Piani di studio (a.a. 2020/21)

Biorobotics

Applied brain science

Biorobotics > Primo anno

- **Codice**: 001MA
- **Cfu**: 12
- **Obiettivi formativi**: This course is divided in two modules “Behavioral and Cognitive Neuroscience” and “Computational neuroscience”. In the class “Behavioral and cognitive neuroscience”, the student will learn the following topics: introduction to cognitive and social neuroscience; introduction to neuronal functioning, brain metabolism and intrinsic brain activity; basic principles of brain imaging methodologies, their uses for research and clinical purposes; introduction to the advanced methods for brain imaging analyses; the neurobiological correlates of human cognition and behavior; the mental representation of the external world; the functional neuroanatomy of perception and imagery; introduction to consciousness and sleep; introduction to psycholinguistics; emotions and behavior; motor control and action representation, and their implications for the development of brain-computer interfaces. The objectives of "Computational neuroscience" class include bio-inspired neural modelling, spiking and reservoir computing neural networks, advanced computational neural models for learning, architectures and learning methods for dynamical/recurrent neural networks for temporal data and the analysis of their properties, the role of computational neuroscience in real-world applications (by case studies).
- **Modalità di verifica finale**: For Behavioral and cognitive neuroscience: Written exam; For Computational neuroscience: Written based on a report and oral exam
- **Propedeuticità e obblighi di frequenza**: None

- **Semestre**: Annuale

Partizionamento	Denominazione modulo	SSD	CFU	Ore didattica frontale	Docente
Non partizionato	Behavioral and cognitive neuroscience	ING-INF/06	6	60	RICCIARDI EMILIANO Scheda programma d'esame
Non partizionato	Computational neuroscience	INF/01	6	60	MICHELI ALESSIO (INF/01) Scheda programma d'esame

Torna all'indice

Bioinspired computational methods

Biorobotics > Primo anno

- **Codice**: 705II
- **Cfu**: 12
- **Obiettivi formativi**: The course aims to introduce the main concepts and techniques used in bioinspired computational methods. The course is divided in two modules “Neural and fuzzy computation” and “Biological data mining”. The first module intends to offer students the opportunity to learn the basic concepts and models of computational intelligence, to have a thorough understanding of the associated computational techniques, such as artificial neural networks, fuzzy systems and genetic algorithms, and to know how to apply them to a wide variety of application areas. The second module will focus on the basic aspects of biological data mining: data pre-processing, frequent pattern mining, classification, prediction, clustering and outlier detection.
- **Modalità di verifica finale**: Oral exam + Lab project
- **Propedeuticità e obblighi di frequenza**: None

- **Semestre**: Annuale

Partizionamento	Denominazione modulo	SSD	CFU	Ore didattica frontale	Docente
Non partizionato	Biological data mining	ING-INF/05	6	60	MARCELLONI FRANCESCO (ING-INF/05) Scheda programma d'esame
Non partizionato	Neural and fuzzy computation	ING-INF/05	6	60	LAZZERINI BEATRICE (ING-INF/05) Scheda programma d'esame

Torna all'indice

Biomechanics of human motion

Biorobotics > Primo anno

- **Codice**: 709II
- **Cfu**: 6
- **Obiettivi formativi**: The objectives of this course are to provide an introduction to the biomechanics of the human movements and then to understand the main role underlying the control of spatial multiple degree-of-freedom human motion. These objectives will be reached by means of both theoretical lessons and practical activities in a lab of human movement analysis.
- **Modalità di verifica finale**: Written and oral exams
- **Propedeuticità e obblighi di frequenza**: None

- **Semestre**: Secondo semestre

Partizionamento	Denominazione modulo	SSD	CFU	Ore didattica frontale	Docente
Non partizionato	Biomechanics of human motion	ING-IND/34	6	60	MONACO VITO Scheda programma d'esame

Torna all'indice

Materials and instrumentation for bionics engineering

Biorobotics > Primo anno

- **Codice**: 701II
- **Cfu**: 12
- **Obiettivi formativi**: The course “Materials and instrumentation for bionics engineering” is composed of two modules: “Instrumentation and measurement for bionic systems” and “Soft and smart materials”. Instrumentation and measurement for bionic systems introduces to the methods and technologies involved in the development of equipment for measuring physical and electrical variables during monitoring and control of bionic systems. The students will be exposed to a system-oriented approach to the theory and practice of bionic measurement systems, cutting across several disciplines, including electronics, systems theory, digital signal processing, statistics and artificial intelligence. Soft and smart materials aims at providing an advanced knowledge on novel soft and smart materials for bionics. Different technologies will be analysed from the basic principles to their exploitation as smart sensors or actuators. The course will enable the student to implement a comparative analysis for the choice of the most suitable technologies for specific engineering problems. The student will be asked to use advanced design principles and tools (like CAD and FEM) as well as to carry out hands-on lab activities.
- **Modalità di verifica finale**: Oral exam
- **Propedeuticità e obblighi di frequenza**: None

