Chemistry [2300103]

Offerta didattica a.a. 2025/2026

Docenti: SARA MARIA GIANNITELLI

Periodo: Primo Ciclo Semestrale

Obiettivi formativi
The course provides an overview of general inorganic chemistry.

Prerequisiti
Basic notions of mathematics and physics.

Contenuti del corso
Introduction remarks: The Scientific Method, Measurements, Scientific Notation, Density, Temperature, Matter and energy, Chemical vs. Physical Changes.
Atoms and Molecules: Dalton's Theory, Bohr Theory, Modern Atomic Theory, Periodic Table, Electronic Structure of Atoms.
Chemical bond: covalent bond, ionic, metallic, Inorganic Nomenclature, hydrogen bond, Electronegativity, Weak interactions.
Chemical Reactions: Mole Concept, Stoichiometry, Types of Reactions, Oxidation-Reduction.
States of Matter: Gas Laws, Intermolecular Forces, Liquids, Solids, Changes of State.
Solutions: Concentration Terms (%w/w, %w/v, v/v %, M, b, N), Colligative Properties.
Chemical Equilibrium: Law of Chemical Equilibrium, Kp, Kc and Kx, van't Hoff Equation, Le Chatelier's Principle.
Solubility Equilibria: Sparingly Soluble Compounds, Kps Concept and Calculations.
Chemical Kinetics: Concepts, Rate Equations, First Order, Second Order, Half-Life, Rate Constants, Energy Profile Diagrams, Catalysis, Activation Energy.
Acids and Bases: Definitions (Arrhenius, Bronsted-Lowry, Lewis), Weak vs. Strong, Hydrolysis, Neutralization, pH, titrations, buffers (bicarbonate and phosphate buffers).
Electrochemistry: Faraday's Law, Galvanic Cells: Concepts, Cell Diagrams, Anode and Cathode, Half-Cell Reactions, Overall Cell Reactions and e.m.f. Nernst Equations.

Metodi didattici
Face-to-face lectures (76%, approx. 53 hours).
Exercises that show the application to specific problems of the knowledge learned in lectures (18%, approx.13 hours).
Laboratory sessions to teach how to work in a chemical laboratory, prepare chemical solutions and see the application of written exercises (6%, approx. 4 hours).

Modalità di verifica dell'apprendimento
Knowledge assessment methods and criteria:
Knowledge and skills will be verified by a multiple choice questions test to be carried out on the University's elearning platform. In the test, the Student will have to answer 30 multiple choice questions in 50 minutes. The Student will receive the result of his test as a score expressed in thirtieths.

Criteria for measuring learning and defining the final grade:
In the test, the Student will have to answer 30 multiple choice questions in 50 minutes, of which:
- each question will have 4 answers (A, B, C, D) of which only one is corrected;
- only one answer can be selected for each question;
- points are assigned as follows: 1 (one) point for each correct answer; 0 (zero) points for each incorrect or not given answer.

Each test will be different from the other and assigned randomly by the system.
The tests will be evaluated automatically through the e-learning system, on the basis of preloaded correct responses. The test score will be provided only to each individual student. Correct answers will be also provided and the Commission will be available to discuss the test answers.
Minimum passing grade is 18/30. In the event of a full grade (30/30), the student will have the opportunity to try for an honor grade (cum laude) through a satisfactory answer to a single-question oral test, carried out immediately after the written test evaluation. In the event of an unsatisfactory answer, the final grade could be reduced by up to 3 points. This question aims to evaluating the logic followed by the Student in problem solving, the use of an

appropriate language in the answer to the question and, also, the adequacy of the proposed solution in relation to the skills that the Student it is assumed that he has acquired at the end of the course. Further skills which will be evaluated encompass making judgements, communication skills and learning skills according with Dublin Descriptors.

Testi di riferimento

Face-to-face lectures and exercises are carried out on an electronic whiteboard. The saved whiteboards will be uploaded on the e-learning platform at https://elearning.unicampus.it/.
These whiteboards allow the student to review and deepen the topics covered and transform into knowledge what has been learned in class and into skills and competences what has been done during the exercises.
Teaching materials recommended for independent study by the Student interested in learning more about the discipline:
- Whitten, Davis, Peck, Stanley, CHEMISTRY, 10th Edition, Cengage Learning.
Exercises:
P.M. Lausarot, G.A. Vaglio, STECHIOMETRIA PER LA CHIMICA GENERALE, Piccin

Altre informazioni

Knowledge and understanding
The course will transfer the following knowledge and understanding to the student:
• the atomic bases of chemistry for the construction of the periodic table of elements and a reasonable prediction about how and why the atoms react;
• the chemical bond and its correlation with the properties of matter; spontaneity and equilibrium of chemical reactions; the main classes of inorganic compounds and their reactivity.
The student will: understand the meaning of chemical reaction and perform stoichiometry calculations; describe the properties and structure of gas, liquid and solids; understand the kinetic aspects of the chemical transformations.

Applying knowledge and understanding
At the end of the course the student will be able to:
• make predictions on the reactivity of an element based on its position in the periodic table;
• write a formula of Lewis structure by sorting the compounds on the basis of the chemical bond and properties;
• discuss a chemical balance and the factors that influence the reaction with particular attention to the acid/base balance;
• define a species oxidant and reductant;
• write formulas of inorganic compounds and use them to synthesize other.
The student must also be able to solve stoichiometric problems of practical utility (e.g., calculation moles, balance reactions, limiting reagent, yield, definition and ways of expressing concentration, preparation of diluted solutions).

L'attività didattica è offerta in:

Facoltà Dipartimentale di Ingegneria

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Degree course	Biomedical Engineering (2025)	comune	7	CHIM/07

Stampa del 12/11/2025

Economics and Management [2300105]

Offerta didattica a.a. 2025/2026

Docenti: GIUSEPPE TURCHETTI

Periodo: Secondo Ciclo Semestrale

Obiettivi formativi
The course aims to provide students with the fundamental elements of economics and management to evaluate and take business decisions. We want to deliver an overview of the business management principles from different points of view that comprise: the identification of the different forms of business according to the Civil Code, the examination of the different possible organizational structures, the analysis of operations and marketing decisions within the organization, and the evaluation tools for investment decisions. Specific attention will be devoted to economic and managerial aspects in the Healthcare sector, comprising reference to related regulatory affairs.

Prerequisiti
There is no mandatory prerequisite but it is strongly suggested to have gained basic knowledge of mathematical concepts.

Contenuti del corso
Module 1 (10 hours). The first module introduces the fundamental concepts regarding business and competition. We will deal with the civil definitions of organizational entities (e.g. definition of enterprise, company and entrepreneur) and the distinction between different legal forms (i.e., sole proprietorships, partnerships and corporations). Then the basics of sustainable development, based on economic, social and environmental sustainability, will be introduced, referring also to all the stakeholders that might be considered by business decisions. Specific reference to the Healthcare sector will be provided.
Module 2 (20 hours). The second module provides an overview of the business system from an organizational point of view. The main organizational forms to support business models and corporate operations will then be illustrated, and the advantages and disadvantages associated with each of them will be discussed. Specific reference to the Healthcare sector will be provided.
Module 3 (10 hours). The third module deals with the fundamentals of marketing, which might be crucial for the success of products and services. The main constituents of marketing decisions will be considered. Specific reference to the Healthcare sector will be provided.
Module 4 (10 hours). The fourth module considers the operations management. The main tools for operations management will be introduced. Specific reference to the Healthcare sector will be provided.
Module 3 (10 hours). The final module introduces tools to evaluate and implement business decisions. First, an introduction to the general principles of financial statements will be considered. Then, the concepts of the time value of cash flows and cost of capital will be introduced. Finally the tools for choosing investments will be considered (i.e., Net Present Value and Payback period). In addition, regulatory affairs related to the Healthcare sector will be covered.

Metodi didattici
The course is based on lectures (50 hours) and exercises (10 hours).

Modalità di verifica dell'apprendimento
Knowledge assessment methods and criteria:
The assessment test is written and will contain a series of questions (multiple-choice and open questions), as well as exercises, aimed at assessing the theoretical and practical knowledge of the topics presented in class.
The exam scores will be distributed as follows: theoretical part 20 points in total; numerical part 12 points in total.
The theoretical part consists of 3 open-ended questions of 4 points each and 8 multiple choice questions.

Testi di riferimento
Slides.
Suggested books:
Essentials of Strategic Management: The Quest for Competitive Advantage, 2020, McGraw Hill.
Corporate Finance, di J. Berk e P. De Marzo 2020, Pearson.

Altre informazioni

1) Knowledge and understanding: Ability to analyze and manage business decisions. Understanding of managerial tools and of the characteristics of the main company functions.
2) Applying knowledge and understanding: ability to apply the knowledge acquired through the use of tools for analyzing and processing business choices in different organizational contexts.
3) Autonomy in making judgements: on the basis of the knowledge acquired, and thanks to the use of methodological tools learned during the course, ability to evaluate investments to be started and possible organizational forms to be adopted, for the improvement of organization performance.
4) Communication skills: communication and interpretation skills, processing and synthesis of data relating to business decisions, acquisition of economic-business terminology suitable for the explanation, interpretation and communication of managerial choices.
5) Learning skills: articulated and organic learning skills that will allow the breakdown of problems in consideration of their complexity, the management of effective solutions.

L'attività didattica è offerta in:

Facoltà Dipartimentale di Ingegneria

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Degree course	Biomedical Engineering (2025)	comune	6	ING-IND/35

Stampa del 12/11/2025

Fundamentals of Computer Science [2300101]

Offerta didattica a.a. 2025/2026

Docenti: ROSA SICILIA

Periodo: Secondo Ciclo Semestrale

Obiettivi formativi
Introduction to the organization and use of a computer system, with particular attention to problem solving through computer programming. The student is also introduced to the use of methodologies and environments that allow efficient software development through the generation and reuse of high-quality modular components.

Prerequisiti
Besides the prerequisites required for accessing the Laurea programme, it is requested knowledge about the notions concerning vectors and matrices which is acquired in the course of Mathematics. Also, the ability to interact with a computer system as a user is a prerequisite.

Contenuti del corso
Elements of computer architecture. Data representation. Computer arithmetic. Boolean algebra. Structure and components of a computer system. (15 hours)
Operating systems. Structure of operating systems. Elements of process management, memory management, device management. File system and user interface. (15 hours)
Compiled languages and interpreted languages. The Python language. Structure of a Python program. Basic types and arithmetic/logical operators, statements, inputs/outputs, control structures and basic declarations. Complex data types (sequences) and built-in methods. File formats (csv, json). Data manipulation and visualization. Standard libraries and reusable software components. Advanced programs and data structures. Functions and parameter passing. Functional programming. Lambda expressions. The map and filter functions. (40 hours)
Object-oriented programming. The concept of class, subclass, and interface. Methods and attributes. Modularity and information hiding. Inheritance and polymorphism. (20 hours)
Fundamentals of software development and organization. Error handling. Code version control tools. Test-driven development. (10 hours)

Metodi didattici
Lectures/flipped classrooms and practical exercises (total of 70 hours, with 30% devoted to present examples and develop exercises).
Laboratory sessions to teach the use of software tools needed for Python programming and to develop exercises (30 hours).

Modalità di verifica dell'apprendimento
Knowledge and abilities will be assessed through a practical programming assessment (I.e. Python) and by an oral test focusing on theoretical topics covered by the course programme. The student must also demonstrate that he/she is familiar with and able to adequately apply the methodologies and techniques presented in the course. The final score is expressed as a fraction of 30. Minimum passing grade is 18 at each of the two tests. The practical evaluation and the discussion of the theoretical topics contribute respectively for 3/5 and 2/5 to the final score.

Testi di riferimento
Lecture notes, Powerpoint presentations, exercises, distributed in electronic format at http://elearning.unicampus.it/.

The course content is available in English in the following textbooks:
• J. Hunt, "A Beginners Guide to Python 3 Programming", Springer
• Luciano Ramalho, Fluent Python, O'Reilly
• Online documentation of Python packages

Altre informazioni
Knowledge and understanding.
The course will transfer to the student the following knowledge and understanding skills:
• Knowledge and understanding of the basic elements of computer architectures.
• Knowledge of user interfaces for interacting with a computer system.

• Knowledge of the representation and storage of data in computer systems.
• Knowledge and understanding of the basic principles of object-oriented programming.
• Knowledge of one or more programming languages that support modular development and reuse of software in a distributed environment.
• Knowledge and understanding of basic algorithms on multidimensional sequences and data structures.
• Knowledge of methodologies for ensuring software quality and documentation.
• Knowledge of software development and maintenance support tools.

Apply knowledge and understanding.
At the end of the course the student will be able to:
• Manage data and software applications in a standard computing environment.
• Understand how to use reusable software components from the available documentation.
• Use a programming language to develop modular, reusable software components.
• Perform quality control of software components and prepare the necessary documentation for their reuse.
• Manage the development cycle of software components.

L'attività didattica è offerta in:

Facoltà Dipartimentale di Ingegneria

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Degree course	Biomedical Engineering (2025)	comune	10	ING-INF/05

Stampa del 12/11/2025

General English [2300106]

Offerta didattica a.a. 2025/2026

Docenti: ROBERTA ARONICA, DOCENTE_FITTIZIO DOCENTE_FITTIZIO

Periodo: Primo Ciclo Semestrale

Obiettivi formativi
The course reinforces level C1 general English

Prerequisiti
NONE

Contenuti del corso
The course focuses on level C1 general English

Metodi didattici
The whole course is taught through frontal lessons.

Modalità di verifica dell'apprendimento
The final exam is a level C1 written test

Testi di riferimento
The material will be provided by teachers.

Altre informazioni
By the end of the course, students will have strengthened a C1 level of general English

L'attività didattica è offerta in:

Facoltà Dipartimentale di Ingegneria

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Degree course	Biomedical Engineering (2025)	comune	1	L-LIN/12

Stampa del 12/11/2025

General Physics [2300104]

Offerta didattica a.a. 2025/2026

Docenti: ALESSANDRO LOPPINI

Periodo: Ciclo Annuale Unico

Obiettivi formativi
The course aims to provide knowledge about the fundamentals of classical mechanics, thermodynamics and electromagnetism and give a basic knowledge of physical laws. The primary learning objective is the development in the student of the ability to grasp the essential aspects of physical processes, framing them with coherent descriptive and quantitative mathematical models related to biomedical engineering applications.

Prerequisiti
Precalculus. A basic prior knowledge of calculus is recommended.

Contenuti del corso
Modulus 1 (1st Semester)
- Introduction. Physical quantities, measurement units systems. Scalar and vector quantities.
- Kinematics in one and two dimensions. Displacement, velocity, acceleration. Motion at constant acceleration. Falling body. Circular motion. Projectile motion.
- Single particle dynamics: Newton's laws. Inertia principle. Mass and force. The second and third laws of motion. Inertial and non-inertial reference systems. Weight force. Constraints and contact forces. Strings and springs. Friction. Drag forces
- Work and kinetic energy. Conservative forces and potential. Conservation of mechanical energy. Impulse and linear momentum. Systems of particles. Center of mass.
- Conservation of linear momentum. Kinetic energy of a system. Collisions.
- Rotations and rigid bodies dynamics. Torque. Moment of Inertia. Rotational kinetic energy. Rigid body rotation with fixed axis. Rolling motion. Static equilibrium. Elastic properties of solids.
- Angular momentum and conservation of angular momentum. Newton’s law of gravity and gravitational field. Kepler’s laws.
- Oscillations. Harmonic motion. Damped oscillations. Driven oscillations and resonance.
- Fluids. Density and pressure. Stevin's law. Buoyant force and Archimedes' principle. Fluids in motion: inviscid fluids and Bernoulli equation. Torricelli's law. Viscid fluids and Poiseuille's law.
- Thermodynamics and thermodynamic systems. Equilibrium states. Temperature and Kinetic theory of gases. Thermal equilibrium and thermometers. Zero law of thermodynamics. Ideal gases. Heat and specific heats. Latent heat. Thermodynamic processes. Work. Joule's experiment and first law of thermodynamics. Internal energy. Transfer of heat. Heat engines and the second law of thermodynamics. Thermodynamic cycles. Carnot engine. Irreversibility and Entropy.

Practical sessions on selected problems will be delivered for a total of 24 hours.

