semester	Second/First
Tentative Calendar	20/01/2026: 11.00-12:40 23/01/2026: 11.00-12:40 27/01/2026: 11.00-12:40 30/01/2026: 11.00-12:40 03/02/2026: 11.00-12:40 06/02/2026: 11.00-12:40 10/02/2026: 11.00-12:40 13/02/2026: 11.00-12:40 17/02/2026: 11.00-12:40 20/02/2026: 11.00-12:40 To be defined
SUMMARY /GOAL	This course offers a comprehensive examination of digital manufacturing technologies and their application within the biomedical engineering domain. It introduces the fundamental principles of digital manufacturing, with particular emphasis on additive manufacturing techniques such as stereolithography, selective laser sintering, fused deposition modeling, and bioprinting. The course also covers 3D scanning and digital modeling methods for the acquisition, processing, and optimization of biomedical geometries. Students explore the properties, processing requirements, and regulatory aspects of biocompatible polymeric, metallic, and composite materials used in biomedical applications. Through the analysis of case studies and hands-on laboratory activities, the course emphasizes the design, fabrication, and evaluation of patient-specific biomedical devices, anatomical models, and surgical tools. By integrating theoretical knowledge with practical experience, students develop the competencies required to critically assess digital manufacturing processes and apply them effectively in biomedical research and clinical contexts.

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Syllabus	
Bibliography	
Examination method	Individual practical project covering selected topics of the course
Room	On-site / Microsoft Teams Digital Manufacturing for Biomedical Applications In person in Aula 3 (eventual on-line classes possible upon agreement)

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DRIME

Course title	Manufacturing modeling and simulation
Lecturer	Maria Rashkovets
Scientific Discipline Sector	IIND-04/A
Hours of instruction	20
CFU	2
Year/Semester	Second/First
Tentative Calendar	20/01/2026: 14.30-16:10 23/01/2026: 14.30-16:10 27/01/2026: 14.30-16:10 30/01/2026: 14.30-16:10 03/02/2026: 14.30-16:10 06/02/2026: 14.30-16:10 10/02/2026: 14.30-16:10 13/02/2026: 14.30-16:10 17/02/2026: 14.30-16:10 20/02/2026: 14.30-16:10 To be defined
SUMMARY /GOAL	This course provides foundational knowledge for simulating manufacturing processes such as fusion welding, solid-state welding, deformation, or additive manufacturing. The classes are divided into two parts: - Theory: an introduction to manufacturing processes, key challenges, and basic principles of Finite Element Modeling (FEM). - Practice: hands-on simulation exercises. Simulations will be carried out using the specialized Finite Element Analysis (FEA) software Simufact MSC. By the end of the course, students will be able to conduct virtual tests, design and optimize manufacturing processes.
Syllabus	
Bibliography	
Examination method	An individual simulation project focused on a manufacturing process chosen by the student
Room	On-site / Microsoft Teams In Aula 11 Link for course registration

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DRIME

Course title	Non-Destructive (NDT): Process, Types and Applications in Mechanical Engineering
Lecturer	Ester D'Accardi
Scientific Discipline Sector	IIND-03/A
Hours of instruction	20
CFU	2
Year	Second
Tentative Calendar	
SUMMARY /GOAL	The course aims to provide PhD students the basic principles of main methods of Non-Destructive Testing for structural diagnostics. PhD students will develop skills related to the use of techniques such as penetrant tests, eddy currents, magnetic particles, thermography, and ultrasound. The lab activities will be focused on Active and Passive Thermography techniques: Pulsed thermography, Lock-in Thermography, Step Heating thermography and Thermoelastic Stress Analysis.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DRIME

Course title	Numerical Approaches to Solid and Applied Mechanics: Boundary Element Methods (BEM)
Lecturer	Carmine Putignano
Scientific Discipline Sector	IIND-02/A
Hours of instruction	20
CFU	2
Year/Semester	Second/First
Tentative Calendar	10/02/2026: 08.30-13:30 11/02/2026: 08.30-13:30 12/02/2026: 08.30-13:30 13/02/2026: 08.30-13:30
SUMMARY /GOAL	**Theory of BEM (6 hours).** Linearity and superposition principle: integral formulation of mechanical problems. Green's function. Translation Invariance. Solution schemes of the integral convolution: Fourier vs Real space. Adaptive mesh. **BEM Applications: Contact Mechanics (6 hours).** BE methods for contact mechanics: formulation for linear elastic and viscoelastic materials, role of the geometric domain (smooth and rough contacts), meshing and solution schemes. Boundary Element (BE) vs Finite Element (FE) methodologies: advantages and drawbacks. **Coupling BEM And Other Numerical Methods (4 hours).** Numerical coupling to study finite domains: BEM and FEM; BEM and molecular dynamics (MD). The case of soft lubrication: coupling BEM and finite difference (FD). **BEM Applications: Structural Mechanics (4 hours).** BEM for modal analysis including fluid-structure interaction: the test case of the modal analysis for a beam immersed in a viscous fluid.
Syllabus	
Bibliography	
Examination method	
Room	Microsoft Teams

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	Numerical Approaches to Solid and Applied Mechanics: Boundary Element Methods (BEM) Codice 56uli3j

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DRISA

Course title	High-energy particle physics instruments and methods for space environment
Lecturer	Roberta Pillera
Scientific Discipline Sector	PHYS-01/A , PHYS-03/A
Hours of instruction	20
CFU	2
Year/Semester	Second/First
Tentative Calendar	11/03/2026: 14:30-17:30 13/03/2026: 10:00-13:00 17/03/2026: 14:30-17:30 19/03/2026: 09:00-12:00 25/03/2026: 14:30-17:30 27/03/2026: 10:00-13:00 01/04/2026: 14:30-17:30
SUMMARY /GOAL	The course aims to provide an overview of basic principles of particle physics and of the main detectors used for space applications. Moreover, the explanation of the environmental verification strategy aims to give the students a complete overview of the steps needed to take a detector from construction to a correct on-orbit operation.
Syllabus	Basic elements of particle physics. Interaction of charged particles and photons with matter. Generalities on astroparticle physics. Detectors for space applications: scintillators, photon detectors, silicon detectors. Environmental verification strategy for space detectors: qualifica-tion and acceptance. Structural and mechanical verification re-quirements. Sinusoidal sweep vibration test, random vibration test, acoustic tests, mechanical shock tests. Electromagnetic com-patibility requirements. Vacuum, thermal and humidity verifica-tion requirements. Thermal balance, thermal vacuum, tempera-ture- humidity verification.
Bibliography	Glenn F. Knoll, Radiation detection and measurements
Examination method	Oral discussion/presentation
Room	On-site / Microsoft Teams Dipartimento Interateneo di Fisica “M.Merlin”, Saletta riunioni, primo piano Generale | High-energy particle physics instruments and methods for space environment PhD course | Microsoft Teams