- **Semestre**: Annuale

Partizionamento	Denominazione modulo	SSD	CFU	Ore didattica frontale	Docente
Non partizionato	Instrumentation and measurement for bionic systems	ING-INF/06	6	60	SABATINI ANGELO MARIA Scheda programma d'esame
Non partizionato	Soft and smart materials	ING-IND/34	6	60	CIANCHETTI MATTEO Scheda programma d'esame

Torna all'indice

Statistical Signal Processing

Biorobotics > Primo anno

- **Codice**: 765II
- **Cfu**: 6
- **Obiettivi formativi**: The course will cover statistical signal processing methods, with application to bioengineering field. The students will become familiar with basic concepts of discrete representation of deterministic and random continuous-time signals, discrete-time random signal analysis, deterministic and random parameter estimation. Various estimation methods will be introduced and compared, such as the method of moments, the maximum likelihood and the linear and non-linear least squares methods. An introduction to Bayesian framework for random parameters and random signals estimation will be provided, with particular emphasis to the problem of linear smoothing, filtering, and prediction. Parametric auto-regressive moving average (ARMA) modeling and identification of discrete-time random signals will be also addressed. Advanced topics in parametric and non-parametric (adaptive and non-adaptive) methods for spectral estimation will be introduced, as well as some basic concepts of time-frequency analysis.
- **Modalità di verifica finale**: Written and oral exam
- **Propedeuticità e obblighi di frequenza**: None

- **Semestre**: Primo semestre

Partizionamento	Denominazione modulo	SSD	CFU	Ore didattica frontale	Docente
Non partizionato	Statistical Signal Processing	ING-INF/03	6	60	GINI FULVIO (ING-INF/03) Scheda programma d'esame

Torna all'indice

Economic assessment of medical technologies and robotics for healthcare

Biorobotics > Primo anno > Gruppo Free choice

- **Codice**: 428PP
- **Cfu**: 6
- **Obiettivi formativi**: The course will provide the rationale and the technical tools for assessing the economic, social, usability, and acceptability dimensions of a new medical technology. The methodologies gained will enable students to assess a new medical technology both during the R&D process and in the pre-marketing phase, increasing the probability of its successful transfer and adoption in the market. A special focus will be devoted to robotics for healthcare.
- **Modalità di verifica finale**: written exam
- **Propedeuticità e obblighi di frequenza**: None

- **Semestre**: Secondo semestre

Partizionamento	Denominazione modulo	SSD	CFU	Ore didattica frontale	Docente
Non partizionato	Economic assessment of medical technologies and robotics for healthcare	SECS-P/08	6	60	TURCHETTI GIUSEPPE Scheda programma d'esame

Torna all'indice

Electronics for Bionics Engineering

Biorobotics > Primo anno > Gruppo Free choice

- **Codice**: 846II
- **Cfu**: 6
- **Obiettivi formativi**: The student who successfully completes the course will be able to demonstrate a solid knowledge of the main issues related to the design of sensor based electronic systems for bionics engineering. He or she will acquire the ability to analyse and design the building blocks of an analogue front-end for the acquisition, conditioning and conversion of biological sensor data, and will master the design methodologies adopted for instrumentation amplifiers, passive and active filters, analogue-to-digital and digital-to-analogue converters. He or she will then familiarise with standard digital interfaces utilised to transfer digitalised sensor data to an embedded microcontroller or microprocessor. The student will deepen his or her learning on the conditioning and digitalization chain of biological sensor data by familiarising with standard digital interfaces utilised to transfer digitalised sensor data to an embedded microcontroller or microprocessor. Finally, he or she will be exposed to state-of-the-art design methodologies adopted for tightly energy-/power-constrained electronic systems in wearable and implantable devices, and will have the opportunity to consolidate his or her learning by working with advanced EDA tools.
- **Modalità di verifica finale**: Oral exam. Students may be asked to carry out practical projects that will be discussed at the oral exam.
- **Propedeuticità e obblighi di frequenza**: None

- **Semestre**: Secondo semestre

Partizionamento	Denominazione modulo	SSD	CFU	Ore didattica frontale	Docente
Non partizionato	Electronics for Bionics Engineering	ING-INF/01	6	60	ROSSI DANIELE (ING-INF/01) Scheda programma d'esame

Torna all'indice

Mechanics of elastic solids and bio-robotic structures

Biorobotics > Primo anno > Gruppo Free choice

- **Codice**: 847II
- **Cfu**: 6
- **Obiettivi formativi**: The course will focus on the principles governing the elastic response of solids and of engineering structures (rods, beams, plates, and shells), on how these principles are operative in biological systems, and how they can be exploited in soft robotics applications. Examples will include locomotion and manipulation tasks inspired by invertebrate organisms, and morphological computation principles used for motility by unicellular organisms.
- **Modalità di verifica finale**: Prova scritta ed eventuale colloquio