Modulus 2 (2nd Semester)
- Electric charge. Conductors and insulators. Coulomb's law. Electric field of discrete charge distributions.
- Electric field of continuous charge distributions. Gauss's law.
- Electrostatic potential energy and electric potential. Capacitance and capacitors. Electrical energy. Batteries.
- Electric current and Direct-Current circuits. Ohm's laws. Kirchhoff's rules. Combination of capacitors and resistors. Joule's effect. RC circuits.
- Magnetic force on moving charged particles, straight current-carrying wires and current elements. Torques on current loops. Hall effect.
- Sources of magnetic field. Biot-Savart law. Gauss's law for magnetism. Ampère's law.
- Magnetic flux. Induced electromotive force and Faraday's law. Len's law. Inductance. Magnetic energy. RL circuits.
- Displacement current and Maxwell-Ampère law. Maxwell's equations in integral and local form. The wave equation for electromagnetic waves. Electromagnetic spectrum.
- Properties of light. Reflection and Refraction. Polarization.
- Geometrical optics: lenses, mirrors, optical systems.

Practical sessions on selected problems will be delivered for a total of 16 hours.

Metodi didattici

Theoretical and practical lectures focused on the topics of the course. Teaching methods involve frontal lectures, slides and whiteboard.

Modalità di verifica dell'apprendimento

Methods and Criteria for Learning Assessment:
Learning is evaluated through two written tests designed to assess the student's preparation on the theoretical and practical topics presented during the course. The first test focuses on the content of the first module (Mechanics and Thermodynamics) and it will be delivered at the end of the first semester. The second test is focused on the content of the second module (Electromagnetism and Optics) and it will be delivered at the end of the second semester. Each test lasts 2 hours and 30 minutes and includes 4 practical problems and 2 theoretical proofs on physical laws presented in class. Problems solution and theoretical proofs must be carried out by explicitly detailing all the mathematical steps required to derive the final results. Following each written test, in case of a grade equal or greater than the minimum score to pass, the student may take an optional oral exam. The oral exam grade will be considered as the final one. If the student fails the oral exam or rejects the final grade, the written test will be invalidated.

Criteria for Measuring Learning and Assigning the Final Grade:
The final grade is calculated based on the results of the exams related to each module. Each problem and theoretical proof is evaluated with a minimum of 0 points and a maximum of 5 points, depending on the correctness of the solution and the clarity of the mathematical steps. The maximum score is 30 for each module. To pass the exam, a minimum score of 18 is required on each test. The final grade will be computed as the weighted average of the scores of the exams related to the two modules. Cum Laude is awarded at the discretion of the lecturers in case of maximum score and particular clarity and completeness in the exposition of the topics.

Testi di riferimento

- Slides and material produced by lecturers and uploaded on the e-learning platform.
- Suggested textbooks: Physics for Scientists and Engineers, Extended Version. 6th Edition, 2020. Paul A. Tipler, Gene Mosca. Macmillan.

Altre informazioni

Knowledge and understanding
Students will achieve an adequate knowledge of physical laws and related mathematical aspects on broad aspects of classical physics, including:
- Kinematics and Newtonian dynamics.
- Fluids.
- Calorimetry and thermodynamics.
- Electromagnetism and geometrical optics.

Students will learn methodological-operational aspects of physics to interpret and describe medical and engineering problems.

Applying knowledge and understanding
At the end of the course, students will be able to correctly use theoretical knowledge to solve for practical problems and applications. Students will be able to interpret physical laws and apply them in different fields typical of medical and bioengineering applications.

Making judgments
At the end of the course, students will be able to combine the acquired theoretical knowledge and practical experience to assess and analyze physical phenomena, by making assumptions and decisions in a consistent and reasoned way.

Communication skills
Students will develop the ability to describe physical laws at different levels of detail. In particular, they will be able to use both a proper technical vocabulary and calculus skills to explain physical processes and the models behind them.

Learning skills
The class will provide individual skills in learning new topics by working on the basic knowledge acquired during the lectures. Students will acquire the capacity to learn advanced details on the topics presented and to extend their knowledge on further aspects of modern physics and on biomedical and bioengineering applications.

L'attività didattica è offerta in:

Facoltà Dipartimentale di Ingegneria

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.

Degree course	Biomedical Engineering (2025)	comune	12	FIS/07, FIS/03

Stampa del 12/11/2025

Initial skills Verification - Mathematics [2300VER01]

Offerta didattica a.a. 2025/2026

Docenti:

Periodo: Ciclo Annuale Unico

Syllabus non pubblicato dal Docente.

L'attività didattica è offerta in:

Facoltà Dipartimentale di Ingegneria

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Degree course	Biomedical Engineering (2025)	comune	0	MAT/08

Stampa del 12/11/2025

Italian [2300107]

Offerta didattica a.a. 2025/2026

Docenti: ROBERTA ARONICA, DOCENTE_FITTIZIO DOCENTE_FITTIZIO

Periodo: Primo Ciclo Semestrale

Obiettivi formativi
The course is aimed at enhancing knowledge of the language. The object of the course is to go into detail with elementary Italian grammatical and syntactic structures. The teaching activities are taught by native speakers who collaborate with the University Language Centre.

Prerequisiti
Each student is required to take a placement test to identify their initial level of Italian. Students with a level B1 or higher can obtain exemption.

Contenuti del corso
In the 1 CFU semester-long curricular course, elementary logical-grammatical structures and Italian vocabulary are studied in depth.

Metodi didattici
The course is offered in the classroom through lectures and exercises.

Modalità di verifica dell'apprendimento
Final exam.
Learning assessment is conducted via a written test consisting of grammar exercises, text comprehension, writing and listening.

Lexical and grammatical knowledge and skills related to comprehension and written production are evaluated through a written test and a listening test with a respective open-ended comprehension questions at course level. Communication skills (speaking) are assessed by the teacher during the course through interactive activities. The test is evaluated on a pass or fail basis.

Testi di riferimento
The teacher will provide the teaching material during the course.

Altre informazioni
By the end of the course, the student must have acquired elementary level knowledge of Italian.
Knowledge and understanding
At the end of the course, the student should be able to:
- read and understand texts in Italian and answer comprehension questions;
- understand conversations and answer questions about what has been heard;
- produce a written text on a general topic of at least 100 words.

Ability to apply knowledge and understanding
The student will be encouraged to develop a critical approach in their comprehension capabilities by listening to Italian audios and in written production through teaching methods gradually introduced during the course. Students will be urged to independently self-correct their own papers while verifying the level of understanding of other texts analyzed during the frontal lessons.

L'attività didattica è offerta in:

Facoltà Dipartimentale di Ingegneria

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.

Degree course	Biomedical Engineering (2025)	comune	1	L-LIN/12

Stampa del 12/11/2025

Mathematics [2300102]

Offerta didattica a.a. 2025/2026

Docenti: MARTA MENCI

Periodo: Primo Ciclo Semestrale

Obiettivi formativi
The course provides the students with the basic mathematical tools needed in engineering
and is designed to increase their knowledge and understanding skills in the framework of Mathematical Analysis and Linear Algebra. Students get also acquainted with setting up and solving mathematical problems, with the aid of many examples. By the end of the course, students should successfully tackle and solve nontrivial mathematical exercises, together with a clear understanding of the most important theoretical results discussed. The course equips students with the essential theoretical and practical foundations to build upon in their future engineering studies and applications.

Prerequisiti
Fundamentals of algebra: first and second degree equations and inequalities, rational and irrational equations and inequalities, exponential and logarithmic equations and inequalities, systems of equations and inequalities. Fundamentals of trigonometry. Geometry: line, circle, parabola, ellipse, hyperbola.

Contenuti del corso
Linear Algebra:
Vector spaces. Vector subspaces. Linear Independence. Generator sets. Bases and dimension of a vector space. Vectors in Euclidean space. Matrices. Elementary matrices. Operations with matrices and properties. Transpose and Inverse of a Matrix and properties. Rank and Determinant of a Matrix and properties. Systems of linear equations: existence of solutions and calculation. Rouchè-Capelli Theorem.

Calculus and Real Analysis:
Number sets. Properties of real numbers and inequalities. Complex numbers: operations with complex numbers and properties, roots of complex numbers. Functions and limits. Fundamental functions and compound functions. Definition of limit of a function of a real variable. Computation of limits. Derivatives: definition and geometric meaning. Derivation rules. Monotony, convexity and concavity. Critical and inflection points. Relative and absolute minima and maxima. Continuity and differentiability of functions. Approximation of functions, Taylor polynomials. Integration. Riemann Integral. Riemann sums. Integrable functions. Fundamental theorem of calculus. Primitives of a function. Indefinite integrals. Rules for calculating indefinite integrals. Definite integrals. Application to the calculation of areas. Linear ordinary differential equations of first and second order.

Metodi didattici
The course topics will be addressed during the lessons with the lecturer. In particular, 20 hours will be devoted to the solutions of guided exercises, aimed at illustrating the use of the proposed solution methodologies and their application in specific contexts.

Modalità di verifica dell'apprendimento
Knowledge and skills will be verified by means of a written test including 4 practical open-form exercises and 4 multiple choice questions. The exercises and the questions will focus on the following topics: vector spaces, matrices, systems of linear equations, functions of one real variable, integration of real functions, and Linear Ordinary Differential Equations.
The choice of the open-form for the exercises is aimed to assess the effective degree of learning and the autonomous elaboration ability of the students, as described in the course objectives. In particular, the written test aims to reward the ability to identify the most important aspects of each topic and to expose them correctly but also in a synthetic fashion. In the theoretical questions students are called to answer to questions mainly related to the theoretical contents of the course program. The written test total score is 32 (maximum) and the time assigned for the test completion is 2 hours. The exam involves an evaluation which is expressed as a grade of out of 30. An exam is deemed to be passed successfully if the grade of written test is equal to or higher than 18/32. If the grade of the written test if higher than 30, the final mark of the exam is 30 cum laude.

Testi di riferimento
- Notes of the lessons, accessible through the elearning page of the course on the online platform

https://elearning.unicampus.it/.
- Book “Mathematics – solved exercises and theory review”.
Authors: M. Buscema, F. Lattanzi, L. Mazzoli, A. Veredice, M. Papi
Editor :Società Editrice Esculapio

Altre informazioni

The course will provide students with knowledge and understanding in the following areas:
- Linear Algebra: vector spaces, matrices, systems of linear equations;
- Differential and Integral Calculus: study of the main analytical properties of real-valued functions, linear ordinary differential equations.
By the end of the course, students will be able to describe the nature of vector spaces, discuss the consistency of systems of linear equations, solve linear ordinary differential equations of first and second order, study and represent real-valued functions using the tools of differential and integral calculus.
Students will apply the acquired knowledge to solve problems of practical use (problems involving operations with matrices, vectors, calculation of areas by means of definite integrals and dynamics described by linear differential equations).

L'attività didattica è offerta in:

Facoltà Dipartimentale di Ingegneria

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Degree course	Biomedical Engineering (2025)	comune	10	MAT/08

Stampa del 12/11/2025

OFA-Matematica [2300OFA01]

Offerta didattica a.a. 2025/2026

Docenti:

Periodo: Ciclo Annuale Unico

Syllabus non pubblicato dal Docente.

L'attività didattica è offerta in:

Facoltà Dipartimentale di Ingegneria

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Degree course	Biomedical Engineering (2025)	comune	0	MAT/08

Stampa del 12/11/2025

Physiology and Anatomy [2300109]

Offerta didattica a.a. 2025/2026

Docenti: GIOVANNI DI PINO, GIORGIO VIVACQUA

Periodo: Ciclo Annuale Unico

Obiettivi formativi
Student must acquire knowledge and understanding of the general organisation of the human body and the specific models and rules that determine its function, with comprehension of the morphology and quantitative aspects of function of cell, tissues and organs, both at a macroscopic and microscopic level.

Prerequisiti
Chemistry, Physics and general knowledge of Molecular Biology

Contenuti del corso
Physiology
Including, but not limited to the following topics: Feedback and feedforward controls and homeostasis (models in physiology, homeostasis, control systems, negative and positive feedback control); Diffusion and transport (basic concepts of transport of material, Gibbs-Donnan equilibrium, mass and molecular transport, Fick's law of diffusion, transport of solutes across membrane); Ion channels (types of ion channels, permeability, selectivity, transport mechanisms using conveyors); Membrane resting potential and action potential (basic physical concepts, membrane potential, equilibrium potential, Nernst equation, Goldman-Hodgkin-Katz equation, equivalent circuit, action potential, Hodgkin-Huxley model, refractory period); Conduction of electrical signals in nerve fibers (electrotonic conduction, point-by-point regeneration of action potential, electrical model of an axon, time and space constant, types of axons, saltatory conduction); Synapses and synaptic integration and plasticity (types of synapses, postsynaptic potentials and receptors, neurotransmitters, neurosecretion, synaptic integration, synaptic plasticity); Muscle physiology (properties of muscle cells, types of muscle tissue, structure of a skeletal muscle fibre, excitation-contraction coupling, muscle action potential, motor unit, isometric and isotonic contraction, length-tension relationship, types of reflexes, smooth muscle physiology); Hill's model (mechanical model of the muscle: passive and active component, Inttrafusal fibers, role of gamma-motoneurons); Autonomic nervous system (autonomic branches, receptors of autonomic system, reflexes in autonomic motor system, central autonomic network); Cardiac physiology (cardiac cycle, cardiac output regulation, cardiac metabolism, coronary circulation); Blood volume and principles of haemodynamics; Respiratory system (respiratory mechanics, pressure in the respiratory system, lung mechanics, pulmonary compliance, surface tension, respiratory resistance); Blood transport of gas; Renal physiology (regulation of RBF and GFR, glomerular function, mechanics of urine production, renal clearance); Renal hormones and acid-base balance; Digestive system and liver (digestive apparatus, enteric nervous system, gastrointestinal motility); Endocrine system physiology and pancreas; Visual physiology (eye optics, retina, visual acuity, phototransduction, visual cortex); Auditory physiology and vestibular system (sound waves, subdivision of the ear, transduction mechanism in the ear, sound characteristic, cochlea); Somatosensory system (touch, proprioception, pain); Motor system physiology (motor control, motor pathways, types of movements, motor centres, locomotion).
Anatomy
General organization of the cell. Cytology and basic cell biology: structure of cellular membranes, cytoplasm and cytoplasmic organelles, principles of DNA and RNA visualization and function. Cells differentiation and specialization. Stem cells. The different tissues of the body: epithelial tissue, connective tissues, muscular and nervous tissue. Morphological bases of neuronal networks. Elements of tissue engineering.
General overview of the body and the apparatuses with elements of comparative anatomy of the vertebrates. Locomotor Apparatus: general overview, structure of the bones and anatomical bases of static and kinematics. Structure of the joints and focus on anatomical bases of prosthesis applications. Organization of the Central Nervous System and peripheral nerves. Cerebral cortex and morphological bases of electroencephalography. Anatomical bases of perception, movement controls and memory function. Organization of sensory organs. Cardiovascular System: general organization. Structure of the arteries and veins, detailed structure of the cardiac valves and applicative aspects of tissue engineering. Respiratory System: general organization. The pulmonary Alveolus and anatomical bases of gas exchange with principles of assisted ventilation. The Urinary system: general organization, the glomerulus and the nephron. Anatomical bases of dialytic therapy.

Metodi didattici
Interactive lectures also with tutor-led small group learning and flipped classroom method.
Interactive practical lessons and exercises.

Seminars will be offered on selected topics and students will also be stimulated to research the scientific literature.

Modalità di verifica dell'apprendimento

The examination of the contents will be an integrated examination of the two modules.
With regard to the Anatomy part, the exam will consist in an oral examination, consisting of 3 questions regarding the topics of the program of Anatomy and 1 regarding the program of Histology. The student will have to explain the anatomical and histological aspects and the related functional correlates, with a precise terminology. Each question will be marked to a maximum of 9. The exam will be considered passed with a minimum mark of 18. The maximum mark of 34 will correspond to 30 cum laude.
Concerning the Physiology part, this is done through an oral interview. The acquired knowledge and understanding are assessed with questions on physiology of the main organs and neurophysiology. The ability to apply the knowledge and understanding, reworking them in a reasoned manner, is assessed with open-ended problems in applied physiology. Particular emphasis is placed on the students' communication skills and their ability to critically reformulate the learnt concepts. Students are also required to graphically represent models and relationships between physiological parameters.
At the end of the integrated course, there will be an oral exam focused on the integrated aspects of the two modules.
The final score of the exam is expressed in thirtieths. The examination takes place at the end of the course on the dates scheduled in the academic calendar.
Results of possible practical projects and exercises carried out during the course are also considered for the final score. The assessment criteria for the oral interview are: the correctness, completeness and clarity of the exposition; the ability to recognise and describe images of anatomical structures and to solve questions related to their functions; the ability to apply knowledge by integrating topics covered in the two modules.
The final score is based on an average of the assessments of the individual topics, weighted on the time of the course devoted to each specific topic.

