PhD Courses offer (2024-2025)

Sommario

Ethics and Bioethics in Bioengineering and Robotics 5

Grant Writing 9

Open Science and Research Data Management (OS&RDM) 11

Science with Arduino 14

Mechanical Drawing Fundamentals 17

C++ programming techniques 19

Computational models of visual perception 21

Effective habits and skills for successful young scientists 22

Robot programming with ROS 24

Modern C++ 27

Computer Aided Design 30

Perceptual Systems 32

Optics for Microscopy and Spectroscopy 34

Electronics and Circuits 37

Motion control drivers 41

Theatrical techniques for scientific presentation 44

Polymers and biopolymers for sustainable future 46

Advanced EEG analyses (aEEGa) 49

Advanced Topics in In Vitro Neuroengineering: Techniques, Applications, and Future Directions 51

Analysis of (networks of) nonlinear oscillators 54

Analytical and computer aided modelling for biomedical engineers: a practical manual to survive 56

An introduction to Body-Machine Interface 57

A journey through Deep Learning 60

Computational models of visual attention 62

Functional quantitative assessment in sport, ergonomics and rehabilitation 64

The 3Rs approach in biomedical research and advanced 3D in vitro tissue models 69

Technologies and methods for medical and surgical training 71
Trustworthy Artificial Intelligence 73

Outline of Courses

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

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

Foundation courses oriented to basic disciplines of robotics and bioengineering

Specialty courses oriented to specific doctorate curricula.

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

Crossover Courses

Mandatory Courses (24 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

Basic Courses

Science with Arduino	Canali C.	2
Mechanical Drawing Fundamentals (BASIC)	Torazza D.	2

[1] Recommended for 2nd and 3rd year students
* Offered by the PhD in Computer Science and Systems Engineering

Foundation Courses

C++ programming techniques	Solari F./Chessa M.	5
Computational models of visual perception	Solari F.	5
Effective habits and skills for successful young scientists*	Roli F.	5
Robot programming with ROS	Recchiuto C.	5
Modern C++	Accame M.	10
Computer aided design	Torazza D.	4
Perceptual Systems	Gori M. / Tonelli A.	4
Optics for Microscopy and Spectroscopy	Slenders E. / Zunino A.	4
Electronics and Circuits (level 1)	Sartore M.	3
Electronics and Circuits (level 2)	Sartore M.	3
Electronics and Circuits (level 3)	Sartore M.	3
Electronics and Circuits (level 4)	Sartore M.	3
Motion control drivers (level 1)	Sartore M.	3
Motion control drivers (level 2)	Sartore M.	3
Motion control drivers (level 3)	Sartore M.	3
Motion control drivers (level 4)	Sartore M.	3
Theatrical techniques for scientific presentation[2]	Sgorbissa A.	5
Polymers and biopolymers for sustainable future	Perotto G.	4

Speciality Courses

Advanced EEG analyses (aEEGa)	Inuggi A./Campus C.	5
Advanced topics in in-vitro neuroengineering: techniques applications and future directions	Brofiga M.	4
Analysis of (networks of) nonlinear oscillators^	Lodi M. / Storace M.	6
Analytical and computer aided modelling for biomedical engineers: a practical manual to survive	Magliaro C.	5
An introduction to body-machine interface	Pierella C.	4
A journey through Deep Learning (1st module) *	Noceti N. / Odone F. Pastore V. P. / M. Moro	6

[2] Recommended for 1st year students

^ Offered by the PhD in Sciences and Technologies for Electrical Engineering and Complex Systems for Mobility

A journey through Deep Learning (2^{nd} module) *	Noceti N. / Odone F. Pastore V. P. / M. Moro	6
Computational model of visual attention	Schiatti L.	4
Functional quantitative assessment in sport, ergonomics and rehabilitation	Zenzeri J.	4
Robotic Virtual Prototyping Design	Cannella F.	6
The 3Rs approach: Replacement, Reduction and Refinement of animal procedures in biomedical research	Pastorino L. Di Lisa D.	4
Technologies and methods for medical and surgical training	Ricci S.	4
Trustworthy Artificial Intelligence§	Oneto L.	6

§ Offered by the PhD in Security Risk and Vulnerability
* 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

January 17 (15.30 - 17:30)

January 20 (15.30 - 17:30)

January 22 (15.30 - 17:30)

January 24 (15.30 - 17:30)

January 27 (15.30 - 17:30)

February 7 (15.00 - 17:30)

February 10 (15.00 - 17:30)

February 12 (15 - 18)

February 14 (15 - 18)

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 (short)

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

Learning Outcomes (further info)

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

12 hours

- Tuesday, January, 28th, 2025, 15.30-18.30
- Wednesday, January, 29th, 2025, 15.30-18.30
- Thursday, January, 30th, 2025,15.30-18.30
- Friday, January, 31st, 2025,15.30-18.30

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

- October 6, 2025 (09:00-13:00)
- October 8, 2025 (09:00-13:00)
- October 10, 2025 (09:00-13:00)

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

<u>Module 1:</u>

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

UNIGE and IIT

Lesson Schedule

10, 11, 12 ,13, 14 February 2025 (10:00 – 12:00)

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.