- **Semestre**: Primo semestre

Partizionamento	Denominazione modulo	SSD	CFU	Ore didattica frontale	Docente
Non partizionato	Mechanics of elastic solids and bio-robotic structures	ICAR/08	6	60	DE SIMONE ANTONIO Scheda programma d'esame

Torna all'indice

Neuromorphic engineering

Biorobotics > Primo anno > Gruppo Free choice

- **Codice**: 706II
- **Cfu**: 6
- **Obiettivi formativi**: The course will explore computational and physical models that emulate the neural dynamics of biological neurons of peripheral and central nervous system. A particular focus will be dedicated to real-time implementation of spiking artefacts that could be integrated in neurophysiological studies and in closed loop hybrid-bionic systems to restore missing sensorimotor functions.
- **Modalità di verifica finale**: project work and oral exam
- **Propedeuticità e obblighi di frequenza**: None

- **Semestre**: Primo semestre

Partizionamento	Denominazione modulo	SSD	CFU	Ore didattica frontale	Docente
Non partizionato	Neuromorphic engineering	ING-IND/34	6	60	ODDO CALOGERO MARIA Scheda programma d'esame

Torna all'indice

Principles of bionics engineering

Biorobotics > Primo anno > Gruppo Free choice

- **Codice**: 708II
- **Cfu**: 6
- **Obiettivi formativi**: The “Principles of Bionics Engineering” course aims to introduce attendants to the vast and interdisciplinary field of bionics and related scientific areas, such as biorobotics and bioengineering. Bionics aims at gathering specific knowledge through the analysis/modeling of living organisms/ecosystems and applies it to the development of newly inspired advanced devices. Bionics also focuses on artificial systems deeply connected to body tissues. The application of bionics principles is nowadays widespread in many engineering sub-fields. During this course, several case studies will be presented that will allow to properly understand the whole loop from scientific insights to engineering innovation. In particular, the course will focus on the key principles of biological locomotion, swarm robotics, artificial organs, morphological computation, energy issues, structural design and fabrication technologies.
- **Modalità di verifica finale**: Oral exam
- **Propedeuticità e obblighi di frequenza**: None

- **Semestre**: Primo semestre

Partizionamento	Denominazione modulo	SSD	CFU	Ore didattica frontale	Docente
Non partizionato	Principles of bionics engineering	ING-IND/34	6	60	DARIO PAOLO Scheda programma d'esame

Torna all'indice

Final examination

Biorobotics > Secondo anno

- **Codice**: 1087Z
- **Cfu**: 15
- **Obiettivi formativi**: The final examination involves the preparation of a report led to a design or research activity, and in its presentation and discussion.
- **Modalità di verifica finale**: The final examination involves the preparation of a report led to a design or research activity, and in its presentation and discussion . The evaluation of the work, as well as on the quality of the work , will be based on the mastery of the analyzed topics, the ability to work autonomously on attitudes of synthesis and communication skills
- **Propedeuticità e obblighi di frequenza**: None

- **Semestre**: Annuale

Torna all'indice

Human and animal models in biorobotics

Biorobotics > Secondo anno

- **Codice**: 848II
- **Cfu**: 6
- **Obiettivi formativi**: The course focuses on bioinspired robotics and biorobotic platforms for neuroscience and biology. The course provides the knowledge about the models of the human brain, of human intelligence, of muscle-skeletal systems, and of perceptual systems that are relevant in biorobotics. The students will learn principles of bioinspiration and biomimetics in robotics and the design methods and the technical tools for implementing such brain models and other animal models in robots. The students will have the opportunity to challenge themselves in their own design of robots inspired to functional mechanisms of human beings and other animals. Where appropriate, hands-on activities and student projects will be included in the course.
- **Modalità di verifica finale**: Oral exam
- **Propedeuticità e obblighi di frequenza**: None

- **Semestre**: Primo semestre

Partizionamento	Denominazione modulo	SSD	CFU	Ore didattica frontale	Docente
Non partizionato	Human and animal models in biorobotics	ING-IND/34	6	60	CALISTI MARCELLO Scheda programma d'esame

Torna all'indice

Lab Training

Biorobotics > Secondo anno

- **Codice**: 1088Z
- **Cfu**: 3
- **Obiettivi formativi**: This activity will consist of Lab training that the student will perform in dedicated facilities and laboratories, with the aim to increase his/her experience in laboratory practice.
- **Modalità di verifica finale**: Oral Exam
- **Propedeuticità e obblighi di frequenza**: None

- **Semestre**: Secondo semestre

Partizionamento	Denominazione modulo	SSD	CFU	Ore didattica frontale	Docente
Non partizionato	Lab Training	NN	3	30	VOZZI GIOVANNI (ING-INF/06) Scheda programma d'esame