Testi di riferimento

After the lessons covering a section of the program, students will be provided with the related didactic materials.

The main recommended textbooks are:

Texts and other learning materials
Anatomy
Gray's Anatomy for Students: With Student Consult Online Access Paperback – Illustrated, 11 April 2019
Physiology
John Hall, Guyton and Hall Textbook of Medical Physiology, 14th edition, 2020
Kandel/Koester/Mack/Siegelbaum, Principles of neural science, VI edition, 2021.
Joseph Feher, Quantitative Human Physiology: An Introduction, II edition, 2016

Altre informazioni

At the end of the course, the student should be able to:
• Describe the general organisation of the human body considered on a macroscopic and microscopic level, relating the structural organisation to the corresponding functions of systems, organs and tissues.
• Know the main indicators and physiological parameters of bodily functions, and their range of normality.
• Know the important theories behind the physiological functions and their key experimental bases.
• Model quantitatively the interaction between the studied physiological parameters and the function of the main organs with the mathematical and physics approach required by the proficient biomedical engineer practice.

L'attività didattica è offerta in:

Facoltà Dipartimentale di Ingegneria

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Degree course	Biomedical Engineering (2025)	comune	10	BIO/09, BIO/16

Stampa del 12/11/2025

The History of Biomedical Engineering in Twelve Machines [23001C1]

Offerta didattica a.a. 2025/2026

Docenti: GIAMPAOLO GHILARDI, LUCA BORGHI

Periodo: Primo Ciclo Semestrale

Obiettivi formativi
The course aims to retrace the history of the relationship between medicine and technology during the last two centuries through the role played by twelve medical instruments that literally changed the face of healthcare. In addition to the technical history of these inventions, attention will also be focused on the human factor of the protagonists of these stories and on the wider medical and scientific framework that made them possible.

Prerequisiti
No one.

Contenuti del corso
1. Introduction. Specula and forceps: to the roots of medicine.
2. The stethoscope and the instrumental diagnostic revolution.
3. The inhaler. When surgery knocked out pain.
4. The ophthalmoscope and the rise of modern ophthalmology.
5. The sphygmograph. Étienne-Jules Marey, the physician who wanted to be an engineer.
6. The X-rays apparatus. Wilhelm Röntgen and the radiological revolution.
7. The negative pressure chamber and the controversial figure of Ernst Ferdinand Sauerbruch.
8. The electrocardiograph. How to cope with a crazy heart.
9. The iron lung and the long battle against polio.
10. The microscope and the discovery of the invisible.
11. The heart-lung machine and the taboo of open-heart surgery.
12. The electroconvulsive therapy machine. Just a skeleton in the closet of modern psychiatry?

Metodi didattici
Lectures and debate.

Modalità di verifica dell'apprendimento
The final exam will take place at the end of the corresponding semester. The exam will consist in an oral talk. The questions will evaluate the students' ability to critically reformulate the learnt concepts and their ability to critically apply the knowledge and understanding.

Testi di riferimento
Textbook: Jessica Casaccia – Luca Borghi, Tools of the Trade. The History of the Relationship between Medicine and Engineering in Twelve Machines, Amazon KDP 2025

Suggested reading: Luca Borghi, Sense of Humors. The Human Factor in the History of Medicine, Amazon KDP 2022

Altre informazioni
• Knowledge and understanding of the importance of the "human factor" in the history of technical-scientific instruments and their evolution over time.
• Autonomy of judgment of the psychological, socio-cultural and ethical aspects of the instrumental evolution.
• Communication skills to be exercised and demonstrated in the personal synthesis during the oral exam about the topics discussed in class.
• Apply knowledge to the discovery and analysis of cases of "cross-fertilization" between different disciplinary areas (engineering and medicine).
• Ability to learn in the further independent analysis of other instrumental evolutions and in the comparison of these with similar current situations.

L'attività didattica è offerta in:

Facoltà Dipartimentale di Ingegneria

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Degree course	Biomedical Engineering (2025)	comune	1	MED/02

Stampa del 12/11/2025

Advanced Physics [2303201]

Offerta didattica a.a. 2025/2026

Docenti: LETIZIA CHIODO

Periodo: Primo Ciclo Semestrale

Obiettivi formativi
The Course of Advanced Physics deals with advanced concepts of classical mechanics, thermodynamics and electromagnetism and provides the basis of quantum mechanics and statistical mechanics at the heart of technologies of interest for biomedical engineers.

Prerequisiti
Formal prerequisites: General Physics. Calculus I.

Required skills: Knowledge of mathematics (algebra, trigonometry, plane geometry, study of functions), calculus, linear algebra (differential and integral calculus, in one and more dimensions, limits, vector and matrix calculus, vector operators); knowledge of the basic principles of mechanics (force, torque, energy, work), thermodynamics (heat, internal energy, first and second law of thermodynamics, entropy), electromagnetism (electric and magnetic fields, static and time-dependent, electric potential, currents, Maxwell's equations).

Contenuti del corso
Advanced Mechanics and Thermodynamics. Angular momentum theorem, physical pendulum, ellipsoid of inertia. Stirling, Otto and Diesel engines. Microscopic origin of entropy (10 hours),

Advanced Electromagnetism. Dielectrics, polarization. Magnetism in matter. Maxwell equations in differential form, in vacuum and in matter (10 hours).

Waves. General properties. Fourier analysis. Mechanical waves. Sound waves. Electromagnetic waves. Interference and diffraction. Photometry and radiometry (10 hours).

Introduction to Quantum Mechanics. Wave functions. Schrodinger wave equation and applications: Step, barrier and potential well. Tunneling effect, Harmonic oscillator. Hydrogen atom (10 hours).

Basic of solid state physics: Maxwell-Boltzmann statistics, quantum statistics. Metals, semiconductors, nanostructures, Scanning Tunneling microscope (STM), Tunnel diode, lasers. (5 hours).

Radiation-Matter interaction. Classical description and quantum description. Photoelectric effect. Interaction of photons, charged particles, neutrons with matter. Energy transfer from radiation to matter (10 hours).

Technological applications: Nuclear Magnetic Resonance, Radioisotopes, Positrons and PET (5 hours).

Metodi didattici
Lectures and flipped classrooms. The theoretical lectures are focused on theoretical concepts and conceptual examples.

Modalità di verifica dell'apprendimento
Knowledge assessment methods and criteria:

The learning assessment consists of a written exam lasting two (2) hours, containing three theoretical questions (each worth 10 points), divided into sub-questions. The written text is followed by an oral discussion. The student provides the written answers and then discusses them with the examiners to assess the student's understanding and ability to organize and sustain a technical-scientific discussion.

Criteria for measuring learning and defining the final grade:

The final grade is expressed as a fraction of 30, with 10 points assigned to each of the questions of the test. A minimum score of 18 has to be reached in each test.

The grade of 30 cum Laude is granted if the student is able to demonstrate a complete, deep and exhaustive understanding, preparation, and advanced written and oral presentation skills in all the topics covered during the exam.

Testi di riferimento

Lecture notes and lecture slides, all available on the e-learning webpage of the course at http://elearning.unicampus.it/.

Basic Textbooks:
Physics for Scientists and Engineers, Extended Version. 6th Edition, 2020. Paul A. Tipler, Gene Mosca. Macmillan.

Modern Physics for Scientists and Engineers, 2010 John C. Morrison. Elsevier.

Semiconductor devices, S.M. Sze, 2006, Wiley

More advanced material and references will be provided by the lecturer, upon request.

Altre informazioni

Knowledge and understanding. The course will transfer to the student the knowledge and understanding of advanced physical mechanisms, in mechanics, thermodynamics, electromagnetism, and the fundamentals of quantum mechanics and materials properties and behaviors, to gain a proper and deep comprehension of physical functioning of technologies used broadly in engineering and specifically in biomedical engineering.

Applying knowledge and understanding. At the end of the course the student will be able to correctly use theoretical knowledge to interpret and understand the physical laws acting in the broad field of materials properties, radiation properties, and materials-radiation interaction, applying the acquired knowledge to technologies and devices of biomedical engineering interest.

Making judgments. The acquired skills will allow students to properly use and apply physical laws in an original manner to analyze issues and problems and to design correct solutions.

Communication skills. The students will be able to describe advanced physical laws, from the conceptual level to the mathematical description, both in written and in oral form.

Learning skills.The students will acquire individual skills in learning advanced technical topics, to extend their knowledge on further aspects of modern physics and in engineering applications, with critical reasoning.

L'attività didattica è offerta in:

Facoltà Dipartimentale di Ingegneria

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Degree course	Biomedical Engineering (2022)	comune	6	FIS/03

Stampa del 12/11/2025

AI and Data Mining [2303309]

Offerta didattica a.a. 2025/2026

Docenti:

Periodo: Secondo Ciclo Semestrale

Syllabus non pubblicato dal Docente.

L'attività didattica è offerta in:

Facoltà Dipartimentale di Ingegneria

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Degree course	Biomedical Engineering (2022)	comune	6	ING-INF/05

Stampa del 12/11/2025

Biomechanics [2303303]

Offerta didattica a.a. 2025/2026

Docenti: FRANCESCA CORDELLA, FEDERICA BRESSI

Periodo: Primo Ciclo Semestrale

Obiettivi formativi
The course aims at providing the student with the knowledge for the biomechanical analysis of the human body, with particular focus on the musculoskeletal system. The student will be provided with solid theoretical and practical knowledge on kinematic analysis, on the study of muscular activity and on the analysis of physiological signals. Furthermore, tools for interpreting the obtained results will be provided.

Prerequisiti
None

Contenuti del corso
Contents for MED/34 (30 hours):

ANATOMY AND PHYSIOLOGY OF THE MUSCULOSKELETAL SYSTEM (30 hours):
• Introduction to the musculoskeletal system (bones, tendons, ligaments, cartilage, joints)
• Physiology and primary functions
• Symptoms and Musculoskeletal System Disorders
• Clinical evaluation techniques
• Common therapies for the musculoskeletal system

Contents for ING/IND34 (60 hours):

1. FOUNDATIONS OF BIOMECHANICS (4 hours)
• Introduction to biomechanics and applications

2. BIOMECHANICS OF THE UPPER LIMB (20 hours)
• Kinematics analysis
• Dynamics analysis
• Methods for data collection and processing (through lectures and laboratory activities)
• Tools for data interpretation and usage for practical cases

3. MUSCULAR ACTIVITY (18 hours)
• Introduction to muscular system
• Generation and modeling of electric muscular signals
• Monitoring of muscle activity through surface and high-density electromyography
• Analysis of the electromyographic signal

4. EVALUATION OF PHYSICAL AND COGNITIVE FATIGUE (18 hours)
• Origin of physiological parameters (heart rate, respiration rate, galvanic skin response)
• Monitoring of physiological data
• Analysis of signals from physiological sensors
• Cognitive and Muscular Fatigue

Metodi didattici
Lectures (72 hours) where theoretical and practical topics will be presented. Practical lessons aims at providing students with the capability of applying theoretical knowledge to practical cases.
Laboratory sessions for acquiring data to be analyzed by means of theoretical-practical tools (MATLAB, Smart Analyzer, Vicon Nexus) (18 hours).
Group practical exercises where students will critically analyze the data acquired during the lectures and the laboratory sessions.

Modalità di verifica dell'apprendimento

The knowledge and skills related to the topics of the course are verified by:
1) multiple choice questionnaire for the module MED/34, on topics covered during the entire course. Duration of the test: 45 minutes
2) oral examination for the module ING/IND34, on topics covered during the entire course.
The teacher can verify the level of mastery of the theoretical tools and their application (acquired both in the classrooms and through personal study) as well as the level of analytical skills and formal rigor achieved by the student.
The final grade is expressed in thirtieths. The whole exam is passed if the grade obtained is greater than or equal to 18/30. The praise is given to the students who have achieved the maximum score with a final score higher than 30/30.
The content of the two modules will be assessed by means of a shared evaluation phase where the student preparation on the two modules' topics will be certified. The score for the final examination will be calculated as a weighted sum of the single grades for the contents of module MED/34 (35%) and for the contents of module ING/IND34 (65%).

Testi di riferimento

• Lecture notes distributed by the teacher.
• N. Ozkaya, M Nordin, Fundamentals of Biomechanics, second edition, Springer.

Altre informazioni

Knowledge and understanding
• Characteristics of the structures and functioning of the musculoskeletal, cardiovascular and respiratory systems.
• Methods for performing the biomechanical analysis of the human motion.
• Software tools to analyze data acquired in laboratory settings and obtain indicators about biomechanical and physiological state.

Ability to apply knowledge and understanding
• Capability to analyze and interpret the human motion
• Capability to obtain the cognitive and muscular state through physiological data and to critically analyze the results obtained during the experimental activities.

Autonomy in judging
The students will be stimulated to develop their analytical and critical skills in understanding the theoretical concepts and in evaluating the results within the experimental activities carried out during the course.

Communication skills and soft skills
Particular attention will be given to the quality of communication and to the soft skills. This objective will be pursued by: i) soliciting pro-active involvement of the students during the lectures, ii) working on group activities aimed at studying and critically analyze the data analyzed during the course.

Learning ability
The course relies on an approach based on the active involvement of the students by promoting the application of the learnt concepts to practical cases.

L'attività didattica è offerta in:

Facoltà Dipartimentale di Ingegneria

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Degree course	Biomedical Engineering (2022)	comune	9	ING-IND/34, MED/34

Stampa del 12/11/2025

Biomechatronics and Biomaterials [2303307]

Offerta didattica a.a. 2025/2026

Docenti: FABRIZIO TAFFONI

Periodo: Secondo Ciclo Semestrale

Obiettivi formativi
The course will provide students with theoretical and scientific elements on components of biomechatronic systems as well as on the properties of biomaterials, i.e. materials to be employed in contact with biological tissues.

Prerequisiti
It is required to have knowledge on Mathematics, Physics, Electronics, Chemistry

Contenuti del corso
1. Biomechatronic Module (3.0 ECTS, F. Taffoni)
• Introduction to Biomechatronics
• Biomechatronic systems – Case studies and architecture modelling
• Electronic circuits and components
• Semiconductor electronics
• Sensors and Actuators
• Control unit
• Data acquisition in biomechatronic systems.
2. Biomaterial Module (3.0 ECTS, A. Rainer)
• Introduction to biomaterials science.
• Host response to biomaterials.
• Mechanical properties and structure-property relationships.
• Elasticity, plasticity, dynamic properties. Corrosion.
• Metallic biomaterials: stainless steel, titanium alloys, cobalt alloys
• Ceramic biomaterials: bioinert and bioactive ceramics.
• Biocompatible polymers.
• Data analysis and reporting

Metodi didattici
Teaching is organized into classroom lectures (5 ECTS) and laboratory activities (1 ECTS). During the multidisciplinary classroom lectures, students will acquire the theoretical knowledge necessary to develop and test a specific device in the bioengineering field and to characterize biomaterials. In the practical laboratory activities, students will be guided by instructors to apply the fundamentals presented in the theoretical module.

Modalità di verifica dell'apprendimento
Students' knowledge and skills will be assessed through an individual written exam consisting of six open-ended questions (three for each module).

Testi di riferimento
• Notes provided by the teacher.
• Alciatore D.G & Histand B. M.(2012). Introduction to mechatronics and measurement systems. New York, NY, USA: McGraw-Hill.

Altre informazioni
Knowledge and understanding

• Understanding the multidisciplinary nature of biomechatronics and its applications in the medical field.
• Understanding relevant problems in developing biomechatronic systems and biomaterials
• Understanding how to select and sizing components for development of biomechatronic devices and biomaterials.
Applying knowledge and understanding
• Capacity to analyze real-world case studies of biomechatronic systems.

• Capacity to model the architecture of biomechatronic systems, understanding the integration of mechanical, electronic, and biological components.
• Capacity to produce preliminary projects of hardware/software sub-models of a biomechatronic systems

Autonomy in judging
Students will be stimulated to develop their analytical and critical skills in the understanding of theoretical concepts, in the identification of solutions for design, development and testing issues and in the evaluation of results of the experimental activities carried out in lab.