Science with Arduino

Number of hours: 12

Credits: 2 CFU

AIMS AND CONTENT

Learning Outcomes (short)

The course is aimed at students who intend to acquire knowledge to develop measurement systems and data analysis algorithms to be adopted in general applications (robotics, test benches, sensor data acquisition). In a first part, methods used in modern data acquisition systems will be described with a special focus on hardware and electronics. The second part will focus on the data analysis side of a measurement process. The aim is to learn how to get the information hidden inside the data, even in presence of noise.

Learning Outcomes (further info)

When successfully accomplished the course, the student will have a comprehensive view on how to set up a data acquisition system: the course will give to the student the capabilities to choose the most appropriate hardware depending from the quantity to be measured and the application. Part of the course will be dedicated to learn how to properly design a DAQ system and all the related problematic (sampling rate, noise, amplification, etc.). An overview about electronics (including microcontrollers, FPGA, amplifiers and analogue electronics, commonly used BUS and sensors, etc.) will be discussed. Moreover, the course will give an overview of the data analysis process: starting from the raw data, acquired using the instruments presented in the first part of the course, and leading to the physical information. After a brief review about measurements and uncertainty, an overview of random variables, outcomes of experiments, and propagation of uncertainty will be presented. Then, useful statistical methods to present and treat the data will be discussed. Finally, some real examples of data analysis using MATLAB® will be shown.

Syllabus/Content

12 hours

- Data acquisition methods
- Sensors and measurements methods
- Arduino programming and data acquisition
- Matlab integration
- Introduction to Electronics 1 (Amplifiers, Filters, S/N ratio, ADC)
- Introduction to Electronics 2 (Real Time systems and Data Acquisition)
- Examples, applications, hands-on exercises

Prerequisites

A basic knowledge of MATLAB® is required. A basic knowledge of C programming is required. Students are also requested to bring their laptops with the following programs installed:

- MATLAB® and the Curve Fitting toolbox
- Arduino IDE

WHO

Teacher(s):

Name: Dr. Carlo Canali

Phone number: +39.010.2896793

HOW

Teaching Methods:

- Lectures (slides of the course will be provided)
- Hands-on lectures (hardware will be provided)
- Practical demonstration coding and computation

Exam Description:

The final lecture of the course will be a laboratory experience using a setup provided by the teacher. The scope is to perform a simple data acquisition & data analysis experience exploiting the knowledge obtained during the course lectures. For this lecture, the presence of the students is mandatory. The students will be required to produce a report about the laboratory experience.

Assessment Methods:

The experimental report will be evaluated by the teacher.

WHERE AND WHEN

Lesson Location

Istituto Italiano di Tecnologia, Via Morego 30 (Bolzaneto), Genova. – Room to be defined.

Lesson Schedule

- May 16th, 2025 morning
- May 23rd, 2025 morning
- June 6th, 2025 afternoon
- June 13th, 2025 afternoon
- June 20th, 2025 afternoon

CONTACTS

The Teachers' office is at CJIR Laboratory, Via Greto di Cornigliano 4-6r (Campi) Genova. The teacher can be contacted by email or by phone to arrange an appointment.

Dott. Carlo Canali, carlo.canali@iit.it, +39.010.2896793

Mechanical Drawing Fundamentals

Number of hours: 18 hours

Credits: 2 CFU

AIMS AND CONTENT

Learning Outcomes

This course provides an introduction to Mechanical Technical Drawing with mention to manufacturing techniques. The aim of the course is to give a base knowledge in understanding and preparing mechanical technical drawings, so there is no need of prior background of mechanical drawing.

Mechanical drawing is the main way to communicate design needs to technicians, workshops, suppliers. A base knowledge of rules and methods helps the researcher, even if not directly engaged in mechanical design, to better contribute to interdisciplinary team working when involved in the design of experimental setups, scientific devices, and the writing/understanding of technical specifications.

Syllabus/Content

- **Introduction** (projection methods and orthogonal projections theory)
- **Technical Drawing Rules** (lines rules, sections, dimensioning)
- **Drawing for manufacturing** (proper dimensioning and prescriptions according to production method)
- **Tolerances and surface finish** (dimensional and geometrical tolerances, roughness)
- **Representation of main removable and non-removable connections** (welds, threads)

WHO

Teacher(s): Diego Torazza, +39 010 2897 231, Diego.Torazza@iit.it

HOW

Teaching Methods: Frontal lessons with projected slides

Exam Description: Written test with multiple answer questions

Assessment Methods: In order to obtain the CFU students need to be present at minimum 15 hours of lessons and successfully pass the written test.