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DRISA

Course title	Hydraulics for Aircraft
Lecturer	
Scientific Discipline Sector	IIND-06/A
Hours of instruction	20
CFU	2
Year	Second
Tentative Calendar	
SUMMARY /GOAL	The course will enable PhD students to gain knowledge about conventional and novel hydraulic systems employed in aircraft for fuel metering and for flight control. In addition, students will master Simulink simulations of these systems. The acquired knowledge can be transferred to the study and simulation of hydraulic components and systems employed in industry and in the transportation sector.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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Course title	Hypersonic aerothermodynamics modelling and simulation
Lecturer	Francesco Bonelli
Scientific Discipline Sector	IIND-01/F
Hours of instruction	20
CFU	2
Year/Semester	Second/Second
Tentative Calendar	05/05/2026: 15.30-18:00 12/05/2026: 15.30-18:00 19/05/2026: 15.30-18:00 26/05/2026: 15.30-18:00 04/06/2026: 15.30-18:00 09/06/2026: 15.30-18:00 16/06/2026: 15.30-18:00 23/06/2026: 15.30-18:00
SUMMARY /GOAL	The aim of the course is to provide fundamentals of the physics, chemistry, and gas dynamics of high-temperature gases in the context of hypersonic flows. The course provides an introduction to gas dynamics of high temperature gases with a specific emphasis to thermochemical non-equilibrium and gas surface interactions with examples of accurate numerical simulations.
Syllabus	**(4h) Introduction to hypersonic flows and short review of basic gas dynamics:** definition of hypersonic flow; Knudsen number, flow regimes and governing equations; quasi-one-dimensional flow, area Mach number relation, normal shock waves, oblique shock, and expansion waves. **(8h) Properties of high-temperature gases**: microscopic description of gases, Boltzmann distribution, thermal and chemical non-equilibrium: classical multi-temperature model and introduction to State-to-State approaches. **(3h) Gas dynamics of high-temperature flows:** quasi-one-dimensional flow, normal shock waves, speed of sound, oblique shock and expansion waves. **(3h) Gas surface interactions:** catalytic and ablation phenomena. **(2h) Overview of Computational Fluid Dynamics approaches for hypersonic flows and numerical examples.**
Bibliography	John D. Anderson J. “Hypersonic and High Temperature Gas Dynamics”, 2nd Ed 2006, AIAA Education Series “Plasma

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	Modeling - Methods and applications", Edited by G. Colonna and A. D'Angola, 2nd Ed 2022, IOP Series in Plasma Physics
Examination method	The exam will take place through an interview on a specific topic as-signed to the student
Room	On-site: aula riunioni al secondo piano della sezione mecca-nica del DMMM

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DRISA

Course title	Identification and propagation of optical photons in different media
Lecturer	Francesca Romana Pantaleo
Scientific Discipline Sector	PHYS-01/A , PHYS-03/A
Hours of instruction	20
CFU	2
Year	Second
Tentative Calendar	
SUMMARY /GOAL	The course aims to provide the student with advanced knowledge of radiation measurements and detection techniques, from classic scintillation detectors to Silicon Photomultiplier devices. Scintillator materials are widely used in particle physics for ion identification and energy measurements. Next-generation space missions will employ plastic scintillator detectors (PSDs) equipped with the new Silicon Photomultipliers (SiPMs) technology to read out the scintillator light emission. Scintillator based detectors are also widely used for radiation monitoring for environmental or industrial purposes. The course requires an elementary background in radiation measurements, radiation-matter interactions and basic electronics.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DRISA

Course title	Integrated Photonics for Space
Lecturer	Caterina Ciminelli
Scientific Discipline Sector	IINF-01/A
Hours of instruction	20
CFU	2
Year	Second
Tentative Calendar	
SUMMARY /GOAL	The course aims to provide an overview of some of the recent technologies related to integrated photonics for space applications. Participants will acquire the related knowledge through theoretical lectures and application examples.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DRISA

Course title	Introduction to space flights
Lecturer	Francesco Santoro
Scientific Discipline Sector	IIND-01/E– IEGE-01/A
Hours of instruction	20
CFU	2
Year	Second
Tentative Calendar	
SUMMARY /GOAL	The purpose of this class is to provide students with a wide range of topics relevant to specific aspects of spaceflight. The class will be integrated with on spot lectures by astronauts, industry/agency representatives who will provide an overview of their experience, functional to the class objectives.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DRISA

Course title	Optical communications for space
Lecturer	Ilaria Marasco
Scientific Discipline Sector	IINF-02/A
Hours of instruction	20
CFU	2
Year/Semester	Second/Second
Tentative Calendar	05/05/2026: 10.30-13:00 07/05/2026: 10.30-13:00 12/05/2026: 10.30-13:00 14/05/2026: 10.30-13:00 19/05/2026: 10.30-13:00 21/05/2026: 10.30-13:00 26/05/2026: 10.30-13:00 28/05/2026: 10.30-13:00
SUMMARY /GOAL	The course aims to provide an overview of some of the recent technologies related to optical/photonic communication for space. Participants will acquire the related knowledge through theoretical lectures and numerical examples.
Syllabus	• Communications in free space; • Satellites communications with optical links; • Metasurfaces and periodic structures for beam steering; • LIDAR principles; • Laboratory activities.
Bibliography	Scientific papers and books on the selected arguments will be used as reference
Examination method	A synthetic report on a chosen topic or PP presentation
Room	On-site / Microsoft Teams The course will be online on Teams with some activies in the Integrated Optics Lab (DEI II floor) Generale | 2025/26 - PhD Course: Optical communications for space | Microsoft Teams

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DRISA

Course title	Space Commercialization
Lecturer	
Scientific Discipline Sector	IEGE-01/A
Hours of instruction	20
CFU	2
Year	Second
Tentative Calendar	
SUMMARY /GOAL	The aim of the course is to develop knowledge about the market challenges and the business opportunities offered to the new generation of European space entrepreneurs by the emerging space economy.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DRISA

Course title	Space Economy: past, present, future
Lecturer	Roberto vittori
Scientific Discipline Sector	IEGE-01/A
Hours of instruction	20
CFU	2
Year	Second
Tentative Calendar	
SUMMARY /GOAL	The objectives of the course are: i) to explain the evolution of the space industry since its inception; ii) to recognize the current trends and challenges of the space sector; iii) to identify humanity's short-term and long-term future ambitions in space, iv) to outline the role of Italy and Europe in the global Space Economy.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DRISA

