ACADEMIC PROGRAMMES

2015-16

ENGLISH TAUGHT FULL DEGREES

SINGLE CYCLE PROGRAMME (5 - 6 YEARS)

Medicine and Surgery – Programme "F"

MASTERS PROGRAMMES (SECOND CYCLE) IN ENGLISH

Masters of Science in Advanced Economics

Masters of Science in Engineering in Artificial Intelligence and Robotics

Masters of Science in Business Management

Masters Programme in Computer Science

Masters of Science in Control Engineering

Masters Programme in Data Science

Masters Programme in Finance and Development

Masters of Science in Mechanical Engineering

Masters of Science in Product Design

Masters Degree in Transport Systems Engineering

Masters of Science in Engineering in Computer Science

COURSES TAUGHT IN ENGLISH

Faculty Of Arts And Humanities

COURSE TITLE	DESCRIPTION
▪ English Language I	▪ This course provides students with tools to analyse the English language in its various forms, including the effects that globalisation and electronic communication systems have on the language. The concept of variation (due to social class, geographic origin, age, gender, etc.) will be addressed with particular emphasis on different types of text and linguistic contexts. The goal is to develop a metalinguistic understanding of English. ▪ The course is taught in English and is open to first-year students from the degree programme in Intercultural Linguistic Mediation who have passed the English language admission test. The final evaluation will be based on a written exam, during which the use of a dictionary is permitted (mono or bilingual). For attending students, there will be a test at the end of the course. Students who do not pass the test (attending or not) will have to take the final exam as well as presenting a short essay (see the professor's news board). ▪ Lectureship: in order to acquire 12 CFUs, students must also attend and/or pass the Lector's exam (written and oral). ▪ For consulting hours and other information, please see the professor's news board: http://seai.uniroma1.it/?q=persone/wardle-mary-louise
▪ English Language III	▪ This course develops a theoretical approach to English by studying how to analyse and speak the language. In order to acquire 6 CFUs, students must attend and pass the written test with the lector and subsequently the oral exam with the professor. Students must be able to comment on various types of English texts in English (including their own lectureship examination essay) from a metalinguistic point of view. Students will have to analyse the text in terms of morphology, grammar, syntax, pragmatics, style, etc. ▪ The course is available to third-year students from the degree programme in Cultural and Linguistic Mediation who have passed the first and second year English language exams. For consulting hours and other information, please see the professor's news board: http://seai.uniroma1.it/?q=persone/wardle-mary-louise
▪ English Literature I-M	▪ Course contents: select literary history in relation to specific periods and cultural and ideological contexts; literary movements, writers, works or genres; development of analytical and philological capabilities in relation to literary texts, studying sources and genesis; perfecting bibliographical orientation; competence in choosing one or more critical methodologies.

Faculty of Civil And Industrial Engineering

COURSE TITLE	DESCRIPTION
▪ Control Systems	▪ The course provides the basic tools for analysing the properties and the synthesis of retroaction control laws for linear dynamic systems, using both state-space representations and entrance-exit descriptions. For systems with only the exit measure and with a single controlled variable, the course will develop synthesis methods based on the use of frequency responses and subsequently algorithmic methods to overcome the typical limitations of frequency synthesis techniques. In particular, the course addresses the problem of stabilising instable linear systems, using both the root locus method and techniques based on the state-space method. For non-linear systems, Lyapunov's theory of stability will be introduced.
▪ Fluid Machinery in Energy Conversion Systems	▪ The course provides in-depth notions of thermodynamics applied to machinery and to thermic, wind and hydraulic energy conversion systems. Moreover, the course will also address mass and energy balance of single components as well as elementary notions of dimensioning. The course includes notions of entropic/exegetic analysis in order to improve students' analytic capacities.
▪ Mechanical Design and Laboratory Characterization of Micro-Nano Devices	▪ Simulation and analysis of device dynamics. Modelling of systems by multi-body, discrete and continuous modelling. Dynamics, modal analysis, auto-values and auto-vectors. Modelling of vibration. Modelling of contacts between components of micro-devices. Designing of micro-nano devices.
▪ Macromolecular Structures	
▪ Electric & Electromagnetic Design of Micro-Nano Devices	▪ Electric and electromagnetic modelling on radio frequency of: Carbon nanotubes (SWCNT, MWCNT) and graphene nano-components for electric micro/nano-circuits; Electric nano-circuits for sensor applications; Nano-interconnections for integrated circuits; EM-field micro-sensors; Advanced micro/nano-structured materials for electromagnetic shielding (multifunctional EM shields, frequency selective shields, radar absorbing shields, high constant dielectric materials, ferrite, meta-materials). Design and applications: Nano-components for electric micro/nano-circuits; Nano-interconnections for integrated circuits; EM-field micro-sensors; Micro/nano-structured EM shields (passive, active, reconfigurable and selective shields); Micro/nano-structured meta-materials for electric-electromagnetic devices. Device Design: analysis of state of the art; Patent analysis; Development of the project; Calculus Lab; Experimental Lab.
▪ Electromagnetic Fields and Nano-systems for Biomedical Applications	▪ The goals of the course are closely related to the knowledge and use of electromagnetic fields for designing nanometre scale (1-100nm) applications and technology for medical use.