WHERE AND WHEN

Lesson Location

@UNIGE …. (contact the teacher for room confirmation)

Lesson Schedule

Monday, 7th January 2025, 9-13

Tuesday, 8th January 2025, 9-13

Wednesday, 9th January 2025, 9-13

Thursday, 10th January 2025, 9-13

Friday, 13th January 2025, 9-11

Office hours for student

The teacher is available on appointment by phone/mail.

CONTACTS

Teacher's office is located in:

Istituto Italiano di Tecnologia, CRIS

Via San Quirico 19 D, Genova.

+39 010 2897 231, Diego.Torazza@iit.it

C++ programming techniques

Number of hours: 20

Credits: 5 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

January 27 to 31, 09.00 – 13.00, a room on the second floor, via Dodecaneso 35.

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, via Dodecaneso 35

Lesson Schedule

February 17 – 21, 14.00 – 18.00, a room on the second floor, via Dodecaneso 35

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

23-27 June 2025, 09:00-13:00

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

3 Sep 2025, 09:00 - 12:00

3 Sep 2025, 14:00 - 17:00

4 Sep 2025, 09:00 - 12:00

4 Sep 2025, 14:00 - 17:00

5 Sep 2025, 09:00 - 12:00

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.

WHERE AND WHEN

Lesson Location

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

Lesson Schedule

1. Introduction 1: on **5 May 2025**, 1000-1300
2. Introduction 2: on **7 May 2025**, 1000-1300
3. The basics 1: on **8 May 2025**, 1000-1300
4. The basics 2: on **12 May 2025**, 1000-1300
5. Advanced topics 1: on **14 May 2025**, 1000-1300
6. Advanced topics 2: on **15 May 2025**, 1000-1300
7. Advanced topics 3: on **19 May 2025**, 1000-1300 These dates may vary due to ICRA Conference
8. Advanced topics 4: on **21 May 2025**, 1000-1300 These dates may vary due to ICRA Conference

9. Language applied 1: on **22 May 2025**, 1000-1300 These dates may vary due to ICRA Conference
10. Language applied 2: on **29 May 2025**, 1000-1300

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.

.

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.

Computer Aided Design

Number of hours: 12 hours

Credits: 4 CFU

AIMS AND CONTENT

Learning Outcomes (short)

The aim of the course is to gain and apply knowledge of 3D CAD concepts and techniques by using high-end CAD systems (*PTC Creo*).

Learning Outcomes (further info)

The course deals with the main CAD modeling techniques to develop the virtual model (DMU) of complex industrial products. The main topics are: 3D parametric and explicit modeling, feature modeling, geometric drawings, assembly modelling, parametric expressions and curves. Tolerances. Manufacturing drawings. Sheet Metal Technology. Basic stress and dynamic analysis.

Syllabus/Content

- Main geometry representation schemes: 2D and 3D mathematical models (Vertex, Line, Surface, Solid, Assembly), main models for geometry exchange (IGS, STP, STL).
- Solid part modeling, main features of 3D CAD modelers, sketch-based modelers, parametric modeling, the concept of history-based modeling, feature-based modeling.
- Assembly-based modeling: top-down setting bottom-up; use of part skeleton and assembly; structuring of an assembly; flat and/or sub-assemblies and implications in project management.
- Modeling aimed at the product concept.
- Basic structural simulations with integrated tools (*Creo Simulate*).

The level of deepening of each topic will depend on average previous knowledge level of the class.

WHO

Teacher(s): Diego Torazza, +39 010 2897 231, Diego.Torazza@iit.it

HOW

Teaching Methods:

The course will be based on 3 hands-on lectures. Slides of the course will be provided.

No previous knowledge of any CAD system is required, but for the best results it is suggested to have basic concepts of mechanical drawing (for reference see the *Mechanical Drawing Fundamentals* Phd course program).

Exam Description:

The assessment of learning takes place through a practical test (project). The test involves the use of the CAD system to develop a parametric DMU of a simple mechanical system (proposed by either the lecturers or the students).

Assessment Methods:

Discussion about the implemented application. A small document describing the application is required. The developed 3D CAD model will be released to the lecturer for correction and proof-reading.

WHERE AND WHEN

Lesson Location

@UNIGE …. (contact the teacher for room confirmation)

Lesson Schedule

11^{th}, 12^{th}, 13^{th} June 2025, h 9-13

Office hours for student

The teacher is available on appointment by phone/mail.