Course title	Space Logistics
Lecturer	Leonardo Amoruso
Scientific Discipline Sector	IEGE-01/A
Hours of instruction	20
CFU	2
Year/Semester	Second/Second
Tentative Calendar	To be provided
SUMMARY /GOAL	The aim of the course is to provide comprehensive introductory knowledge about the theory, practice, and advanced ideas of implementing space system design to guarantee operability and supportability, and on the management of the flow of materials, technologies, services, and information needed throughout a space system lifecycle.
Syllabus	• Overview of the course: objectives and structure • Introductory Concepts and Historical Elements (1 hour) • Classes of Supply (COS) for the Logistics of different areas of space application (4 hours): • Focus: Space Station on-orbit resources management (2 hours) • Focus: Spaceport ground processing and launch logistics (2 hours) • Advanced Space Logistics Infrastructures: (3 hours) o solar power stations, o on-orbit fuel depots, o reusable vehicles, o planetary or asteroid resource infrastructures • Advanced Supportability Concepts: (2 hours) o In-space Servicing, Assembly, and Manufacturing (ISAM), o flight hardware scavenging and reuse, o resource pre-positioning o consumables recycling. • Advanced Destination Logistics: (2 hours) o outpost management and provisioning, o in-situ resource logistics, o EVA logistics. • Commercial space logistics opportunities (1 hour)

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	• Project work: In-class design of a space logistic infrastructure (approx. 3 hours)
Bibliography	To be provided
Examination method	Project work evaluation
Room	On-site / Microsoft Teams

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DRISA

Course title	Spacecraft Structural Dynamics & Loads
Lecturer	Adriano Calvi
Scientific Discipline Sector	IIND-01/D
Hours of instruction	20
CFU	2
Year	Second
Tentative Calendar	
SUMMARY /GOAL	The course aims to explain basic notions as well as some advanced concepts about structural dynamics and its importance in the development of the spacecraft structures (design, analysis, and test). Both numerical methods and experimental results will be presented.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DRISS

Course title	Analysis and management of heritage buildings: efficiency and innovative technologies
Lecturer	Paola Lassandro
Scientific Discipline Sector	CEAR-08/A – CEAR-08/C
Hours of instruction	20
CFU	2 (Modulo A: 1 CEAR-08/A + Modulo B: 1 CEAR-08/C)
Year	Second
Tentative Calendar	
SUMMARY /GOAL	This course will explore the concepts of efficiency in historic buildings, highlighting the role of innovative technologies in improving building performance from building decarbonization perspective. Furthermore the module provides a general overview of the methodological workflow supporting the assessment and control of performances, risk vulnerabilities and pathologies in traditional and modern heritage buildings, with specific focus toward onsite non-destructive survey, diagnostics and monitoring techniques, as well as emerging solutions for data processing and management. In detail, theoretical contents, experimental applications and international research experiences and studies will address the following specific topics: ▪ The diagnostic process: conceptual, operational and normative framework; ▪ Onsite investigation of masonry, reinforced concrete and timber building components: methods, techniques and operation protocols; ▪ Digital 2D/3D reality-based models for decay mapping and monitoring, multi-spectral imaging and multi-sensory data collection: research trends and relevant application. Collaborative virtual platforms for data collection, analysis and management: WebGIS, BIM, VR/AR.
Syllabus	
Bibliography	
Examination method	

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Room	On-site / Microsoft Teams

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DRISS

Course title	Bridges and critical infrastructures: seismic risk and wind-structure interaction
Lecturer	Fabio Rizzo
Scientific Discipline Sector	CEAR-07/A
Hours of instruction	20
CFU	2
Year	Second
Tentative Calendar	
SUMMARY /GOAL	This course aims to investigate the structural response of bridges and high-rise buildings under the simultaneous action of wind flow and seismic impulse. The main goal is to estimate the multi-hazard effects on flexible structures, the seismic and wind actions. The calculation of the induced vibration and the comfort limits for users and occupants will be discussed.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DRISS

Course title	Characterization and modeling of light alloys
Lecturer	Angela Cusanno
Scientific Discipline Sector	IIND-04/A
Hours of instruction	20
CFU	2
Year/Semester	Second/Second
Tentative Calendar	16/06/2026: 09.00-13:00 17/06/2026: 09.00-13:00 18/06/2026: 09.00-13:00 24/06/2026: 09.00-13:00 25/06/2026: 09.00-13:00
SUMMARY /GOAL	This course will be focused on the main experimental methodologies for the technological characterization of light alloys for automotive/aerospace/biomedical applications.
Syllabus	1. Introduction to sheet metal forming processes to produce lightweight components: overview of lightweight alloys, conventional and innovative sheet metal forming processes 2. Methodologies for characterization: mechanical characterization methods for cold and warm/hot forming processes 3. Evaluation of light alloys forming limits: Nakajima and Marciniak tests, bulge tests 4. Hands-on activities: Performing mechanical tests studied during the course on a light alloy, obtaining the mechanical properties of the alloy from experimental data
Bibliography	I. Polmear, D. StJohn, J. Nie, M. Qian, Light Alloys (Fifth Edition), Butterworth-Heinemann, 2017, ISBN 9780080994314 Z. Marciniak, J.L. Duncan, S.J. Hu, Mechanics of Sheet Metal Forming (Second Edition), Butterworth-Heinemann, 2002, ISBN 9780750653008
Examination method	Performing one of the experimental mechanical tests studied, along with general questions covering the syllabus
Room	On-site Laboratorio di Advanced Forming & Manufacturing, Sede Japigia DMMM

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DRISS

Course title	Dynamic identification and structural monitoring: fundamentals and applications to wind turbines Modulo A (part one of two)
Lecturer	Natalia Pinchuk
Scientific Discipline Sector	CEAR-06/A – CEAR-07/A
Hours of instruction	10
CFU	1 (Modulo A: 1 CFU CEAR-06/A + Modulo B: 1 CFU CEAR-07/A)
Year	Second
Tentative Calendar	
SUMMARY /GOAL	This course concerns experimental investigations of the structural response of wind turbines, in order to calibrate models for structural analysis under dynamic loads, like wind and seismic actions, and to investigate the structural health of those structures. Applicative issues will be introduced by theoretical and experimental fundamentals.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DRISS

Course title	Dynamic identification and structural monitoring: fundamentals and applications to wind turbines Modulo B (part two of 2)
Lecturer	Dora Foti
Scientific Discipline Sector	CEAR-06/A – CEAR-07/A
Hours of instruction	10
CFU	1 (Modulo A: 1 CFU CEAR-06/A + Modulo B: 1 CFU CEAR-07/A)
Year	Second
Tentative Calendar	
SUMMARY /GOAL	This course concerns experimental investigations of the structural response of wind turbines, in order to calibrate models for structural analysis under dynamic loads, like wind and seismic actions, and to investigate the structural health of those structures. Applicative issues will be introduced by theoretical and experimental fundamentals.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DRISS

