



## PhD Courses offered (2020-2021)

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## Outline of Courses

The offered courses 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 (26 Credits)

Theatrical techniques for scientific presentation <sup>1</sup>	Sgorbissa A.	5
Ethics and Bioethics in Bioengineering and Robotics <sup>1</sup>	Battistuzzi L.	5
Paper Writing <sup>1</sup>	Marchese M.	5
Grant writing <sup>2</sup>	Camurri A.	5
Bioengineering, A.I. and Robotics: applicable law, liability, contract and data protection.	Di Gregorio V.	3
An Introduction to Open Science and Research Data Management	Pasquale V./Pastorini A.M.	3

## Basic Courses

Introduction to Computer Programming for Researchers <sup>3</sup>	Goccia M.	2
Data acquisition and data analysis methods	Canali C./Pistone A.	2

## Foundation Courses

Programming

C++ programming techniques	Solari F./Chessa M.	6
Robot programming with ROS	Recchiuto C.	5
Modern C++	Accame M.	5

<sup>1</sup> Recommended for 1<sup>st</sup> year students

<sup>2</sup> Recommended for 2<sup>nd</sup> and 3<sup>rd</sup> year students

<sup>3</sup> For non-engineers

## Mechanical Design

Mechanical Drawing Fundamentals (BASIC)	Torazza D.	2
Computer aided design	Berselli G.	5

## Modelling and Computational Methods

An introduction to spatial (6D) vectors and their use in robot dynamics	Featherstone R.	4
Computational Robot Dynamics	Featherstone R.	5
Interaction in Virtual and Augmented reality	Chessa M.	6
Computational models of visual perception	Solari F.	4
Perceptual Systems	Gori M./Tonelli 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

## Speciality Courses

Advanced EEG analyses	Inuggi A./Campus C.	5
Research oriented structural and functional neuroimaging	Inuggi A./Greco D.	6
The 3Rs approach: Replacement, Reduction and Refinement of animal procedures in biomedical research	Pastorino L.	3

Advanced Optical Fluorescence Microscopy Methods, practice	Bianchini P.	3
Fluorescence Super-Resolution Microscopy: Basis, Applications and Perspectives	Vicidomini G.	3
Nanophotonic devices: from fabrication to applications	Toma A.	5
Polymers for sustainability, food packaging and biomedics	Perotto G. /Papadopoulou E. /Suarato G.	6
Hybrid microfluidics systems for electronics, photonics, and sensors	Surdo S.	3
Principle of tissue engineering and regenerative medicine	Marrella A.	4

Cognitive Robotics for Human-Robot Interaction	Rea F./Tanevska A./Vannucci F.	6
Introduction to physical Human-Robot Interaction	Zenzeri J.	5
Optimization-based trajectory planning for legged robots	Focchi M.	4

Robotic technologies for sensorimotor rehabilitation	Morasso P./Zenzeri J.	5
Robotic Virtual Prototyping Design	Cannella F. /D'Imperio M./ Abidi H.	6
CVCC - Computer Vision Crash Course	Odone F.	6
Trustworthy AI: Learning from Data with Safety, Fairness, Privacy, and Interpretability Requirements	Oneto L.	5

# Theatrical techniques for scientific presentation

**Scientific Disciplinary Sector:** ING-INF/05

**Number of hours:** 12

**Credits:** 5

## 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 to short theatrical performance to test the techniques they have learnt during lessons.

## WHERE AND WHEN

### Lesson Location

@UNIGE: Aula Tagliasco Villa Bonino Viale F. Causa 13 or VIDEOCONFERENCE

### Lesson Schedule

- May 5th 9:30-12:30
- May 12th 9:30-12:30
- May 20th 9:30-12:30
- May 28th 9:30-12:30

### 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.

# Ethics and Bioethics in Bioengineering and Robotics

Scientific Disciplinary Sector: MED02/MED43/IUS20/M-FIL03

Number of hours: 15

Credits: 5

## AIMS AND CONTENT

### Learning Outcomes (short)

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

- explain some of the key ethical issues in bioengineering and robotics
- identify ethically problematic facets of a project
- apply an ethical decision-making framework to a scenario in order to determine an ethically appropriate course of action.