CONTACTS

Teacher's office is located in:

Istituto Italiano di Tecnologia, CRIS
Via San Quirico 19 D, Genova.
+39 010 2897 231, Diego.Torazza@iit.it

Perceptual Systems

Number of hours: 12

Credits: 4 CFU

AIMS AND CONTENT

Learning Outcomes

From birth, we interact with the world through our senses. One of the main questions in experimental psychology is how the brain processes and transforms sensory signals into perceptual outputs. The course aims to present the perceptual from the anatomical, physiological, and functional points of view. A particular focus will be on how physical stimuli are transduced into sensory signals by our peripheral sensory apparatus in a hierarchy that organizes complex behaviour. In the last part of the course, these topics will be described concerning cross-sensory interaction and multisensory integration in the adult and the developing brain.

Students will learn how the primary sensory systems function, i.e., vision, audition, touch, smell, and taste. Moreover, it will explain the multisensory integration and cross-modal interaction process.

Syllabus/Content

Class 1 (3 hours): Visual system I.
Class 2 (3 hours): Multisensory integration and development of sensory systems.
Class 3 (3 hours): Auditory and tactile systems.
Class 4 (3 hours): Olfactory and gustatory systems and cross-modal interaction + Final exam.

WHO

Teacher(s):

Name:

Monica Gori – Istituto Italiano di Tecnologia – +39 0108172217, monica.gori@iit.it

Alessia Tonelli – Istituto Italiano di Tecnologia – +39 0108172232, alessia.tonelli@iit.it

HOW

Teaching Methods:

Frontal lessons and presentations.

Exam Description:

The exam will consist of a multiple-choice questionnaire, which must be completed in one hour.

Assessment Methods:

In order to obtain the 4 CFU, students must correctly answer at least 65% of the questions.

WHERE AND WHEN

Lesson Location

The lessons will be held at IIT – Erzelli. The room's name depends on availability and will be communicated in advance.

Lesson Schedule

Class 1: 27 March 2025 – from 9 a.m. to 12 p.m., IIT-Erzelli

Class 2: 31 March 2025 – from 9 a.m. to 12 p.m., IIT-Erzelli

Class 3: 1 April 2025 – from 2 p.m. to 5 p.m., IIT-Erzelli

Class 4: 3 April 2025 – from 2 p.m. to 5 p.m., IIT-Erzelli

Optics for Microscopy and Spectroscopy

Number of hours: 12 h

Credits: 4 CFU

Aims and Content

Learning Outcomes

Light is an essential tool for many important scientific applications, such as optical microscopy and spectroscopy. This course is intended to provide the essential theoretical background of optics and imaging. In particular, the course will focus on both traditional and state-of-the-art optical techniques. Additionally, students will have the opportunity to attend a demonstration with custom-built optical setups. The student will acquire a general overview of the physical principles of modern optical techniques and their most relevant applications.

Syllabus/Content

The course will focus on theory and applications.

A minimum knowledge of mathematics is expected from the students.

Class 1 (2h): Fundamentals of optics (geometrical, scalar, and vectorial optics)

Class 2 (2h): Imaging and wide-field microscopy

Class 3 (2h): Non-linear optics and applications to imaging

Class 4 (2h): Super-resolution microscopy I: deterministic approaches

Class 5 (2h): Super-resolution microscopy II: stochastic approaches

Class 6 (2h): Fluorescence correlation spectroscopy and fluorescence lifetime

Who

Teacher(s):

Dr. Eli Slenders, eli.slenders@iit.it, +39 010 28 97 619

Dr. Alessandro Zunino, alessandro.zunino@iit.it, +39 010 28 97 619

How

Teaching Methods:

This course requires the active participation of all class members through active listening and discussion. For the lessons, a blackboard and slide presentations will be used. In addition, the course includes a visit to the microscopy laboratory for interested students.

Exam Description: The examination will be a short, written test containing multiple questions regarding the key messages of the course.

Assessment Methods: Class attendance and regular participation are required for this course. The assessment will be in written form.

Where and When

Lesson Location

To be decided.

Lesson Schedule

The course will be organized into six lessons of two hours each:

March 17, 2025 (15:00-17:00)

March 18, 2025 (15:00-17:00)

March 19, 2025 (15:00-17:00)

March 20, 2025 (15:00-17:00)

March 21, 2025 (15:00-17:00)

March 24, 2025 (15:00-17:00)

Contacts

Dr. Eli Slenders

Molecular Microscopy and Spectroscopy

Istituto Italiano di Tecnologia (IIT) – Center for Human Technologies (CHT)

Via Enrico Melen, 83, Building B, 16152, Genoa, Italy

Office: 10th floor, 10-ST08.0, +39 010 28 97 619

e-mail: eli.slenders@iit.it

Dr. Alessandro Zunino

Molecular Microscopy and Spectroscopy

Istituto Italiano di Tecnologia (IIT) – Center for Human Technologies (CHT)

