PhD Courses offer (2025-2026)

Sommario

Outline of Courses

The courses offered can be roughly grouped into three distinct classes:

Crossover courses are oriented to scientific methodology, writing, results exploitation, and intellectual property protection.

Foundation courses are oriented to basic disciplines of robotics and bioengineering.

Specialty courses are oriented to specific doctorate curricula.

In the following, the courses offered in each class by the doctorate are listed along with the instructors and the number of credits.

Crossover Courses

Mandatory Courses (26 Credits)

Ethics and Bioethics in Bioengineering and Robotics[1]	Battistuzzi L.	7
Paper Writing[1]	Marchese M.	5
Grant writing[1]	Leone C.	5
Open Science and Research Data Management (OS&RDM)	Pasquale V./Pastorini A.M.	4
From Labs to Enterprise*	Redoano F.	5

Foundation Courses

C++ programming techniques	Solari F./Chessa M.	6
Principles of Polymer Synthesis, Functionalization, and Recycling	Nardi M.	4
Effective habits and skills for successful young scientists	Roli F.	5
Robot programming with ROS	Recchiuto C.	5
Modern C++	Accame M./Gaggero V./Genesio N.	10
Electronics and Circuits	TO BE ASSIGNED	12
Motion control drivers	TO BE ASSIGNED	12

[1] Recommended for 2nd and 3rd year students
* Mandatory for the XLI cycle, warmly suggested for XL cycle, suggested for XXXIX cycle

Theatrical techniques for scientific presentation[2]	Sgorbissa A.	5
Computational models of visual perception*	Solari F.	5

Speciality Courses

Advanced topics in in-vitro neuroengineering: techniques applications and future directions	Brofiga M.	4
An introduction to body-machine interface	Pierella C.	4
Cloud Architectures and RESTful Services for Robotics	Grassi L.	4
Computational model of visual attention	Schiatti L.	4
Dynamic Modelling of Multiphysics Systems	Ludovico D.	6
Functional quantitative assessment in sport, ergonomics and rehabilitation	TO BE ASSIGNED	4
Introductory Systems and Circuit Neuroscience for Neuroengineering	Forli A.	3
Multimodal Brain Analysis Reconstruction	TO BE ASSIGNED	5
Robotic Virtual Prototyping Design	D'Imperio M. / 2nd TEACHING TO BE ASSIGNED	6
The 3Rs approach: Replacement, Reduction and Refinement of animal procedures in biomedical research	Di Lisa D.	4
Technologies and methods for medical and surgical training	Ricci S.	4
Theory and Practice of Learning from Data	Oneto L.	6

[2] Recommended for 1st year students

* Offered by the PhD in Computer Science and Systems Engineering

Ethics and Bioethics in Bioengineering and Robotics

Number of hours: 21 hours

Credits: 7 CFU

Learning Outcomes

Can ethical considerations be incorporated into the design of novel artifacts? What duties and obligations do researchers have towards research participants? How can we develop models of human-robot interaction that preserve human values?

Increasingly, researchers and professionals in the fields of bioengineering and robotics are faced with ethical questions like these. The goal of this course is therefore twofold: to develop PhD students' sensitivity to the ethical issues that arise in research and professional practice, and to provide them with knowledge and tools that will help them navigate ethically complex scenarios.

Upon successful completion of this course, students will be able to:

- explain some of the key ethical and bioethical issues in bioengineering and robotics
- identify ethically problematic facets of a research project
- apply an ethical decision-making framework to ethically problematic scenarios involving questions that are relevant to their research interests.

Syllabus/Content

Topics covered may include:

- Ethics and bioethics: concepts and frameworks
- Ethical decision-making
- Research ethics
- The ethical requirements of research involving human subjects
- Research protocols and ethical review
- Informed consent
- Personal data and privacy
- Trust
- Ethical issues in human-robot interaction
- Value Sensitive Design in bioengineering

WHO

Teacher(s):

Name: Linda Battistuzzi

Email: linda.battistuzzi@unige.it

HOW

Teaching Methods:

The course will be delivered using different teaching and learning methods, including lectures and group discussions and activities. Case-Based learning, an approach to learning and instruction that uses factual or fictional scenarios exemplifying the issues at hand, will be extensively used.

Exam Description:

Students will be split into groups and each group will be asked to develop an ethically problematic case of their own, explaining the issues it raises and proposing an ethically appropriate course of action to solve it or engage with it.

Assessment Methods:

Students will present their case and discuss it during class time. Contributions to class discussion will be considered a part of the assessment.

WHERE AND WHEN

Lesson Location

UNIGE

Lesson Schedule

9, 13, 16, 23, 27 February (15:30 - 18:30)

2, 6 March (15:30 - 18:30)

Office hours for student

I can generally be reached by email. Appointments can be organized if necessary.

CONTACTS

Students should contact me by email: linda.battistuzzi@unige.it.

Paper Writing

Number of hours: 12 hours

Credits: 4 CFU

AIMS AND CONTENT

Learning Outcomes

The course aims to provide some basic elements to:

- choose a research topic
- manage and use sources
- do a novel, serious, and useful research
- describe and explain a research

At the end of the Course the PhD students will know how to organize and focalize a scientific activity, how to explain their research, and how to write a scientific paper and a PhD thesis.
The Course will be highly interactive and will benefit from the comments of the students.

Syllabus/Content

- What is a scientific activity
- What is a rigorous research?
- How to choose a research topic
- How to manage and use sources
- How to do a novel, serious, and useful research
- How to describe and explain a research
- Basic rules of writing
- Scientific language
- Scientific paper structure
- Elements of paper presentation

WHO

Teacher(s): Prof. Mario Marchese, Ph. +39-010-33-56571 (office) Ph. +39-010-33-52806 (lab)

email: mario.marchese@unige.it

HOW

Teaching Methods

Direct instruction (slides and course material).

Exam Description

The exam will be the drafting of a scientific article, even a short one, which will be reviewed and evaluated by the teacher. It is the only way to get a certificate to get credits. No participation certificate will be issued.

Assessment Methods

Written exam as explained above

WHERE AND WHEN

Lesson Location

Online through Office 365 Teams platform

Lesson Schedule

- Tuesday, April, 28th, 2026, 16.00-18.00

- Wednesday, April, 29th, 2026, 16.00-18.00

- Tuesday, May, 5th, 2026, 16.00-18.00

- Wednesday, May, 6th, 2026, 16.00-18.00

- Thursday, May, 7th, 2026, 16.00-18.00

- Tuesday, May, 12th, 2026, 16.00-18.00

CONTACTS

The teacher is available by email (mario.marchese@unige.it).

Grant Writing

Number of hours: 12 hours

Credits: 5 CFU

AIMS AND CONTENT

Learning Outcomes (short)

The course will present and discuss guidelines on how to design a research grant proposal and on the coordination of a research grant, with a special focus on European Horizon Europe Framework Programme. The students will be invited to participate to concrete exercise and the drafting of real and possible project ideas. A part of the lessons is dedicated to participatory activities.

Learning Outcomes (further info)

A particular focus will be on project proposals to be developed by PhD students and Early Stage Researchers. Use cases of successful projects coordinated by the teacher will be studied and analysed. A short simulation of the development process of a draft research proposal will conclude the course.

Syllabus/Content

European research grants, EU Horizon Europe, Project Drafting.

WHO

Teacher(s): Cinzia Leone, email: cinzia.leone@unige.it

HOW

Teaching Methods

Direct instruction (slides and course material) followed by a flipped classroom final short session.

Exam Description

Written exam (test and open questions) followed by a discussion of an example of case study.

Assessment Methods

Exam (test and oral discussion)

WHERE AND WHEN

Lesson Location

@UNIGE: TBA

Lesson Schedule

5, 7, 9 October

Office hours for student

Emails and appointments on request.

CONTACTS

The teacher is available by email (cinzia.leone@unige.it).

Open Science and Research Data Management (OS&RDM)

Number of hours: 10

Credits: 4 CFU

AIMS AND CONTENT

Learning Outcomes

This training module for PhD Students aims to introduce early-career researchers to the principles of scholarly communication, Open Science and Research Data Management. Students will gain a better understanding of the available research e-infrastructures, tools, and services for Open Access publishing, Research Data Management and FAIR Data. Students will also learn the importance and the transformative potential of Open Science practices in research, especially to improve reproducibility and increase research integrity. They will learn what means to make data FAIR, as required by many funders, including the European Commission, and how to draft a data management plan. Finally, they will have the chance to practice on common tools for Research Data Management, like Data Stewardship Wizard, Zenodo, and Dataverse.