▪ Micro-Nano Fluidics and Micro-Nano Fluidic Devices	▪ The course allows students to fully understand the behaviour of micro and nano devices. The course imparts notions on the mechanisms by through which fluids interact with their surrounding environment. Moreover, it provides critical knowledge on various descriptions of fluids and their movement for applications in micro and nano-technologies. The course also develops basic competences in the design and management of fluidic micro and nano-systems.
▪ Combustion	▪ This course provides notions on the main phenomenology, theories and mathematical/numerical models that characterize the processes of combustion in gas blends.
▪ Experimental Aerodynamics	▪ The course addresses the theory and practice of methods and experimental apparatus used in aerodynamics and fluid dynamics. Systems of flow visualization: effect of pigment and tracing particles; Examples of visualizations; Laser Induced Fluorescence Technique (LIF). Measurement of the field of density and temperature: Shadowgraph, Schlieren, and interferometric techniques. Measurement of the field of velocity: techniques of hot wire and film anemometry (HWA and HFA), technique of Laser Doppler Anemometry (LDA), image analysis techniques: Particle Image Velocimetry and Particle Tracking Velocimetry (PIV and PTV). Advanced procedures of PIV images. Analysis of fluid dynamic signals: calculation of probability, statistic moments, functions of auto-correlation, scale characteristics of turbulence and transformation of Fourier ad spectral density function. Vortex structures during turbulence.
▪ Experimental Testing for Aerospace Structures	▪ Theory and application of experimental research methods for static and dynamic tests on aerospace structures for verification and certification.
▪ Aeroelasticity	▪ The course provides basic knowledge on linear field aeroelasticity (vibrations of elastic-linear solids in potential linearized flux). The course focuses specifically on aeroelastic modelling of aircraft with fixed wings and resulting issues of stability and static and dynamic aeroelastic response (divergence, flutter, gust response, response to command areas, efficiency and inversion of commands) together with issues related to the numeric implementation.
▪ Aircraft Aerodynamics And Design	▪ Analytic aerodynamic design for an aircraft.
▪ Computational Gas Dynamics	▪ The course introduces students to modern numeric analysis techniques applied to gas dynamics and focuses on the definition of general criteria for the development of numeric schemes and their implementation in calculating codes to resolve multidimensional Eulero equations.
▪ Environmental Impact of Aircraft Engines	▪ The course addresses the causes of chemical and sounds emissions by aeronautic motors, as well as the factors that might mitigate them. Chemical emissions are contextualized in the general framework of man-made polluting and contaminating emissions, and their resulting effects are analysed in detail. The sources of sound emissions will be identified, including non-propulsive ones, together with the relative methods to subvert them.