Via Enrico Melen, 83, Building B, 16152, Genoa, Italy

Office: 10th floor, 10-ST08.0, +39 010 28 97 619

e-mail: alessandro.zunino@iit.it

Electronics and Circuits

Number of hours: 48 (divided in 4 Modules of 12 hours each)

Credits: 3 CFU per Module

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:

Marco Sartore, 3472207478, Via Roma 10 – 57030 Marciana (LI)

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 @ UNIGE, usually (but to be confirmed) 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 January and February 2025, one module of 12 hours per week, with the following schedule (extremes included):

January 13th to 17th: Module1 and Module 2,

January 13th from 3 PM to 6 PM
January 14th to 16th from 9 AM to 12 AM & from 2 PM to 5 PM
January 17h from 8.30 AM to 11.30 AM

February 3rd to 7th: Module3 and Module 4,

February 3rd from 3 PM to 6 PM
February 4th to 6th from 9 AM to 12 AM & from 2 PM to 5 PM

February 7h from 8.30 AM to 11.30 AM

Office hours for students

Students can ask info to the teacher by phone, email or asking for an appointment.

CONTACTS

Students can write to sartore@elbatech.com or can freely phone to +393472207478 either to ask information or to arrange for an appointment.

*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 (divided in 4 Modules of 12 hours each)

Credits: 3 CFU per Module

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:

Marco Sartore, 3472207478, Via Roma 10 – 57030 Marciana (LI)

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

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

June 9th to 13th: Module1 and Module 2,

June 9th from	3 PM to 6 PM
June 10th to 12th	from 9 AM to 12 AM & from 2 PM to 5 PM
June 13th from	8.30 AM to 11.30 AM

June 16th to 20th: Module3 and Module 4,

June 16th from	3 PM to 6 PM
June 17th to 19th	from 9 AM to 12 AM & from 2 PM to 5 PM
June 20th	8.30 AM to 11.30 AM

Office hours for students

Students can ask info to the teacher by phone, email or asking for an appointment.

CONTACTS

Students can write to sartore@elbatech.com or can freely phone to +393472207478 either to ask information or to arrange for an appointment.

*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

- May 6, 2025 (09:00-12:00)
- May 13, 2025 (09:00-12:00)
- June 9, 2025 (09:00-12:00)
- June 16, 2025 (09:00-12:00)

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.

Polymers and biopolymers for sustainable future

Number of hours: 12

Credits: 4 CFU

AIMS AND CONTENT

Learning Outcomes

Polymers are ubiquitous materials due to their broad range of properties, light weight and low cost. In this PhD course, we will show the main reasons that determine the final properties of polymers and how polymer composites can further expand the properties and applications of the base materials. We will describe techniques and methodologies for their fabrication, modification and characterization. Applications in the in packaging will be discussed.

The fabrication methods include standard synthetic and manufacturing (e.g., extrusion, injection molding…) processes.

The characterization ranges from spectroscopies, to investigate the chemical composition, the polymer structure and the molecular arrangement, to the characterization of macroscopic mechanical, thermal and functional properties.

The end-of-life of polymeric material and their environmental sustainability will be discussed.

An overview of the applications of polymers and their composites in different fields, such as food packaging and circular economy, will be presented.

Objectives of this course are the description of the synthetic methodologies and the experimental techniques used for polymer preparation and characterization. The approach is very applied, starting from some samples concerning the fabrication of the most commonly used polymers and the theory for each technique, leading to practical strategies for material testing, result interpretation and device design.

Syllabus/Content

Polymer preparation methods: synthetic routes for the fabrication of polymers from both a lab and industrial scale point of view. Different manufacturing processes and strategies for polymer synthesis will be shown and discussed.

Physical-Chemical characterization: UV/VIS, infrared and Raman spectroscopies and nuclear magnetic resonance, thermal characterization, X-ray diffraction, tests for mechanical and electrical properties, wetting properties.

Approaches to design polymeric materials with improved sustainability: substitution of raw materials with renewable components and strategies to improve their end-of-life: recyclability, biodegradation, composting. End of life of polymeric material and their recyclability.

Fabrication methods: Different fabrication methods, for both lab and industrial scale production, such as spray coating, dip coating, injection molding, extrusion etc will be discussed.

Sustainable packaging: we will discuss the development of sustainable materials and the physical properties they must possess for efficient food packaging and smart packaging (wetting properties, oxygen/water vapour permeability etc).