Syllabus/Content

Module 1:

The transformative potential of Open Science for research (V. Pasquale, A. M. Pastorini)

Definition of Open Science; potential and benefits for different stakeholders.

Scholarly communication (A. M. Pastorini)

What is scholarly communication; the publication cycle and type of publications; peer-review process; bibliometrics (impact factor, h-index, other indicators, bibliometrics limits); citation databases; avoid plagiarism; literature search engines and reference managers.

The management of rights in scholarly communication (A. M. Pastorini)

Intellectual property: trademarks and patents; author's rights and copyright (Italian and European contexts); fair use vs exceptions and limitations to rights; editorial policies: contract and license; open access as an economic model; open licenses for sharing contents and data.

Open access in scholarly communication (A. M. Pastorini)

Overview on open access; open digital repositories and institutional archives; open access journals and bibliometrics; the different business models of open access; cOAlitionS and PlanS; OA policies and regulations (with specific reference to Unige and IIT context).

Author's rights and PhD Thesis (A. M. Pastorini)

Author's rights and PhD Thesis; regulation about PhD Thesis; the submissions of PhD Thesis in the institutional repository (IRIS UniGe); information and support: the OS UniGe website www.openscience.unige.it; open science & RDM support in IIT (*V. Pasquale*).

Module 3

What is Research Data Management? (V. Pasquale)

Research data management: a definition; Research data lifecycle: from data management planning to sharing.

The Research Data Lifecycle: Plan & fund (V. Pasquale)

Funder requirements; data management planning; support for DMP at IIT.

Hands-on activity: using online tools for data management planning (V. Pasquale)

Students will be asked to draft a data management plan of their PhD project by using online tools (e.g., Data Stewardship Wizard).

Module 4

The Research Data Lifecycle: Work with data (V. Pasquale)

Secure storage & backup; tips & tricks: file formats, data organisation, filenaming conventions, version control and "house-keeping" rules; data documentation; electronic lab notebooks.

The Research Data Lifecycle: Preserve & share (V. Pasquale)

FAIR data: how to make your data FAIR; data and metadata standards; digital preservation: repositories, open data licenses, persistent identifiers, how to make your research outputs (data, models, code) citable.

Hands-on activity: share a dataset in a trusted repository (V. Pasquale)

Students will be asked to create a dataset and share it by using a trusted repository (e.g., Zenodo, Dataverse, figshare, etc.)

WHO

Teacher(s):

Anna Maria Pastorini, SBA UNIGE, annamp@unige.it;

Valentina Pasquale, IIT, valentina.pasquale@iit.it.

How

Teaching Methods

Frontal lectures, hands-on activities.

Exam Description

To be recognized credits (CFU), students will have to take an exam. The exam may consist in a combination of multiple-choice tests and/or practical activities, such as the elaboration of a sample data management plan and/or sharing a research dataset.

Assessment Methods

Students will be evaluated on the basis of the multiple-choice tests, and/or on the execution of practical activities.

Where and When

Lesson Location

At UNIGE every day from 10:00 to 12:00.

09/02/2026 Aula G2B

10/02/2026 Aula G3B

11/02/2026 Aula G2B

12/02/2026 Aula G2B

13/02/2026 Aula G2B

Contacts

Anna Maria Pastorini, Servizio Sistema Bibliotecario di Ateneo, Ufficio Biblioteca Digitale e Open Access, Università di Genova
Email: annamp@unige.it

Valentina Pasquale, Research Data Management specialist, Via Morego 30, 16163, Genova (1st floor)
Email: valentina.pasquale@iit.it

Office hours for student

Students can ask questions sending emails to the teachers. Office hours: 8.30-17.30.

From Labs to Enterprise

Guidelines for technology transfer and the creation of startups aimed at exploiting the results of academic research

Number of hours: 14

Credits: 5 CFU

AIMS AND CONTENT

Learning Outcomes

From the tech transfer process to the incorporation and governance of the company, passing through the relationship among the founders and with investors and collaborators, to the fundraising. The course aims to provide a complete and practical guide on how to turn research into an enterprise and to avoid common mistakes, with a focus on the legal aspects.

Aims and Learning Outcomes

The course is addressed to students and researchers interested in launching or being involved in a startup project, or simply curious about it. Moving from real cases deriving from professional experience as a startup lawyer, the course addresses the dos and don'ts to launch a startup, with a legal prospective and a simple approach. The aim is to provide basic knowledge and legal instruments to navigate the leap between academic research and startups. In particular, at the end of the course the student will get familiar with the following areas:

- Differences between startups and traditional SMEs
- Tech transfer and Intellectual Property rights
- Team creation and founders' agreements
- Incorporation, structure and governance of the company
- By-laws and shareholders agreement
- Key people and collaborators
- Financing
- Investors, investment negotiation process and investment agreements
- Safe and SFP
- Exit

Syllabus/Content

- Startup vs SMEs: definition and introduction
- Tech transfer, IP rights and IP strategies: protection and exploitation of scientific discoveries
- Team creation: co-founders, key people and collaborators

- Company structure: incorporation, by-laws and shareholders agreements
- Company governance: how to set an adequate governance structure to avoid responsibilities as a member and as a director of the company
- Financing: grants, debt, and the importance of equity and semi-equity investments
- Equity investors and startup stages: FFF, accelerators, business angels, venture capital, CVC
- Equity financing: negotiation process, deal terms and legal documentation in the contest of traditional equity rounds
- Safe (Safe agreement for future equity) and SFP (*strumenti finanziari partecipativi*)
- Exit: trade sale and IPO

WHO

Teacher(s):

Name Surname: Francesca Redoano

HOW

Exam Description

Multiple choice questions

Assessment Methods

Minimum 50% correct answer

WHERE AND WHEN

Lesson Location

@ UNIGE

Lesson Schedule

21 January 10:00 – 12:00

28 January 9:00 – 12:00

4 February 9:00 – 12:00

11 February 14:00 -- 17:00

18 February 9:00 – 12:00

CONTACTS

Phone number: 0230356000

Email: Francesca.redoano@twobirds.com

Office: Via Porlezza 12, Milano

Introductory Systems and Circuit Neuroscience for Neuroengineering

Number of hours: 9 hours

Credits: 3 CFU

AIMS AND CONTENT

Aims and Learning Outcomes

This course introduces PhD students to the key concepts, methods, and landmark findings in modern systems and circuit neuroscience. Special emphasis is placed on the engineering dimension, both in terms of the technologies that drive discovery and the technological implications of neuroscientific advances. No specialized background is required beyond a basic understanding of biology and physics.

Teaching Methods: In person lectures with slides. Copies of slides will be provided for the students.

Syllabus/Content

<u>Part 1 (Week 1) – Concepts and Techniques</u>

- Definition and historical overview of Systems and Circuit Neuroscience
- Electrophysiology: electrodes and neural recordings
- Imaging approaches: MRI and fMRI, fluorescence activity imaging
- Calcium and voltage indicators
- Basics of transgene expression
- One- and multi-photon imaging and microscopy
- Causal approaches: lesions, pharmacology, optogenetics

<u>Part 2 (Week 2) – Example Discoveries</u>

- Neurophysiology of behavior (overview and neuroengineering applications)
- Neurophysiology of visual perception: from V1 to face cells
- Neurophysiology of cognition: place, grid, and concept cells
- Neurophysiology of orientation: ring attractors and neural manifolds
- Neurophysiology of innate behaviors and survival: hypothalamic circuits

WHO

Name Surname: Angelo Forli

How

Exam Description: Oral Assessment

Assessment Methods: 1-to-1 conversation (~15-20 min) between the teacher and the student about arguments discussed during the course.

Where and When

Lesson Location

IIT (Via Morego 30, Genova) or UNIGE, depending on student logistics

Lesson Schedule

10, 12, 17, 19 February (10:30 – 12:45)

Contacts

Email: angelo.forli@iit.it

Office: IIT, Via Morego 30, 16163, Genova

C++ programming techniques

Number of hours: 20

Credits: 6 CFU

AIMS AND CONTENT

Learning Outcomes (short)

This course introduces the specificities of C++ object-oriented programming language and focuses on the use of C++ for the implementation of object-oriented software modules. In particular, programming techniques to tackle the issues of memory management, robustness and efficiency are considered.