▪ Smart Composite Structures	▪ The course addresses the thermic problems of aerospace structures caused by the thermic environment of aeronautic and aerospace mission systems. The course provides an introduction to smart structure technology. The physical principles of heat conduction in solids and the conditions of radiation and convection. The general equation of thermo-elasticity permits a representation of the phenomena related to the thermic expansion produced in structures by temperature variation. The course provides a formulation with fixed elements that permit the treatment of the problems related to real cases of complex geometry. The second part of the course illustrates the properties of smart structures as opposed to traditional structures, describing the physics of the main active materials (piezoelectric materials and certain shape memory alloys). The course describes various descriptive models of the mechanisms of implementation and sensing that allow the smart structures to provide their functionalities. The general equations of piezoelectricity will be represented in their general form and its formulation in terms of fixed elements will also be provided. The contents of the course are completed with various applications of the aerospace engineering sector.
▪ Aerospace Materials	▪ The course provides students with knowledge and skills useful for the virtuous circle of innovation-technology-materials-products-processes in the structural and propulsive aviation industry. The course will apply an inter and multi-disciplinary approach, with the aim of linking the knowledge and skills related to the development and use of innovative technologies of materials, aimed at realization and application and the aspects of selection/design.
▪ Nonlinear Analysis of Structures	▪ The course completes the analysis of the structural problem, focusing on nonlinear problems. In particular, it provides the theoretical and computational tools for the response analysis of structures in non-linear regimes both of movement and deformations as well as of constitutive relation and of coercion, such as aerodynamic or thermic effects. Critical knowledge of the basics of non-linear mechanics of deformable solids, one-dimensional structures (cables, beams) and two-dimensional structures (plates). Methodological skills of planning, calculation and critical analysis of applied problems of nonlinear mechanics of solids and structures, with the assessment of limit states and post-critical response scenarios.
▪ Digital Control Systems	▪ n/a
▪ Robust Control	▪ The course is for students who wish to enhance their knowledge of the methods of project control systems in presence of uncertainties in controlled system models. Basic analysis techniques will be introduced in a systematic manner, based on the use of linear matrix inequalities and design techniques, both for situations of uncertainty in parameters (structured uncertainties) and uncertainty due to model approximations (unstructured uncertainties). The course analyses draft control systems, including those with a number of inputs and outputs and that meet two fundamental specifications: stability and performance in continuous operation to exogenous inputs. The course provides students with several tools for analysis and design to verify and ensure that the specifications in question remain insured either for the presence of parameter variations or in the

	presence of non-modelled parasitic dynamics. These techniques generally refer to the use of linear matrix inequalities.
▪ Liquid Rocket Engines	▪ The course provides a basic understanding of the functioning of the parts constituting liquid-propellant rockets and of rocket systems as a whole. This course focuses on the analysis of the main parts of the fuelling and cooling systems. The course also addresses the basic elements for the study of turbo-machinery and combustion instability.
▪ Spacecraft Control	▪ This course addresses the structure control of launchers and satellites.
▪ Solid Rocket Motors	▪ The course provides an analysis of the general structure of solid rocket motors (SRM) and the complex phenomenology that characterizes them. An introductory section provides the theoretical base and will illustrate the first mathematical models of the engine able to describe the near steady-state operation. Subsequently the course addresses various aspects of the combustion of energetic materials and in particular of solid propellants. Furthermore, the course describes specific aspects of solid motors such as erosion of composite material nozzles, two-phase flow, grain geometry and transitional ignition. Finally, the course provides notions on some variants of solid motors as hybrid engines. Exercises will be carried out in support of all parts of the course.
▪ Smart Composite Structures	▪ n/a
▪ Aerospace Materials	▪ n/a
▪ Spacecraft Design	▪ The course provides students with in depth knowledge of the methodologies used for the design of satellites and satellite systems, according to international standards.
▪ Multi-body Space Structures	▪ The course provides methodologies for modelling and analysis of complex space structures such as multi-body systems in space.
▪ Artificial Intelligence I	▪ The course presents the basic elements of Artificial Intelligence. Students will be introduced to problem solving and automated search, knowledge representation and reasoning techniques, and the language PROLOG. After the course the student will be able to use such techniques to model and solve problems.

Faculty of Information Engineering, Informatics and Statistics

COURSE TITLE	DESCRIPTION
▪ Games and Equilibrium	▪ This course addresses the mathematical models that can be used to describe situations in which there is more than one decision maker. In particular, the course analyses models based on variational inequalities and game theory. The computational aspects will be given particular emphasis. Expected learning outcomes. At the end of the course, students will be able to formulate balance problems with as variational inequalities and to develop appropriate algorithms to solve them. Furthermore,

	students will be able to use realistic game models and to find their balance algorithmically, also in cases of realistic models. The course is set up with an interdisciplinary approach.