Naturally-derived polymers: chemical structures and physico-chemical properties of natural polysaccharides and protein-based materials will be presented, together with their supply and extraction processes. Basic concept of polymeric chain conformation and secondary structures will be reviewed, as closely related to the processing and usage of naturally-derived materials. A panoramic of the applications of natural polymers in various fields (such as medical, pharmaceutical, tissue engineering, biosensors, cosmetics) will be given.

WHO

Teacher(s):

Giovanni Perotto, giovanni.perotto@iit.it; 010 71781 773

HOW

Teaching Methods:

Lectures

Exam Description:

The examination consists in a written test (multiple-choice and open-ended questions).

Assessment Methods:

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

WHERE AND WHEN

Lesson Location:

IIT, Center For Convergent Technologies, via Morego 30, Aula Volta

Lesson Schedule:

19/05/2025 14:00 – 17:00

20/05/2025 14:00 – 17:00

21/05/2025 14:00 – 17:00

22/05/2025 14:00 – 17:00

CONTACTS

Teachers' offices are in the 4th floor of the IIT building (via Morego 30, 16163, Genova). Students asking info to the teachers can contact them by email anytime.

Advanced EEG analyses (aEEGa)

Number of hours: 15 hours

Credits: 5 CFU

AIMS AND CONTENT

Learning Outcomes (short)

Learn how to analyze EEG data, starting from artefact removal from raw data to the group statistical analysis of both sensors' and sources' data.

Learning Outcomes (further info)

The present course will introduce the student to the most advanced technique to process the EEG signal and infer over the cortical areas that create it. The course will consist on a first part based on sensors analysis and a second part on distributed sources analysis. Analysis will be performed in both the time and time-frequency domain and will be performed within the Matlab and R environments, using a semi-automatic analysis framework developed in the RBCS department.

Syllabus/Content

- Class 1 (3h) EEG signal origin and spatial-temporal-spectral characteristics. Data recording, preprocessing (referencing, filtering and epoching) and artefact removal through independent analysis as implemented in EEGLAB. *Teacher Alberto Inuggi and Claudio Campus*.
- Class 2 (2h) Electrode analysis of ERP. Peak analysis, clustering electrodes and averaging time interval. Subject and group level analysis. Statistical analysis in EEGLAB and R. *Teacher Claudio Campus.*
- Class 3 (2h) Spectral analysis of ER**S**P. Peak analysis, clustering electrodes and averaging time interval. Subject and group level analysis. Statistical analysis in EEGLAB and R. *Teacher Claudio Campus.*
- Class 4 (2h) Introduction to EEG source analysis. Theory, forward model and inverse problem resolution. Differences between dipoles and distributed source analysis. Alternative models. *Teacher Alberto Inuggi.*
- Class 5 (3h) Results post-processing (dimensionality reduction) approaches. Source analysis in Brainstorm. *Teacher Alberto Inuggi.*
- Class 6 (3h). Statistical analysis in SPM. Comparison between EEG, fMRI and TMS tools. Final Examination. *Teacher Alberto Inuggi and Claudio Campus.*

WHO

Teacher(s):

Alberto Inuggi alberto.inuggi@gmail.com

Claudio Campus, +39 010 2097 208, claudio.campus@iit.it

HOW

Teaching Methods:

Projected slides

Exam Description:

Students will undergo a 45 minutes written examination consisting in 30 multiple selection questions. 15 questions will regard sensors analysis, 15 the source analysis part.

Assessment Methods:

In order to obtain the 5 CFU, students are expected to correctly answer a total of at least 18 questions. Moreover, at least 7 correct answers for each of the two section (sensors and sources) are required.

WHERE AND WHEN

Lesson Location

Lessons will be either done remotely through Teams platform or at Center for Human Technologies, Via Enrico Melen 83, Building B,16152 Genova, Italy, IIT Erzelli. In the latter case, the exact room will be later indicated.

Lesson Schedule

17/03/2025	10:00 – 13:00
19/03/2025	10:00 – 12:00
21/03/2025	10:00 – 12:00
24/03/2025	10:00 – 12:00
26/03/2025	10:00 – 13:00
28/03/2025	10:00 – 13:00

Office hours for student

Students enquires about course content and organization should be sent by e-mail. Personal appointment shall be arranged when necessary.

CONTACTS

Students should preferably interact with the teachers by e-mail.

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

8th September 2025 10:00 – 13:00

10th September 2025 10:00 -13:00

12th September 2025 10:00 – 13:00

15th September 2025 10:00 – 13:00

CONTACTS

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

Analysis of (networks of) nonlinear oscillators

Number of hours: 20

Credits: 6 CFU

AIMS AND CONTENT

Learning Outcomes

This course aims to provide the students with mathematical and numerical tools for analyzing nonlinear dynamical systems, even networked, with either fixed or changing parameters (in the latter case the lessons' topic will be the so-called bifurcation analysis). In particular, the lessons will focus on geometrical methods for qualitative analysis and the most diffused numerical methods for quantitative analysis. The main theoretical results will be applied to dynamical systems from different fields and illustrated through computer demos in the MATLAB programming environment.