Course title	Indoor comfort evaluation
Lecturer	Francesco Martellott
Scientific Discipline Sector	IIND-07/B
Hours of instruction	20
CFU	2
Year	Second
Tentative Calendar	
SUMMARY /GOAL	The course will provide an introduction to the basic principles of indoor environment quality including thermal, visual, acoustic comfort as well as indoor air quality. After a brief introduction on the subjective/physiological parameters and their objective counterparts, a quick tutorial on measurement techniques will be provided.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DRISS

Course title	Mechanical models for masonry structures
Lecturer	Aguinaldo Fraddosio
Scientific Discipline Sector	CEAR-06/A
Hours of instruction	20
CFU	2
Year	Second
Tentative Calendar	
SUMMARY /GOAL	Although masonry constructions represent the vast majority of the architectural heritage, to date the scientific community is still wondering about the definition of the most appropriate structural models, especially for the analysis of complex structures (arches, vaults, domes) and for the study of the effects of seismic actions. This course will offer to the Ph.D. students a state-of-the-art review of mechanical models for masonry structures, also giving suggestions for new research directions to be followed.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DRISS

Course title	Numerical and heat transfer challenges in Thermal Energy storage
Lecturer	Aminhossein Jahanbin
Scientific Discipline Sector	IIND-07/A – IIND-06/A
Hours of instruction	20
CFU	2 (Modulo A: 1 ING-IND08 + Modulo B: 1 IIND-07/B)
Year/Semester	Second/First
Tentative Calendar	23/04/2026: 15:00 – 17:00 28/04/2026: 14:00 – 17:00 30/04/2026: 14:00 – 17:00 04/05/2026: 14:00 – 17:00 07/05/2026: 14:00 – 17:00 11/05/2026: 14:00 – 17:00 13/05/2026: 14:00 – 17:00
SUMMARY /GOAL	Decarbonization is a crucial step towards a sustainable future, and renewable energy plays a vital role in enabling this transition. However, the intermittency of sources such as wind and solar energy necessitates the use of efficient energy storage systems. This course introduces various energy storage technologies and examines the role of thermal energy storage within the broader energy storage landscape. Different types of thermal energy storage systems are analyzed in detail, with emphasis on heat transfer challenges, efficiency considerations, and dynamics during charging and discharging processes. Advanced numerical modelling approaches are presented and applied through research-oriented case studies, using computational tools for system-level analysis and optimization.
Syllabus	
Bibliography	
Examination method	Presentation and discussion on a selected topic
Room	Microsoft Teams Numerical and heat transfer challenges in Thermal Energy storage

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DRISS

Course title	Resilient and secure (historic) built environment in a multi-hazard perspective
Lecturer	Elena Cantatore
Scientific Discipline Sector	CEAR-08/A
Hours of instruction	20
CFU	2
Year	Second
Tentative Calendar	
SUMMARY /GOAL	The course will focus on a general overview of theories about risk assessment in single and multi-risk scenarios – both synchronous and asynchronous – in order to provide a practical toolkit to PhD students for understanding and analyzing the multi-vulnerabilities of the historic built environment (e.g., urban historic districts). Starting from the study of international normative and scientific background, the module will provide: ▪ Introduction on the meaning of risk and its assessment for the built environment, coherently with the theories of the "secure and resilient cities"; ▪ Operative methods to study the occurrence of natural and anthropic hazards (e.g., phenomenological analysis of historical events or onsite measurements); ▪ Strategies and tools for the study of combinations of actions or effects in multi-risk scenarios. Digitalization of knowledge for the risk communication of the built environment (GIS-based, VR-based) towards decision-supporting systems.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DRISS

Course title	Seismic risk of reinforced concrete buildings: innovative modeling, analysis, and mitigation strategies
Lecturer	
Scientific Discipline Sector	CEAR-07/A
Hours of instruction	20
CFU	2
Year	Second
Tentative Calendar	
SUMMARY /GOAL	This course aims to investigate the reinforced concrete response of some cases study. The structural response of reinforced concrete buildings will predict through Machine Learning applications. In particular, Matlab algorithms and Straus software will be used and discussed in this course. This approach will be discussed.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DRISS

Course title	Smart buildings
Lecturer	Roberto Stasi
Scientific Discipline Sector	IIND-07/B
Hours of instruction	20
CFU	2
Year/Semester	Second/Second
Tentative Calendar	10/06/2026: 10.30-13:30 12/06/2026: 10.30-13:30 17/06/2026: 10.30-13:30 19/06/2026: 10.30-13:30 24/06/2026: 10.30-13:30 26/06/2026: 10.30-13:30 27/06/2026: 10.30-12:30
SUMMARY /GOAL	Smart zero energy buildings combine energy efficiency measures and renewable energy generation to consume only as much energy as can be produced onsite through renewable resources over a specified time period. This course aims to provide participants with a comprehensive understanding of smart building technologies, their applications, and the role they play in creating sustainable, energy-efficient, and interconnected building systems. Participants will gain hands-on experience with smart systems and learn how to integrate, manage, and optimize building functions using modern technologies.
Syllabus	1. Fundamentals of Building Physics and Energy Systems • Overview of heat transfer mechanisms • Overview of psychrometrics and HVAC systems • Overview of thermal comfort, indoor air quality (IAQ) and indoor environmental quality (IEQ) 2. Introduction to Smart Buildings • Overview of smart buildings and key components • Evolution of building automation and control systems • Case studies: Smart buildings around the world • Introduction to SRI and EN ISO 52120-1:2022 3. Smart building technologies and protocols

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	• Benefits of smart buildings: energy efficiency, sustainability, occupant comfort, and operational efficiency • Smart HVAC systems: optimizing heating, ventilation, and air conditioning systems in buildings • Smart lighting systems: energy-efficient lighting solutions with occupancy sensor • Facility management software: centralised control systems (BMS/BAS) • Communication protocols: BACnet, Zigbee, KNX, Z-Wave, etc. • Occupant-centric building management: user experience, personalisation, and adaptability 4. Hands-on design exercise: Creating a smart building blueprint, focusing on integrating smart systems (lighting, HVAC, RES) with energy-saving measures.
Bibliography	• Marco Casini, "Smart Buildings: Advanced Materials and Nanotechnology to Improve Energy-Efficiency and Environmental Performance", Woodhead Publishing • Tatari, M.; Agarwal, P.; Alam, M.A.; Ahmed, J. Review of Smart Building Management System. Lecture Notes in Networks and Systems 2022, 321, 167–176, doi:10.1007/978-981-16-5987-4_18. • Sinopoli, J. Smart Buildings Systems for Architects, Owners and Builders. 2009, 1–231, doi:10.1016/C2009-0-20023-7. • Anu Prakash, Ashish Shrivastava, Anuradha Tomar, "Control of Smart Buildings", 2022. doi:10.1007/978-981-19-0375-5.
Examination method	End-course examination based on a final written test or a project work, which involves applying the learned concepts and techniques to a real-world problem.
Room	On-site / Microsoft Teams Generale | Scudo - Smart Buildings 2025-2026 | Microsoft Teams