### Learning Outcomes (further info)

*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: first, to develop PhD students' sensitivity to the ethical issues that arise in research and professional practice, and, second, to provide them with knowledge and tools that will help them navigate ethically complex scenarios and reach ethically appropriate decisions.

### Syllabus/Content

Topics covered will include:

- Ethics and bioethics: concepts and frameworks
- Ethical decision-making
- The requirements of ethical research
- Research protocols and ethical review
- Informed consent
- Personal data and privacy
- Value Sensitive Design

The reading list will be provided after the first session.

## WHO

Teacher(s): Linda Battistuzzi, e-mail: [linda.battistuzzi@unige.it](mailto:linda.battistuzzi@unige.it).

## HOW

## **Teaching Methods**

The course will be delivered using a range of 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 asked to develop an ethically problematic case of their own, explaining the issues it raises and proposing an ethically appropriate course of action.

## **Assessment Methods**

Students will present their cases during class for group discussion.

<b>WHERE AND WHEN</b>
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## **Lesson Location**

Remotely via Teams (to be confirmed).

## **Lesson Schedule**

10:30 – 12:30 on February 4, 11, 18, 22 and March 4,

10:00 – 12:30 on March 11, 18.

## **Office hours for student**

I can generally be reached by email.

<b>CONTACTS</b>
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Students should contact me by email.

# Grant Writing

**Scientific Disciplinary Sector:** ING-INF/05

**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 2020 and the upcoming Horizon Europe Framework Programmes.

### Learning Outcomes (further info)

A particular focus will be on ICT, Creative Europe, FET, ERC. Use cases of successful projects coordinated by the teacher will be studied and analyzed. A short simulation of the development process of a draft research proposal will conclude the course.

### Syllabus/Content

European research grants, EU Horizon 2020, Horizon Europe, ICT, FET, ERC.

## WHO

**Teacher(s):** Antonio Camurri, +390102758252, email [antonio.camurri@unige.it](mailto:antonio.camurri@unige.it)

Cinzia Leone,

email: [cinzia.leone@unige.it](mailto: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: Casa Paganini-InfoMus, Piazza S.Maria in Passione 34 ([www.casapaganini.org](http://www.casapaganini.org))

### Lesson Schedule

To be defined



**Office hours for student**

Emails and appointments on request.

<b>CONTACTS</b>
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The teacher is available by email ([antonio.camurri@unige.it](mailto:antonio.camurri@unige.it)), and may receive students at the research centre Casa Paganini-InfoMus ([www.casapaganini.org](http://www.casapaganini.org)).

# Bioengineering, A.I. and Robotics: applicable law, liability, contract and data protection.

**Scientific Disciplinary Sector:** IUS/01 IUS/02 IUS/05 IUS/17

**Number of hours:** 6

**Credits:** 3

## AIMS AND CONTENT

### Learning Outcomes (short)

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

- - get acquainted with the basic legal issues linked to the new technologies, A.I. and robotics areas
- - enhance the knowledge of the European and Italian Law liability rules in relation to the producer, the designer and the seller.
- - learn when, why, how to make a project in compliance with applicable law.
- - be aware of the legal effects in order to make a decision.
- - know data protection rules

### Learning Outcomes (further info)

1. *How can we develop models of human-robot interaction that respect the law principles? How can set forth the liability for damages? Who does bear the relevant risks? Which kind of contracts can we provide?*

Researchers and professionals in bioengineering, A.I. and robotics areas deal with legal questions like these. The course aims to: develop PhD students' ability to identify legal issues that could arise in research and professional practice and provide them with the knowledge and tools that will sort out legal problems in the complex scenarios and reach appropriate decisions.