Syllabus/Content

1. Introduction to nonlinear dynamical systems (both continuous-time and discrete-time)
2. Phase portraits, invariant sets and stability
3. Geometrical method
4. State space, parameter space and control space
5. Bifurcations
6. Networks of nonlinear dynamical systems
7. Master Stability Function
8. Numerical analysis methods

WHO

Teacher(s):

Name: Matteo Lodi

Name: Marco Storace

Registration: by e-mail to marco.storace@unige.it

HOW

Teaching Methods:

The topics of the course are presented and illustrated through examples during frontal lectures, which mainly consist of:

- PowerPoint or pdf presentations

- teacher-led demonstrations and presentation of examples on the blackboard
- use of simulation tools (Matlab)

Exam Description:

Oral examination focused on analyzing a specific nonlinear dynamical system (chosen by the student and approved by the teachers), using the analytical and numerical tools introduced during the lectures.

Assessment Methods:

The assessment will be based on:

-) communication skills

-) knowledge and comprehension of the subject topics

-) ability to draw connections among ideas

-) ability to analyze (networks of) nonlinear dynamical systems

WHERE AND WHEN

Lesson Location
via Opera Pia 11A (DITEN), room D3 ("Aula conferenze", ground floor).

Lesson Schedule

21/01 9.30-12

23/01 9.30-12

28/01 9.30-12

30/01 9.30-12

3/02 9.30-12

5/02 9.30-12

10/02 9.30-12

12/02 9.30-12

Analytical and computer aided modelling for biomedical engineers: a practical manual to survive

Number of hours: 15

Credits: 5 CFU

AIMS AND CONTENT

Learning Outcomes

The course aims at introducing the students to the physics and multi-physics based modelling, focusing on applications in the field of biomedical engineering and biotechnology. The first part of the course will provide basics about advanced in vitro models (e.g., organoids, spheroids, scaffold-based constructs), focusing then on Multi-physics software for modelling physical phenomena, in particular transport and reaction of chemical species, heat transfer and fluidics. Then, the last part of the course will be devoted to hands-on using the software, identifying exercises close to the activities of the students during their PhD experience.

Syllabus/Content

- Advanced in vitro constructs: analytical physics-based models serving their generation and maintainance
- Brief introduction to Physics and Multi-Physics modelling and to the COMSOL platform
- Definition of easy and complex geometries and meshing
- Parametric sweep solutions
- “Transport and reaction of chemical species”, “heat transfer” and “CDF” modules
- Data handling: post-processing and plotting
- Examples and applications

WHO

Teacher(s):

Name: Chiara Magliaro

Phone number: +39 3386011490

Email: chiara.magliaro@unipi.it

Office: Largo Lucio Lazzarino, 1 56122 Pisa (PI)

HOW

Teaching Methods: The course will have both theoretical and practical sessions. Questions and learning-by-doing during the lectures will consolidate the concepts covered.

Exam Description: The student will give a presentation on a project (ideally, his/her PhD project) where the aid of computational physics-based models is crucial. S/he will be evaluated on the basis of the demonstrated ability to discuss the main contents of the course (analytical models, FEM modeling) using the appropriate terminology. The student's knowledge of the subject will be verified, with particular attention to the theoretical foundations, the modeling criteria of in vivo and in vitro systems using FEM software.

Assessment Methods: The acquisition of skills will be verified through questions to students during the frontal lessons, to verify the acquisition and consolidation of the concepts covered and through exercises, in which the ability to use the tools discussed during the course will be assessed.

WHERE AND WHEN

Lesson Location

The lesson will be done at UNIGE. Room to be checked.

Lesson Schedule

Day1 – 2 July, 9.30-12.30 (3h) and 14.30-17.30 (3h)

Day2 – 3 July, 9.30-12.30 (3h) and 14.30-17.30 (3h)

Day3 – 4 July, 9.30-12.30 (3h)

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

July 7, 2025 (09:00 - 13:00)

July 8, 2025 (09:00 - 13:00)

July 9, 2025 (09:00 - 13:00)

July 10, 2025 (09:00 - 13:00)

Office hours for student

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

CONTACTS

camilla.pierella@edu.unige.it

A journey through Deep Learning

Number of hours: 40 (20 per module)

Credits: 6 CFU per module

AIMS AND CONTENT

Learning Outcomes

Deep Learning (DL) is a branch of Machine Learning that has been driving breakthroughs across a wide range of field.

This intensive school will offer a comprehensive introduction to DL, combining foundational theory with practical, hands-on experience.