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DRSATE

Course title	Advanced Probabilistic Methods For The Reliability Analysis In Structural Engineering Problems
Lecturer	Andrea Nettis
Scientific Discipline Sector	CEAR-07/A
Hours of instruction	20
CFU	2
Year	Second
Tentative Calendar	
SUMMARY /GOAL	Introduction of elements of probability theory applied to structural and earthquake engineering: In the first part, basic elements and references about the common procedures adopted in the structural engineering are provided, accounting, in particular, the case of seismic actions. According to the recent scientific literature, the course will provide an overview about seismic demand quantification, conceptual design, mechanical and geometrical parameters configuration of the buildings, numerical modelling through finite element approaches, linear and nonlinear analyses. Within this framework, the discussion will focus on the basic concepts of probability theory applied to structural engineering, starting from the definition of random variables, statistics and sampling, regression analyses, appropriateness of fit tests, estimation of distribution parameters, testing of hypotheses and related significance. The probabilistic approach of Performance Based Earthquake Engineering (PBEE): In this part, the main limits of deterministic approaches, as commonly used by practitioners, will be highlighted, and the approach of PBEE will be formally presented. Within this framework, all aspects covered by the PBEE will be faced, accounting for the probabilistic study of seismic demand (through the definition of the probabilistic seismic hazard analysis), structural analysis (through the definition of modelling and analysis methods, such as Incremental Dynamic Analysis - IDA, Multi Stripes Analysis and cloud analysis), damage analysis (through the definition of the fragility curves by using articulated and simplified tools) and loss analysis (through the definition of the losses curves by using articulated and simplified tools) (8 hours). Practical ex-

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	amples of PBEE and applications in different fields of civil engineering: Based on the previous concepts, some applications of PBEE to the analysis of Reinforced Concrete (RC) buildings will be shown, with a specific reference to the most useful numerical tools presently available (from the simplest to the most sophisticated).
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DRSATE

Course title	Advances in Geomatic Engineering
Lecturer	Alberico Sonnessa
Scientific Discipline Sector	CEAR-04/A
Hours of instruction	20
CFU	2
Year	Second
Tentative Calendar	
SUMMARY /GOAL	Recent advances in space (satellite) technology, computing (software and hardware) technology and Geomatic engineering instrumentation technology have had a revolutionary impact on the practice of many engineering fields. The goal of this course is to provide the students the theoretical background and knowledge necessary to manage modern complex geospatial information and technology. The lectures will deal with the following research areas: Multimedia cartography and information delivery; Geospatial Information Science and Geographic Databases; Geospatial Web and Big Data; Technologies and methods in Remote Sensing (proximal/drone/aerial/satellite platforms); Survey and 2D/3D geospatial data processing; Geospatial data modelling and analysis. The advanced topics may serve as an introduction to research skills that may be useful at multidisciplinary level.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DRSATE

Course title	Cutting-edge Nanomaterials for Advanced Technologies
Lecturer	Chiara Lo Porto
Scientific Discipline Sector	CHEM-06/A
Hours of instruction	10
CFU	1
Year/Semester	Second/First
Tentative Calendar	13/03/2026: 11:00-13:00 27/03/2026: 11:00-13:00 10/04/2026: 11:00-13:00 15/05/2026: 11:00-13:00 29/05/2026: 11:00-13:00
SUMMARY /GOAL	The Cutting-edge Nanomaterials for Advanced Technologies course (1) aims to offer a knowledge base in the field of nanomaterials applied to technologies. The training objective is the understanding of the basic principles and key methodologies in the synthesis, characterization and technological applications of nanostructured materials, to stimulate research in the various emerging sectors of nanotechnology, and also considering the regulatory aspects linked to their use on the environment and human health. Topics overview: • Introduction to Nanochemistry: History and Fundamental Properties. • Synthesis of Nanostructured Materials. • Advanced Characterization of Nanomaterials. • Design and Applications of Nanomaterials for the Environmental Sector, Electronics and Construction Industries, the Textile Sector, and Medicine. Safety and Regulatory Aspects of Nanomaterials.
Syllabus	
Bibliography	
Examination method	
Room	Microsoft Teams General | Cutting-edge nanomaterials for advanced technologies a.a. 2025/2026 | Microsoft Teams

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DRSATE

Course title	How to build an ontology that lasts for design matters: Lab.
Lecturer	
Scientific Discipline Sector	CEAR-12/A
Hours of instruction	10
CFU	1
Year	Second
Tentative Calendar	
SUMMARY /GOAL	The course aims to develop models to build ontological representations of knowledge, applied in particular to Town and Country Planning (Planificazione urbanistica e territoriale) and Territory Engineering (Ingegneria del territorio). Lessons learned from recent Poliba research, such as the monastery as an architectonical type and urban square as a physical and social place, will be retrieved and discussed. As a whole, the program is focused on: (i) a brief introduction recalling basic aspects of theory; (ii) examples and exercises for application to each studied disciplines, particularly to Town and Country Planning and Territory Engineering. In this lab course each student will be asked to develop a work concerning the application of theoretical topics to a specific case, which can be identified at their choice among the topics of their doctoral course.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DRSATE

Course title	Laser scanning for architectural surveying. Techniques and applications
Lecturer	Anna Christiana Maiorano
Scientific Discipline Sector	CEAR-10/A
Hours of instruction	10
CFU	1
Year	Second
Tentative Calendar	
SUMMARY /GOAL	This course provides a comprehensive overview of modern architectural surveying techniques, with emphasis on laser scanning and point cloud management. The goal is to transfer practical skills and knowledge applicable to real projects in the field of architectural heritage. Initially, the lecture covers the fundamentals of architectural surveying, comparing traditional methods with digital advances. Then, laser scanning, details of LiDAR technology, photogrammetry, and various applications in engineering, architecture, cultural heritage, reverse engineering, and public safety are explored. The different types of laser scanners and their principles of operation, particularly phase-shift scanners, are examined. The course also delves into point clouds, discussing their basic concepts, creation with laser equipment, and alignment using Autodesk Recap software. Data processing techniques such as filtering, decimation and AI segmentation are covered. The program concludes with an interactive final project in which participants plan and conduct a laser survey, acquire and process data, and extract architectural elements. This hands-on component reinforces the practical application of the skills learned.
Syllabus	
Bibliography	
Examination method	