Syllabus/Content

- Basic Facilities: The C and C++ languages: pointers, arrays, and structures. Functions. Namespaces and exceptions.
- Abstraction Mechanisms: Classes and objects. Operator overloading. Class hierarchies. Polymorphism. Templates.
- Case studies: Containers and algorithms. Iterators.

WHO

Teacher(s):

Fabio Solari, fabio.solari@unige.it, +39 010 3536756

Manuela Chessa, manuela.chessa@unige.it, +39 010 3536626

HOW

Teaching Methods

Classroom lectures with theory and examples.

Exam Description

The exam will consist in the development of a specific software module/application.

Assessment Methods

Discussion about the implemented software module. A short document describing the application is required.

WHERE AND WHEN

Lesson Location

@ UNIGE, via Dodecaneso 35

Lesson Schedule

26, 27, 28, 29, 30 January (14:00 – 18:00)

CONTACTS

The teachers will be available on appointment (fabio.solari@unige.it manuela.chessa@unige.it)

Computational models of visual perception

Number of hours: 20

Credits: 5 CFU

AIMS AND CONTENT

Learning Outcomes

This course introduces paradigms and methods that allow students to develop computational models of visual perception, which are based on hierarchical networks of interacting neural units, mimicking biological processing stages. Case studies on computer vision applications and mixed reality systems are considered.

Syllabus/Content

Introduction to visual perception and to the cortical dorsal and ventral streams for action and recognition tasks.

Hierarchical networks of functional neural units. Computational models of the visual features estimation for action and recognition. Comparison among computational models and computer vision algorithms. Benchmark Datasets. How to use computational models to improve virtual and augmented reality systems to allow natural perception and interaction.

WHO

Teacher(s):

Name: Fabio Solari

Phone number: +39 010 3536756

Email: fabio.solari@unige.it

Office: Via Dodecaneso 35, terzo piano

HOW

Teaching Methods:

Classroom lectures with theory and examples.

Exam Description:

The exam will consist of the development of a specific software module.

Assessment Methods:

Discussion about the implemented software module. A short document describing the computational model is required.

WHERE AND WHEN

Lesson Location

UNIGE, a room on the second floor, via Dodecaneso 35

Lesson Schedule

8, 10, 12, 15 June (14:00 – 17:00)

17, 19 June (14:00 – 18:00)

Effective habits and skills for successful young scientists

Number of hours: 20

Credits: 5

AIMS AND CONTENT

Learning Outcomes

Although tons of books on effective habits and soft skills have been published, they have not been thought for scientists, and, therefore, issues that are relevant for them are not easily available. This short course aims to collect spread ideas and place them in a coherent framework useful for young scientists and provide a small tactical guide for scientists at the first stages of their career. First, I review the main concepts of Steve Covey's personal and time management paradigm, the inspirational speeches of Professor Randy Pausch, and the paradigm of atomic habits of James Clear, and discuss their utility for daily activity of a young scientist. Then, I focus on a few practical skills, namely, on how to write a great paper and give a great talk. I try to convey the message that succeeding in science and technology requires skills and habits beyond the pure intelligence and intellectual abilities, and that good habits and skills of personal and time management are extremely important for young scientists.

Syllabus/Content

1. Basic concepts of theory of habits. Effective habits for young scientists.
2. Basis concepts of personal and time management. Effective personal and time management for young scientists.
3. Survival skills in the game of science. Know yourself: match your goals to your character and talents.
4. How to write a great paper.
5. How to give a great talk.

References:

- S. Covey, The 7 Habits of Highly Effective People, 2020
- J. Clear, Atomic habits, 2018
- F. Rosei, T. Johnston, Survival skills for scientists, 2006
- F. Roli, Personal and time management for young scientists, tutorial at the International Conference on Machine Learning and Cybernetics, 2013
- R. Hamming, You and your research, 1986
- U. Alon, How to choose a good scientific problem, Molecular Cell, 2009.

- D. A. Patterson, How to have a bad career in research, Talks at Google, 2016

WHO

Teacher(s):

Name: Fabio Roli

Phone number: 320 4372999

Email: fabio.roli@unige.it

https://www.saiferlab.ai/people/fabioroli/effective-habits

HOW

Teaching Methods: Lectures. The lecturer will use slides. Copies of slides will be provided to the students.

Exam Description: written assessments.

Assessment Methods: written assessments with open-ended questions

WHERE AND WHEN

Lesson Location

online on MS Teams. Teams code: 145m0pn. If you are not a student of Univ. of Genova, please, send me an email for enrollment

Lesson Schedule

22, 23, 24, 25, 26, June (9:00 – 13:00)

CONTACTS

Fabio Roli

DIBRIS, Via Dodecaneso 35, Room 207

Email: fabio.roli@unige.it

Robot programming with ROS

Number of hours: 15 hours

Credits: 5 CFU

AIMS AND CONTENT

Learning Outcomes

- Learning the ROS communication architecture.
- Applying ROS functionalities to selected case studies.
- Understanding the ROS2 basic concepts.

ROS is a robotic middleware that offers a collection of packages for commonly used functionality, low-level control, hardware abstraction, and message passing. Given all these aspects, it has become a standard in robotics. The course will explore its most relevant functionalities, with the help of different examples, analyzing how the ROS framework may help in solving common problems in robotics. The course will describe in detail the ROS framework, also giving some general operative instructions (classes I – II- III), and it will then deal with some specific aspects (class IV-V), in particular, 3D simulations with ROS and ROS2. The course is particular suggested to students who have never used ROS, which will receive some insights about its features.

The course will foresee the usage of some commonly used robotic simulators, such as Gazebo, giving the possibility of practically testing the ROS features. During the course, a Docker image with ROS and ROS2 already installed will be given to students.

Syllabus/Content

- Class I (3 hours) – Introduction to ROS Topics. Class examples.
- Class II (3 hours) – Services and Nodes. Class examples.
- Class III (3 hours) – Custom messages and services. ROS Actions. Class examples and Assignment I.
- Class IV (3 hours) – Robot modelling and 3D simulations. Class examples.
- Class V (3hours) – ROS2 Topics, Services and Nodes. Class examples and Assignment II.

WHO

Teacher(s):

Name: Carmine Tommaso Recchiuto

Phone number: +393480667920

Email: carmine.recchiuto@dibris.unige.it

HOW

Teaching Methods. The teaching methodology will combine lectures together with supervised exercises that will address all most relevant theoretical aspects. Slides of the course will be provided before each lecture. Two mandatory assignments will be given at the end of the 3nd and of the 5th lecture.

Exam Description. The assignments will consist of the implementation of robotic simulations based on software written using the ROS framework. Simulation environments will be shown during the courses. The students will be required to write some ROS nodes, re-use existing ROS packages and create/modify robotic models for the simulation. The final exam will consist of an oral discussion about the implementation of the assignments.

Assessment Methods. The teachers will assess the appropriateness of the code and the effectiveness of the simulations. The students will present their work during an oral examination, after making an appointment with the teacher. The assessment will take in consideration how the students have learnt, selected, and implemented the techniques shown during the course.

WHERE AND WHEN

Lesson Location

@ UNIGE

Lesson Schedule

9, 10 September (10:00 – 13:00 & 14:00 – 17:00)

11 September (10:00 – 13:00)

Office hours for student

The teacher may be contacted by mail or by phone (see contacts)

CONTACTS

Prof. Carmine Tommaso Recchiuto, Associate Professor, RICE Lab (DIBRIS, E building 2nd floor)

Phone: +393480667920

Mail: carmine.recchiuto@dibris.unige.it

Modern C++

Number of hours: 30

Credits: 10 CFU

AIMS AND CONTENT

Learning Outcomes

The students will learn the new syntax and philosophy of Modern C++ (releases C++11, -14, -17, -20) with hands on the code at every lesson, its application with modern SW development techniques and finally they will challenge themselves with an online assignment where they will put in practice what learnt.