### Syllabus/Content

1. Topics covered will include:
  - Basic concepts of European and National law (U.E. directives, resolutions, italian laws)
  - Knowledge of legal issues, especially on liability
  - Product Liability and Consumer Protection
  - Data Protection (GDPR)
  - General Principles of Contract Law and Intellectual Property Law
  - Case studies

The reading list will be provided after the first session.

## WHO

1. **Teacher : Valentina Di Gregorio**, tel. 0102099911, e-mail: [valentina.digregorio@unige.it](mailto:valentina.digregorio@unige.it).

## HOW

### Teaching Methods:

The course will be delivered using a range of teaching and learning methods, including lectures, group discussions, activities and case studies.

**Exam Description:**

Students will be asked to obtain the ability in identify potential legal issues and to solve them in order to avoid negative effects on the project.

**Assessment Methods :**

Students will describe their case in a short report (1000-1500 words).

**WHERE AND WHEN**

**Lesson Location**

DIBRIS (UNIGE), Dipartimento di Giurisprudenza (Albergo dei Poveri) or Teams Platform

**Lesson Schedule**

The course will take place in two sessions of three hours each

**Office hours for student**

The teacher can generally be reached by email. Appointments can be organized if necessary.

**CONTACTS**

Prof. Valentina Di Gregorio  
Email: [valentina.digregorio@unige.it](mailto:valentina.digregorio@unige.it)

# An Introduction to Open Science and Research Data Management

**Scientific Disciplinary Sector:** ING/INF-06

**Number of hours:** 6

**Credits:** 3

<b>AIMS AND CONTENT</b>
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## **Learning Outcomes**

Training Course for PhD Students, composed of four modules. It aims to introduce early-career researchers to scholarly communication and to the principles of Open Science (Open Access to Publications, Open Data, Open Licenses) and Research Data Management. At the end of the course students will have a better understanding of the available research e-infrastructures, tools, and services for Open Access Publication, Research Data Management and FAIR Data. Students will also learn the importance of open science in research, especially to improve science reproducibility and increase research integrity. They will learn how to make research data FAIR, as required by many funders, including the European Commission. Finally, they will have the chance to practice on common tools for Research Data Management, like DMPOnline and Zenodo.

## **Contents**

### **Module 1:**

*Setting the context: why open science? (V. Pasquale, A. M. Pastorini) – 15 minutes*

Open science: a definition; benefits of open science: for researchers and for the scientific system and society as a whole.

Short intro to the contents of the course.

*Scholarly communication (A. M. Pastorini) – 45 minutes*

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) – 30 minutes*

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

### **Module 2:**

*Open access in scholarly communication (A. M. Pastorini) – 45 minutes*

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) – 45 minutes*

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](http://www.openscience.unige.it); open science & RDM support in IIT (V. Pasquale).

### **Module 3**

*What is Research Data Management? (V. Pasquale) – 15 minutes*

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

*The Research Data Lifecycle: Plan & fund (V. Pasquale) – 30 minutes*

Funder requirements; data management planning; data ownership; basic notions of data privacy & ethics; support for DMP in IIT.

*Hands-on activity: using DMPOnline for data management planning (V. Pasquale) – 45 minutes*

Students will be asked to log in DMPOnline and draft a data management plan of their PhD project.

### **Module 4**

*The Research Data Lifecycle: Work with data (V. Pasquale) – 15 minutes*

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

*The Research Data Lifecycle: Preserve & share (V. Pasquale) – 35 minutes*

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; why data sharing is important: meta-analysis & meta-reviews.

*Hands-on activity: share a dataset in Zenodo (V. Pasquale) – 40 minutes*

Students will be asked to log in Zenodo-sandbox and create a mock dataset.

<b>WHO</b>
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**Teacher(s):** Anna Maria Pastorini, SBA UNIGE, [annamp@unige.it](mailto:annamp@unige.it); Valentina Pasquale, IIT, [valentina.pasquale@iit.it](mailto:valentina.pasquale@iit.it).

<b>HOW</b>
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**Teaching Methods**

Online 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 in Zenodo.