▪ Productivity and Efficiency Analysis	▪ The course will combine lectures on the economic theories of production and efficiency with lessons on econometric estimation methodologies applied in specialist literature, including the most recent contributions. To develop the critical capacity and autonomy when using methodologies presented during the course, students are required to produce an empirical work with real data from an industry of their own choosing. In particular, the class exercises will be used to present the open source software that will be necessary to complete the aforementioned task. The main objectives of the course are: 1. To provide an overview of economic theories and economic productivity; 2. To propose a unified framework on the main methodological tools for the evaluation and comparison of productivity and efficiency of operative units (plants, factories, business units in general, companies); 3. Introduce students to some open source econometric software for applied economic analysis; 4. To provide the analytical tools to analyse the specialist literature; 5.To stimulate critical analysis of the theoretical, methodological and empirical contents; 6. To create interaction with students through exercises, oral presentations and guided work with real data.
▪ Marketing and Innovation Management	▪ The course provides students with the basic concepts and tools for understanding the marketing environment and the industrial dynamics of technological innovation and the development and implementation of marketing strategies and technological innovation. Introduction to marketing; Company and marketing strategy aimed at the client relationship; The marketing environment of the enterprise; Marketing information systems aimed at obtaining data on the customers; Buying behaviour in the market environment of the consumer; Buying on the business market; Client focused marketing strategy; Product, services and brand strategies; Price strategies; Marketing channels; Value communication to customers; Marketing plan; Integration of environmental sustainability in marketing strategy: "green " marketing; Introduction to Innovation Management; Sources of innovation; Forms and models of innovation; Conflicts of standard and dominant design; The choice of time of entry into the market; Protection mechanisms of innovation; Development of a new product; Management of a new product development process; Management of a new product development process team; Integration of environmental sustainability in developing a new product: Green Product Development
▪ Optimization Methods for Machine Learning	▪ The course provides the skills needed to create classification algorithms and algorithms for supervised learning of neural networks and support vector machines (SVM), based on the use of optimization methods. Expected course outcomes: Basic knowledge of the different types of neural models and SVM and learning problems formulated in terms of problems of nonlinear optimization; ability to use and to achieve optimization software for training.
▪ Probabilistic Models for Finance	▪ The course goal is to provide students with some of the basic concepts of probability 'and statistics in order to introduce some stochastic models used in finance. It also seeks to sharpen the critical skills of students, in order to enhance their ability to address new problems critically. Course contents: Introduction to

	credit scoring; Classification; ROC and CAP curves; Logistic Model for credit scoring; Discriminant function analysis for credit scoring; Introduction to financial mathematics; Some properties of the financial markets; Recall probability; Integration of Stieltjes; Convergence in probability and law; Introduction to stochastic processes; Brownian motion; Poisson process; Martingale and conditioning; Times of arrest; Portfolio selection; CAPM; Discrete models for finance; Complete markets and price of European options; The Cox Ross and Rubinstein model; From the CRR to the Black Scholes model; Ito's Lemma; The Black Scholes formula; Volatility; Price of American options; Stochastic volatility: SABR, GARCH Simulation and Monte Carlo methods for finance. Analysis of data with R: http://www.r-project.org/

▪ Pervasive Systems	▪ This course should provide the basic notions concerning theoretical issues, techniques and practices of planning and realization of present and future pervasive systems, focusing on innovative technologies and the need to render the systems autonomous both from the point of view of energy and of safety. The themes will be addressed within a broad spectrum, presenting the currently most common problems of pervasive systems. In this way, students can complete their training in the field of wireless technologies, sensor networks and of intelligent and distributed processing of signals, which is of particular interest in the scientific and industrial area(logistics, transportation, security, telemedicine, cultural heritage, etc.). Students should therefore acquire skills of analysis and problem solving related to the design, construction and operation of pervasive systems, with particular reference to wireless technology, sensor networks and applications in the ICT field.
▪ International Trade and Business	▪ The first part of the course deals with the theories of international trade. Initially, the focus will lie on models of perfect competition that explain the inter-industry trade created by comparative advantage. The topics examined include the Ricardian and the Heckscher-Ohlin model. The discussion will then move on to models of imperfect competition that explain intra-industry international trade among similar countries. This first part of the course ends with an analysis of the phenomenon of offshoring. The analysis will then target some aspects of trade policy (the multiple forms taken by protectionism, economic integration, and international negotiations for the liberalization of trade). Finally, the course will outline the role of multinational companies and direct investment in the process of economic integration at the international level. The implications of this theoretical apparatus will be illustrated with real examples from contemporary economy. The analytical tools provided by the course will help students understand the rapid and complex process of globalization that has affected the world economy in recent years and understand important aspects of the profound changes taking place in the global economy.
▪ Data Management	▪
▪ Enterprise Information Systems	▪ This course provides students with working knowledge of technologies and methodologies related to corporate information systems, starting from the description of the organization in terms of business processes and information assets. Discussing a simple class project, students are expected to understand and be able to make practical use of SIA technologies (with examples suggested within Data Warehouse / Business Intelligence) as an integral part of the examination. Learning results: The student has the opportunity to develop the ability to deal with concrete problems and build (or help build, in a team with other specialists) solutions based on appropriate technologies for operational support and/or information treatment.
▪ Engineering Electromagnetics	▪ Elements of electromagnetic fields; Circuit characterization of devices and microwave and optical circuits; Types of passive and active microwave devices; Guiding and resonant microwave