Torna all'indice

Robotics for assisted living

Biorobotics > Secondo anno

- **Codice**: 696II
- **Cfu**: 12
- **Obiettivi formativi**: The course “Robotics for assisted living” is composed by two modules: “Robot companions for assisted living” and “Cloud robotics”. The module “Robot companions for assisted living” aims to provide students with basic knowledge on design principles and methodologies, grounded in the scientific studies, for developing cooperative robots that can effectively negotiate natural environments, better interact with human beings and provide services and support in a variety of real-world, real-life activities. This module presents: 1) hardware architectures, 2) actuators, 3) control strategies, 4) sensors, 5) power supply solutions, 6) human-robot interfaces and 7) communication protocols of service, rehabilitation and assistive robots. Hands-on activities on developing biomechanical models, programming wearable sensors and analysing data recorded by robotic devices are part of this module. The module “Cloud Robotics” aims to provide basic knowledge and methodology for the design and implementation of service robotics solutions based on the integration of mobile robotic platforms, sensor networks and Cloud computing. This module presents the main challenges and concepts related to: 1) software and hardware architectures, 2) perception-reasoning/controlactuation paradigm, 3) Cloud-based services for robotics, 4) distributed wearable and environmental sensor networks. Specific aspects for programming robot architectures (ROS, Gazebo), Internet of Things sensor nodes (STM32 microcontrollers and wireless connectivity) and Virtual Machines on Cloud Platforms are also faced with the use of real robotic platforms and sensor boards. Thus, students are instructed to create practical robotic applications, implementing perception robot capabilities and using Cloud resources. Finally this module presents theoretical and research aspects of artificial intelligence for social robotics and industry applications and in general for human robot interaction, including emotion, gesture and activity recognition.
- **Modalità di verifica finale**: For “Robotics for assisted living”: Oral exam and workgroup For “Cloud robotics”: Oral exam
- **Propedeuticità e obblighi di frequenza**: None

- **Semestre**: Annuale

Partizionamento	Denominazione modulo	SSD	CFU	Ore didattica frontale	Docente
Non partizionato	Cloud robotics	ING-IND/34	6	60	FALOTICO EGIDIO Scheda programma d'esame
Non partizionato	Robot companions for assisted living	ING-IND/34	6	60	CARROZZA MARIA CHIARA Scheda programma

Partizionamento	Denominazione modulo	SSD	CFU	Ore didattica frontale	Docente
					d'esame

Torna all'indice

Robotics for surgery and targeted therapy

Biorobotics > Secondo anno

- **Codice**: 697II
- **Cfu**: 12
- **Obiettivi formativi**: The course “Robotics for surgery and targeted therapy” is composed of two modules: “Robotics for minimally invasive therapy” and “Micro/nano robotics and biomaterials”. The course aims to teach students how to design and develop robotic technologies at different scales, bionic organs and smart biomaterials for minimally invasive therapy, diagnosis and surgery, organ function replacement, drug delivery and tissue regeneration. At the end of the course the student will be able to identify the most appropriated targeting/therapeutic solutions for different human body districts, at different scales, and for different pathologies. Bioengineering solutions for regenerative medicine, alternative to or synergic with traditional medical/surgical procedures, will be also highlighted. Hands-on laboratory activities are part of the course: students will be involved in practical activities concerning micro/nano fabrication procedures, physical and chemical characterization techniques, biomaterial synthesis and functionalization and cell cultures.
- **Modalità di verifica finale**: For both modules oral exam, which may include a previous resolution of problems and tests. Students could be asked to prepare simple projectual works to be associated and evaluated together with the formal oral exam.
- **Propedeuticità e obblighi di frequenza**: None

- **Semestre**: Annuale

Partizionamento	Denominazione modulo	SSD	CFU	Ore didattica frontale	Docente
Non partizionato	Micro/nano robotics and biomaterials	ING-IND/34	6	60	RICOTTI LEONARDO Scheda programma d'esame
Non partizionato	Robotics for minimally invasive therapy	ING-IND/34	6	60	MENCIASSI ARIANNA Scheda programma d'esame

Torna all'indice

Wearable robotics

Biorobotics > Secondo anno

- **Codice**: -
- **Cfu**: 12
- **Obiettivi formativi**: The course is composed of two modules: Prostheses and Exoskeletons. The overall goal is to introduce students to the main challenges to design wearable powered robots for movement assistance, rehabilitation, augmentation and/or functional replacement. Along with the analyses of the main components involved in the development of an effective human-robot interaction, students will be engaged in laboratory and hands-on activities with working devices. In particular: Within the module “Prostheses” students will be introduced to and will experiment the architecture and function of the microcontroller. Within the module “Exoskeletons” students will learn how to conceive, rapid-prototype and test multi-layered control architectures running on real-time targets endowed with FPGA processors.
- **Modalità di verifica finale**: Oral exam + projectual work.
- **Propedeuticità e obblighi di frequenza**: None