### **Assessment Methods**

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

## WHERE AND WHEN

### **Lesson Location**

Online lectures, using Microsoft Teams.

### **Lesson Schedule**

February 1<sup>st</sup>, 3<sup>rd</sup>, 8<sup>th</sup>, 12da<sup>th</sup> – 10-11.30 AM

### **Office hours for student**

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

## CONTACTS

Anna Maria Pastorini, Sistema Bibliotecario di Ateneo, Università di Genova

Email: [annamp@unige.it](mailto:annamp@unige.it)

Phone: +39 010 209 51554

Valentina Pasquale, Research Data Management specialist, Via Morego 30, 16163, Genova (1<sup>st</sup> floor)

Email: [valentina.pasquale@iit.it](mailto:valentina.pasquale@iit.it)

Phone: +39 010 2896 475

# Introduction to Computer Programming for Researchers

**Scientific Disciplinary Sector:** INF/01

**Number of hours:** 15 hours

**Credits:** 2 CFU

## AIMS AND CONTENT

### Learning Outcomes (short)

The course will take the students with no or minimal prior experience of programming through the main principles and best practices of programming. The course is intended for researchers who wish to learn the Python programming language.

### Learning Outcomes (further info)

The course is suitable for students who have minimal or no programming experience. It will introduce the fundamental programming structures, and it will also cover some central mechanisms of object-oriented programming techniques. The course will also include an introduction to testing and debugging code techniques. During the course there will be practical exercises.

### Syllabus/Content

- Overview of the fundamental programming structures: primitive data types, constants, variables, operators, functions, strings.
- Classes and objects: OOP principles, class variables and methods, abstraction, inheritance, polymorphism.
- Introduction to good programming techniques.
- Testing and debugging code.
- Practical exercises

## WHO

### Teacher(s):

Marcello Goccia,

Tel. (+39) 010 8172 216,

email: marcello.goccia@iit.it

## HOW

### Teaching Methods:

Frontal lessons with practical exercises. The students need to bring their laptop for the practical exercises

### Exam Description:

There will be a final examination decided by the instructor.

**Assessment Methods:**

According to the frequency of the course and the success in the examination.

<b>WHERE AND WHEN</b>
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**Lesson Location**

Istituto Italiano di Tecnologia, Via Enrico Melen 83, Building B, Genova

or

Online (depending on the circumstances)

**Lesson Schedule**

Thursday 14 January 2021, 9:00-12:00

Friday 15 January 2021, 9:00-12:00

Tuesday 19 January 2021, 9:00-12:00

Thursday 21 January 2021, 9:00-12:00

Friday 22 January 2021, 9:00-12:00

**Office hours for student**

Students can send e-mail.

<b>CONTACTS</b>
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Teacher's office is in:

Center for Human Technologies

Fondazione Istituto Italiano di Tecnologia (IIT)

Via Enrico Melen 83, Genova, Italy

Tel. (+39) 010 8172 216



# Data Acquisition and Data Analysis Methods

**Scientific Disciplinary Sector:** ING-INF/04 OR ING-INF/05 OR ING-INF/06

**Number of hours:** 15

**Credits:** 2

<b>AIMS AND CONTENT</b>
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## **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). This course presents an overview about data acquisition and data analysis methods. 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, using statistical and computing methods.

## **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) 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 ending with 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**

9 hours,

- Data acquisition methods
- Sensors and measurements methods
- Introduction to Electronics 1 (Amplifiers, Filters, S/N ratio, ADC)
- Introduction to Electronics 2 (Real Time systems and Data Acquisition)
- Example and applications

6 hours

- Dealing with uncertainties (1h)
- Introduction to Statistical methods (1h)
- Data analysis using MATLAB® (4h)
  - Curve fitting and parameters identification
  - Periodicity analysis and pre-processing tools

<b>WHO</b>
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**Teacher(s):**

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

Dr. Alessandro Pistone, alessandro.pistone@iit.it, +39.010.2896810

<b>How</b>
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**Teaching Methods:**

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

**Exam Description:**

Short thesis describing a practical implementation of the contents of the course. The project can be done in groups of maximum 2 students (must be agreed with the teachers). The aim of the project can be proposed by the student and/or by the teachers. The work can include one or both of the following tasks:

- Construction of a real Data Acquisition System
- Implementation of a Data Analysis program/code

**Assessment Methods:**

Thesis will be evaluated by teachers.