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Room	On-site / Microsoft Teams

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DRSATE

Course title	Life Cycle Assessment for buildings
Lecturer	Carmine Cavalliere
Scientific Discipline Sector	CEAR-08/B
Hours of instruction	10
CFU	1
Year/Semester	Second/Second
Tentative Calendar	07/05/2026: 16.30-19:00 14/05/2026: 16.30-19:00 21/05/2026: 16.30-19:00 28/05/2026: 16.30-19:00
SUMMARY /GOAL	The aim of the course is to provide students with the knowledge of understanding the impact of the construction sector on the environment, the need for building sustainability, and the regulations driving them. Then the students will learn about the core concepts of LCA, including building life-cycle stages and environmental impact assessment. Finally, the third part of the course will provide students with a hands-on experience of modelling techniques and tools to simulate a LCA of a case study building. The assessment will be based on the modelling of a selected case study and on the analysis of the effects of different adaptation technologies.
Syllabus	
Bibliography	Scientific papers, slides and support material from lecturer.
Examination method	Oral discussion
Room	On-site / Microsoft Teams

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DRSATE

Course title	Soil-atmosphere interaction and slope stability: processes and numerical modelling
Lecturer	Pasquale Perrini
Scientific Discipline Sector	CEAR-01/B e CEAR-05/A
Hours of instruction	20
CFU	2
Year	Second
Tentative Calendar	
SUMMARY /GOAL	Recently the scientific literature has highlighted that climatic factors such as rainfall rate, net solar radiation, relative humidity, wind speed and air temperature determine a set of coupled phenomena, controlling both the skeleton of the soil and the pore fluids in the slope. Such phenomena, on the whole referred to as the 'soil–atmosphere' interaction, can differ in their nature (thermodynamic, hydraulic, mechanical and chemical) and strongly impact the balances of both the liquid and gas masses in the soil pores and the energy balance of the system. The corresponding transient seepage generates – from the ground surface to depth in the slope – variations of the effective stresses and the available shear strengths over time, which in turn impact slope stability. On the whole, the soil–atmosphere interaction at the slope top boundary, together with the processes that it determines in the slope at any depth, represent the 'slope–atmosphere' interaction. Multiple examples of weather-induced deep landslide mechanisms can be found in the Southern Apennines (Italy), which represents a pilot areas where the scientific research is still ongoing. This course will deals with transport processes at the interface between atmosphere and the soil, focussing on the exchange of energy and water between the soil and the lower part of the atmosphere. In particular, different numerical strategies, with different level of coupling, to solve the thermal, hydraulic, and mechanical processes within the soil-vegetation-atmosphere interaction will be presented to simulate and predict water and energy fluxes. Particular reference will be made to risk mitigation, with also the aim to check if such modelling strategies may be of use to design an

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	early warning system to reduce the risk related to landsliding and / or flooding.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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DRSATE

Course title	Sustainable Technologies for Circular Economy in Waste Management
Lecturer	Francesco Todaro
Scientific Discipline Sector	IMAT-01/A
Hours of instruction	20
CFU	2
Year	Second
Tentative Calendar	
SUMMARY /GOAL	Today's linear economic model (take-make-dispose) is wasteful and unsustainable. In a circular economy, the maximum value is extracted from resources in use, then products and materials are recovered and regenerated at the end of each service life. The transition from a linear economy to a circular economy is currently one of the biggest challenges in the field of waste management. In this perspective, the aim of this course is to develop scientific and technical aspects on the closing the loop of both urban and industrial waste. The goal is to ensure PhD students obtain a solid background in environmental technologies, with competencies for designing and tailoring new waste management systems, and with a specific view to the sustainability of processes and technologies. The course is developed on principles of Circular Economy and Sustainable Development, on circularity as a tool for saving non-renewable raw materials and reducing the waste production. In particular, the lessons discuss basic scientific principles and recent technological advances in current strategies for resource recovery from waste (for example: recycling of dry waste and composting of organic waste). Also, the course presents solutions to pressing problems associated with waste management and treatment, as well as the health impacts created by improper waste disposal and pollution. The major topics covered by the course are: 1) circular economy and sustainability: basics and application; 2) closing the loop: the circularity as a tool for saving raw material and natural resources

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	and to reduce waste production; 3) industrial symbiosis and urban mining definition; 4) recovery and recycling of industrial and urban waste; 5) innovative and sustainable technologies: pre-treatment and selection, mechanical-biological treatment, energy recovery, disposal in landfills; 6) use of secondary raw materials.
Syllabus	
Bibliography	
Examination method	
Room	On-site / Microsoft Teams

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SSI

Course title	Energy storage
Lecturer	
Scientific Discipline Sector	IIND-06/A
Hours of instruction	20
CFU	2
Year	Second
Tentative Calendar	
SUMMARY /GOAL	The course addresses the topic of energy storage with a multidisciplinary approach, analyzing the differences between thermal and electrical storage from a global perspective
Syllabus	This course examines different energy storage technologies, empowering the reader to make informed decisions on which system is best suited for their specific needs. Decarbonization is a crucial step towards a sustainable future, and renewable energy plays a vital role in making this transition possible. However, the intermittency of some sources such as wind and solar energy requires the use of energy storage systems. The course contains a detailed study of the fundamental principles of energy storage operation, a mathematical model for real-time state-of-charge analysis, and a technical analysis of the latest research trends, providing a comprehensive guide to energy storage systems. From battery storage systems to hydrogen storage systems, this course provides the tools to effectively manage energy and ensure that excess energy is utilized during times of deficit and signposts the likely future development and lines of research enquiry for each technology discussed.
Bibliography	Energy Storage Systems: Fundamentals, Classification and a Technical Comparative, José Manuel Andújar Márquez, Francisca Segura Manzano, Jesús Rey Luengo
Examination method	Written
Room	On-site / Microsoft Teams

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SSI

Course title	Microgrid structures and operation
Lecturer	Giuseppe Forte
Scientific Discipline Sector	IIND-08/B
Hours of instruction	20
CFU	2
Year	Second
Tentative Calendar	
SUMMARY /GOAL	The aim of the course is to describe the methodologies and procedures for planning, managing and controlling multi-energy microgrids, in AC or DC configurations, in grid-connected and islanded modes. Control and supervision of an MG is carried out by a SCADA system that, through proper Energy Management System (EMS), can optimize operation and reliability.
Syllabus	Smart grids and microgrids Planning, management and operation of microgrids in the presence of electric and thermal demand The role of microgrids in markets and enhanced grid integration through ancillary services Design, programming and control of DC microgrid for supplying electric vehicles Experiences on experimental microgrid management and operation.
Bibliography	Scientific papers and books on the selected arguments.
Examination method	A synthetic report on a chosen topic.
Room	On-site / Microsoft Teams