Torna all'indice

Neural Engineering

Applied brain science

Neural Engineering > Primo anno

- **Codice**: 001MA
- **Cfu**: 12
- **Obiettivi formativi**: This course is divided in two modules “Behavioral and Cognitive Neuroscience” and “Computational neuroscience”. In the class “Behavioral and cognitive neuroscience”, the student will learn the following topics: introduction to cognitive and social neuroscience; introduction to neuronal functioning, brain metabolism and intrinsic brain activity; basic principles of brain imaging methodologies, their uses for research and clinical purposes; introduction to the advanced methods for brain imaging analyses; the neurobiological correlates of human cognition and behavior; the mental representation of the external world; the functional neuroanatomy of perception and imagery; introduction to consciousness and sleep; introduction to psycholinguistics; emotions and behavior; motor control and action representation, and their implications for the development of brain-computer interfaces. The objectives of "Computational neuroscience" class include bio-inspired neural modelling, spiking and reservoir computing neural networks, advanced computational neural models for learning, architectures and learning methods for dynamical/recurrent neural networks for temporal data and the analysis of their properties, the role of computational neuroscience in real-world applications (by case studies).
- **Modalità di verifica finale**: For Behavioral and cognitive neuroscience: Written exam; For Computational neuroscience: Written based on a report and oral exam
- **Propedeuticità e obblighi di frequenza**: None

- **Semestre**: Annuale

Partizionamento	Denominazione modulo	SSD	CFU	Ore didattica frontale	Docente
Non partizionato	Behavioral and cognitive neuroscience	ING-INF/06	6	60	RICCIARDI EMILIANO Scheda programma d'esame
Non partizionato	Computational neuroscience	INF/01	6	60	MICHELI ALESSIO (INF/01) Scheda programma d'esame

Torna all'indice

Bioinspired computational methods

Neural Engineering > Primo anno

- **Codice**: 705II
- **Cfu**: 12
- **Obiettivi formativi**: The course aims to introduce the main concepts and techniques used in bioinspired computational methods. The course is divided in two modules “Neural and fuzzy computation” and “Biological data mining”. The first module intends to offer students the opportunity to learn the basic concepts and models of computational intelligence, to have a thorough understanding of the associated computational techniques, such as artificial neural networks, fuzzy systems and genetic algorithms, and to know how to apply them to a wide variety of application areas. The second module will focus on the basic aspects of biological data mining: data pre-processing, frequent pattern mining, classification, prediction, clustering and outlier detection.
- **Modalità di verifica finale**: Oral exam + Lab project
- **Propedeuticità e obblighi di frequenza**: None

- **Semestre**: Annuale

Partizionamento	Denominazione modulo	SSD	CFU	Ore didattica frontale	Docente
Non partizionato	Biological data mining	ING-INF/05	6	60	MARCELLONI FRANCESCO (ING-INF/05) Scheda programma d'esame
Non partizionato	Neural and fuzzy computation	ING-INF/05	6	60	LAZZERINI BEATRICE (ING-INF/05) Scheda programma d'esame

Torna all'indice

Biomechanics of human motion

Neural Engineering > Primo anno

- **Codice**: 709II
- **Cfu**: 6
- **Obiettivi formativi**: The objectives of this course are to provide an introduction to the biomechanics of the human movements and then to understand the main role underlying the control of spatial multiple degree-of-freedom human motion. These objectives will be reached by means of both theoretical lessons and practical activities in a lab of human movement analysis.
- **Modalità di verifica finale**: Written and oral exams
- **Propedeuticità e obblighi di frequenza**: None

- **Semestre**: Secondo semestre

Partizionamento	Denominazione modulo	SSD	CFU	Ore didattica frontale	Docente
Non partizionato	Biomechanics of human motion	ING-IND/34	6	60	MONACO VITO Scheda programma d'esame

Torna all'indice

Materials and instrumentation for bionics engineering

Neural Engineering > Primo anno

- **Codice**: 701II
- **Cfu**: 12
- **Obiettivi formativi**: The course “Materials and instrumentation for bionics engineering” is composed of two modules: “Instrumentation and measurement for bionic systems” and “Soft and smart materials”. Instrumentation and measurement for bionic systems introduces to the methods and technologies involved in the development of equipment for measuring physical and electrical variables during monitoring and control of bionic systems. The students will be exposed to a system-oriented approach to the theory and practice of bionic measurement systems, cutting across several disciplines, including electronics, systems theory, digital signal processing, statistics and artificial intelligence. Soft and smart materials aims at providing an advanced knowledge on novel soft and smart materials for bionics. Different technologies will be analysed from the basic principles to their exploitation as smart sensors or actuators. The course will enable the student to implement a comparative analysis for the choice of the most suitable technologies for specific engineering problems. The student will be asked to use advanced design principles and tools (like CAD and FEM) as well as to carry out hands-on lab activities.
- **Modalità di verifica finale**: Oral exam
- **Propedeuticità e obblighi di frequenza**: None