Syllabus/Content

Each of the following modules will be 3.0 hours each with theory and hands-on

1. Introduction 1: presentation of the course, basics of used tools (CMake, gitpod, git, Markdown, etc).
2. Introduction 2: refresh of C++98.
3. The basics 1: nullptr, auto, type aliases, initializer list, uniform initialization
4. The basics 2: range based loops, constexpr, scoped enums, override and final.
5. Advanced topics 1: lambda functions, STL containers, algorithms
6. Advanced topics 2: move semantics, smart pointers.
7. Advanced topics 3: multithread.
8. Advanced topics 4: new features in C++20
9. Language applied 1: hands on code.
10. Language applied 2: Critic discussion and correction of the code assignment.

WHO

Teachers:

Marco Accame (coordinator): marco.accame@iit.it

Valentina Gaggero: valentina.gaggero@iit.it

Nicolò Genesio: nicolo.genesio@iit.it

HOW

Teaching Methods:

Slides with code examples, hand on code using gitpod or other environment (each student needs a laptop), open discussion and questions.

Exam Description:

An online assignment with some questions and / or development of a simple project using what learned during the course. The goal of the assignment is not to check if a student knows by heart some coding syntax, but to learn how to design and present a piece of work.

Assessment Methods:

To be admitted to the online assignment the student must have attended at least 7 lessons. The assessment is passed if the developed code compiles, produces reasonable results and a simple report is presented.

The assignment will be revealed during the course. The students will have some time to complete it and solutions will be critically discussed during the last day of the course.

WHERE AND WHEN

Lesson Location

IIT-CRIS (Center for Robotics and Intelligent Systems), Via San Quirico 19D, 16163 Genova, Italy

Lesson Schedule

4, 11 May (14:00 – 17:00)

6, 7, 13, 14, 20, 21, 28 May (10:00 – 13:00)

CONTACTS

Place: First floor of IIT-CRIS (Center for Robotics and Intelligent Systems), Via San Quirico 19D, 16163 Genova, Italy.

Preferred interaction modes:

- email with subject beginning with the string “[MODERN-C++]” so that your email can be filtered out and immediately spotted.
- Teams platform after arranged appointment.
- Face to face.

Cloud Architectures and RESTful Services for Robotics

Number of hours: 12 hours

Credits: 4 CFU

AIMS AND CONTENT

Learning Outcomes

At the end of the course, students will be able to:

- Understand the principles of cloud architectures and RESTful service design.
- Develop Python-based cloud services using Flask.
- Build client–server architectures to support robotic applications.
- Integrate external cloud APIs (speech-to-text, text-to-speech, text generation, multimodal models, computer vision).
- Design and deploy lightweight cloud services suitable for robotic systems.

Aims and Learning Outcomes

The course provides doctoral students with practical skills for designing, implementing, and integrating cloud services and AI/ML APIs within robotic systems. Emphasis is placed on pragmatic development in Python, REST API design, and the integration of generative models applicable to multiple branches of robotics.

Syllabus/Content

This course introduces students to modern cloud-based architectures and AI services for robotics, focusing on RESTful design, Python microservices, and integration of speech, vision, and language models. Through hands-on exercises, students build both servers and clients, explore major cloud AI APIs, and develop a complete end-to-end pipeline.

Topics include:

- Cloud architectures for robotics and REST fundamentals
- Python microservices, clean API design, error handling, logging
- Python clients, and client-server interaction
- AI cloud services for speech, text generation, and vision
- Full system integration, best practices, and final demo preparation

WHO

Teacher: Lucrezia Grassi

How

Teaching Methods:

- Lectures with live coding
- Hands-on programming sessions
- Demonstrations with real API calls
- Take-home project (exam)

Exam Description:

Each student must develop a small cloud-based application in Python using Flask, including:

- at least one REST API designed and implemented from scratch;
- a Python client interacting with the service;
- integration of at least one external AI API.

The project must be submitted as a Git repository including:

- server and client code,
- a README describing the architecture,
- short usage instructions.

Assessment Methods:

Evaluation will be based on:

- Functionality and correctness of the implemented service
- Quality and clarity of REST API design
- Integration and correct use of external AI services
- Documentation and code structure

Where and When

Lesson Location

@ UNIGE

Lesson Schedule

12 June (9:00 – 12:00)

11, 16, 18 (14:00 – 17:00)

Contacts

Email: lucrezia.grassi@unige.it

Office: RICE Lab, DIBRIS – secondo piano Padiglione E, Via all’Opera Pia 13, 16145 Genova

Dynamic Modelling of Multiphysics System

Number of hours: 18

Credits: 6

AIMS AND CONTENT

Learning Outcomes

At the end of the course the students will be able to model and simulate the dynamics of multiphysics systems exploiting energy-based methods (Lagrangian, Hamiltonian) and represent complex systems through Bond Graph modeling technique.

Aims and Learning Outcomes

The course aims to provide students with the theoretical foundations and practical skills required to model and simulate the dynamics of multiphysics systems using energy-based approaches. By the end of the course, students will be able to:

- Understand the principles of energy-based modeling for mechanical, electrical, and multiphysics systems.
- Apply Lagrangian and Hamiltonian formulations to derive dynamic models of physical systems.
- Represent multiphysics systems using Bond Graph methodology for unified modeling across domains.
- Implement numerical simulations of dynamic systems in MATLAB, validating models through computational experiments.

Syllabus/Content

- **Lagrangian/Hamiltonian Modeling**
    - Mechanical Systems
    - Electrical Systems
    - Multiphysics Systems
- **Bond Graph Modeling**
    - Mechanical Systems
    - Electrical Systems
    - Multiphysics Systems
- **Numerical Simulation of Multiphysics Systems**

WHO

Teacher:

Daniele Ludovico - daniele.ludovico@iit.it

HOW

Teaching Methods:

The course combines lectures on theoretical concepts with supervised exercises for practical implementation. Students are required to bring a laptop with MATLAB installed for hands-on sessions.

Exam Description:

Students will complete a project involving the modeling and simulation of a physical system using the techniques learned during the course.

Assessment Methods:

- Submission of a written report detailing:
    - Modeling process
    - Simulation implementation
    - Analysis of results
- Delivery of the MATLAB code used for the simulation.

WHERE AND WHEN

Lesson Location
The lessons will be held at IIT (contact the teacher for the room confirmation)

Lesson Schedule

19, 26 May (10:00 – 13:00)

21 May (14:00 – 17:30)

9, 11, 16 June (10:00 – 13:00)

Electronics and Circuits

Number of hours: 48

Credits: 12

AIMS AND CONTENTS

Learning Outcomes (short)

This course offers detailed knowledge and very practical skills about the electronics circuits and systems that Ph.D. students in the Engineering fields are likely to need during their research studies. The approach totally differs from standard electronics courses where a strong theory hides the useful circuitry and methods of analysis in hard-to-find sections and endnotes, thus leaving the practicing Engineer weak in circuit design. Attending the whole course is strongly reccommended to take the most benefit from the addressed topics, because each class relies on the preceding one and it is a basis for the next one, in a progressive scheme. Nevertheless, students are allowed to attend just single modules.
The course is divided into 4 Modules and these are its main outcomes:
Module 1: analog and digital electronics
Module 2: mixed signals and data conversion
Module 3: advanced design techniques
Module 4: CAD design of Printed Circuit Boards (PCBs)

Learning Outcomes (further info)

Level 1: learning basic Operational Amplifier circuit design and practices; learning digital electronics basics.

Level 2: understanding Analog-to-Digital and Digital-to-Analog conversion and being able to write the specifications of an analog system for signal conditioning and of a mixed-signal system (signal conditioning, data acquisition, filtering) to provide to a thirdy-part designer or to select an off-the-shelf solution available on the market

Level 3: more electronic components; schematic circuit design of "standard modules" to be used as building-blocks in more complex or custom systems, more advanced technical issues (e.g. circuit layout dos and don'ts), circuit design best practices

Level 4: learning a CAD tool for the design of circuit schematics and of the related customized Printed Circuit Boards.

Syllabus/Content

Module 1: students will learn the Operational Amplifier and will be able to go through a typical Datasheet, understanding the various features and characteristic curves. In this module they will practice with basic circuits while learning how to optimize the design in terms of requested features (e.g. noise, stability, etc.). In the second part students will go through the basics of digital design, confining the activities on typical digital building blocks useful for the following Module 2 module.