Learning skills
Students will learn the ability to autonomously extent the acquired knowledges and to apply and contextualize bioengineering methods to different problems not addressed within the course.

Communication abilities and soft skills
Students will be introduced to the preparation of technical presentations through in-class examples and laboratory activities. Particular attention will be given to the quality of technical communication, with a specific focus on the technical language (clarity, effectiveness, appropriateness, and formal correctness) used in both reporting and the written exam

L'attività didattica è offerta in:

Facoltà Dipartimentale di Ingegneria

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Degree course	Biomedical Engineering (2022)	comune	6	ING-IND/34

Stampa del 12/11/2025

Biomedical Research and Innovation Management and Assessment [2303310]

Offerta didattica a.a. 2025/2026

Docenti:

Periodo: Secondo Ciclo Semestrale

Syllabus non pubblicato dal Docente.

L'attività didattica è offerta in:

Facoltà Dipartimentale di Ingegneria

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Degree course	Biomedical Engineering (2022)	comune	6	ING-IND/34

Stampa del 12/11/2025

Biomedical Signal Processing [2303301]

Offerta didattica a.a. 2025/2026

Docenti: LEANDRO PECCHIA

Periodo: Ciclo Annuale Unico

Obiettivi formativi

The goal of this course is to provide a solid foundation in the principles, methods, and tools of signal processing as applied to medicine and biology. Emphasis is placed on the use of engineering and physics-based approaches to extract meaningful information from biomedical signals for diagnosis, prognosis, and monitoring of health states. The course is structured in two parts. The first part introduces fundamental concepts, including biostatistical analysis, signal acquisition, and basic signal processing techniques. The second part addresses more advanced engineering methodologies, including signal modeling, spectral analysis, and signal decomposition, with specific applications to signals such as electrocardiograms (ECG) and electroencephalograms (EEG). Finally, students will apply concepts of machine learning to tasks such as classification, regression, and clustering, in order to identify meaningful patterns and extract relevant information from biomedical data. Upon completion, students will possess both theoretical knowledge and practical skills necessary for the preparation, processing, and interpretation of biomedical data in clinical and research contexts.

Prerequisiti

This course builds on Year 1 and 2 modules. Coding skills and familiarity with tools like MATLAB are strongly recommended.
Prerequisites: Mathematics, General Physics, Computer Science, Physiology and Anatomy, Probability and Statistics, Mathematics II, Electronics, Electrotechnics, Advanced Physics.

Contenuti del corso

Module I – Core Foundations (5 CFU, Semester 1)
Part 1: Biomedical Data and Statistics (2.5 weeks)
• Descriptive & Inferential Statistics: Central tendency and variability, confidence intervals, hypothesis testing
• Parametric and Non-parametric Biostatistics: When and why to use parametric vs. non-parametric tests, t-test, ANOVA, Wilcoxon, Kruskal-Wallis
• MATLAB for Statistics: Basic syntax, statistical analysis, plotting, simple data processing

Part 2: Signal Acquisition and Fundamentals (3.5 weeks)
• Biomedical Signal Acquisition: Definition, types (ECG, EEG, EMG), acquisition chain, electrodes, INA, noise sources
• Sampling and Quantization: Sampling theorem, aliasing, A/D conversion
• Time and Frequency Analysis: Time vs frequency domain, Fourier Transform basics, PSD estimation (e.g. Welch)
• Filtering Basics: Why filter biomedical signals, FIR vs IIR filters, MATLAB filtering
• Artifacts and Cleaning: Common artifacts (ocular, muscle, movement, powerline), basic artifact reduction

Part 3: Applications in Biomedical Signals (4–5 weeks)
• Electrocardiography: ECG generation and structure, Lead systems and derivations and QRS detection methods
• Heart Rate and Variability: HR and HRV definitions, Time and frequency features, Basic non-linear measures
• EEG and Multichannel Signals: EEG overview, junction box and montages, 10–20 electrode system, Use of open-source software (e.g. EEGLAB, Brainstorm).

Module II – Advanced Signal Processing (2.5 CFU, Semester 2)
Part 1: Signals and Systems Theory
• Classification of signals: energy vs power, periodic vs aperiodic, deterministic vs stochastic
• Elementary signals: impulse, step, sinusoid, exponential
• Linear systems: time invariance, linearity, causality, stability
• LTI systems and convolution
• Fourier Series (periodic signals)
• Fourier Transform: definition, properties, physical meaning
• Frequency response of LTI systems

Part 2: Spectral and Time-Frequency Analysis
• DFT and FFT: resolution, leakage, windowing

• Power Spectral Density (in depth): periodogram, Welch
• Short-Time Fourier Transform (STFT), spectrogram
• Autoregressive models: Yule-Walker, model order selection
• Z-transform (overview, as needed for digital filter theory)
• Introduction to wavelet transform (optional depending on time)

Module III – Machine Learning on Biomedical Signals (2.5 CFU, Semester 2)
Part 3: Feature Extraction and Machine Learning on Biomedical Signals
• Overview of biological and non-biological artifacts and processing techniques
• Feature extraction from biological signals: time (e.g., intervals, amplitudes), frequency (e.g., power spectral density, frequency-band features), and non-linear features (e.g., entropy, fractal dimension)
• Introduction to supervised learning: classification vs. regression problems
• Feature engineering: selection, scaling, dimensionality reduction
• Classification algorithms, e.g., Logistic regression, k-Nearest Neighbors (k-NN), Support Vector Machines (SVM), Decision Trees and Random Forests, Basic neural networks
• Regression algorithms, e.g., Linear and polynomial regression, Support Vector Regression (SVR), Random Forest Regression
• Model validation & tuning: stratified k-fold cross-validation, grid/random search
• Performance metrics for classification (e.g., accuracy, precision, recall, F1-score, AUC-ROC) and regression (e.g., MSE, RMSE, R^2)
• Hands-on exercises (Python)

Final Project
During the second part of the course, students will work in small groups to design a biomedical experiment, acquire signals, preprocess them, extract and compare features statistically, and present results. In-class time will be dedicated to support and mentoring.

Metodi didattici
The course includes lectures presenting the main topics and exercises to demonstrate their application to specific problems (50 hours, with about half the time dedicated to examples). Laboratory sessions (25 hours) focus on the use of software tools for biomedical signal processing, combining solved problems and guided exercises. Additional time (25 hours) is dedicated to group work and individual learning, including project development, data analysis, and interpretation tasks based on real biomedical signals.

Modalità di verifica dell'apprendimento
Knowledge assessment methods and criteria:
Knowledge and skills related to the application of methods and tools for biomedical signal preprocessing and analysis will be assessed through group presentations and a final exam, which includes both written and oral components. Exercises will be similar to those presented during lectures and provided on the e-learning platform. During the oral exam, students will be expected to demonstrate their understanding, apply the techniques covered in the course, and justify the selection of appropriate methods for specific biomedical signal analysis tasks.

Criteria for measuring learning and defining the final grade:
Each component of the course is graded on a scale of 30 and is considered passed only if the score is at least 18. The final grade is the average of three equally weighted components: Module 1 (written and oral exam covering theory and practice), Modules 2 and 3 combined (written and oral exam, equally weighted), and the final group project involving signal acquisition, processing, and analysis.

Testi di riferimento
Handouts of Processing of Biomedical Signals, powerpoint presentations, exercises (including exemplary exam tests), freely distributed in electronic document at http://elearning.unicampus.it/.
- Semmlow, J. Circuits, signals, and systems for bioengineers: a MatLab-based introduction (2024, Elsevier)
- Abood S. Digital Signal Processing A primer with MATLAB (2020, CRC Press)
- Hu L. & Zhang Z. EEG Signal Processing and Feature Extraction (2019, Springer)

Altre informazioni
KNOWLEDGE AND UNDERSTANDING
The course provides students with a solid understanding of the fundamental principles underlying biomedical signal generation, acquisition, and processing. This includes knowledge of physiological, biological, physical, and mathematical concepts relevant to biomedical signals, as well as engineering and statistical methods used for their analysis. Students will also gain insight into the clinical and research contexts in which these signals are used for diagnosis, prognosis, and monitoring.

APPLIED KNOWLEDGE AND UNDERSTANDING
Students will be able to apply core techniques in signal acquisition, preprocessing, spectral analysis, and modeling, as well as apply machine learning methods for classification, regression, and clustering of biomedical data. They will learn to choose appropriate methods for specific clinical or experimental scenarios, implement them using MATLAB,

Python and other tools, and interpret the results in the context of human physiology and healthcare needs.

JUDGEMENT AND CRITICAL THINKING
The course encourages students to develop independent judgment in selecting and evaluating biomedical signal processing techniques. They will be trained to assess the suitability and limitations of different approaches based on the nature of the signal and the clinical or experimental goals. Group work and project activities will foster the ability to critically evaluate results and make informed methodological decisions.

COMMUNICATION SKILLS
Students will develop the ability to clearly present biomedical signal analysis methods and results, both orally and in written form. Emphasis will be placed on using appropriate technical language and structuring arguments in a logical, coherent manner. Through project presentations and discussions, students will learn to communicate effectively with both technical and clinical audiences.

LEARNING SKILLS
The course aims to strengthen students' ability to learn autonomously through lectures, hands-on exercises, and project work. Students will be encouraged to engage actively in class, explore additional resources, and apply a structured study method that supports both theoretical understanding and practical implementation. These skills will support continued learning in advanced topics in biomedical engineering and related fields.

L'attività didattica è offerta in:

Facoltà Dipartimentale di Ingegneria

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Degree course	Biomedical Engineering (2022)	comune	10	ING-INF/06

Stampa del 12/11/2025

Electronics and Electrotechnics [2303205]

Offerta didattica a.a. 2025/2026

Docenti: MAURO PARISE

Periodo: Secondo Ciclo Semestrale

Obiettivi formativi

Module A: Electrotechnics
The course aims to provide a thorough introduction to the operation modes of electrical systems and to the methodologies for the analysis of the linear electrical networks. Students will acquire knowledge and understanding of the basics concerning the analysis of the steady-state DC and AC linear electrical and magnetic networks, of the fundamentals of three-phase systems, of the working principles of electrical machines.

Module B: Electronics
To provide students with the basic knowledge about electronic components and devices, methodologies for circuit analysis, and on the analog and digital topologies used in the most common IC.

Prerequisiti

Module A: Electrotechnics
The a-priori knowledge of the fundamentals of Electromagnetics is strongly advised

Module B: Electronics
No preparatory.
Suggested prerequisites: basic knowledge of electrical quantities, electronic components and circuit calculation strategies normally addressed in the course of Electromagnetics and in the first module of this course: Electrotechnics.

Contenuti del corso

Module A: Electrotechnics
Steady-state DC circuits and networks. Linear time-invariant circuit elements. Voltage- and current-controlled generators. Ohm's, Joule's and Kirchhoff's laws. Series and parallel resistances. Voltage and current dividers. Wye-delta transformation. Methods of analysis. Nodal and mesh analysis. Network theorems. Linearity. Superposition principle. Thevenin's and Norton's theorems. Maximum power transfer. Circuits and networks in the time-domain. Capacitors. Capacity. Dielectric strength. Magnetic circuits. Hopkinson's law. Reluctance. Magnetic networks. Self and mutual inductance. Coupling coefficient. First- and second-order circuits. Transient response, step and impulse responses. Convolution. Networks and circuits in sinusoidal steady-state. Phasors of time-harmonic quantities. Alternating current single-phase circuits. AC power. Instantaneous, average, reactive, apparent and complex powers. Three-phase networks. Symmetrical and balanced three-phase systems. Single-phase equivalent circuit. Power in three-phase systems. Determining the three-phase and single-phase equivalent circuits corresponding to a single-wire scheme. Elements of electrical machines. Transformers. Theory of single-phase transformer. Rotary electrical machines.

Module B: Electronics
INTRODUCTION (10 h)
One-port and RCL circuits, two-port networks, STC Circuits, LP and HP filters.
SEMICONDUCTORS, DIODE AND TRANSISTOR (18 h)
Semiconductors. Diode. Circuits with diodes. BJT and MOSFET: physics, I-V characteristics, functioning as an amplifier, biasing, small-signal models, single stage amplifiers, frequency analysis.
ANALOG INTEGRATED CIRCUITS (22 h)
Differential amplifier. Operational Amplifier. Current and voltage sources. Feedback.
INTRODUCTION TO DIGITAL ELECTRONICS (10 h)
The inverter; logic family; Characteristic parameters of digital components. A / D and D / A conversion. Combinatory circuits. Sequential circuits. Memories. Microcontrollers.

Metodi didattici

Module A: Electrotechnics
Lectures on the topics of the course (35 hours)
Interactive exercises aimed at solving electrical networks and a set of electrical engineering problems, as well as focused on self-assessment of acquired knowledge, abilities, and skills (15 hours)

Module B: Electronics
Lectures presenting the basic topics of electronics, the functioning of the fundamental devices and the most common circuit topologies (36 h).
Practical training using simulation SW and during laboratory session to show the application to specific real problems (6 h).
Discussion on practical real cases by mean of the presentation of commercial components via online catalogues and datasheets (6 h).
Seminars on the current fabrication technologies of electronic devices (6 h).
Workgroups in lab for testing simple electronics circuits (6 h).

Modalità di verifica dell'apprendimento

Module A: Electrotechnics
Possession of expected knowledge and skills is assessed through a written numerical computation test, 2.5 hours in duration.

The computation test is constituted by 3 exercises, which pose 6 questions that are to be answered sequentially and independently of each other (that is to say, the answer to a given question does not depend on the answers to the preceding questions). In the first exercise, students must show to be able to solve a sinusoidal steady-state electrical network problem, that is to calculate current intensities, voltages, and power associated with the various components of the electrical network. Thevenin's equivalent voltage source must be determined too. The second and the third exercises require, respectively, to solve a magnetic circuit problem and to study a three-phase network with balanced loads starting from the knowledge of its single-wire diagram. Students are asked to solve the problem on paper and, after digitizing the summary of the obtained numerical answers, to upload the generated pdf file on e-learning platform by using the "assignment" activity. Students are also asked to upload the solution that has led to the numerical answers, so as to make it possible to check the correctness of the used procedure.

The final grade is five times the overall number of correct answers out of the six asked questions. The applied criteria for checking the correctness of the answers are as follows:

The single answer is deemed to be correct unless:
- the numerical result is not correct;
- the numerical result is only accidentally correct, since the uploaded solution has revealed a wrong procedure underlying its derivation.

The exam is deemed to be passed successfully if and only if the final grade is equal to or higher than 18 points.

Module B: Electronics
The Knowledge assessment methods will be based on oral tests.
This strategy for oral test will allow the verification of the student's communication skills regarding the specific topics of the course. The oral exam will take place gradually, allowing to verify the consolidation of basic knowledge and, gradually developing the required topic, allowing the student to demonstrate her/his ability to generalize the operation to more complex systems and apply this knowledge to the resolution of real simply problems.

The knowledge and skills acquired will be verified by means of a test structured into three moments in the context of a single oral test: a written question in which the student will have to demonstrate her/his mastery of the fundamental topics for which she/he will have 30 minutes; the content of this work will be presented by the student at the beginning of the oral exam (score from 0 to 10); a second question with which the student will be asked to apply their knowledge to the solution of a real problem (score from 0 to 15); a third question on classroom or laboratory exercises (score from 0 to 5).The final mark out of thirty will be the sum of the two scores obtained in the two tests above.
The minimum sufficient mark to pass the exam, equal to 18/30, can be achieved by the student who will have demonstrated knowledge of the components and circuits presented in the course, knowing how to explain them in their most basic contents.

Testi di riferimento

Module A: Electrotechnics
Alexander C. and Sadiku M., Fundamentals of Electric Circuits, 6° ed., McGraw-Hill Education, 2017
Chapman S., Electric Machinery Fundamentals, McGraw-Hill Education, 2003

Module B: Electronics
Material provided by the teacher

Suggested textbooks

The Art of Electronics
Paul Horowitz, Winfield Hill
Cambridge University Press, Third Edition (2015)

Altre informazioni

Module A: Electrotechnics
- Students will acquire knowledge and understanding of the basics concerning the analysis of the steady-state DC and AC linear electrical and magnetic networks, of the fundamentals of three-phase systems, of the working principles of transformers and rotary electrical machines.