	structures; Printed circuit boards and dielectric waveguides; Optical links and propagative features in fibre; Sources and optical detectors; Numerical methods and CAD techniques of analysis and design of high-frequency circuits; Interference and electromagnetic compatibility; Measurement techniques and instrumentation for devices and high-frequency circuits.
▪ Network Security	▪
▪ Computational Intelligence	▪ Course contents: Machine Learning; Introduction to data driven modelling: soft computing, computational intelligence; Problem definition of clustering classification, unsupervised modelling, functional approximation and prediction; Ability of generalization; Deduction and induction; Induction principle on normed spaces; Models and learning algorithms; The choice of metric and the pre-processing of data; Optimization problems; Optimality conditions; Linear Regression: LSE and RLSE algorithm; Numerical algorithms for optimization: algorithms based on gradient descent; The Newton method; Principles of fuzzy logic: definition, elementary operations; Fuzzy induction principle; Fuzzy rules classification systems: measures of performance and sensitivity; K-NN classifier; The biological neuron and central nervous system; Perceptron; Feed-forward networks: multi-layer perceptron; Error Back Algorithm; Automatic learning algorithms; Sensitivity to structural parameters; Constructive and pruning algorithms; Optimization of the capacity of generalization and cross-validation criteria of Occam's Razor; Min-Max neuro-fuzzy classifiers: classic and regularized learning algorithm: ARC: PARC; Principal Component Analysis; Generalized neuro-fuzzy networks; GPARC; Swarm Intelligence; Evolutionary Computation; Genetic Algorithms, Particle Swarm Optimization, Ant Colony Optimization; Automatic feature selection; Fuzzy reasoning; Generalized modus ponens; FIS systems; Procedures of “fuzzyfication” and “defuzzyfication”; ANFIS systems; Canonical training algorithms; Advanced algorithms for the synthesis of ANFIS networks: clustering in joint space, clustering in hyper-planes space; Problems of prediction and cross-prediction: embedding based on genetic algorithms; Applications and case studies: modelling and control of energy flows in micro-grids, optimization and control of smart grids, classification of TCP/IP traffic flows; Search for regular patterns and extraction rules in large databases (Big Date: Analytics).
▪ Radar and Remote Sensing Laboratory	▪ The course will mention concepts inherent to radar operation with particular reference to the functions of target detection, noise cancellation, localization and estimation of the parameters of motion of the target, creation of images. The computer exercises using the MatLab software aim to implement appropriate processing techniques to achieve the above tasks within specific radar systems considered as examples. Particular attention is given to practical application of the techniques analysed, including their operation in real-time mode. The techniques implemented are tested, where possible, on sets of real data acquired through specific systems (students can get involved in these measurement campaigns). In particular, with reference to passive radar systems the course will: analyse the state of adapted filtering for situations of continuous-wave transmissions and implement efficient processing techniques for the evaluation of the map of cross-correlation delay/Doppler; discuss various