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SSI

Course title	Microwave Photonics for Smart Systems
Lecturer	Giuseppe Brunetti
Scientific Discipline Sector	IINF-01/A
Hours of instruction	20
CFU	2
Year	Second
Tentative Calendar	
SUMMARY /GOAL	Microwave photonics is an important interdisciplinary field that, among a host of other benefits, enables engineers to implement new functions in microwave systems. From an educational perspective, the fields of microwave engineering and photonics are often taught in separate courses. This course aims to provide both a theoretical and practical introduction to microwave photonics devices and applications. The first part is on microwave photonics principles and technologies, with a focus on applications and future developments. The second part is a laboratory and aims to prepare students for the final project. It will be shown how to design a simple component, following all the steps from the choice of technological platform to software simulations.
Syllabus	Opening with an overview to the subject, this course covers direct modulation, photonic oscillators for THz signal generation, and terahertz sources. It takes a unique application-focused approach and describes: • Advantages with respect to standard RF technologies; • Basic building blocks; • Design criteria; • Microwave photonic signal processing for Space applications; Biomedical applications.
Bibliography	Slides provided during the lessons
Examination method	Final project
Room	On-site / Microsoft Teams

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SSI

Course title	Nanotechnologies for energy transition
Lecturer	Umberto Berardi
Scientific Discipline Sector	IIND-07/B
Hours of instruction	20
CFU	2
Year	Second
Tentative Calendar	
SUMMARY /GOAL	This course gives a comprehensive overview of nanotechnology for design engineers working in the energy transition.
Syllabus	This course gives a comprehensive overview of nanotechnology for design engineers. It introduces students to how materials' fundamental physical, electrical, and optical properties change on the nanoscale compared to their bulk counterparts. The methods used to fabricate nanomaterials will be discussed with the physics and chemistry underpinning their extraordinary complexities, empowering students to tailor nanomaterial properties and deduce design principles guiding nanotechnology applications.
Bibliography	Nanotechnology and Nanomaterials for Energy Authors: Pierre Camille Lacaze, Jean-Christophe Lacroix ISBN:9781786304971
Examination method	Written
Room	On-site / Microsoft Teams

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SSI

Course title	NIR and MIR laser coupling with fibers
Lecturer	Mariagrazia Olivieri
Scientific Discipline Sector	PHYS-01/A , PHYS-03/A– PHYS-03/A , PHYS-04/A - PHYS-06/A
Hours of instruction	20
CFU	2
Year/Semester	Second/Second
Tentative Calendar	21/05/2026: 10:00-13:00 22/05/2026: 10:00-13:00 25/05/2026: 10:00-13:00 26/05/2026: 10:00-13:00 27/05/2026: 10:00-13:00 28/05/2026: 10:00-13:00 29/05/2026: 10:00-12:00
SUMMARY /GOAL	The goal of the course is to provide students with the basic concepts of how light is guided in optical fibers and how their structure can be optimized to guide near-infrared (NIR) and mid-infrared (MIR) sources.
Syllabus	1. Step-Index Waveguides: starting from the scalar Helmholtz equation, hybrid modes HE and EH will be derived in solid core waveguides. 2. Hollow Core Waveguides: the propagation of light in void structure will be analyzed, focusing on the several materials employed to realize hollow core waveguides. 3. Simulation of Solid and Hollow Core Waveguides: solid and hollow core waveguides will be simulated with COMSOL. 4. Laboratory activity: realization of an optical setup for alignment of laser sources with hollow core fibers and measurement of the beam profile of NIR and MIR-coupled sources.
Bibliography	Clifford R. Pollock, Michal Lipson - Integrated Photonics (2003, Springer) Xingcun Colin Tong - Advanced Materials for Integrated Optical Waveguides (2014, Springer)
Examination method	Report on laboratory activity
Room	On-site / Microsoft Teams

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SSI

Course title	Photonics for Industry 4.0
Lecturer	Giovanni Magno
Scientific Discipline Sector	IINF-02/A
Hours of instruction	20
CFU	2
Year/Semester	Second/Second
Tentative Calendar	19/06/2026: 10.30-13:00 26/06/2026: 10.30-13:00 26/06/2026: 15.00-17:30 03/07/2026: 10.30-13:00 03/07/2026: 15.00-17:30 10/07/2026: 10.30-13:00 10/07/2026: 15.00-17:30 17/07/2026: 10.30-13:00
SUMMARY /GOAL	The course focuses on the different photonic technologies that are utilized in advanced manufacturing and high-performance communication within the Smart Industry. Participants will gain knowledge about recent photonic technologies for the Smart Industry and beyond, as well as the use of microcontrollers in creating basic lidar-type devices. The course will comprise theoretical lectures and hands-on workshops conducted in small groups, which will encourage active participation and collaborative problem-solving.
Syllabus	• Introduction to Photonic applications in Industry 4.0 and beyond. • Light Detection and ranging principles and applications. • Light-based manufacturing: Laser additive and subtractive advanced fabrication. Semantic segmentation for automatic feature recognition in additive manufacturing. • Photonics for Automotive. Augmented reality principles. • Introduction to wireless optical communication, free-space optics and light fidelity (LiFi) • Arduino-like microcontrollers for smart industry • Hands-on workshops: practical realisation of a lidar-like prototype device employing Arduino microcontrollers and time-of-flight sensors for smart industry applications
Bibliography	• LiDAR technologies and systems, P. McManamon, SPIE, 2019.

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	• T. Masood and J. Egger, "Augmented Reality: Focusing on Photonics in Industry 4.0," in IEEE Journal of Selected Topics in Quantum Electronics, vol. 27, no. 6, 2021, doi: 10.1109/JSTQE.2021.3093721. • Optical Wireless Communications - An Emerging Technology, M. Uysal, C. Capsoni, Z. Ghassemlooy, A. Boucouvalas, E. Udvary, Springer International Publishing, 2016
Examination method	The exam will consist of a project work, with the completion of a prototype, that enables students in small groups to actively experiment with some aspects of the contents learned during a course.
Room	On-site Laboratorio “Grande” Micorosft Teams Photonics for Industry 4.0