- Students will be able to apply knowledge and understanding to the analysis of a steady-state DC or AC linear electrical network. They will be able to read and interpret single-wire diagrams of balanced three-phase circuits, to study magnetic circuits and balanced and unbalanced three-phase circuits, to determine the equivalent circuit of a single-phase transformer or a rotary induction machine starting from the data sheet.

- Students will be able to evaluate the applicability of the methodologies for electrical network analysis to the study of complex electrical system. Moreover, they will be able to determine and solve the equivalent electrical circuit of an intermediate-complexity device, and to interpret the results of the circuit analysis. Finally, they will be able to identify the three-phase network described by a single-wire diagram, and to estimate the operation state of an electrical power system.

- Students will acquire the capability to communicate the learned fundamentals and methods, by making use of the appropriate terminology. He will also be able to discuss how to formulate and solve problems in the area of electrical engineering, with specialized and non-specialized professionals.

- Through the course training, students will acquire the learning skills required to undertake specialized studies in the area of electrical engineering, and to face the subsequent courses focused on specific electrical systems with a high level of autonomy.

Module B: Electronics
Applying knowledge and understanding
The acquired knowledge will give the student the ability to engage in a conscious and proactive way with the latest and most common IC and electronic technologies used in his professional field.
Making judgements
The student will gain the ability to enrich his/her knowledge thanks to his/her skill in reading ant interpreting technical documentation (e.g. datasheets).
Communication skills
The student will have to develop the ability to communicate, in a synthetic way and in general terms, the functioning of a component or an electronic circuit and to justify the choices made.
Learning skills
The student will be able to expand his knowledge thanks to the ability to read and interpret the technical documentation.

L'attività didattica è offerta in:

Facoltà Dipartimentale di Ingegneria

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Degree course	Biomedical Engineering (2022)	comune	11	ING-IND/31, ING-INF/01

Stampa del 12/11/2025

Fundamentals of Anthropology and Ethics [2303210]

Offerta didattica a.a. 2025/2026

Docenti: GIAMPAOLO GHILARDI

Periodo: Primo Ciclo Semestrale

Obiettivi formativi
The course aims to provide a clear understanding of the rich and large set of values, virtues, and moral characteristics which relate to Engineering and its practice. Other than this, due to the connection with bio-medical sciences, the course will also provide an insight to the core values of medical practice.

Prerequisiti
None

Contenuti del corso
Anthropology: Introduction/general overview. What anthropology is. On Truth. Anthropology and Technologies. Homo faber/homo sapiens. Anthropology and industry 4.0. Anthropology and Engineering. Transhumanism. Posthumanism. Humanism and humanities. Leonardo and humanism. Recap of the programme.

Ethics: Introduction/general overview. What ethics are. Why ethics in Engineering. Ethical schools. Free will. Libet's experiments on free will. The trolley dilemma. Utilitarianism and consequentialism. Consciousness. Agency: what does it mean to be a moral agent. The notion of personhood. Virtues. Epistemic virtues. Happiness and its value in professionalism. Professional virtues. Virtues for science. The good scientist. Precision Medicine or Personalized Medicine hoe technology can carry out the project. Recap of the programme.

Metodi didattici
The aims of the class will be achieved by a combined approach involving a traditional inductive teaching method (10 h.), video projections (2 h.), Power Point presentations (10 h.) and interactive learning (8 h.). These different teaching approaches will be combined. The students will always be stimulated and will not be treated as passive learners but they will be called to actively participate in the lectures. The teaching methods promote classroom engagement and cooperation. Both the interactive lectures and group activities will entail the active involvement of students.

Modalità di verifica dell'apprendimento
The final exam will take place at the end of the course, in the sessions scheduled by the academic calendar. The exam will be written, involving a combination of multiple choice and possible short answer questions. The questions will test the knowledge related to the Aims and Objectives of the course, described above, and the ability to apply it. The written test will take 30 minutes, it entails 11 questions, for every correct answer 3 points will be given, no penalty for the wrong ones.

Testi di riferimento
Anthropology:
• G. Ghilardi, Elements od Anthropology and Ethics, KDP, 2025
• G. Ghilardi, "Analogia Sensuum: The knowing body", in: N. Di Stefano, V. Tambone (eds.), About the living body, Nova science, New York 2016, pp. 15-31
• G. Ghilardi, D. Accoto, Post-Human and Scientific Research: How Engineering Carried Out the Project, in Cuadernos de Bioetica, (3), 2014, pp. 379-86.

• V. Tambone, G. Ghilardi, "An ethical evaluation methodology for clinical cases", Persona y Bioética, 20 (1), 2016, pp. 48-61
• G. Ghilardi, "Epistemological remarks on Libet's experiments on free will", Rivista Internazionale di Filosofia e Psicologia, 6 (1), 2015, pp. 110-119
• V. Tambone, G. Ghilardi, Philosophy and Deontology of Medical Practice, Ethics of the work well done in bio-medical sciences, SEU, Roma 2020
• L. Campanozzi, G. Ghilardi et al., Building trust in social robotics: a pilot survey, IEEE Technology and Society Magazine, December 2019, doi 0.1109/MTS.2019.2948440, pp. 45-54. ISSN 0278-0097/19

Altre informazioni
- Knowing and understanding what means to be a human being, what human values and virtues are.
- Applying knowledge and understanding and develop ethical reasoning in biomedical sciences.
- Being able to give an ethical assessments of Technological products

L'attività didattica è offerta in:

Facoltà Dipartimentale di Ingegneria

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Degree course	Biomedical Engineering (2022)	comune	3	M-FIL/03

Stampa del 12/11/2025

Fundamentals of Automatic Control [2303312]

Offerta didattica a.a. 2025/2026

Docenti: FILIPPO CACACE

Periodo: Primo Ciclo Semestrale

Obiettivi formativi
Specific Learning objectives:
The course aims at providing the basic notions for the analysis of the systems and for the design of basic controllers. The student will learn how to design and evaluate a controller for linear stationary systems.

Prerequisiti
Linear algebra, calculus and basic notions of programming in Matlab.

Contenuti del corso
Systems theory. Linear continuous-time and discrete-time systems. Superposition principle. Natural modes, free and forced evolution. Stability. Lyapunov stability criteria. Laplace and transform. Transfer functions. Bode diagrams. Control theory and design. Nyquist criterion. Transient and steady-state control specifications. Proportional, integral, derivative controls. Compensators with leading and retarding networks. Compensators with the roots locus. State space representation. Controller design in state space. Eigenvalue assignment. Observers. Separation principle. Output feedback controller design. Numerical simulation of systems in Matlab. Numerical evaluation of controllers in Matlab.

Metodi didattici
Lectures presenting the content of the course, guided exercises to show their application. Interactive simulation sessions in Matlab.

Modalità di verifica dell'apprendimento
Knowledge and abilities concerning the topics of the course are assessed through an oral discussion, in presence.
The oral test lasts about 20 minutes and it includes the illustration of the core concepts and results of system theory and control design. Specifically, in the oral test each student will discuss 3 topics concerning systems theory, frequency-based control design, and time-domain based control design. The topics are chosen by the teachers. Each candidate discusses these topics with two distinct teachers.
Students may discuss at the oral test their solution to the homework proposed during the course, that can be downloaded from the page of the course on the e-learning platform. In this case, the oral test will concern concepts related to the homework.
The final grade will be expressed as a fraction of 30 and calculated as the average of the scores of the three questions. The score is determined by the ability to explain the core topics of the course and establish at least some conceptual link among them. Praise is attributed when the candidate exhibits a high level of mastery on the subjects of the oral test.
Formal proofs of the theoretical results, as well as the knowledge of numerical tools relevant to analysis and design of control systems are not requested to pass the exam but they contribute to a positive evaluation. Illustrative examples may be discussed, but detailed or lengthy calculations are not necessary.

Testi di riferimento
The contents of the course can be found in English in the following textbook:
• Åström, K. J., & Murray, R. (2021). Feedback systems: an introduction for scientists and engineers. Princeton University Press.

Altre informazioni
Specific learning outcomes:
Knowledge and understanding.
The course will transfer the following knowledge and understanding to the student:
• The representation of systems through input, state and output for discrete-time and continuous-time systems

• The basic notions of stability, feedback and control.
• The specifications of the desired closed-loop system behavior.

Applying knowledge and understanding. At the end of the course the student will be able to:
• Understand the behavior of a linear time invariant system from the diagram of its frequency response.
• Tune a PID controller to meet the control specifications.
• Develop the conceptual design of a state-feedback and output-feedback controller in state space form.

Making judgments. The knowledge and understanding skills acquired must give the student the ability to evaluate a control design with respect to the control specifications.

Communication skills. The student will develop the ability to understand the features of a system described by frequency response diagrams and to write the control specifications relevant to a given application.

Learning skills. The student will possess the core concepts to learn more advanced control approaches for broader classes of systems.

L'attività didattica è offerta in:

Facoltà Dipartimentale di Ingegneria

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Degree course	Biomedical Engineering (2022)	comune	9	ING-INF/04

Stampa del 12/11/2025

Fundamentals of Bioengineering [2303304]

Offerta didattica a.a. 2025/2026

Docenti: FABRIZIO TAFFONI

Periodo: Secondo Ciclo Semestrale

Obiettivi formativi
The purpose of the course is to provide students with some basic knowledges and skills needed for multidisciplinary design, development, integration, and virtual testing of devices for bioengineering applications.
The course aims at making students able to: i) apply mechanical, electronic, and simulation principles for the development of devices in the bioengineering field; ii) concurrently design hardware and software sub-modules for complex human-centered devices; iii) prototype sub-modules and integrate them into a hybrid (physical-virtual) demonstrator; iv) perform experimental activities for functional bench testing and validation in simulated environment.

Prerequisiti
It is required to have knowledge on Mathematics, Physics, Geometry, Mechanics of Solids, Electronics, Programming.

Contenuti del corso
1. Multidisciplinary design, integration, and testing in bioengineering (0.5 ECTS - Lecture)

2. Applied mechanics for bioengineering (1.5 ECTS – Lecture; 0.5 ECTS Laboratory)
• Fundamentals of mechanical design
• Sizing and verification of machine components
• Design of machines and biomechanical systems through CAE

3. Applied electronics for bioengineering (1.5 ECTS – Lecture; 0.5 ECTS Laboratory)
• Technical specifications and selection criteria of electronic components
• Introduction to electronic architectures for bioengineering systems
• Introduction to communication standards for interoperability

4. Bioengineering hardware integration and prototyping (0.5 Lecture; 1 ECTS - Laboratory)

5. Virtual environment for human-centered applications (1 ECTS - Lecture; 1 ECTS- Laboratory)
• Introduction to simulation environments
• Designing/building user-centered virtual scenes

6. Human-system interface development and customization (1 ECTS - Lecture; 1 ECTS - Laboratory)
• Introduction to multimodal human-machine interfaces for the control of biomedical devices
• Introduction to sensory feedback in human-machine interface
• Methods for designing/building user-centered control strategies for biomedical devices

7. Bioengineering software/hardware integration (0.5 ECTS - Laboratory)

8. Experimental functional testing and validation (1.5 ECTS - Laboratory)

• Setting experiments and define validation metrics
• Bench testing and human-in-the-loop validation
• Data analysis and reporting

Metodi didattici
Teaching is organized in classroom lectures (6 ECTS) and laboratory activities (6 ECTS). In the classroom multidisciplinary lectures, students will be provided with the theoretical knowledge necessary to develop and test a specific device in the bioengineering field.
In the practical laboratory activities students will be divided in small groups (4-5 students) and will be driven by the instructor to apply fundamentals presented in the theoretical module to design, develop, integrate, and virtual test a specific demonstrator for a bioengineering application in a specified use case. Finally, each group will be asked to

prepare a final presentation on the laboratory activity, which must be discussed during the oral exam by the group.

Modalità di verifica dell'apprendimento

Knowledge assessment methods and criteria:

Knowledges and skills developed by the students will be assessed thanks to an individual oral exam (50% of the final grade) and to a group presentation on the practical activities carried out in the laboratories (20% of the final grade) followed by a Q&A session (30% of the final grade). The individual oral exam aims at assessing the acquisition of the theoretical knowledges on the fundamentals of bioengineering; the group presentation aims at assessing the capacity of teamworking in a multidisciplinary context and the communication skills, while the Q&A aims at rating the personal contribution to the group activities and the personal capability in applying technical knowledge to the practical problem.

Criteria for measuring learning and defining the final grade:

The final grade will be the weighted mean of the partial scores given to: the individual oral exam on theoretical fundamentals of bioengineering, the presentation of the group work on laboratory activities, and to the personal capacity to apply theoretical knowledge to the laboratory problem. Students will be assessed with a numeric score expressed on a scale between 1 and 31. Laude will be awarded to all those students whose final mark exceeds the threshold of 30.5 (without rounding) and with the unanimous opinion of the commission.

Testi di riferimento

• Notes provided by the teacher.
• Kutz, M. (2009). Biomedical engineering and design handbook (Vol. 1). New York, NY, USA:: McGraw-Hill.
• Jerald, J. (2015). The VR book: Human-centered design for virtual reality. Morgan & Claypool.
• Boy, G. A. (Ed.). (2017). The handbook of human-machine interaction: a human-centered design approach. CRC Press.

Altre informazioni

Knowledge and understanding
• Knowledge of fundamentals of bioengineering and of concurrent design for the development of human-centered devices including mechanical, electronic and software components.
• Understanding relevant problems in developing bioengineering integrated systems interfacing with humans.
• Knowledge of fundamentals for practically develop in the laboratory sub-module prototypes and integrate them into a demo complete device.
• Knowledge of fundamentals to set and perform experimental activities to test the developed device in a simulated environment.
• Understanding how to analyze data collected during experimental activities, critically discuss results and provide motivations and explanations on the outcomes.
Applying knowledge and understanding
• Capability to design hardware/software sub-models for a human-centered device.
• Capability to develop sub-module prototypes in the laboratory.
• Capability to integrate sub-modules into a demo complete device.
• Capability to perform experimental tests on the developed device.
• Capability to analyze collected data and critically discuss results.
• Capability to present the performed laboratory activities by means of a technical presentation.
Autonomy in judging
Students will be stimulated to develop their analytical and critical skills in the understanding of theoretical concepts, in the identification of solutions for design, development and testing issues and in the evaluation of results of the experimental activities carried out during the entire course.

Learning skills
Students will learn the ability to autonomously extent the acquired fundamentals and to apply and contextualize bioengineering methods to different problems not addressed within the course.

Communication abilities and soft skills
This course wants to develop soft skills through team activities requiring the development and the experimental test of devices for bioengineering applications. Students will be introduced to the preparation of a technical presentation on the laboratory activities.
Particular attention will be given to the quality of communication, with specific reference to the spoken language (clarity, effectiveness, property of language, formal correctness) during the presentation of the slides.

L'attività didattica è offerta in:

Facoltà Dipartimentale di Ingegneria

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Degree course	Biomedical Engineering (2022)	comune	12	ING-IND/34

Stampa del 12/11/2025

Healthcare Information Systems and Telemedicine [2303204]

Offerta didattica a.a. 2025/2026

Docenti: ANNA SABATINI

Periodo: Primo Ciclo Semestrale

Obiettivi formativi
The main objective of the Healthcare Information Systems and Telemedicine course is to provide students with: (i) the concept of Healthcare as an ecosystem of different kinds of medical care, interconnected with each other and designed around the patient, (ii) the basic concepts for understanding Telemedicine by recalling its more classical version up to a more modern look in which an intensive use of intelligent systems is made, (iii) the fundamentals of technologies and the main communication protocols of a modern computer network, the use of databases and the realisation of an interface for the representation and analysis of patient data.

Prerequisiti
It is suggested to have passed the Fundamentals of Computer Science exam.

Contenuti del corso
Module I: Healthcare Information Systems
- What is a Healthcare Information System.
- Telemedicine and its evolution over the years.
- The Electronic Health Record (EHR).
- Medical data processing, informed consent and privacy management.
- Strategies for managing the patient at a distance for short or long periods.
- Outlines of Intelligent Systems applied to Telemedicine.
- Examples and use cases.