	issues related to the cancellation of disturbances that restrict the disclosure of targets and implement possible techniques for their removal based on adaptive approaches; implement CFAR (Constant False Alarm Rate)detection techniques operating on two-dimensional domains. In relation to an image radar system the course will: analyse the basic principle of ISAR (Inverse Synthetic Aperture Radar) image creation of man-made targets in motion and implements processing techniques for focusing such images assuming the motion of the target is known; implement estimation techniques of translational motion (motion compensation) and, where possible, rotation (for ISAR image scaling); address the problems of selection of the instant of imaging and of the related CPI (Coherent Processing Interval) for obtaining high quality images.
▪ Ultra Wide Band Radio Fundamentals	▪ The course addresses UWB transmission technology and its application to the design of advanced networks such as ad hoc and sensor networks, and generally of distributed wireless networks. The analysis addresses key issues of UWB systems in order to highlight the potential of a technology that appears as one of the top candidates in the establishment of standards for next-generation wireless networks. The course addresses the theoretical foundations of UWB communications, complementing the discussion with practical examples and application principles for each topic. Students will acquire advanced knowledge related to the analysis and design of UWB networks, in particular with reference to: * Analysis of UWB signal and its spectral features * Dimensioning the link, link budget and current status regarding standardization * Distance estimate and protocols of positioning using UWB * Multi-user systems and access systems (Medium Access Control) for UWB networks * Routing strategies that are power efficient and based on positioning information availability in UWB networks * Introduction of cognitive mechanisms in UWB networks
▪ Electronics & Telecommunications Laboratory	▪
▪ Pervasive Systems	▪ This course should provide the basic notions concerning theoretical issues, techniques and practices of planning and realization of present and future pervasive systems, focusing on innovative technologies and the need to render the systems autonomous both from the point of view of energy and of safety. The themes will be addressed within a broad spectrum, presenting the currently most common problems of pervasive systems. In this way, students can complete their training in the field of wireless technologies, sensor networks and of intelligent and distributed processing of signals, which is of particular interest in the scientific and industrial area (logistics, transportation, security, telemedicine, cultural heritage, etc.). Students should therefore acquire skills of analysis and problem solving related to the design, construction and operation of pervasive systems, with particular reference to wireless technology, sensor networks and applications in the ICT field.

▪ Microcontroller System Design	▪ The course is designed to provide training regarding the design of microcontroller-based systems. The educational objectives corresponding to the phases in which the course is divided are: 1) acquiring hardware architectures design methodologies of real-time processing based on microcontrollers, both CISC and RISC; 2) acquiring programming methodologies of microcontrollers in real time application systems.
▪ Distributed Optimization over Complex Networks	▪ The course addresses the basics of graph theory and distributed optimization and to demonstrate the potential applications for sensor networks and communication. The course covers both methodological and application-oriented aspects. The methods include fundamental theoretical tools, such as algebraic graph theory, convex optimization and game theory. Application-oriented aspects concern the application of the methodologies to cognitive networks and sensor networks. The course is self-contained. It does not require any prior knowledge of graph theory, game theory and distributed optimization. The only prerequisite is a basic knowledge of optimization theory and probability theory.
▪ Multimedia Systems ▪	▪
▪ Network Traffic Engineering	▪ This course provides the methodological tools and examples of application for the analysis of the performance of networks and of protocols and their sizing. Introduction. Role and context of performance evaluation in telecommunication networks. Traffic engineering and metrics. Examples. Models for performance evaluation. Little's law. Description of network traffic. Data analysis, identifying patterns of packet arrival. Queues as a models of network buffers. Jackson and Gordon-Newell queuing networks. Priority queues: conservation law, examples (HOL, SJF). Limits and approximations for analysing queues: fluid approximation. Simulation of telecommunication networks and protocols. Practice with ns-2. Analysis of output traces, extraction of statistics. Traffic measures. Practice with Wireshark. Analysis of traffic traces. Adaptation of models to data of captured traffic traces. Analysis and network dimensioning. Kleinrock's packet network model. Network optimization problems. Optimized assignment of network capacity. Reactive congestion control. Models and performance evaluation of TCP. Fluid model of TCP / IP networks. Project of a network as an optimization problem of utility functions (NUM). Formulation of the prime problem. TCP as distributed controller for the solution of the NUM problem.
▪ Neural Networks ▪	▪
▪ Laboratory of Stochastic Processes	▪ The main objective of the course is to provide students with the basic concepts of the theory of Markov chains. These models are often used in applications such as biology, economics, and statistics. In particular, they are the basis of so-called MCMC methods.
▪ Analysis of Complex Data Structures	▪ Course goals - Students completing the course will have a thorough enough understanding of the main techniques of model based statistical analysis to deal with the problems of