Module 2: students will mix the acquired concepts into the A/D and D/A technologies, learning how to select the appropriate converter for a given application especially in terms of resolution and speed. They will afford a real-case situation where an input analog signal must be pre-processed and filtered before the converter stage. They will also learn the main communication protocols to interface with converters and other programmable integrated circuits (SPI, I2C, etc.).

Module 3: this module will offer some details about other components useful to afford the design of more complex systems. Based on the knowledge of the two preceding modules, students will be ready to design circuits intended as more or less standard building blocks for complex applications, determining the design parameters and selecting the best options vs. the case study. Examples of real-life schematics will offer a good dictionary of solutions that the student can add to a library for future use in the real life. It will be then the time to go into some insights of the electronic design with a series of good and bad circuits to analyze and discuss, exploiting what learned till now and being ready to understand what are the best practices of "the art of electronics".

Module 4: this module is intended as the natural final stage of the preceding learning. Here the student will learn Kicad, a cross platform and Open Source electronics design automation suite. We will start with the circuit schematics, then adding a physical footprint to each component , defining a set of PCB rules to respect while routing and finally designing the corresponding Printed Circuit Board, up to the generation of the fabrication output files ready to be sent to a PCB facility.

WHO

Teacher:

Prof. Marco Sartore

HOW

Teaching Methods

The students will be equipped with Kits containing breadboards, components and test instruments to practically experiment on the class' subjects. Personal Computers will NOT be available but are strongly recommended.

Classes will be held in a Laboratory and based on:
- taught-lessons to offer a clear explanation of the theoretical foundations and methods of the topics (respective to the Modules enumerated above)
- practical-lessons where students will be guided to physically realize the explained circuits using a set of provided components, performing all the measurements to test and verify them by means of available instruments such as Oscilloscope, Waveform Generator, Power Supplies, Multimeter.

Exam Description

The students will be asked to design circuits, realize them in the Lab and demonstrate their proper operation with the necessary measurements. Drill problems will be submitted during the lessons and the Students will be asked to answer with short reports.

Assessment Methods

Continuous assessment throughout the course with verification of students' interest and care, plus a final evaluation of the exam result and reports.

WHERE AND WHEN

Lesson Location

Lessons will be done at:

DITEN Laboratories, Via all'Opera Pia 11, Padiglione C, Aula Mattera.

Due to the practical nature of the course, with the need of Lab equipment and aiming to the physical realization and test of circuits and systems, it cannot be offered on-line.

Lesson Schedule

Lessons will be offered during 2 weeks (from Monday to Friday) in March 2025, one module of 12 hours per week, with the following schedule (extremes included):

- **Monday 2**: 10:00 AM to 1:00 PM (3 morning hours)
- **Tuesday 3**: 9:00 AM to 12:00 PM and 2:00 PM to 5:00 PM (3 morning hours, 3 afternoon hours)
- **Wednesday 4**: 9:00 AM to 12:00 PM and 2:00 PM to 5:00 PM (3 morning hours, 3 afternoon hours)
- **Thursday 5**: 9:00 AM to 12:00 PM and 2:00 PM to 5:00 PM (3 morning hours, 3 afternoon hours)
- **Friday 6**: 9:00 AM to 12:00 PM (3 morning hours)

- **Monday 16**: 2:00 PM to 6:00 PM (4 afternoon hours)
- **Tuesday 17**: 9:00 AM to 1:00 PM and 2:00 PM to 4:00 PM (4 morning hours, 2 afternoon hours)
- **Wednesday 18**: 9:00 AM to 12:00 PM (3 morning hours)
- **Thursday 19**: 9:00 AM to 1:00 PM and 2:00 PM to 5:00 PM (4 morning hours, 3 afternoon hours)
- **Friday 20**: 9:00 AM to 1:00 PM (4 morning hours)

*The course has an operational cost of € 250,00 for PhD students of Bioengineering and Robotics and 500 for external ones. Since it involves practical exercises, a maximum of 10 students is allowed. The cost for PhD students will be covered using the PhD student budget.

Motion control drivers

Number of hours: 48

Credits: 12

AIMS AND CONTENTS

Learning Outcomes (short)

This course offers detailed knowledge about the correct way to drive the main motor types utilized in Robotics, exploring the driver circuits and highlighting the related insights, namely Stepper and Brushless motors (despite DC Motors are not explicitly included, the students will however get the necessary skills to deal with them too).
Attending the whole course is strongly recommended to take the most benefit from the addressed topics, because each class relies on the preceding one and it is a basis for the next one, in a progressive scheme. Nevertheless, students are allowed to attend just single modules.
The course is divided into 4 Modules and these are its main outcomes:
Module 1: preparatory circuits for motor drivers
Module 2: Stepper Motors and their basic drivers
Module 3: advanced motor drivers circuits
Module 4: Brushless Motors and drivers

Learning Outcomes (further info)

Module 1: learning circuits based on transistors working as switches, both bipolar and MOSFETs, varying the load connections and operating conditions.
Module 2: learning how a Stepper Motor is composed and how it must be correctly driven, combining its mechanical features with driver's requirements, up to the realization of a simple electronic circuit to interface a Stepper Motor.
Module 3: understanding the insights of fine drivers for Stepper Motors, learning microstepping techniques and their practical application in the physical realization of an advanced driver.
Module 4: understanding the structure of Brushless Motors and the field oriented control (FOC), with the practical realization of drivers using dedicated integrated circuits, up to programming a microcontroller as the smart portion of an advanced driver.

Syllabus/Content

Module 1: students will work with bipolar and MOSFET transistors learning the insights of their function as switches, which is the basic building block to design motor drivers. They will design, step-by-step, mono and multi-polar circuits based on discrete parts, in order to get a deep knowledge of the drivers' core.

Module 2: students will learn the internal structure of a Stepper Motor and its physical pros and cons in motion control applications. Then we will focus on drivers and learn how to design a simple circuit making use of the circuits developed in the preceding Module. Students will start also programming a microcontroller to provide the necessary signals to the discrete drivers.

Module 3: students will exploit the acquired concepts into more advanced designs, where the driver will no longer be made of discrete parts but a dedicated IC driven by a programmable microcontroller or IC. They will then realize a real driver where micro stepping will be applied and they will get a fine positioning of the motor. Torque/speed and acceleration issues will be also addressed.

Module 4: this module will offer the knowledge about Brushless Motors, including their internal structure and function. Students will learn which signals are needed to properly drive such motors and will learn how to design a real circuit, which will be tested in practice with a real motor. Among the advanced topics, they will figure out how to deal with Clarke and Park transforms and will finally realize also the software part of an advanced driver.

WHO

Teacher:

TO BE ASSIGNED

HOW

Teaching Methods

The students will be equipped with Kits containing the parts, components and motors to practically experiment on the class' subjects. Personal Computers will NOT be available but are strongly recommended.
Classes will be held in a Laboratory and based on:
- taught-lessons to offer a clear explanation of the theoretical foundations and methods of the topics (respective to the Modules enumerated above)
- practical-lessons where students will be guided to physically realize the explained set-ups using a set of provided components, motors and microcontroller boards, performing all the measurements to test and verify them by means of available instruments such as Oscilloscope, Waveform Generator, Power Supplies, Multimeter.

Exam Description

The students will be asked to realize the described drivers in the Labs and to demonstrate their functioning when connected to the respective test motor, performing the necessary measurements. They will write a report describing the driver(s) and the related results.

Assessment Methods

Continuous assessment throughout the course with verification of students' interest and care, plus a final evaluation of the exam result and report.

WHERE AND WHEN

Lesson Location

Lessons will be done @ UNIGE

Lesson Schedule

TBA

*The course has an operational cost of € 250,00 for PhD students of Bioengineering and Robotics and 500 for external ones. Since it involves practical exercises, a maximum of 10 students is allowed.
The cost for PhD students will be covered using the PhD student budget.

Theatrical techniques for scientific presentation

Number of hours: 12

Credits: 5 CFU

AIMS AND CONTENT

Learning Outcomes (short)

Upon successful completion of this course, students will be able to successfully prepare a scientific presentation for a specific audience, and to deliver it to the public by using their voice, their body and the space around them in the most efficient way as possible.