Module II: Computer Networks
- What is a Computer Network
- ISO/OSI model and TCP/IP.
- Physical components of a network, Data Link, Switch and Router.
- The design of IP networks, addressing and dimensioning plan, subnetting, VLANs.
- HTTP, HTTPS, DNS, SMTP, POP, IMAP, Peer2Peer protocols.
- Elements of SOA (REST, SOAP)

Module III: Databases
- Generalities and architecture of modern Databases
- The relational model: definition of tables and queries using SQL language and relational algebra.
- Conceptual design using the ER model and translation into the logical model.
- Queries using the SQL language and the Python language.
- The non-relational model: properties and applications.
- Data Warehousing

Module IV: Data representation and processing
- Utility of a user-side and physician-side interface.
- Types of interfaces and graphical user interfaces (GUIs, web).
- Construction of a graphical user interface.
- Querying a Database.
- Quantitative analysis and representation of data via a graphical interface.

Metodi didattici
The teaching is based on lectures and computer-based exercises, using open-source or proprietary packages and appropriate simulation and code development tools. The split between lectures and computer-based exercises is 50%-50%, respectively, unless specific needs may arise during teaching.

Modalità di verifica dell'apprendimento
Knowledge and skills relating to the course are tested by means of two tests. The first consists of project work to be carried out individually during the examination in the form of a computer-based test simulating a computer system,

which consists of the macro-blocks of: sending (simulated) data from the computer to an external repository, construction of a structured database in which to deposit the previously sent data and request with processing and visualisation via a graphical interface of different data from the database. The macro-blocks must be interconnected and cooperate in real-time. The lecturer may provide structural blocks of code to start from, from among those seen in the lectures, which must then be amalgamated and organised by the student in accordance with the outline. The project will then be discussed during the oral interview. The aim of this test is to verify that the student has acquired the design criteria of a Telemedicine system in a Healthcare environment, and the software tools for designing and building a Telemedicine system.
The second test consists of an oral interview, aimed at verifying the level of knowledge acquired by the student for the concepts concerning modern Healthcare and Telemedicine models, the design criteria of a Telemedicine system and the typical problems of data management through databases.

Testi di riferimento

Teaching materials used
- Lecturer's slides

Recommended teaching materials
- J. Kurose, K. Ross Pearson, “Reti di calcolatori e Internet. Un approccio top-down”, 2017 (7a ed.)
- P. Atzeni, S. Ceri, S. Paraboschi, R. Torlone, “Database Systems concepts, languages and architectures”, McGraw-Hill, 1999
- Dee W. Ford, Shawn R. Valenta, “Telemedicine. Overview and Application in Pulmonary, Critical Care, and Sleep Medicine”, Humana Cham, 2021
- Joan M. Kiel, George R. Kim, Marion J. Ball, " Healthcare Information Management Systems”, Springer Cham, 2022 (5a ed.)

Altre informazioni

Knowledge and understanding
Principles underlying Healthcare models in today's world, considering aspects of data privacy and the existence of intelligent systems, methods and tools for sending data in a Telemedicine system.
Design criteria for a computer network. Software tools for the design and implementation of a Telemedicine system involving a database and graphical interface for the visualisation and analysis of the collected data.

Knowledge and understanding applied in practice
The student will have to acquire specific skills:
• Know how to design and analyse a Telemedicine system, with particular reference to sending data to a database remotely via the Internet
• Know how to use the main protocols used to construct the database most suited to the objective of the Healthcare system
• Know how to build an interface for requesting data from the database and analysing them in real time.

Autonomy of judgement
The student should be able to judge which are the fundamental elements of a Telemedicine system to be used to solve real application cases in modern Healthcare.

Communication skills
The student should be able to design a telemedicine system in an appropriate development environment, and be able to explain the contents of the course in appropriate technical language.

Ability to learn
The student should be able to develop the "wide ranging" learning and reasoning skills necessary to undertake further studies with a high degree of autonomy.

L'attività didattica è offerta in:

Facoltà Dipartimentale di Ingegneria

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Degree course	Biomedical Engineering (2022)	comune	6	ING-INF/05

Stampa del 12/11/2025

Healthcare Robotics [2303308]

Offerta didattica a.a. 2025/2026

Docenti: LOREDANA ZOLLO

Periodo: Secondo Ciclo Semestrale

Obiettivi formativi
The course aims to provide students with a comprehensive overview of the applications of robotics in the biomedical field through a combination of theory and practice. Students will gain basic knowledge of robotics. They will be introduced to different types of robots and their applications in the biomedical field. Students will analyze real scenarios to understand how robots can contribute to personal health and improve patients' quality of life through specific case studies.
The course aims to prepare students to face the challenges and opportunities offered by robotics in the healthcare sector, training competent and innovative professionals in this continuously evolving field. Students will gain practical experience through laboratories, case study analyses, and hands-on projects, which will include the use and testing of robotic solutions in the biomedical field.

Prerequisiti
None

Contenuti del corso
• Introduction to Robotics: Fundamental concepts, definitions, main structures of manipulators, and basic components.
• Module 1: Robotic Systems for Motor Rehabilitation
o Introduction to robot-mediated rehabilitation systems, classification, and characteristics of robots for motor rehabilitation;
o Patient treatment and evaluation, feedback, and data analysis related to treatment outcomes;
o Hands-on project #1: Guided simulation of a robot-mediated motor rehabilitation system in MATLAB/Simulink, data collection, and analysis.
• Module 2: Robotic Systems for Assisting with Daily Life Activities
o Fundamental concepts, objectives, and benefits of assistive robotics for daily life and user autonomy;
o Robots for Mobility Assistance (Exoskeletons, powered wheelchairs);
o Robots for Communication Assistance (Social and interactive robots, communication interfaces);
o Robots for Personal Assistance (Companion robots, domestic assistants);
o Hands-on project #2: Guided simulation of a robotic system for assisting with daily life activities in MATLAB/Simulink, data collection, and analysis.
• Module 3: Robotics in Hospital 4.0 and 5.0
o Definition and characteristics of Hospital 4.0 and 5.0;
o Integration and interoperability of robotic systems in hospitals and hospital information systems, communication protocols;
o Robotic solutions for patient care;
o Robotic solutions for management and logistics;
o Robotic solutions for the safety of patients and clinical staff;
o Hands-on project #3: Guided simulation of a robotic system to support logistical tasks in hospitals in MATLAB/Simulink, data collection, and analysis.

Metodi didattici
• Lectures (20 hours) on the topics of the course and exercises to demonstrate their application to specific problems.
• Classroom exercises and laboratory sessions (24 hours) related to each module presented in MATLAB/Simulink environment.
• Seminars (4 hours) on specific applications of robotics in the clinical field.

Modalità di verifica dell'apprendimento
The assessment of the acquired knowledge will be carried out by the teacher, who will verify the knowledge of the theoretical and practical aspects of the course.

During the oral exam, the teacher will ask three questions, in written or verbal form, aimed at verifying students' knowledge of theoretical issues. All the questions have the same weight in the evaluation (i.e. 11 points for each

one).

Maximum duration of the oral exam: 45 minutes.

Each of the three questions will be graded on a scale from 0 to 11 points.
The exam is passed if the candidate achieves at least 18 out of 30.

Honors will be given in case of full marks for all the examinations and a final score higher than 30.

Testi di riferimento
• Van Wynsberghe, Aimee. Healthcare robots: Ethics, design and implementation. Routledge, 2016.
• B. Siciliano and O. Khatib Eds., Handbook of Robotics, Springer 2008 (Chapters: 53-55, 57, 58)
• Lecture notes provided by the teacher.

Altre informazioni
Knowledge and understanding
• Knowledge and understanding of the fundamental principles of robotics and their specific applications in the biomedical field;
• Critical thinking regarding the use of robotic solutions aimed at improving clinical practices and patients' quality of life;
• Knowledge of the principles of human-robot interaction, with a particular focus on the safety and ergonomics of patients and healthcare operators.

Autonomy of judgment: Students will be encouraged to develop their analytical and critical skills through exercises and practical activities on topics covered in class.

Learning ability: The course adopts an approach that actively involves students in their educational journey, encouraging the review and deepening of skills acquired in previous studies and the application of learned concepts to specific areas.

Communication skills and soft skills: The course also aims to develop skills related to communication and soft skills to work in teams and multidisciplinary contexts. This objective will be pursued by promoting the proactive involvement of students during lectures and through group activities aimed at carrying out simple project tasks that require the application of theoretical knowledge learned.

L'attività didattica è offerta in:

Facoltà Dipartimentale di Ingegneria

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Degree course	Biomedical Engineering (2022)	comune	6	ING-IND/34

Stampa del 12/11/2025

Humanities for Bioengineering [2303306]

Offerta didattica a.a. 2025/2026

Docenti: GIAMPAOLO GHILARDI, MARTA BERTOLASO

Periodo: Secondo Ciclo Semestrale

Obiettivi formativi

Specific Learning objectives:

The course uses frontier cases of interpenetration between technology and life sciences: bio-inspired robotics, in silico medicine, advanced biotechnology (e.g. CRISPR technique), micro- and nano-engineering for medical and biological research, simulation, life and artificial intelligence, bioinformatics.

Cases are used for:
1. Coach the recognition and treatment of philosophical, epistemological, and methodological problems that continually arise in engineering work when dealing with complex, sensory and living systems;
2. Enhance critical and systemic thinking about the specificity of living things,biological systems and their complexity by exploring the frontiers between natural and artificial;
3. Build a critical awareness of the dynamics of scientific knowledge also concerning its roots and social implications;
4. To unleash the capacity of knowledge, understanding and search for solutions in the current context of contamination between knowledge and attenuation of disciplinary boundaries.

Specific learning outcomes:

Knowledge and Learning Skills
The course aims to train students in 'critical thinking' by introducing them to the logic and fundamental issues of the philosophy of science and technology. The Philosophy of Scientific Acting concept will be explained and exemplified by discussing the 'methodological approach to the natural world of inventors and scientists.'

Autonomy of judgment
The study and understanding of the cognitive process and the modelling of natural realities, as well as of some functional characteristics of applicative models, aims a) to increase students' independent judgment; b) to develop a critical and constructive attitude towards engineering problems in general; c) to enhance the "human dimension" that every discovery and invention presupposes.
Application and judgment skills
Growth in the skills necessary for interdisciplinary work, i.e. work capable of creating new theoretical frameworks or paradigms adequate to respond to emerging social or environmental needs and market demands. This means developing the ability to listen, to be interested in the reasons of others, to value the contribution of others in teamwork, to elaborate new ideas starting from one's own and others' experience and, finally, to be able to argue one's positions with clarity and serenity. In other words, this course helps to train people who are creative and reliable and contribute and promote an integrated approach to complex and multi-disciplinary problems.

Prerequisiti

None

Contenuti del corso

1. The difference between natural and artificial
New emerging paradigms in complex systems in modelling the human
An integrated approach to complex and multi-disciplinary problems
The cognitive process and modelling of natural realities: notions of mechanism and system

2. Science, Life science and Artificial Intelligence:
Technological and social impact of frontier engineering solutions
Technoscience

3. Philosophical perspectives on artificial agents:

Xenobot
Bionic Prosthesis
Robotics Plants

4. Philosophy of Technology
Technics and Technology
The rise of a new “epoch”: the born of philosophy of technology
The “empirical turn”
Philosophy of engineering

Metodi didattici

During the lectures, the case studies and the clarification (historical and philosophical) of the concepts required for such discussion provide essential opportunities for academic dialogue between the students and the professor.

Modalità di verifica dell'apprendimento

Knowledge assessment methods and criteria:

Mode of Verification: oral examination.
The knowledge acquired is evaluated based on conceptual clarity in the oral presentation in the exam.
Skills will be tested in terms of the adequacy of the discussion of the model chosen and in terms of the ability to apply the proposed model to other engineering issue.

Criteria for measuring learning and defining the final grade:

To pass the exam with a score close to 18/30, the student must demonstrate that he/she has acquired sufficient knowledge of the course's main topics and basic understanding of the case studies covered in class.
To obtain a score of 27/30 or higher, the student must demonstrate an excellent knowledge of all the topics covered in the course, being able to connect them logically and coherently according to a critical perspective.

Testi di riferimento

Bertolaso M, (2011) Le Human Enhancement Technologies e l’Irriducibilità della Complessità Biologica, in Migliorare l’uomo? La sfida etica dell’enhancement. S. Kampowski – D. Moltisanti (eds.) Cantagalli, Siena, pp. 35-58. ISBN: 978-8882726010
Bertolaso M, Di Bernardo M (2016) Questioni Epistemologiche Emergenti nelle Bio- Discipline (Epistemic Values at the intersection of Bio-Techno-Practice. An introduction to Biodisciplines) in Biodisciplines (a cura di Marta Bertolaso e Mirko Di Bernardo), Scienze e Ricerche, 30: pp. 5-8. ISSN: 2283-5873
Bertolaso M (2019), Artificialmente e Umanamente: Epistemologie a Confronto, in Transizione digitale (Stefano Zamagni, Ed), Paradoxa 2/2019, pp. 137-149.
Corti L. (2021) Metamorfosi e mutamento continuo ai tempi delle bio-tecnologie, in Metamorfosi, a cura di F. Pisano, La scuola di Pitagora Editore
Di Stefano N., Ghilardi G. (2013). Embodied intelligence: epistemological remarks on an emerging paradigm in the artificial intelligence debate, Epistemologia, 1, 100-111.
Additional bibliography:
Achterhuis, Herman Johan. American philosophy of technology: The empirical turn. Indiana University Press, 2001.
Bertolaso M., Di Stefano N., Ghilardi G. and Marcos A. (2015). Scientific Personal Agency, in M. Bertolaso (Ed.), Bio-Techno-Logos. Science in Practice and its Philosophical Implications, Pickering & Chatto Publishers, pp. 179-191.
Bertolaso M. & MacLeod M (Eds) (2016) In Silico Modeling: the Human Factor, Humana.Mente Journal of Philosophical Studies, Vol. 30 III-V, pp. III-XV. ISSN 1972-1293
Bertolaso M (2017) Building bridges - Between, in and for the philosophy of biology. Introduction to the Monothematic Section, in Emerging trends in Philosophy of Biology (Ed. Marta Bertolaso), Acta Philosophica, 26 (1): 11-18 ISSN: 1121-2179
Bertolaso M, Marcos A (2020) Para una concepción humanista de la tecnología. Reflexión crítica sobre la era bio-digital, en la Serie Sociedad Tecnológica y Futuro Humano, Héctor Velazquez (Ed), in press.
Bertolaso M, Capone L (2021) Forma e Materia. Schizzi preliminari per una teoria del dato, in Etica Digitale (Marta Bertolaso, Giovanni Lo Storto, Eds), Luiss editrice
Coeckelbergh, M. (2013). Human being@ risk: Enhancement, technology, and the evaluation of vulnerability transformations (Vol. 12). Springer Science & Business Media.
Corti L, Bertolaso M, (2019), Prospettive sulle/delle metamorfosi tecnologiche, in “Metamorfosi del vivente”, ATQUE 24 n.s./2019, pp. 63-84.
Corti L, Bertolaso M (2020) Embodiment from philosophy to life science and back. Ludus Vitalis, vol. XXVII, num. 52, 2019, pp. 137-142.
Costantino, A., Di Stefano, N., Taffoni, F., Di Pino G., Casale, M., Keller F. (2020). Embodying melody through a conducting baton: a pilot comparison between musicians and non-musicians. Experimental Brain Research

Di Stefano N. (2016). Contextual and cultural factors of consonance and dissonance notions in the Trecento and their relevance to contemporary music perception and cognition theories, Special Issue on Cognition of Early Polyphony, Journal of Interdisciplinary Music Studies, Vol. 8, 1-2, 79-80.
Jasanoff, S. (2016). The ethics of invention: technology and the human future. WW Norton & Company.
Mitcham, C. (1998). The importance of philosophy to engineering. Teorema: Revista internacional de filosofía, 27-47.
Verbeek, P. P. (2021). What things do. Penn State University Press.

Altre informazioni

- Knowledge and understanding
The course aims to train students in 'critical thinking' by introducing them to the logic and fundamental issues of the philosophy of science and technology. The Philosophy of Scientific Acting concept will be explained and exemplified by discussing the 'methodological approach to the natural world of inventors and scientists.'

- Ability to apply knowledge and understanding
Growth in the skills necessary for interdisciplinary work, i.e. work capable of creating new theoretical frameworks or paradigms adequate to respond to emerging social or environmental needs and market demands. This means developing the ability to listen, to be interested in the reasons of others, to value the contribution of others in teamwork, to elaborate new ideas starting from one's own and others' experience and, finally, to be able to argue one's positions with clarity and serenity. In other words, this course helps to train people who are creative and reliable and contribute and promote an integrated approach to complex and multi-disciplinary problems.