	measurement of quantity, which, in reality, cannot be directly observed. The course will refer, in particular, to latent class models, Rasch models and structural equation models. Skills acquired - Knowledge of the most common techniques of model based statistical analysis for multivariate data with complex structures. Ability to plan and implement these techniques using statistical software.
▪ Optoelectronics	▪ The course provides a solid and well-coordinated knowledge of phenomena, materials, optoelectronic devices and techniques, with particular reference to the creation, detection and processing of optical signals.
▪ Embedded Systems	▪ The course intends to provide an introduction and a further development of problems inherent in the architecture and design methodologies of embedded systems. In particular, the study covers methodological aspects, design methods and some notions of CAD tools that allow students to define and create the appropriate system starting from its requirements, the limits of the project and taking into account the costs. Students will learn and elaborate the capturing issues of system requirements; of functionality specification; of architecture synthesis of computing and communications; of breakdown and distribution of the various software components; of hardware and software co-design and of the evaluation of real-time limits. In addition, students focuses on some architectural and constructional aspects of embedded systems. Course outcome: After completing the course, students will be able to understand the structure and design phases of an embedded system, analyse its performance and use software tools for modelling, simulation and performance evaluation.
▪ Photonic Microsystems	▪ The course provides students with the tools for understanding the production technologies and the performance of systems and microsystems that consist of optoelectronic and photonic components.
▪ Laser Fundamentals	▪ The course addresses the behaviour of the interaction between radiation and matter in frequency intervals. It provides students with comprehension of the mechanisms by which it is possible to create laser sources, potentially also miniaturized, as well as devices able to convert and manipulate light. Students will learn to identify, based on the fundamental laws of radiation and matter interaction, the most suitable model for the design of miniaturized optical sources.
▪ Distributed Optimization Over Complex Networks	▪ The course addresses the basics of graph theory and distributed optimization and to demonstrate the potential applications for sensor networks and communication. The course covers both methodological and application-oriented aspects. The methods include fundamental theoretical tools, such as algebraic graph theory, convex optimization and game theory. Application-oriented aspects concern the application of the methodologies to cognitive networks and sensor networks. The course is self-contained. It does not require any prior knowledge of graph theory, game theory and distributed optimization. The only prerequisite is a basic knowledge of optimization theory and probability theory.
▪ Distributed Optimization	▪

Over Complex Networks	
▪ Pattern Recognition	▪ The course provides students with the basic principles on the techniques of pattern recognition, classification and clustering of non-necessarily algebraic dominions. The student will learn to design a recognition system, synthesized via inductive modelling techniques, also on structured data, appropriately choosing the technique of pre-processing and the measure of dissimilarity between patterns. Furthermore, the student will learn to measure the performance of the system.
▪ Pervasive Systems	▪ The course will provide a basic understanding of the theoretical, technical and practical issues concerning the design and development of current and future pervasive systems, focusing on innovative technology and the need to make independent systems autonomous also in terms of energy and safety. The course will address wireless technology, sensor networks, intelligent and distributed analysis of signals and a range of other issues that are of particular interest for science and industry (logistics, transports, security, tele-medicine, cultural heritage, etc.). Students will acquire the ability to analyse and solve problems related to the design, development and operation of pervasive systems with particular reference to wireless technology, sensor networks and ICT applications.
▪ Advanced Electromagnetics & Scattering	▪ Planar guiding structures, equivalent transmission lines for two-dimensional waveguides. The transverse-resonance method and applications. The effective-dielectric-constant method for three-dimensional waveguides. The spectral-domain method for the study of general planar stratified structures; integral equations for the currents: numerical solution with the method of moments. Spectral decomposition of the fields radiated by an aperture. Asymptotic evaluation of integrals: integration by parts, the stationary-phase method. Computation of the far field. General introduction to electromagnetic scattering and review of principal applications. Canonical problems: scattering from cylindrical and spherical structures. Simulation of generic two- or three-dimensional scatterers.
▪ Advanced Antenna Engineering	▪ 1. Review of the main theorems and parameters of antennas 2. Alignment of antennas and mime systems 3. Periodical structures and their applications 4. Travelling planar wave antennas 5. Integrated resonant antennas 6. Numerical methods and electromagnetic CAD
▪ Advanced Antenna Engineering	▪
▪ Accelerator Physics and Relativistic Electrodynamics	▪ The course provides the fundamental concepts that are the cornerstone of modern physics, based on the knowledge acquired during the physics courses 1 and 2. The theory of special relativity, applied mechanics and electromagnetism, will enrich students expanding the foundations of physics they learned in the two years of engineering. Lastly, the course will teach the application of these theories and methodologies to particle accelerators, illustrating its basic principles, which provide advanced theoretical and experimental tools in this innovative area of great technological interest.