- **Semestre**: Annuale

Partizionamento	Denominazione modulo	SSD	CFU	Ore didattica frontale	Docente
Non partizionato	Instrumentation and measurement for bionic systems	ING-INF/06	6	60	SABATINI ANGELO MARIA Scheda programma d'esame
Non partizionato	Soft and smart materials	ING-IND/34	6	60	CIANCHETTI MATTEO Scheda programma d'esame

Torna all'indice

Statistical Signal Processing

Neural Engineering > Primo anno

- **Codice**: 765II
- **Cfu**: 6
- **Obiettivi formativi**: The course will cover statistical signal processing methods, with application to bioengineering field. The students will become familiar with basic concepts of discrete representation of deterministic and random continuous-time signals, discrete-time random signal analysis, deterministic and random parameter estimation. Various estimation methods will be introduced and compared, such as the method of moments, the maximum likelihood and the linear and non-linear least squares methods. An introduction to Bayesian framework for random parameters and random signals estimation will be provided, with particular emphasis to the problem of linear smoothing, filtering, and prediction. Parametric auto-regressive moving average (ARMA) modeling and identification of discrete-time random signals will be also addressed. Advanced topics in parametric and non-parametric (adaptive and non-adaptive) methods for spectral estimation will be introduced, as well as some basic concepts of time-frequency analysis.
- **Modalità di verifica finale**: Written and oral exam
- **Propedeuticità e obblighi di frequenza**: None

- **Semestre**: Primo semestre

Partizionamento	Denominazione modulo	SSD	CFU	Ore didattica frontale	Docente
Non partizionato	Statistical Signal Processing	ING-INF/03	6	60	GINI FULVIO (ING-INF/03) Scheda programma d'esame

Torna all'indice

Economic assessment of medical technologies and robotics for healthcare

Neural Engineering > Primo anno > Gruppo Free choice

- **Codice**: 428PP
- **Cfu**: 6
- **Obiettivi formativi**: The course will provide the rationale and the technical tools for assessing the economic, social, usability, and acceptability dimensions of a new medical technology. The methodologies gained will enable students to assess a new medical technology both during the R&D process and in the pre-marketing phase, increasing the probability of its successful transfer and adoption in the market. A special focus will be devoted to robotics for healthcare.
- **Modalità di verifica finale**: written exam
- **Propedeuticità e obblighi di frequenza**: None

- **Semestre**: Secondo semestre

Partizionamento	Denominazione modulo	SSD	CFU	Ore didattica frontale	Docente
Non partizionato	Economic assessment of medical technologies and robotics for healthcare	SECS-P/08	6	60	TURCHETTI GIUSEPPE Scheda programma d'esame

Torna all'indice

Electronics for Bionics Engineering

Neural Engineering > Primo anno > Gruppo Free choice

- **Codice**: 846II
- **Cfu**: 6
- **Obiettivi formativi**: The student who successfully completes the course will be able to demonstrate a solid knowledge of the main issues related to the design of sensor based electronic systems for bionics engineering. He or she will acquire the ability to analyse and design the building blocks of an analogue front-end for the acquisition, conditioning and conversion of biological sensor data, and will master the design methodologies adopted for instrumentation amplifiers, passive and active filters, analogue-to-digital and digital-to-analogue converters. He or she will then familiarise with standard digital interfaces utilised to transfer digitalised sensor data to an embedded microcontroller or microprocessor. The student will deepen his or her learning on the conditioning and digitalization chain of biological sensor data by familiarising with standard digital interfaces utilised to transfer digitalised sensor data to an embedded microcontroller or microprocessor. Finally, he or she will be exposed to state-of-the-art design methodologies adopted for tightly energy-/power-constrained electronic systems in wearable and implantable devices, and will have the opportunity to consolidate his or her learning by working with advanced EDA tools.
- **Modalità di verifica finale**: Oral exam. Students may be asked to carry out practical projects that will be discussed at the oral exam.
- **Propedeuticità e obblighi di frequenza**: None

- **Semestre**: Secondo semestre

Partizionamento	Denominazione modulo	SSD	CFU	Ore didattica frontale	Docente
Non partizionato	Electronics for Bionics Engineering	ING-INF/01	6	60	ROSSI DANIELE (ING-INF/01) Scheda programma d'esame

Torna all'indice

Mechanics of elastic solids and bio-robotic structures

Neural Engineering > Primo anno > Gruppo Free choice

- **Codice**: 847II
- **Cfu**: 6
- **Obiettivi formativi**: The course will focus on the principles governing the elastic response of solids and of engineering structures (rods, beams, plates, and shells), on how these principles are operative in biological systems, and how they can be exploited in soft robotics applications. Examples will include locomotion and manipulation tasks inspired by invertebrate organisms, and morphological computation principles used for motility by unicellular organisms.
- **Modalità di verifica finale**: Prova scritta ed eventuale colloquio