<b>WHERE AND WHEN</b>
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**Lesson Location**

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

**Lesson Schedule**

- 4 May 2021: 14:30 – 16:30
- 6 May 2021: 14:30 – 16:30
- 10 May 2021: 11:00 – 13:00
- 14 May 2021: 11:00 – 13:00
- 17 May 2021: 11:00 – 13:00
- 19 May 2021: 11:00 – 13:00
- 21 May 2021: 10:00 – 13:00

## Office hours for student

Appointments, email.

<b>CONTACTS</b>
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The Teachers' office is at 3<sup>rd</sup> floor at Istituto Italiano di Tecnologia, Via Morego 30 (Bolzaneto), Genova. Teachers can be contacted by email or by phone to arrange an appointment.

Dr. Carlo Canali, [carlo.canali@iit.it](mailto:carlo.canali@iit.it), +39.010.2896793

Dr. Alessandro Pistone, [alessandro.pistone@iit.it](mailto:alessandro.pistone@iit.it), +39.010.2896810

# C++ programming techniques

**Scientific Disciplinary Sector:** INF/01

**Number of hours:** 18 hours

**Credits:** 6 CFU

## AIMS AND CONTENT

### Learning Outcomes (short)

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

### Learning Outcomes (further info)

#### 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](mailto:fabio.solari@unige.it), +39 010 3536756

Manuela Chessa, [manuela.chessa@unige.it](mailto: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 (DIBRIS, via Dodecaneso 35) or remotely through Teams platform.

### Lesson Schedule

5, 8, 9, 12, 15,16 March 2021, each afternoon h 15-18

**Office hours for student**

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

<b>CONTACTS</b>
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Email: [fabio.solari@unige.it](mailto:fabio.solari@unige.it)

Office: Valletta Puggia - Via Dodecaneso 35, 3rd floor, room 303, 16146 Genova - ITALY

Phone: +39 010 353 6756

Email: [manuela.chessa@unige.it](mailto:manuela.chessa@unige.it)

Office: Valletta Puggia - Via Dodecaneso 35, 2nd floor, room 226, 16146 Genova - ITALY

Phone: +39 010 353 6626

# Robot programming with ROS

**Scientific Disciplinary Sector:** ING-INF/05

**Number of hours:** 15 hours

**Credits:** 5 CFU

## AIMS AND CONTENT

### Learning Outcomes (short)

- Learning and understanding the ROS communication architecture.
- Understanding the ROS2 basic concepts and how to integrate ROS2 with ROS1 systems
- Learning how to implement ROS-based cloud robotics applications
- Using native ROS code on Android

### Learning Outcomes (further info)

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. Please notice that the course will not describe in detail the ROS framework, but it will give some general operative instructions (classes I and II), and it will then deal with some specific aspects (classes III-V): the integration of ROS systems with ROS2 systems, the development of ROS-based cloud robotics applications, and the possibility of using native ROS code on Android. For this reason, the course may be useful both for students that are already proficient with ROS, which may review some general aspects and possibly learn some new concepts, and for students who have never used ROS, which will receive some insights about ROS (that may be possibly individually deepen) and some of its features. The course will foresee the usage of some commonly used robotic simulators, such as Gazebo and VREP, 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 (C1) (3 hours) - Introduction to ROS Topics, Services and Nodes. Class examples -
- Class II (C2) (3 hours) - Software representation of a Robot and robotic.simulations with Gazebo. Class examples. Guided exercise
- Class III (C3) (3hours) – ROS2 Topics, Services and Nodes and ROS1 bridge. Class examples. Assignment I
- Class IV (C4) (3 hours) –Cloud Robotics Frameworks and ROS. Class examples. Guided exercise
- Class V (C5) (3 hours) – RosJava and ROS for android. Class examples. Assignment II.