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SSI

Course title	Real-time Simulation and Hardware-in-the-Loop testing for Smart Energy Systems
Lecturer	Sergio Bruno
Scientific Discipline Sector	IIND-08/B
Hours of instruction	20
CFU	2
Year/Semester	Second/First
Tentative Calendar	12/03/2026: 14:30-17:00 19/03/2026: 14:30-17:00 26/03/2026: 14:30-17:00 02/04/2026: 14:30-17:00 09/04/2026: 14:30-17:00 23/04/2026: 14:30-17:00 30/04/2026: 14:30-17:00 07/05/2026: 14:30-17:00
SUMMARY /GOAL	The course aims to give the fundamentals on the concepts of real-time simulation (RTS) and Hardware-in-the-Loop testing for applications in the fields of smart industry and smart energy systems. The students will also participate to laboratory activities where they will learn to use real-time simulation tools, prepare some basic projects and develop Hardware-in-the-Loop tests on cyber-physical systems. The lab activities will focus on applications for electrical power systems, but applications for any other engineering field can be foreseen (power electronics, mechanical, automotive, etc.).
Syllabus	Digital simulation, Real-time Simulations, Co-simulation, Geographical Distributed Co-Simulation. Classification of real-time simulation testing, Software-in-the-Loop (SIL), Hardware-in-the-Loop (HIL), Control Hardware-in-the-Loop (CHIL), Power Hardware-in-the-Loop (PHIL). Coupling methods, accuracy and stability of simulations. Modelling of an electrical power grid for real-time simulation. Coupling with physical devices. Use of communication network and Standard protocols (i.e Modbus TCP/IP). Seminars on the use of HIL/PHIL in the electrical industry. Prior knowledge of the Matlab/Simulink environment is suggested.

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Bibliography	Selected papers and books on the field.
Examination method	The participants will prepare a simple RTS project coherent with their field of expertise using the Simulink-based RT-Lab environment.
Room	On-site / Microsoft Teams Lectures will be held in the LabZERO laboratory (Officine Politecniche, via Amendola 132: https://maps.app.goo.gl/3qiJtBQkzqXNJ7YRA) Because this course is primarily lab-based, **physical attendance is highly recommended**. Students will receive support for the achievement of the Certification "OP101 - RT-LAB certification" for the use of the RT-LAB software for real-time simulation. Real-time Simulation and Hardware-in-the-Loop testing for Smart Energy Systems

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SSI

Course title	Smart energy cities
Lecturer	Umberto Berardi
Scientific Discipline Sector	IIND-07/B
Hours of instruction	20
CFU	2
Year	Second
Tentative Calendar	
SUMMARY /GOAL	The course addresses the topic of smart cities from the point of view of energy networks.
Syllabus	The focus of this course is on urban and territorial energy infrastructures and the methods that allow their design aimed at their intelligent and automated management, through supervision and control logics aimed at reducing energy consumption, ensuring greater penetration of renewable energies and their greater safety and resilience. The course includes seminars with leading companies in the energy storage sector
Bibliography	Smart Energy in the Smart City: Urban Planning for a Sustainable Future (Green Energy and Technology) Springer ISBN-10:3319809776
Examination method	Written
Room	On-site / Microsoft Teams

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SSI

Course title	Time-series databases for sensor data analysis
Lecturer	Saverio Ieva
Scientific Discipline Sector	IINF-05/A
Hours of instruction	20
CFU	2
Year/Semester	Second/First
Tentative Calendar	15/01/2026: 14.30-18:30 22/01/2026: 14.30-18:30 29/01/2026: 14.30-18:30 05/02/2026: 14.30-18:30 12/02/2026: 14.30-17:30 19/02/2026: 14.30-15:30
SUMMARY /GOAL	Despite significant advances in sensor data modeling, most of the space-time data models proposed in the past decade rely on time-stamping of collected data values, simply reusing solutions available in relational databases. The main purpose of the course is to introduce basic notions about modeling time-series information, highlighting the complexity of managing spatiotemporal data and state-of-the-art tools in this field. The course also provides theory, models and methods related to time series analysis detailing the main techniques used to extract value from raw data and to identify new useful information. Predictive analytics approaches, suitable for sensor data analysis, are described and applied to real-world case studies by means of hands-on practical exercises.
Syllabus	• Time-series database: features of time-series data - variability, seasonality, stationarity, autocorrelation; time-series modeling approach - structured data, data stream; basic geospatial data types; time-series DBMS • Processing time-series data: data visualization and monitoring solutions; predictive analytics for sensor data • Using a time-series database: collect data from sensors and systems; query time series data; visualize and manage time series data; process, analyzing and acting on time series data in real time.
Bibliography	A. Nielsen. Practical Time Series Analysis. O'Reilly Media, Inc. (2019) - ISBN: 9781492041658

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Examination method	Online evaluation form composed of 15 multiple choice questions
Room	On-site / Microsoft Teams Time-series databases for sensor data analysis

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SSI

Course title	Xtended Experiences for Smart and Sustainable Industry
Lecturer	Michele Fiorentino
Scientific Discipline Sector	IIND-03/B
Hours of instruction	20
CFU	2
Year	Second
Tentative Calendar	
SUMMARY /GOAL	Quickly introduce the researchers to the Augmented, Virtual, and Mixed technologies providing the key concepts and methods, and by a hands-on practical laboratory. A course project will be tailored according to researcher's interest. The goal is to explore and envision new and disruptive research domains, applications and experiences.
Syllabus	• Human computer Interface (HCI) history and evolution(4 h, 0.5 CFU): command line, GUI, NUI, Multimodal, Spatial (VR, AR, MR), in-body. Input devices: Physical, Virtual, Voice, Scanners, Gesture, Gaze, Electromyography, BCI. Output Devices: Output: Display, Haptic, 3D audio, Taste, and Smell. • Next-Gen interfaces (4 h, 0.5 CFU): Milgram continuum, AR vs. VR, trends, AR-enabling Technologies, Virtual-Digital combiner (Spatially Augmented Reality, Spatial see-through display, Head-up displays, Handheld Displays, Video see-through HMD, Optical see-through HMD, retinal), AR tracking, AR UI, AR applications, AR metaverse and AR ethics • Kickstart Unity3D (4 h, 0.5 CFU): Why unity, installation with Unityhub, start a new project Interface Layout, Scene-Game workflow, Playmode \ edit mode, How navigate the scene, Create\move basic geometries+ camera, Use of hierarchy, Project Explorer and asset store, Console, Save\retrieve scenes, Deployment. • Project Development (4 h, 0.5 CFU): Conceptualization, implementation, user experience validation, data collection, analysis and report.
Bibliography	• Virtual and Augmented Reality (VR/AR): Foundations and Methods of Extended Realities (XR) 1st ed. 2022 Edition

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	by Ralf Doerner (Editor), Wolfgang Broll (Editor), Paul Grimm (Editor), Bernhard Jung (Editor) • Augmented Reality: Principles and Practice (Usability) 1st Edition by Dieter Schmalstieg (Author), Tobias Hollerer (Author)
Examination method	Course Project and final presentation
Room	On-site / Microsoft Teams

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