Syllabus/Content

Topics covered will include:

- How to prepare a presentation by taking into account the scientific context and the public;
- Structuring the presentation: the importance of the beginning and the end;
- Scientific journals and conferences;
- Theatrical techniques to use the space;
- Theatrical techniques to use the body;
- Theatrical techniques to use the voice.

WHO

Teacher(s):

Antonio Sgorbissa, +393204218938, antonio.sgorbissa@unige.it

HOW

Teaching Methods:

The course will be delivered using a range of teaching and learning methods, including lectures, group discussions and activities, as well as acting exercises to control the body, the voice, and the surrounding spaces.

Assessment Methods:

Students will be required to 1) prepare a presentation to be delivered to other students, and 2) participate in a short theatrical performance to test the techniques they have learnt during lessons.

WHERE AND WHEN

Lesson Location

Villa Bonino, Viale Francesco Causa 13, Genova

Lesson Schedule

18, 25 May (9:00 – 12:00)

15, 22 June (9:00 – 12:00)

Office hours for student

Contact the teacher to fix an appointment.

CONTACTS

Via Opera Pia 13, Second Floor. Contact the teacher via phone and email.

Principles of Polymer Synthesis, Functionalization, and Recycling

Number of hours: 12

Credits: 4 CFU

Aims and Content

Learning Outcomes

The aims of the course is to gain basic knowledge in organic, polymer and material chemistry. Synthetic methods, industrial manufacturing processes (e.g., extrusion, injection molding…), and characterization techniques for polymeric materials will be thoroughly explained. In addition, concepts related to end-of-life scenarios of polymers, such as biodegradability, composting, recycling, and upcycling, will be explored. The students will acquire skills on common polymers widely used both in academic and industrial fields and useful information about how to handle, recognize, and recycle them in ordinary life.

Syllabus/Content

Base concepts of polymer chemistry; polymer synthesis: chain-growth polymerization (radical polymerization), ring-opening polymerization (e.g. epoxy resins, PLA synthesis), step-growth polymerization (e.g. polyurethanes), living polymerization; polymer structure and morphologies; determination of molecular weight and molecular weight distribution; biopolymers; functionalization of polymers. Thermosetting, thermoplastics and vitrimers. Fabrication of polymers from the lab to the industrial scale. Overview of small organic molecules and polymers characterization methods: NMR; infrared spectroscopies; UV-visible spectroscopy; chromatography techniques: High performance liquid chromatography (HPLC), Gas chromatography (GC), Size exclusion chromatography (SEC); principles of mass spectrometry; thermal characterization, tests for mechanical properties. Bio-based polymers and biodegradable polymers. End-of-life of polymers: landfill, chemical and mechanical recycling, upcycling, and compostability.

Who

Teacher(s):

Name Surname: Martina Nardi

Office: IIT (4th floor), via Morego 30, 16163, Genova

How

Exam Description

Oral exam

Assessment Methods

Formative assessment (feedback with the students by oral questions during lessons)

Where and When

Lesson Location:

@IIT, via Morego 30, 16163, Genova

Lesson Schedule:

14, 16, 21, 23, 27, 29 April (14:00 – 16:00)

Contacts

Phone number: +39 3408611509

Email: martina.nardi@iit.it

Multimodal Brain Analysis Reconstruction

Number of hours: 26 hours

Credits: 8 CFU

AIMS AND CONTENT

Learning Outcomes

The present course will introduce the student to the most advanced techniques to non-invasively reconstruct brain activity using both electroencephalography (EEG) and magnetic resonance imaging (MRI). The EEG section of the course will consist of a first part based on sensors analysis and a second part on distributed sources analysis. Guidelines and common good practices for acquisition and analysis will be discussed considering both the time, the frequency, and the time-frequency domains. The MRI section will cover both structural (either grey and white matter integrity) and functional (at rest and during a task) MRI and their integration. Comparison between EEG and MRI will be described.

Syllabus/Content

- Class 1 (3h) EEG and MRI signal origin and spatial-temporal-spectral characteristics. EEG Data recording,
- Class 2 (3h) EEG experiment design, pro EEG data acquisition, preprocessing (referencing, filtering and epoching) and artefact removal.
- Class 3 (2h) Electrode analysis of ERP. Peak analysis, clustering electrodes and averaging time intervals. Subject and group level analysis. Statistical analysis.
- Class 4 (2h) Frequency and time-frequency analysis. Peak analysis, clustering electrodes and averaging time intervals. Subject and group level analysis. Statistical analysis.
- Class 5 (3h) Introduction to EEG source analysis. Theory, forward model and inverse problem resolution. Differences between dipoles and distributed source analysis. Alternative models.
- Class 6 (3h) Results post-processing (dimensionality reduction) approaches. Source analysis in Brainstorm.
- Class 7 (3h). Common MRI preprocessing steps.
    - Structural MRI.
    - Evaluating gray matter: density (VBM), cortical thickness
    - Evaluating white matter: TBSS, Tractography
    - Miscellaneous (Pediatric templates, longitudinal coregistration)
- Class 8 (3h) Functional MRI. Functional MRI at rest. Brain functional (FC) and effective (EC) connectivity.

    - Within networks FC (Melodic analysis).
    - Whole brain FC (seed-based FC)
    - EC at rest
    - Connectomics (between network/regions) FC with CONN software

- Class 9 (4h) Functional MRI during a task. Task-based FC (DCM, PPI) and fMRI.
  Epi correction within high field scanners. Comparison between EEG, fMRI and TMS tools. Final Examination.

WHO

Teacher(s):

TO BE ASSIGNED

HOW

Teaching Methods:

Projected slides

Exam Description:

Students will undergo 90 minutes written examination consisting in 60 multiple selection questions. 15 questions will regard EEG sensors analysis, 15 the EEG source analysis part and 30 the MRI part

Assessment Methods:

To obtain the 8 CFU, students are expected to correctly answer a total of at least 36 questions. Moreover, at least 7 – 7 - 15 correct answers for each of the two sections (EEG sensors, EEG sources and MRI) are required.

WHERE AND WHEN

Lesson Location

TBA

Lesson Schedule

2 July (9:00 – 12:00)

7 July (14:00 – 17:00)

9, 10 July (14:00 – 16:00)

13, 14, 15, 16 July (9:00 – 13:00)

17 July (10:00 – 13:00)

Advanced Topics in In Vitro Neuroengineering: Techniques, Applications, and Future Directions

Number of hours: 12

Credits: 4 CFU

AIMS AND CONTENT

Learning Outcomes

The PhD course is designed to provide students with a comprehensive understanding of in vitro neuroengineering, focusing on the principles, techniques, and applications of engineering approaches for studying and manipulating neuronal systems in vitro. The course will cover fundamental concepts, experimental methodologies, and cutting-edge advancements in the field, with an emphasis on multidisciplinary perspectives. Students will gain practical skills in designing and conducting experiments, and analyzing data.

Syllabus/Content

The course is divided into 4 sections:

1. Introduction to In Vitro Neuroengineering
    a. Overview of in vitro neuronal systems
    b. Historical context and significance of in vitro neuroengineering
    c. Ethical considerations in in vitro experiments
2. Neuronal Cell Culture Techniques
    a. Cell culture fundamentals
    b. Primary neuronal culture techniques
    c. Induced pluripotent stem cell-derived neuronal cultures
    d. Co-culture systems and organoids

3. Microelectrode Arrays (MEAs)

   a. Principles of MEAs

   b. Fabrication and design considerations

   c. Signal acquisition and data analysis

   d. Applications in electrophysiology and neural interface development

4. Microfluidics and Brain-on-a-Chip Systems

   a. Microfluidic device fabrication and operation

   b. Integration of neuronal cultures in microfluidic platforms

   c. Advancements in drug delivery and chemical stimulation

   d. Disease modeling and high-throughput screening

WHO

Teacher(s):

Name: Martina Brofiga

Phone number: +39 3880732345

Email: martina.brofiga@dibris.unige.it

HOW

Teaching Methods:

Frontal lessons and hands-on activities

Exam Description:

Project proposal (2 pages max) and presentation of it.

Assessment Methods:

Feasibility of the project and the clarity of the presentation will be both evaluated.