The program will cover the fundamental principles of deep learning, delve into various architectures, and present the most widely used tools and frameworks. A key feature of the course is the integration of theory with practice, through hands-on lab sessions using the Python language, and relying on popular frameworks like Tensorflow and PyTorch. In the practical sessions, we will focus in particular on Computer Vision tasks, one of the domains where DL has provided the most astonishing results.

In addition to well-established approaches, the school will also present current research trends, challenges and open problems that may shape prospective lines of research.

During the week, a dedicated poster session will provide participants with the opportunity to showcase their work, foster collaboration, and engage in insightful discussions with peers.

Syllabus/Content

1st module DAY1 – Machine Learning reprise; Basics of (dense) neural networks
1st module DAY 2 – From images to Convolutional Neural Networks; Applications
2nd module DAY 3 – Dealing with sequential data: from Recurrent models to Transformers and beyond
2nd module DAY 4 – Generative models; Open issues: dealing with dataset bias, learning with data scarcity
DAY 5 – Group project

WHO

Teachers:

Matteo Moro, Nicoletta Noceti, Francesca Odone, Vito Paolo Pastore,

MaLGa-DIBRIS, Università degli Studi di Genova

{matteo.moro, nicoletta.noceti, francesca.odone, vitopaolo.pastore}@unige.it

https://malga.unige.it

How

Teaching Methods: Theoretical classes and hands-on activities

Exam Description: a group project, whose goal is to suggest the use of one (or more) methodology studied in the course in real-world applications. The project is presented at the end of the course with slides

Assessment Methods: the feasibility of the proposed task and the clarity of the presentation will be both evaluated.

Where and When

Lesson Location

Classes will be in presence in via Dodecaneso 35, 16146, Genova. The room will be defined in due time

Lesson Schedule

16-20 June 2025

Contacts

Giulia Casu (MaLGa lab manager), giulia.casu@ext.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

May 5, 2025 (14:00-17:00)

May 6, 2025 (14:00-17:00)

May 7, 2025 (14:00-17:00

May 9, 2025 (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): Jacopo Zenzeri, 3408311387, jacopo.zenzeri@rewingtech.com

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

DIBRIS, University of Genova (room to be decided)

Lesson Schedule

June 25, 26, 27 2025, time 9 -13

CONTACTS

Jacopo Zenzeri, ReWing s.r.l., 6th floor, Via XII Ottobre 1, 16121, Genova, 3408311387, jacopo.zenzeri@rewingtech.com

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

Teacher:

Ferdinando Cannella *0102896562* *ferdinando.cannella@iit.it*

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

In presence: Istituto Italiano di Tecnologia, Via Morego 30 (Bolzaneto), Genova. The Meeting room will be communicate to the attendees two weeks in advance the course.
Online: via Teams call conference (Only DRIM students not located in Genoa)

Lesson Schedule

October 1, 2, 3 (9.00-12.00)
October 13, 14, 15 (14.30-17.30)

CONTACTS

The Teachers' office is in Unità di Robotica Industriale at 4th floor at Istituto Italiano di Tecnologia, Via Morego 30 (Bolzaneto), Genova.

Ferdinando Cannella *0102896562* *ferdinando.cannella@iit.it*

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(s):

Laura Pastorino, 0103536547, laura.pastorino@unige.it

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

July 14, 16, 18 - 2025 (09:00-13:00)

CONTACTS

laura.pastorino@unige.it

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

January 7, 2025; h 15 - 18

January 8, 2025; h 15 - 18

January 10, 2025; h 15 - 18

January 21, 2025; h 15 - 18

Trustworthy Artificial Intelligence

Number of hours: 20

Credits: 6

Aims and Content

Learning Outcomes

It has been argued that Artificial Intelligence (AI) is experiencing a fast process of commodification. This characterization is of interest for big IT companies, but it correctly reflects the current industrialization of AI. This phenomenon means that AI systems and products are reaching the society at large and, therefore, that societal issues related to the use of AI and Machine Learning (ML) cannot be ignored any longer. Designing ML models from this human-centered perspective means incorporating human-relevant requirements such as reliability, fairness, privacy, and interpretability, but also considering broad societal issues such as ethics and legislation. These are essential aspects to foster the acceptance of ML-based technologies, as well as to be able to comply with an evolving legislation concerning the impact of digital technologies on ethically and privacy sensitive matters.

Syllabus/Content

- Introduction to AI and ML
- Trustworthy AI and ML
- Reliable ML
- Fair ML
- Private ML
- Interpretable/Explainable ML

Who

Teacher(s):

Name: Luca Oneto

Email: luca.oneto@unige.it

How

Teaching Methods:

Theoretical lesson plus laboratories in Python using Google Colab

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

Lesson Location

Online on Zoom

Lesson Schedule

July 2025