## WHO

**Teacher(s):** Prof. Carmine Tommaso Recchiuto, +390103532801, [carmine.recchiuto@dibris.unige.it](mailto: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 3<sup>nd</sup> and of the 5<sup>th</sup> lecture.

**Exam Description.** The assignments will consist on 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 on 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

TEAMS platform

### Lesson Schedule

Wednesday 3 Mar 2021, 10:00-13:00

Wednesday 10 Mar 2021, 10:00-13:00

Wednesday 17 Mar 2021, 10:00-13:00

Wednesday 24 Mar 2021, 10:00-13:00

Wednesday 31 Mar 2021, 10:00-13:00

### Office hours for student

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

## CONTACTS

Dr. Carmine Tommaso Recchiuto, Assistant Professor, Laboratorio (DIBRIS, E building 2<sup>nd</sup> floor)

Phone: +390103532801

Mail: [carmine.recchiuto@dibris.unige.it](mailto:carmine.recchiuto@dibris.unige.it)

# Modern C++

**Scientific Disciplinary Sector:** ING-INF/05 / ING-INF/06

**Number of hours:** 15

**Credits:** 5

## AIMS AND CONTENT

### Learning Outcomes (short)

The students will learn the new syntax and philosophy of Modern C++ (releases C++11, -14, -17).

### Learning Outcomes (further info)

Left intentionally empty.

### Syllabus/Content

Each of the following modules will be 2.5 hours each

1. Introduction: presentation of the course, refresh of C++98.
2. The basics: nullptr, auto, type aliases, initializer list, uniform initialization
3. The basics: range based loops, constexpr, scoped enums, override and final.
4. Advanced topics: move semantics, smart pointers
5. Advanced topics: lambda functions, STL containers, algorithms
6. Advanced topics: concurrency

## WHO

### Teacher(s):

Marco Accame

+39 010 2898201

marco.accame@iit.it

## How

### Teaching Methods:

Slides with code examples, exam simulation, open discussion and questions.

We shall use teleteaching with Microsoft Teams. The participation is however limited to 25 students. Hence, it is recommended to all students who have an interest in the course to contact the teacher via email by the date of 15 Dec 2020. The participant list will be frozen by 31 Dec 2020.



**Exam Description:**

Two sets of tests: one for the basics and one for the advanced topics. The tests will be done probably in telepresence.

**Assessment Methods:**

The be admitted to each test one must have followed the lessons of the relevant group. It is possible to miss at most one lesson per group.

PASS if 50% of answers are correct, FAIL otherwise.

<b>WHERE AND WHEN</b>
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**Lesson Location**

Remotely through Teams platform.

**Lesson Schedule**

1. Introduction: on **2 March 2021**, 1400-1630
2. The basics 1: on **4 March 2021**, 1400-1630
3. The basics 2 + test regarding modules 1, 2, 3: on **9 March 2021**, 1400-1630
4. Advanced topics 1: on **11 March 2021**, 1400-1630
5. Advanced topics 2: on **16 March 2021**, 1400-1630
6. Advanced topics 3 + test regarding modules 4, 5, 6: on **18 March 2021**, 1400-1630

**Office hours for student**

0900-1700 Monday to Friday.

<b>CONTACTS</b>
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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++]”,
- phone
- Teams platform after arranged appointment.
- Face to face if sanitary conditions allow.

# Mechanical Drawing Fundamentals

**Scientific Disciplinary Sector:** ING-IND/15

**Number of hours:** 18 hours

**Credits:** 2 CFU

## AIMS AND CONTENT

### Learning Outcomes (short)

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.