- **Semestre**: Primo semestre

Partizionamento	Denominazione modulo	SSD	CFU	Ore didattica frontale	Docente
Non partizionato	Mechanics of elastic solids and bio-robotic structures	ICAR/08	6	60	DE SIMONE ANTONIO Scheda programma d'esame

Torna all'indice

Neuromorphic engineering

Neural Engineering > Primo anno > Gruppo Free choice

- **Codice**: 706II
- **Cfu**: 6
- **Obiettivi formativi**: The course will explore computational and physical models that emulate the neural dynamics of biological neurons of peripheral and central nervous system. A particular focus will be dedicated to real-time implementation of spiking artefacts that could be integrated in neurophysiological studies and in closed loop hybrid-bionic systems to restore missing sensorimotor functions.
- **Modalità di verifica finale**: project work and oral exam
- **Propedeuticità e obblighi di frequenza**: None

- **Semestre**: Primo semestre

Partizionamento	Denominazione modulo	SSD	CFU	Ore didattica frontale	Docente
Non partizionato	Neuromorphic engineering	ING-IND/34	6	60	ODDO CALOGERO MARIA Scheda programma d'esame

Torna all'indice

Principles of bionics engineering

Neural Engineering > Primo anno > Gruppo Free choice

- **Codice**: 708II
- **Cfu**: 6
- **Obiettivi formativi**: The “Principles of Bionics Engineering” course aims to introduce attendants to the vast and interdisciplinary field of bionics and related scientific areas, such as biorobotics and bioengineering. Bionics aims at gathering specific knowledge through the analysis/modeling of living organisms/ecosystems and applies it to the development of newly inspired advanced devices. Bionics also focuses on artificial systems deeply connected to body tissues. The application of bionics principles is nowadays widespread in many engineering sub-fields. During this course, several case studies will be presented that will allow to properly understand the whole loop from scientific insights to engineering innovation. In particular, the course will focus on the key principles of biological locomotion, swarm robotics, artificial organs, morphological computation, energy issues, structural design and fabrication technologies.
- **Modalità di verifica finale**: Oral exam
- **Propedeuticità e obblighi di frequenza**: None

- **Semestre**: Primo semestre

Partizionamento	Denominazione modulo	SSD	CFU	Ore didattica frontale	Docente
Non partizionato	Principles of bionics engineering	ING-IND/34	6	60	DARIO PAOLO Scheda programma d'esame

Torna all'indice

Bionic senses

Neural Engineering > Secondo anno

- **Codice**: 710II
- **Cfu**: 6
- **Obiettivi formativi**: The course “Bionic senses” refers to engineering artificial sensing and perceptual systems through biological principles to implement neuroprostheses to restore lost functions, for human augmentation and bioinspired perceptional machines. The basis of needed methodology and technology will be given tutorially.
- **Modalità di verifica finale**: oral exam
- **Propedeuticità e obblighi di frequenza**: None

- **Semestre**: Primo semestre

Partizionamento	Denominazione modulo	SSD	CFU	Ore didattica frontale	Docente
Non partizionato	Bionic senses	ING-INF/06	6	60	TOGNETTI ALESSANDRO (ING-INF/06) Scheda programma d'esame

Torna all'indice

Final examination

Neural Engineering > Secondo anno

- **Codice**: 1087Z
- **Cfu**: 15
- **Obiettivi formativi**: The final examination involves the preparation of a report led to a design or research activity, and in its presentation and discussion.
- **Modalità di verifica finale**: The final examination involves the preparation of a report led to a design or research activity, and in its presentation and discussion . The evaluation of the work, as well as on the quality of the work , will be based on the mastery of the analyzed topics, the ability to work autonomously on attitudes of synthesis and communication skills
- **Propedeuticità e obblighi di frequenza**: None

- **Semestre**: Annuale

Torna all'indice

Integrative cerebral function and image processing

Neural Engineering > Secondo anno

- **Codice**: 002MI
- **Cfu**: 12
- **Obiettivi formativi**: The course is divided in two modules: Integrative cerebral functions – All cognitive and emotional functions are the by-product of the activity of anatomo-functional distributed and, at the same time, integrated networks. The didactic module entitled "Integrative cerebral functions" will address the following main topics: 1) Node and rich-clubs in the human connectome; 2) Sleep, mentation and dreaming; 3) Biological bases of consciousness; 4) Theory of mind and mirror neuron system; 4) Empathy in the emotional context; 5) Stress in the context of body and mind integration Advanced image processing - This module will cover advanced image processing methods that can be applied to biomedical images of the brain. In particular, the methods used to study structural and functional connectivity, as well as brain metabolism, will be deeply covered. The students will be trained to process images acquired using different neuroimaging techniques, as those based on MRI, PET and NIRS. The course will also introduce the main approaches for the integration of biomedical images and electrophysiological recordings.
- **Modalità di verifica finale**: Integrative cerebral functions – Written and oral exam Advanced image processing – Written computer based and oral exam.
- **Propedeuticità e obblighi di frequenza**: None