L'attività didattica è offerta in:

Facoltà Dipartimentale di Ingegneria

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Degree course	Biomedical Engineering (2022)	comune	2	M-FIL/02

Stampa del 12/11/2025

Italian [2303209]

Offerta didattica a.a. 2025/2026

Docenti: ROBERTA ARONICA, DOCENTE_FITTIZIO DOCENTE_FITTIZIO

Periodo: Primo Ciclo Semestrale

Obiettivi formativi
The course is aimed at enhancing knowledge of the language. The object of the course is to go into detail with elementary Italian grammatical and syntactic structures. The teaching activities are taught by native speakers who collaborate with the University Language Centre.

Prerequisiti
Each student is required to take a placement test to identify their initial level of Italian. Students with a level B1 or higher can obtain exemption.

Contenuti del corso
In the 1 CFU semester-long curricular course, elementary logical-grammatical structures and Italian vocabulary are studied in depth.

Metodi didattici
The course is offered in the classroom through lectures and exercises.

Modalità di verifica dell'apprendimento
Final exam.
Learning assessment is conducted via a written test consisting of grammar exercises, text comprehension, writing and listening.

Lexical and grammatical knowledge and skills related to comprehension and written production are evaluated through a written test and a listening test with a respective open-ended comprehension questions at course level. Communication skills (speaking) are assessed by the teacher during the course through interactive activities. The test is evaluated on a pass or fail basis.

Testi di riferimento
The teacher will provide the teaching material during the course.

Altre informazioni
By the end of the course, the student must have acquired elementary level knowledge of Italian.
Knowledge and understanding
At the end of the course, the student should be able to:
- read and understand texts in Italian and answer comprehension questions;
- understand conversations and answer questions about what has been heard;
- produce a written text on a general topic of at least 100 words.

Ability to apply knowledge and understanding
The student will be encouraged to develop a critical approach in their comprehension capabilities by listening to Italian audios and in written production through teaching methods gradually introduced during the course. Students will be urged to independently self-correct their own papers while verifying the level of understanding of other texts analyzed during the frontal lessons.

L'attività didattica è offerta in:

Facoltà Dipartimentale di Ingegneria

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.

Degree course	Biomedical Engineering (2022)	comune	2	L-FIL-LET/12

Stampa del 12/11/2025

Laboratory of Measurements [2303311]

Offerta didattica a.a. 2025/2026

Docenti: DANIELA LO PRESTI

Periodo: Secondo Ciclo Semestrale

Obiettivi formativi
The course is designed to provide fundamental knowledge in developing and designing experiments to characterize measurement systems specifically used for biomedical applications. Additionally, it will cover the assessment of static and dynamic properties (e.g., including calibration curves, accuracy, sensitivity, frequency bandwidth, and response time) of a measuring system used for diagnosis and physiological monitoring through the engagement of students in practical experiments. These metrological properties, both static and dynamic, will be critically compared to meet the specific requirements of various biomedical applications, such as physiological parameter monitoring and medical device testing. Moreover, key techniques in signal conditioning and the analysis of experimental data relevant to biomedical fields will be also explored.

Prerequisiti
There are no prerequisites other than those necessary for admission to the Laurea program.

Contenuti del corso
The course will cover the following concepts in detail:
• Measurement systems and metrological properties: understanding the fundamentals of measurement systems and their metrological characteristics.
• Analog and digital oscilloscopes: usage and principles of analog and digital oscilloscopes for waveform analysis of physiological parameters.
• Measurements of current, voltage, and electrical resistance: techniques and methodologies for measuring electrical parameters related to physiological monitoring (e.g., biopotential or electrical output of sensors used for physiological monitoring).
• Static calibration of a measuring system: procedures and principles involved in calibrating measuring systems under static conditions used in biomedical applications.
• Experimental assessment of loading effects: evaluating the impact of loading on measurement accuracy and reliability.
• Filters, operational amplifier, and instrumentation amplifier: techniques and applications of filtering, operational amplifiers, and instrumentation amplifiers in measurement systems. Examples in phisiological monitoring of processing stage.
• First- and Second-Order system response: analysis of first- and second-order system responses.
• Measurements of the main biomedical parameters like flow rate, pressure, force, strain, and temperature with specific examples (e.g., cardiorespiratory monitoring, mechanical ventilation...).
• Data processing and data acquisition: techniques and tools for processing and acquiring data from measurement systems.
• Biomedical data acquisition and data analysis in MATLAB: methods for acquiring biomedical signals and analyzing data for interpretation and insights.

Metodi didattici
The course includes lectures covering various topics and exercises demonstrating the application of measuring systems in specific biomedical contexts. Laboratory sessions are designed to instruct students on the use of software tools necessary for analyzing data. In each session the focus will be always related to biomedical applications with special attention to physiological parameters. Specifically, the lectures are structured around the following themes:
• Theoretical insights and practical experiments on measuring electrical and mechanical parameters.
• Theoretical foundations and hands-on experiments involving digital oscilloscopes and signal generators.
• Technology testing methodologies.
• Static and dynamic calibration techniques for measurement systems used in biomedical applications.
• Detailed exploration of operational amplifiers, instrumentation amplifiers, and passive and active filter design.
• Introduction to MATLAB for biomedical data analysis.

Modalità di verifica dell'apprendimento
The assessment will be based on two components:

1. Laboratory experiments and computer-based activities (20/30). This part evaluates the practical execution of laboratory experiments, where students will conduct a series of measurements to gather experimental data and assess the metrological properties of a measurement chain using computer tools.
2. Design and Implementation of a measurement system for physiological monitoring (10/30). Students will be graded with an oral test on their ability to design and construct a measuring system specifically aimed at estimating a physiological parameter.
Honors (cum laude) will be awarded to students who, in addition to achieving the maximum grade, demonstrate excellence in the use of laboratory instrumentation, clarity and precision in the execution of the exercise, and a significant contribution to the group project.

Testi di riferimento

Beckwith, T. G., Marangoni, R. D., & Lienhard, J. H. (2007). Mechanical measurements. Upper Saddle River, NJ: Pearson Prentice Hall.
• Figliola, R. S., Beasley, D. E. (2011). Theory and Design for Mechanical Measurements. John Wiley & Sons, Inc.
• Tranquillo, J., Goldberg, J., & Allen, R. (2022). Biomedical Engineering Design. Academic Press.
• Lecture notes which will be available via the e-learning platform of the Università Campus Bio-Medico di Roma.

Altre informazioni

The student will deepen their understanding and skills by interpreting activities focused on evaluating the metrological properties of measuring systems used to estimate biomedical parameters. Furthermore, they will cultivate skills in clear and technical communication regarding metrological properties and their relevance in biomedicine. Lastly, they will broaden their proficiency in reading and interpreting datasheets for measuring systems and sensors in biomedical contexts, along with technologies utilized for testing medical devices

L'attività didattica è offerta in:

Facoltà Dipartimentale di Ingegneria

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Degree course	Biomedical Engineering (2022)	comune	6	ING-IND/12

Stampa del 12/11/2025

Mathematics II [2303211]

Offerta didattica a.a. 2025/2026

Docenti: FLAVIA SMARRAZZO, MARCO PAPI

Periodo: Ciclo Annuale Unico

Obiettivi formativi
The course aims to provide students with the basic tools of Linear Algebra and Mathematical analysis, including linear applications between vector spaces, differential equations, and differential and integral calculus for functions of several variables. The course also covers vector calculus and number series. Students will be required to apply their theoretical knowledge and skills to practical problems by formulating standard applied science problems in mathematical terms. The ability to apply knowledge and understanding, choose the most appropriate techniques for solving a given problem, and follow logical argumentation in arriving at a solution will be central.

Prerequisiti
Mathematics I. In particular, students are expected to know the basic notions of real vector spaces and differential and integral calculus for functions of a single variable.

Contenuti del corso
1. Linear Transformations (15 hours - Papi): Linear Transformations between vector spaces. Nul space and Col space. The matrix associated to a linear transformation. Eigenvalues and eigenvectors, diagonalization.
2. Analytic geometry (15 hours - Papi): lines and planes. Angle between lines, parallel lines. Distance from point to line, point to plane, line to plane.
3. Differential calculus for functions of several variables (20 hours - Papi): limits and continuity. Partial derivatives, tangent plane, directional derivatives. The Hessian matrix. Optimization: local maxima and minima. Local invertibility and implicit functions defined by a system of equations. Constrained extrema.
4. Integral calculus for functions of several variables (25 hours - Papi): integral of a bounded function defined on a rectangle. Integrable functions on non-rectangular domains. Reduction methods. Change of variables.
5. Parametric curves and surfaces (5 hours - Papi): Curves and vector-valued functions. Elements of differential geometry for curves. Line integral of scalar-valued functions. Parametric surfaces in R3 and surface integrals. Divergence theorem.
6. Vector Calculus (20 hours - Smarrazzo): Conservative vector fields and potentials. Differential forms. Exact and closed differential forms in R^n. Gauss-Green formula in the plane. Stokes' theorem.
7. Numerical sequences and series (15 hours - Smarrazzo): main theorems on the limit of sequences; basic properties of number series; convergence criteria for series with non-negative terms. The absolute convergence criterion and alternating series. Notes on Taylor series.
8. Ordinary differential equations (15 hours): linear and nonlinear first order ordinary differential equations. Existence and uniqueness of the local solution for the first order Cauchy problem. Maximal and global solutions. Linear systems of ordinary differential equations.

Metodi didattici
- Lessons (100 hours).
- Exercise sessions (30 hours), with a weekly planning.

Modalità di verifica dell'apprendimento
The exam consists of the following:
- A full test (complete exam) with four exercises and two open-ended questions covering the entire Multivariable Calculus and Advanced Mathematical Analysis syllabus. The maximum score is 32 points, while the minimum is 18 points. The time allotted is three hours.

OR:

Two partial exams related to the Multivariable Calculus (I semester) and Vector Calculus (II semester) modules, respectively. The first partial proof (PP1) consists of four open-ended exercises and two theoretical questions for a maximum score of 32 points and a minimum score of 18 points. The time allotted for the PP1 is two and a half hours. The second partial proof (PP2) consists of three questions, each divided into a practical exercise and a theoretical question. The maximum score is 32 points, and the minimum is 18 points. The time allotted is 2 hours

and 45 minutes.
The open-form questions are designed to effectively verify the degree of learning and the ability to independently rework and apply the main contents of the course to specific problems.

Criteria for Measuring Learning and Awarding the Final Grade
The examination grade is expressed in thirtieths. The exam is considered passed with a score of at least 18/32 on the complete exam or, equivalently, with a score of at least 18/32 on both partial exams. The final grade achieved through the two partial tests (PP1 and PP2) is calculated using the following formula:

Final grade = (grade PP1)*(8/13) + (grade PP2)*(5/13).

Up to two points in each test will be reserved for communication skills and clarity of exposition. The "laude" is awarded to students who achieve a score of 31/32 or higher.

Testi di riferimento

[1] D.C. Lay, "Linear Algebra and Its Applications", Addison-Wesley, Fourth Edition.
[2] J. Stewart, "Calculus, Early Transcendentals", Brooks/Cole, Seventh Edition.
[3] S. Lang, “Undergraduate Analysis”, Springer, Second Edition.

Altre informazioni

- Knowledge and comprehension of the basic techniques of Linear Algebra concerning the study of linear operators.
- Ability to apply the methodologies of Linear Algebra in the framework of the Euclidean geometry.
- Comprehension skills and ability to apply the main notions and techniques of Mathematical Analysis concerning differential and integral calculus for functions of several variables, vector calculus (with special emphasis on the study of vector fields and line integrals), numerical sequences and series, qualitative properties of solutions to Cauchy problems for ordinary differential equations.
- Analytical skills, synthesis capability, and clarity of exposition in both verbal and written communication, with particular emphasis on the drafting of exam tasks with practical open-form exercises and open-form theoretical questions.

L'attività didattica è offerta in:

Facoltà Dipartimentale di Ingegneria

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Degree course	Biomedical Engineering (2022)	comune	13	MAT/08, MAT/05

Stampa del 12/11/2025

Measurements and Instrumentation in Biomedical Engineering and Standards for Medical Devices [2303305]

Offerta didattica a.a. 2025/2026

Docenti: EMILIANO SCHENA

Periodo: Primo Ciclo Semestrale

Obiettivi formativi

The course aims to provide fundamental knowledge of methodologies and techniques for estimating physical quantities and measurement uncertainty. It will also focus on the operating principles and performance of the most widely used measurement systems, sensors, and transducers in biomedical applications. Finally, the course will offer basic knowledge of the standards governing medical devices.

Students will acquire foundational knowledge of methodologies and techniques for measuring physical quantities and estimating the associated uncertainty. They will also gain an understanding of the operating principles, metrological properties, and performance of key measurement systems, sensors, and transducers used in the biomedical field. In addition, the main regulatory standards for medical devices will be introduced.

Students will be able to apply the acquired knowledge to analyze and select appropriate measurement systems according to specific requirements in healthcare and biomedical contexts. They will be capable of interpreting data obtained from measurement processes, evaluating uncertainty, and verifying consistency with application requirements. Furthermore, students will be able to carry out experimental tests on medical devices, understanding their implications from both a technical and regulatory perspective.

Prerequisiti

There are no prerequisites or prior course requirements, other than those necessary for admission to the degree program.

Contenuti del corso

The course content includes:
• Basic Concepts of Measurement Methods
Measurement of a physical quantity. Measurement system. Units of measurement: the International System of Units and other systems, with a special focus on units used in biomedical scenarios. Fundamental units. Conversion between units. Measured quantity and influencing factors. Repeatability and reproducibility.
• Significant Figures and Uncertainty
Operations and significant figures. Significant differences between experimental data. Analysis of static and dynamic measurements. Representation of experimental data: graphs and tables. Measurement uncertainty. Gaussian and Student's t-distributions. Law of uncertainty propagation.
• Response of Measurement Systems
Static metrological properties: measurement range, calibration curve, sensitivity, resolution, discrimination threshold, accuracy, precision, linearity, signal-to-noise ratio. Dynamic metrological properties: response time, settling time, frequency response (amplitude ratio and phase shift). First- and second-order systems, error function gamma and logarithmic decrement. Lissajous curves. Display instruments.
• Signal Conditioning Stage
Loading effect. Amplification stage. Signal processing circuits with particular focus on those used in certain medical devices (e.g., electrocardiograph). Sampling and ADC. Design of a measurement chain.
• Length and Strain Measurements
Length measurements. Caliper, potentiometer. Strain measurements. Mechanical and electrical strain gauges; strain gauge electronics and temperature compensation. Biomedical application of these parameters.
• Position, Displacement, Velocity, and Acceleration Measurements
Resistive, capacitive, and inductive sensors. LVDT. Optical encoder. Accelerometer. Biomedical application of this parameter.
• Mass, Force, and Torque Measurements
Load cells. Biomedical application of this parameter.
• Pressure Measurements
Basic concepts of pressure measurement. Barometer. Liquid manometer. Strain-gauge-based manometer. Differential pressure sensor. McLeod vacuum gauge. Biomedical application of this parameter (e.g., blood pressure).
• Flow Measurements

Pitot tube. Mass and volumetric flow. Venturi tube. Flow measurements based on pressure drops: orifice meter. Rotameter. Hot-wire and hot-film anemometers. Biomedical application of this parameter (e.g., mechanical ventilation and respiratory monitoring).
• Temperature Measurements
Standards and definition of temperature. Temperature scale. Thermometers based on thermal expansion. Electrical resistance thermometers. Thermocouples. Biomedical application of this parameter (e.g., body temperature, thermal treatments for cancer removal).
• Standards for Medical Devices
Key standards applicable to medical devices and specific examples. The main role of “measurements” in this context and in medical device testing.
• Verification and Performance Testing of Medical Devices
Verification and electrical testing of a medical device (e.g., mechanical ventilator, defibrillator).

Metodi didattici
Lectures covering the topics of the course and exercises to demonstrate their application in solving specific problems. Experimental evaluation of a medical device.

Modalità di verifica dell'apprendimento
The exam is designed to assess the knowledge and skills defined in the specific learning objectives. These are evaluated through an oral examination, during which students are required to discuss specific topics, with particular attention to the course content. Students will be asked to present two topics from the course.

Students must demonstrate that they have acquired a solid theoretical understanding of the topics covered, clearly and confidently explaining fundamental concepts, operating principles, metrological properties, and relevant regulatory standards. The two topics, selected either by the instructor or the student, will serve to assess comprehension and communication skills.