WHERE AND WHEN

Lesson Location

Lessons will be done @ UNIGE

Lesson Schedule

6, 7, 8, 9 July (10:00 – 13:00)

CONTACTS

On appointments scheduled by email: martina.brofiga@dibris.unige.it

An introduction to Body-Machine Interface

Number of hours: 12 hours

Credits: 4 CFU

AIMS AND CONTENT

Learning Outcomes (short)

The course will introduce the field of body-machine interface (BoMI). It will present different concepts for dimensionality reduction to be applied in the domain of biological signals to control external devices. It will also discuss current scientific and technological perspectives and limitations.

Emphasis will be given to the study of the learning process while using a BoMI both from a modeling and from a data analysis point of view.

Learning Outcomes (further info)

Controlling an external device, like a computer or a robotic manipulator, can play a crucial role in improving lives of individuals especially assisting those with motor impairments (Beckerle et al 2017, Park et al 2020) or augmenting the abilities of healthy people (Penaloza et al 2018, Guggenheim et al 2020). In recent years, body-machine interfaces (BoMIs) through a linear or non-linear mathematical function have been proven to be able to transform body signals issued by the user into 2D/3D signals to control an external device like a cursor on a screen (Casadio et al 2011), a virtual and real wheelchair (Thorp et al 2016) or a virtual robotic arm (Rizzoglio et al 2020), and it could be customized to fit the ability of each user.

Syllabus/Content

The first part of the course will introduce the general concept of redundancy and its application in body-machine interface and we will do an interactive discussion on the state of the art, highlighting perspective and limitations. We will then analyze more in details linear and non-linear dimensionality reduction techniques to map body movement into a control command for an external device.

In the second part we will approach the BoMI from a modeling point of view, trying to understand how humans solve the dimensionality reduction problem and how they deal with the redundancy while learning to use a BoMI.

WHO

Teacher(s):

Name: Camilla Pierella

Email: camilla.pierella@edu.unige.it

HOW

Teaching Methods

Lectures with theory and examples

Exam Description

There will be a final examination decided by the instructor

Assessment Methods

The teacher will evaluate the final examination

WHERE AND WHEN

Lesson Location

The lessons will be done @ UNIGE (Room to be confirmed) or remotely through Teams platform.

Lesson Schedule

23, 24, 25, 26 June (14:00 – 17:00)

Office hours for student

Students can ask info to the teacher by appointments or through e-mail

CONTACTS

camilla.pierella@edu.unige.it

Computational models of visual attention

Number of hours: 12

Credits: 4

AIMS AND CONTENT

Learning Outcomes

By the end of the course, students will be able to:

- Describe the basic mechanisms of human visual attention based on eye movements.
- Design an experimental protocol with eye-tracking and select suitable outcome measures.
- Identify, train and visualize the output of ANNs suitable to model human visual attention.
- Discuss the choice of different ANNs architectures based on a specific application.
- Present a project idea and discuss their scientific hypothesis and methodological choices.

Syllabus/Content:

The course is designed to provide students with an overview of existing computational methods to model human and machine attention during visual tasks (e.g. object recognition, visual search, detection of social cues). During the first part of the course, students will gain a basic background about human visual attention mechanisms based on gaze data, as well as advantages and limitations of existing eye-tracking technologies. Second, they will learn how to incorporate attention mechanisms into the most common ANNs' architectures, and to interpret both human and machine attention on visual tasks. Hands-on sessions will help students to gain a quick, practical experience in building computational models of visual attention. The course will conclude with a project proposal presentation with feedback from the instructor and the other students.

WHO

Teacher(s):

Name: Lucia Schiatti

Email: lucia.schiatti@iit.it; schiatti@mit.edu

HOW

Teaching Methods: The course is composed by 3 lectures, including both a theoretical presentation of the content and a practical hands-on session. Hands-on sessions will include software exercises implemented in Python. The final lecture will be devoted to the student projects' presentation and discussion.

Exam Description: Students will be required to prepare a project proposal about one potential application of the methods presented during the course, and to set up a methodological approach for implementation. Students' projects will be presented through a pitch session during the last lecture.

Assessment Methods: Students will be encouraged to actively participate to the lectures through small groups' activities and discussions. They will practice the learned concepts through software lab exercises with incremental complexity. For the summative assessment, students will be required to prepare a final project proposal and to present it at the end of the course.

WHERE AND WHEN

Lesson Location: Aula Pitagora-Fibonacci, piano 10, Center for Human Technologies, IIT

Via Enrico Melen 83, Building B, 16152 Genova (Campus Tecnologico Erzelli).

Lesson Schedule

21, 22, 23 September (14:00 – 17:00)

25 September (9:00 – 12:00)

CONTACTS

Students can interact with the instructor via email.

Functional quantitative assessment in sport, ergonomics and rehabilitation

Number of hours: 12 hours

Credits: 4 CFU

AIMS AND CONTENT

Learning Outcomes

The present course will introduce the topic of functional quantitative assessment. This subject is becoming fundamental in all the fields where is important to understand human sensorimotor performance and in general in all the applications where the human is physically in the loop, such as collaborative robotics, wearable robotics, rehabilitation robotics, and many others. The difficulty to quantify human performance is due to the complexity of human behaviour. In fact, the human nervous system is capable of a simultaneous, integrated, and coordinated control of 100-150 mechanical degrees of freedom via tensions generated by about 700 muscles. There is also a different number of sensors (visual, auditory, proprioceptive) and actuators (muscles and skeletal system) to take into account.

The course will initially review the traditional techniques adopted to quantitatively assess human sensorimotor performance in the fields of sport, rehabilitation and ergonomics. In the second part of the course will be deeply analysed all the potential technologies that can be exploited to innovate the traditional techniques, with special emphasis on robotic technologies.

Syllabus/Content

- The concept of functional quantitative assessment and the application scenarios
- Lower limb traditional techniques
- Upper limb traditional techniques
- Lower limb robot-based techniques
- Upper limb robot-based techniques
- New trends and potential future technologies

WHO

Teacher(s):

TO BE ASSIGNED

HOW

Teaching Methods:

Slide presentation and critical discussion of a reading list

No Prerequisites

Reading List: Specific readings will be assigned for each class.

Exam Description:

There will be a final examination decided by the instructor and communicated to the students at the beginning of the course, after contacting the students and evaluating their background.

Assessment Methods:

The assessment method will be decided by the instructor and communicated to the students at the beginning of the course.

WHERE AND WHEN

Lesson Location

TBA

Lesson Schedule

8, 9, 10 June (9:00 – 13:00)

CONTACTS

Robotic Virtual Prototyping Design

Number of hours: 18 hours

Credits: 6 CFU

AIMS AND CONTENT

Learning Outcomes (short)

The aim of the Robotic Virtual Prototyping Design course is to give the basic knowledge about the Finite Element Analysis (FEA) and Multi-Body Simulations (MBS) applied to the robotics. These computational techniques predict the behavior of physical systems: joined together permit to study the dynamics taking in account the body flexibility, the control and optimization. It will be introduced mainly applied to the mechanical field, in particular to the robotic anthropomorphic arm. The student gets 6 credits if he/she attends the entire course and accomplishes the final project.

Learning Outcomes (further info)

Virtual Prototyping Design is the basic part of the Computer Aided Engineering (CAE) that in the last decades involved more and more the R&D of the industries and the Research Centres. The reason is that the physical models need more time and energies for being improved than virtual ones. Moreover, running numerous simulations, these models permit to be optimized depending on several parameters.

Thus the course will give an overview on the virtual prototyping design building the models with the main worldwide mechanical numerical simulation software (MSC.Nastran, Ansys/Workbench and MSC.Adams). In the second part of the course, Multibody and Finite Element Analysis will be integrated in order to take the best advantage from the virtual prototyping technique and applied to some mechanisms and robot arms. Then the control (Matlab/Simulink) and the optimization (ModeFRONTIER) will be applied to the simulations.

Even if the training solutions concern the mechanical and robotic problems, it is designed to provide to attendants with both the comprehensive and subject-specific knowledge; the students need to effectively apply software tools to solve general problems: static, dynamic, linear, non-linear and motion or multi-physics analysis. So the aim of the course is not only knowing the performances of the software used to build the basic models, but it is also to be able to improve their skill by themselves.