- **Semestre**: Annuale

Partizionamento	Denominazione modulo	SSD	CFU	Ore didattica frontale	Docente
Non partizionato	Advanced image processing	ING-INF/06	6	60	VANELLO NICOLA (ING-INF/06) Scheda programma d'esame
Non partizionato	Integrative cerebral function	M-PSI/02	6	60	GEMIGNANI ANGELO (M-PSI/02) Scheda programma d'esame

Torna all'indice

Interactive Systems and Affective Computing

Neural Engineering > Secondo anno

- **Codice**: 916II
- **Cfu**: 12
- **Obiettivi formativi**: The course is composed of two modules “Interactive Systems” and “Affective computing”. The module of “Interactive Systems” will introduce students to tools, techniques and methods for the design and developments of “Interactive” systems aimed at interacting with humans. Various interactive systems like: social robots, interactive devices, IOT frameworks, chatbot and mobile applications will be studied as references for the understanding of a how human-machine interaction paradigms are evolving. The course is a journey through several disciplines and technical sectors such as: psychology, product design, computer science, internet of things, embedded programming and robotics. The module of “Affective computing” aims at showing how computational technology can be used to understand and interpret human emotions. Specifically, modelling of human emotional expression will be addressed, including software and hardware solutions to acquire, ommunicate, and express affective information. Understanding how emotions can be experienced can be also of help to quantify correlated patterns of central and autonomic nervous activity in order to investigate on mood and consciousness disorders.
- **Modalità di verifica finale**: for both modules oral exam
- **Propedeuticità e obblighi di frequenza**: None

- **Semestre**: Annuale

Partizionamento	Denominazione modulo	SSD	CFU	Ore didattica frontale	Docente
Non partizionato	Affective computing	ING-INF/06	6	60	SCILINGO ENZO PASQUALE (ING-INF/06) Scheda programma d'esame
Non partizionato	Interactive System	INF/01	6	60	MAZZEI DANIELE (INF/01) Scheda programma d'esame

Torna all'indice

Lab Training

Neural Engineering > Secondo anno

- **Codice**: 1088Z
- **Cfu**: 3
- **Obiettivi formativi**: This activity will consist of Lab training that the student will perform in dedicated facilities and laboratories, with the aim to increase his/her experience in laboratory practice.
- **Modalità di verifica finale**: Oral Exam
- **Propedeuticità e obblighi di frequenza**: None

- **Semestre**: Secondo semestre

Partizionamento	Denominazione modulo	SSD	CFU	Ore didattica frontale	Docente
Non partizionato	Lab Training	NN	3	30	VOZZI GIOVANNI (ING-INF/06) Scheda programma d'esame

Torna all'indice

Neural prostheses

Neural Engineering > Secondo anno

- **Codice**: 700II
- **Cfu**: 12
- **Obiettivi formativi**: The course on “Neural prostheses” is composed of two modules: “Neural interfaces and bioelectronic medicine” and “Neural tissue engineering”. During the course on “Neural interfaces and bioelectronic medicine” the students will acquire the basic principles underlying the design and development of implantable neural interfaces for different parts of the nervous system. They will also develop a broad view on existing neuroprosthetic systems to restore motor functions and on novel solutions based on the stimulation of the autonomic nervous system, and will be able to identify current limitations and challenges for future applications. Finally, the students will learn the conceptual and practical bases for the development of a novel neuroprosthesis (group project). The course “Neural tissue engineering” will introduce the students to the methods, protocols and engineering tools for mimicking both the central nervous system (CNS) and peripheral nervous system (PNS) at the microscale. Specifically, after a brief introduction on the physiopathology of human nervous system and its buiding blocks (i.e. neurons and glia cells), the course will focus on biomaterials and biofabrication techniques, traditional and advanced in vitro systems as well as computational methods for modeling, monitoring and characterizing neural structure and function.
- **Modalità di verifica finale**: For Neural interfaces and bioelectronic medicine : Oral exam For Neural tissue engineering: project work and oral exam
- **Propedeuticità e obblighi di frequenza**: None

- **Semestre**: Annuale

Partizionamento	Denominazione modulo	SSD	CFU	Ore didattica frontale	Docente
Non partizionato	Neural interfaces and bioelectronic medicine	ING-IND/34	6	60	MICERA SILVESTRO Scheda programma d'esame
Non partizionato	Neural tissue engineering	ING-INF/06	6	60	VOZZI GIOVANNI (ING-INF/06) Scheda programma d'esame

Torna all'indice