Students will also be expected to apply the acquired knowledge to practical contexts, such as analyzing application scenarios, selecting appropriate measurement systems, interpreting experimental data, or identifying issues related to uncertainty or regulatory compliance of medical devices.

The maximum grade (30/30) will be awarded to students who demonstrate a well-structured and thorough theoretical understanding of the course content, as well as strong command of technical language and concepts. Achieving the top grade requires not only accurate knowledge, but also analytical and synthetic skills, appropriate use of technical terminology, and the ability to apply concepts to real or simulated scenarios.

Honors (cum laude) will be awarded to students who, in addition to earning the maximum grade, demonstrate outstanding clarity of presentation, critical mastery of the subject matter, and the ability to make advanced connections or provide insightful, relevant observations.

Testi di riferimento
- T. G. Beckwith, R. D. Marangoni, J. H. Lienhard. Mechanical Measurements, Addison-Wesley Pub Company, Reading, MA, USA.
- R. S. Figliola, D. E. Beasley. Theory and Design for Mechanical Measurements, Wiley.
- Lecture notes and materials provided on the e-learning platform of Università Campus Bio-Medico di Roma.

Altre informazioni
Students will learn to analyze and select measurement systems with performance characteristics suitable for the requirements of specific biomedical applications. They will develop the ability to identify the most appropriate measurement system to meet clearly defined specifications for performing a specific measurement in the healthcare context and, more broadly, in biomedical applications. Furthermore, they will be encouraged to deepen their understanding and critically analyze the course content.

Students will also develop the ability to communicate both concisely and accurately, using general language as well as technical terminology related to the course topics. They will be able to enhance their knowledge by interpreting and analyzing data collected during measurement processes, evaluating the associated uncertainty, and understanding the operating principles and metrological properties of measurement systems and sensors.

In addition, students will become familiar with key standards governing medical devices and learn how to conduct experiments for testing medical equipment. Their learning skills will be progressively strengthened through the course thanks to a continuously interactive teaching approach.

L'attività didattica è offerta in:

Facoltà Dipartimentale di Ingegneria

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Degree course	Biomedical Engineering (2022)	comune	7	ING-IND/12

Stampa del 12/11/2025

Mechanics of Solids [2303206]

Offerta didattica a.a. 2025/2026

Docenti: ALESSIO GIZZI

Periodo: Secondo Ciclo Semestrale

Obiettivi formativi
The course addresses the foundations of Solid & Structural Mechanics through an inductive approach. The fundamental theoretical concepts are introduced starting from elementary problems, extended then to more complex cases. The learning process is accompanied by many practical examples aiming at helping the understanding of the fundamental principles of the subject. A wide part of the classes is dedicated to the study of structures usually applied in biomedical engineering.

Prerequisiti
Linear algebra and Calculus.
Mechanics and Thermodynamics (Physics I).

Contenuti del corso
Part 0: Geometry of areas and introduction (2 hours)
Introduction. Preliminaries. Forces and vectors.
Geometry of areas. First and second moment of area. Polar moment.
Principal system. Inertia ellipsoid.
Part I: The rigid body (8 hours)
The model of rigid body. Rigid displacements and kinematic constraints. The kinematic problem. Statics of the rigid body. External loads and static constraints. Static-kinematic duality. Reticular structures.
Part II: One dimensional elastic beam (20 hours)
Modeling. Kinematics and Statics of the beam. Constitutive material model. The elastic problem for the beam. The displacement method. The Virtual Work Theorem. The force method. Beam structures.
Part III: The three-dimensional continuum (20 hours)
The continuum medium: analysis of deformation and stress. The linear elastic law. The problem of the elastic equilibrium.
Part V: Design and structural analysis. (6 hours)
Strength criteria. Structural stability. Structural verification.
Part VI: Insight. (4 hours)
Cylindrical structure under internal pressure. Energetic aspects of strength criteria.

Metodi didattici
Teaching activity comprises theoretical classes (4 hours per week) supported by exercises classes (2 hours per week).
Lectures, in which the topics of the course are presented, theoretical demonstrations provided and exercises that show their application to cases of principle.
Classroom exercises that deepen the theoretical topics with more complex exercises and prepare the student for the exam tests.

Modalità di verifica dell'apprendimento
Knowledge and abilities concerning the foundations of Solid Mechanics are assessed through an exam consisting of a written and an oral test to evaluate autonomy and communicative skills.
The written test, 2 hours long, consists of:
1) open/multiple-choice questions covering all the theoretical aspects presented during the course to evaluate the general understanding of the discipline;
2) one exercise administered on paper covering all the technical aspects explored during the course to evaluate the specific understanding of the discipline and the autonomy in problem-solving within the context of Solid Mechanics.
The oral test consists of verifying the theoretical knowledge and the quality of learning via oral answers on specific arguments not fully covered during the written test, such as evaluating the level of understanding and the communicative skills via the technical language of Solid Mechanics.

The written test (up to 30 points) will be graded up to 15 points for the theoretical part and up to 15 points for the practical part. If the grade of the written test is equal to or higher than 18/30, the student will have an oral test that is

graded up to plus/minus 4 points.
The final grade will be confirmed or modified according to the oral tests within a single exam. The grand honor (lode) will be assigned based on the student's preparation at the oral test specifically evaluating making judgement and communicative skills.

Testi di riferimento
Testo di riferimento:
P.Casini, A. Gizzi, M.Vasta. Scienza delle Costruzioni per Ingegneria Biomedica, CittàStudiEdizioni, 2023, ISBN: 9788825174434.
http://www.cittastudi.it/catalogo/ingegneria/scienza-delle-costruzioni-per-ingegneria-biomedica-3848
- R. Hulse, Jack Cain. Structural Mechanics, McMillman, 2000.
- A. Bertram, R. Glüge. Solid Mechanics, Springer, 2015.
Dispense del docente: Esercizi trattati a lezione posti sul servizio e-learning.
Testi di approfondimento:
C. Comi & L. Corradi dell'Acqua. Introduzione alla meccanica strutturale. McGrawHill, III edizione 2016.
https://www.mheducation.it/9788838667145-italy-meccanica-delle-strutture-v1-2ed

Altre informazioni
The course addresses the foundations of Solid & Structural Mechanics through an inductive approach. The fundamental theoretical concepts are introduced starting from elementary problems, extended then to more complex cases. The learning process is accompanied by many practical examples aiming at helping the understanding of the fundamental principles of the subject. A wide part of the classes is dedicated to the study of structures usually applied in biomedical engineering.
At the end of the course, the student will be able to:
understand and explain the fundamental principles of Solid Mechanics (knowledge and understanding);
apply theoretical models to analyze elementary and complex structural problems, especially in the biomedical engineering context (applying knowledge and understanding);
critically assess the adopted solutions and evaluate alternative approaches (making judgments);
clearly communicate technical reasoning, results, and design choices using appropriate terminology (communication skills);
develop the ability to independently extend their knowledge and skills to advanced topics and interdisciplinary applications (learning skills).

L'attività didattica è offerta in:

Facoltà Dipartimentale di Ingegneria

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Degree course	Biomedical Engineering (2022)	comune	6	ICAR/08

Stampa del 12/11/2025

Probability and Statistics [2303203]

Offerta didattica a.a. 2025/2026

Docenti: MARCO PAPI

Periodo: Primo Ciclo Semestrale

Obiettivi formativi
The course aims to provide students with fundamental knowledge in probability and statistics necessary for understanding and analyzing experimental data and random phenomena in the field of biomedical engineering. Particular emphasis will be placed on applications of descriptive statistics, probability theory, and statistical inference to biomedical contexts, with examples and case studies based on real data.

Prerequisiti
Students are expected to be familiar with basic concepts of linear algebra (vectors, matrices, systems of linear equations) and calculus (functions, limits, derivatives, integrals), as covered in the Mathematics I course.

Contenuti del corso
Descriptive Statistics:
- Types of data. Graphical representations. Frequency tables.
- Mean, median, mode, variance, standard deviation.
- Percentiles, interquartile range.
- Covariance and correlation. Simple and multiple linear regression.

Probability:
- Probability spaces. Classical, frequentist, and axiomatic definitions.
- Operations on events. Law of total probability. Bayes' theorem.
- Independence.

Random Variables:
- Discrete variables: binomial, geometric, Poisson distributions.
- Continuous variables: uniform, exponential, normal distributions.
- Cumulative distribution function. Expectation and variance.
- Bivariate random variables. Covariance and correlation. Marginal and conditional distributions.

Statistical Inference:
- Sampling. Sampling distributions. Central limit theorem.
- Point estimation: estimators and desirable properties.
- Confidence intervals for mean and proportion.
- Hypothesis testing: tests on means and proportions, type I and II errors, p-values.
- Applications to hypothesis validation in biomedical contexts.

Metodi didattici
-Lectures (40 hours): theoretical exposition and discussion of examples from biomedical applications.
-Exercise sessions (20 hours): problem-solving and case studies using real or simulated data, including the use of statistical software (e.g., MatLab, Excel).

Modalità di verifica dell'apprendimento
Assessment methods and criteria:
Knowledge and skills will be assessed through a written exam, which includes:
- 2 open-ended exercises (on probabilistic modeling, probability computation, and statistical inference)
- 2 multiple-choice questions on theoretical topics.
The maximum score for the written exam is 32 points.
Duration of the exam: 2 hours.
Grading criteria:
The final grade is expressed in thirtieths. The exam is passed if the score is at least 18/32. If the score is above 30/32, the final grade is 30 cum laude.

Testi di riferimento

[1] S.M. Ross – Introduction to Probability and Statistics for Engineers and Scientists Academic Press (Elsevier), 6th edition, 2021, ISBN: 978-0-12-824346-6.
[2] Dimitri P. Bertsekas and John N. Tsitsiklis - Introduction to Probability, Athena Scientific, 2nd edition, 2008, ISBN: 978-1-886529-23-6.
[3] A. Agresti & C. Franklin – Statistics: The Art and Science of Learning from Data, Pearson, 5th edition, 2022, ISBN: 978-0-13-530688-2.
[4] Sheldon M. Ross – Student Solutions Manual for Introduction to Probability and Statistics for Engineers and Scientists, Academic Press (Elsevier), 6th edition, 2021, ISBN: 978-0-12-824351-0.
[5] Teaching materials provided by the instructor through the e-learning platform.

Altre informazioni

Knowledge and understanding
The course will provide students with knowledge and understanding in the following areas:
- Descriptive statistics: measures of central tendency and variability, graphical representations.
- Probability: definitions, axioms, conditional probability, independence.
- Random variables: discrete and continuous, relevant probability distributions.
- Statistical inference: point and interval estimation, hypothesis testing.

Applying knowledge and understanding
By the end of the course, students will be able to:
- describe and represent real-world datasets using descriptive and graphical tools;
- build probabilistic models of observable phenomena;
- apply common distributions to practical problems;
- conduct inferential analysis on samples from biomedical populations;
- understand statistical results in clinical and experimental studies.

L'attività didattica è offerta in:

Facoltà Dipartimentale di Ingegneria

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Degree course	Biomedical Engineering (2022)	comune	6	SECS-S/02

Stampa del 12/11/2025

Technical English [2303208]

Offerta didattica a.a. 2025/2026

Docenti: ADAM JAMES MARTIN, DOCENTE_FITTIZIO DOCENTE_FITTIZIO

Periodo: Primo Ciclo Semestrale

Obiettivi formativi
The course focuses on scientific terminology and abstract writing.

Prerequisiti
Each student has to pass the first year test before they can take the final exam.

Contenuti del corso
The course focuses on the reading comprehension of medical articles and on abstract writing technique

Metodi didattici
The whole course is taught through frontal lessons and classroom work

Modalità di verifica dell'apprendimento
The final exam is a written test where students have to write the abstract of a scientific article.

Testi di riferimento
The material will be provided by teachers.

Altre informazioni
By the end of the course, students will be able to write abstracts of scientific articles

L'attività didattica è offerta in:

Facoltà Dipartimentale di Ingegneria

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Degree course	Biomedical Engineering (2022)	comune	2	L-LIN/12

Stampa del 12/11/2025

Transport Phenomena and Termodynamics [2303207]

Offerta didattica a.a. 2025/2026

Docenti: LUISA DI PAOLA

Periodo: Secondo Ciclo Semestrale

Obiettivi formativi
The course aims at providing students with basic tools to analyse, model and solve typical problems of the biomedical engineering practice, involving transport phenomena and thermodynamics in terms of key physical properties
The approach will pursue the analysis of typical cases in the biomedical engineering applications, such as oxygen transport and heat exchange in hemodialyzers.
The methodological approach of the course is based on the application of the mass and energy conservation laws, expressed in terms of transport phenomena and thermodynamics principles.
Knowledge and understanding
The student will be able to give a quantitative description of systems of interest in the biomedical field through the application of mass and energy conservation laws in the light of the principles of transport phenomena and thermodynamics.
Applied knowledge and understanding
The student will be able to models systems to correctly understand physical phenomena and express reasonable models for their qualitative description.

Prerequisiti
None

Contenuti del corso
- Molecular transport of momentum, heat, and mass and constitutive equations;
- Local mass balances and mass transport through dense membranes;
- Elements of fluid dynamics: turbulent and laminar flow;
- Mass transfer coefficients: Definition and examples related to membrane hemodialysis and membrane oxygenator;
- Thermodynamic state and state properties. Volumetric properties of pure fluids and mixtures;
- Thermodynamic potentials: fugacity, activity coefficients. Thermodynamic equilibrium condition;
- Liquid-vapor and gas-liquid equilibria;
- Macroscopic mass balances and fundamentals of bioreactor modeling;
- Artificial kidney: modeling and design of the dialysis module;
- Artificial liver: modeling and design of the dialysis module;
- Introduction to pharmacokinetic models;
- Exercises (15 hours).

Metodi didattici
Lectures (40h) and exercises (20h) will be carried out targeting practical cases. All teaching material (presentations, digital whiteboard, recorded video) will be provided by the teacher on the e-learning platform or in a purposed cloud-sharing service, directly managed by the teacher.

Modalità di verifica dell'apprendimento
Learning assessment will include a written trial (elapsing 2 hours), which consists of the solution of two problems dealing with the application of the methods provided during the course, and an oral trial (two practical cases to be discussed in around one hour) aimed at evaluating the problem-solving ability of the student in the topics of interest in the course.

Criteria for measuring learning and defining the final mark:
Both the written and the oral trials contribute with 50% of the final mark assessment. The evaluation of the processing capacity of each problem (written and oral discussion) weighs for 25% of the final grade.
The evaluation is given in thirties, the oral trial threshold to access the written trial is 18/30.
The final minimum mark is 18/30, the maximum is 30/30 with honors.

Testi di riferimento

Teaching material:
1. M.C. Annesini, Fenomeni di trasporto fondamenti e applicazioni;
2. R.B. Bird, W. E. Stewart and E.N. Lightfoot, Transport Phenomena 2nd Ed., John Wiley & Sons.
3. S.I. Sandler - Chemical, Biochemical and Engineering Thermodynamics. John Wiley&Sons (2006)
4, L.Marrelli - Termodinamica degli equilibri di fasi fluide. Ed. Efesto (2017)
5. Lecture notes by the teacher and solved exercises, available on the e-learning platform and through cloud sharing appropriately prepared by the teacher.

Altre informazioni

At the end of the course, the student will be able to:
• Understand the laws of conservation of mass and momentum;
• Understand the thermodynamic principles underlying the description of fluid phase equilibria;
• Understand the operation of hepatic/renal dialysis modules;
• Solve mass and momentum balances;
• Calculate equilibrium compositions for L–V and L–G phases;
• Evaluate the performance of hepatic/renal dialysis modules under different configurations;
• Set up and solve pharmacokinetic models to describe the patient–dialysis device interaction.
In addition, the student must demonstrate independent judgment in modeling the cases of interest in the course, using all the tools provided during the course (applications of the laws of mass conservation, principles of transport phenomena, and thermodynamics) and with the support of mathematical tools previously acquired in prior courses. Furthermore, the student must acquire all the necessary skills to effectively communicate the solutions to the practical problems proposed during the assessments.

L'attività didattica è offerta in:

Facoltà Dipartimentale di Ingegneria

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Degree course	Biomedical Engineering (2022)	comune	6	ING-IND/24

Stampa del 12/11/2025