Syllabus/Content

- class 1 (C1)
  - Overview on Virtual Prototyping: Finite Element Analysis (FEA), Multibody Simulation (MBS)
- class 2 (C2)
  - Anthropomorphic Arm Modelling (FEA+MBS)

- class 3 (C3)
  - Anthropomorphic Arm Modelling (MBS + FEA)
- class 4 (C4)
  - Anthropomorphic Arm Modelling (MBS + FEA + Co-Simulation Control)
- class 5 (C5)
  - Anthropomorphic Arm Modelling (MBS+ FEM + Co-Simulation Control+ Optimisation)
- class 6 (C6)
  - Final Project Assignment

WHO

Teachers:

Mariapaola D'Imperio

TO BE ASSIGNED

HOW

Teaching Methods

Methods

The course will be based on 6 traditional teacher-led mixed to hand-on lectures
Slides of the course will be provided before each lectures
Final project for the exam will be prepared with the teachers during the 6th lectures

Prerequisites

Basic knowledge: classical physics and programming.

Installed Software: MSC ADAMS, ANSYS/Workbench, MatLab/Simulink and ModeFRONTIER should be already installed before the lectures (the software will be provided by the teachers for those who have not got them).

Reading List

- Klaus-Jurgen Bathe, Finite Element Procedures, Prentice-Hall of India, 2009
- Robert D. Cook, David S. Malkus, Michael E. Plecha & Robert J. Witt, "Concepts and Applications of Finite Element Analysis", 4th Edition, John Wiley & Sons, 2001 (ISBN: 0 471 35605 0)
- Rajiv Rampalli, Gabriele Ferrarotti & Michael Hoffmann, Why Do Multi-Body System Simulation?, NAFEMS Limited, 2011
- R.J.Del Vecchio, Design of Experiments, Hanser Understanding Books, 1971.

Remarks

Weekly homework will be assigned at the end of each lecture with an estimated average workload of 1 hours per week. Nevertheless the Project Assignment has an estimated average workload of 1-2 days.

- the minimum attendance is 4 out 6 classrooms (the Project Assignment is not mandatory);
- the Project Assignment should be pass according to the policy.

Exam Description

- the minimum mark to pass the Project Assignment is 75%;
- the Project Assignment is due 4 weeks after they are assigned and should be done in a neat and orderly fashion on PowerPoint presentation following the template (provided with the Project Theme). Late submission will not be accepted;
- the project can be:
    1) standard project (proposed by teachers)
    2) project related to the student PhD project (proposed by the student)
    3) quick paper publication on a topic to be decided (teachers and student together)

Assessment Methods

The Students should provide the:

- kinematics, dynamics of the project mechanism with rigid and flexible component(s)
- numerical models, drawings and charts of comparison of these two conditions
- PowerPoint presentation (according to the provide template)

WHERE AND WHEN

Lesson Location

TBA

Lesson Schedule

6, 8, 10, 13, 15, 17 July (14:00 – 17:00)

Office hours for students

The teachers will be available (on the office or on skype) every Wednesday morning from 11:00 to 14:30 from 1st June to the 31st of July 2026

CONTACTS

Mariapaola D'Imperio mariapaola.dimperio.phd@gmail.com
TBA

The 3Rs approach in biomedical research and advanced 3D in vitro tissue models

Number of hours: 12 hours

Credits: 4 CFU

AIMS AND CONTENT

Learning Outcomes

Replacement, Reduction, and Refinement:

3Rs methods are becoming an essential element in the whole field of biomedical research, from its most fundamental aspects to its daily applications. Today 3Rs methods represent a multidisciplinary scientific area comprising animal science, basic biology, test development, pharmacology, toxicology, regulations and regulatory practices, as well as ethics and behavioral sciences. The aim of the course is to raise consciousness for the scientific soundness of the 3Rs methodology.

Advanced 3D in vitro models:

Bioprinting can be applied to engineer 3D in vitro tissue models by mimicking the structure and function of native tissue through the precise assembly of materials and cells. This approach allows the spatiotemporal control over cell–cell and cell–extracellular matrix communication and thus the recreation of tissue-like structures. Tissue models are applied in regenerative medicine, pharmaceutical, diagnostic, and basic research, reducing the use of laboratory animals according to the 3Rs principle.

According to European Directive 2011/63/eU1, all personnel working with experimental animals should be educated to be competent to work with animals.

Syllabus/Content

The topics cover the 3Rs principle, basic research, toxicological applications, method development and validation, regulatory aspects, case studies and ethical aspects of 3Rs approaches.

- Drivers for the change towards 3Rs
- The 3R concept
- Regulatory testing, validation and applicability domains
- Scaffold free in vitro models: spheroids, organoids and assembloids.
- Scaffold supported in vitro models: 3D bioprinting and microfluidics.

WHO

Teacher:

Donatella Di Lisa, 0103536547, Donatella.Dilisa@edu.unige.it

HOW

Teaching Methods:

Frontal lessons and lab activities

Exam Description:

The course will be assessed by a lab project

Assessment Methods:

Evaluation of the lab project

WHERE AND WHEN

Lesson Location

@ UNIGE Room to be confirmed

Lesson Schedule

29 June (9:00 – 13:00)

1, 3 July (9:00 – 13:00)

CONTACTS

Donatella.Dilisa@edu.unige.it

Technologies and methods for medical and surgical training

Number of hours: 12

Credits: 4

AIMS AND CONTENT

Learning Outcomes

Technology has been increasingly used in healthcare education. As an example, adult learning theories support the use of immersive technologies such as Virtual Reality, Augmented Reality and Mixed Reality, for the training and evaluation of medical students, healthcare providers, patients and caregivers. Indeed, the use of different technologies (i.e., computer based-simulations, low-cost electronics) provide a riskless, controlled and personalized environment, that might also be realistic and engaging for the user. Another important advantage of using technology in medical education concerns the possibility of assessing the users in an objective and quantitative way, as most of the evaluations are currently based on instructor observations. Medical training covers a broad range of very different abilities: form theoretical and procedural knowledge, manual skills, and non-technical skills (e.g., stress management, communication). Therefore, it is crucial to select and use the most appropriate technology, considering the end user and the skill to be trained and/or evaluated. The course provides an overview of healthcare simulation, and how different technologies and methods can improve the training and evaluation of medical and surgical skills. The course includes an introduction on the theories supporting medical education, followed by a part on simulation methodologies and technologies and how they are used in different specialties.

Syllabus/Content

1. Introduction to healthcare simulation and animatronics (1h)
2. Basis of Education and Learning Theories for medical training (1h)
3. Simulation Methodologies (3h)
    a. Standard Patients
    b. Manikins
    c. Software-based solutions
    d. Immersive Technologies
    e. 3D Modelling
4. Simulation in different Specialties (2h)
    a. Surgery

    b. Radiology
    c. Etc.
5. Methods to assess medical and surgical abilities (1h)
6. Design and Development of the most appropriate educational system (1h)
7. Hands on Activities (3h)

WHO

Teacher:

Name: Serena Ricci

Email: serena.ricci@unige.it

Office: SimAv – Via Pastore 3, 16132 Genova

HOW

Teaching Methods:

Lectures, hands-on activities, and open discussions

Exam Description:

Depending on the number of students attending the course, the exam will include a test with multiple-choice/open questions or a presentation.

Assessment Methods:

To obtain the CFUs, students need to attend more than 75% of the course and successfully pass the final exam.

WHERE AND WHEN

Lesson Location

@UniGe – Via all'Opera Pia or SimAv Via Pastore

Lesson Schedule

4, 5, 10, 12 February (14:00 – 17:00)

Theory and Practice of Learning from Data

Number of hours: 20

Credits: 6

AIMS AND CONTENT

Learning Outcomes

This course aims at providing an introductory and unifying view of learning from data (inductive Artificial Intelligence). The course will present an overview of the theoretical background of learning from data, including the most used algorithms in the field, as well as practical applications.

Syllabus/Content

- Inference: induction, deduction, and abduction
- Statistical inference
- Machine Learning
- Deep Learning (and Transfer Learning)
- Model selection and error estimation

WHO

Teacher(s):

Name: Luca Oneto

Email: luca.oneto@unige.it

HOW

Teaching Methods:

Theoretical lesson plus laboratories in Python using Google Colab https://colab.research.google.com/

Exam Description:

Small presentation (max 30 min) on how the concepts presented in the course ca be used/extended during the student PhD.

WHERE AND WHEN

https://www.lucaoneto.it/teaching/tpld-phd