FACULTY OF ECONOMICS

COURSE TITLE	DESCRIPTION
▪ Planning and Strategic Management	▪ N/A
▪ Supply Chain Management	▪ The course provides a comprehensive view of network logistic and production from raw material procurement to distribution of finished products and after-sales. The course describes the inter-relationships of the process, with particular attention to aspects of planning and management and highlighting the design choices, policies, methods, and skills suited to support managing a complex logistics system. In addition, through the support of examples and case studies, students encounter problems and solutions of great interest to the study of management.
▪ Innovation and Organization of Companies	▪ N/A

FACULTY OF MATHEMATICAL, PHYSICAL AND NATURAL SCIENCES

COURSE TITLE	DESCRIPTION
▪ Archaeometry - Dating Methods and Statistical Data Processing	▪ This course provides students with in-depth knowledge of the archaeometric methods and results of research regarding archaeological and historical-artistic heritage. Knowledge of current specialist literature. Critical understanding and distribution of research results published in international specialist literature. Statistical data analysis: descriptive statistics, regression methods, multivariate analysis, and principal component analysis. Digital images: methods of acquisition and processing of images of archaeological records and of cultural heritage. Characterization of excavated material: techniques and advanced methods of characterization of excavated material developed through archaeometric campaigns.
▪ Advanced Chemical Methods in Archaeological Materials Science	▪ This course trains students in the sciences of archaeological materials, with particular emphasis on metallic materials. The main topics are materials in cultural heritage: structure and properties; Concepts of archaeo-metallurgy: The archaeological metals; deterioration of metal products; corrosion process: kinetics; Principles of thermodynamics and conservation of metal artefacts; Modern techniques of characterization.
▪ Laboratory of Archaeometry	▪ The course provides a basic understanding of general palaeontology, principles and methods of paleoecology and the active mechanisms of ecosystem transformations, particularly the continental paleo-environments of the Quaternary and the first Holocene period. With these notions, students will be able to apply principles that are useful in understanding the significance of the fossils in their geo-archaeological context and use different methodological approaches to reconstruct the paleo-environmental context of fossil accumulations and its evolution over time.
▪ Molecular Bases of the Cell Cycle**:**	▪ The cell cycle is the basis of fundamental processes such as development, growth, regeneration, the maintenance of stem cells and differentiation. It integrates all levels of control operating in molecular biology and the loss of control mechanisms is the basis of transformation and tumour proliferation. The course deepens the concepts emerging, experimental models and cutting-edge methods in the study of the cell cycle to understand the regulatory mechanisms and clarify the processes of convergence between development and cancer.
▪ Biodiversity and Human Evolution	▪ The course develops students' knowledge and skills regarding the main aspects of human biology and biodiversity in an evolutionary framework, making them aware of their importance for both basic and biomedical research. The approach of this course provides, in addition to theoretical knowledge, a discussion of case studies and practical applications with online resources and dedicated software currently used in studies on human biodiversity.
▪ Proteomic Analysis	▪ The course provides students with in depth knowledge of the main methods of biochemical analysis of cellular protein. They will learn to understand the various molecular-biological applications of the spatiotemporal analysis of gene expression.
▪ Gene Therapy	▪ The course provides students with basic understanding of gene and cell transfer systems and their therapeutic goals. The analysis covers viral and non-viral vectors, with particular attention to their evolution. The course examines the approaches of gene and cell therapy, based on the use of progenitor stem cells, for treatment of specific human diseases such as cystic fibrosis, immunodeficiency, cancer and muscular dystrophies. Students will be introduced to the modern discoveries regarding the alterations of biosynthesis and growth of RNA in hereditary, congenital and

	acquired pathologies and the use RNA as a therapeutic molecule.