### Learning Outcomes (further info)

Mechanical drawing is the main way to communicate design need 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](mailto:Diego.Torazza@iit.it)

## HOW

**Teaching Methods:** Frontal lessons with projected slides (*if possible due to Covid Emergency, otherwise online using MS Teams*)

**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

Istituto Italiano di Tecnologia, Via E. Melen 83, Building B, Genova. Room to be defined.

### Lesson Schedule

7, 8, 11, 12, 13, 18 January 2021 (9-12)

**Office hours for student**

The teacher is available on appointment by phone/mail.

<b>CONTACTS</b>
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Teacher's office is located in:

Center for Human Technologies

Fondazione Istituto Italiano di Tecnologia (IIT)

Via E. Melen 83, Building B, 7th floor, Genova, Italy

+39 010 2897 231, [Diego.Torazza@iit.it](mailto:Diego.Torazza@iit.it)

# Computer Aided Design

Scientific Disciplinary Sector: ING-IND/15

Number of hours: 12 hours

Credits: 5 CFU

## AIMS AND CONTENT

Learning Outcomes (short)

The aim of the course is to gain and apply knowledge of advanced CAD concepts and techniques by using high-end CAD systems (i.e. *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, surface 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 modeling CSG and B-Rep: 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: continuous curvature parametric curves, double curvature surfaces (free-form) based on curves, modeling of surfaces from edge curves, modeling of path-based surfaces and the concept of sweeps.

Direct modeling: management of the history-free models

Geometry preparation techniques for structural simulations. Basic simulations with integrated tools (*Creo Mechanisms and Creo Simulate*).

## WHO

Teachers:

Giovanni Berselli 010 33 52839 [giovanni.berselli@unige.it](mailto:giovanni.berselli@unige.it)

Pietro Bilancia 0103352839 [pietro.bilancia@edu.unige.it](mailto:pietro.bilancia@edu.unige.it)

**HOW**

Teaching Methods:

The course will be based on 3 hands-on lectures. Slides of the course will be provided before each lectures. No previous knowledge of any CAD system is required.

Exam Description:

The assessment of learning takes place through a practical test (project) in a computer lab. 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

Lessons will take place online.

Lesson Schedule

12-13-14 June 2021 h 9-13

Office hours for student

The teacher will be available on appointment ([giovanni.berselli@unige.it](mailto:giovanni.berselli@unige.it))

**CONTACTS**

Email: [giovanni.berselli@unige.it](mailto:giovanni.berselli@unige.it)

Office: DIME - Sezione MEC - First floor - Left Corridor, Via all'Opera Pia 15/A - 16145 Genova (ITALY)  
Phone: +39 010 33 52839

# An Introduction to Spatial (6D) Vectors and Their Use in Robot Dynamics

**Scientific Disciplinary Sector:** ING-INF/04

**Number of hours:** 10

**Credits:** 4

## AIMS AND CONTENT

### Learning Outcomes (short)

The course provides an introduction to spatial vector algebra, which is a tool that simplifies the task of solving problems in rigid-body dynamics by reducing the quantity of algebra needed to describe and solve a problem, and reducing the amount of computer code needed to calculate the answer.

### Learning Outcomes (further info)

Spatial vectors combine the linear and angular aspects of rigid-body motion, so that a single spatial vector can provide a complete description of a rigid-body's velocity, acceleration, momentum, or the forces acting upon it. The result is a large reduction in the quantity of algebra needed to describe and solve a problem in rigid-body dynamics: fewer quantities, fewer equations, and fewer steps to the solution. There is also a large reduction in the quantity of computer code needed to calculate the answer. This course explains spatial vectors in sufficient detail to allow students to understand what they are, how they work, and how to use them in their own research.

### Syllabus/Content

- motion and force
- Plucker coordinates
- differentiation and acceleration
- equation of motion
- motion constraints

**Prerequisites:** A basic knowledge of Newtonian dynamics is required (i.e., dynamics using 3D vectors), such as can be obtained from a first course in dynamics at undergraduate level. A basic knowledge of linear algebra is also required (vector spaces and subspaces, bases, coordinates, linear independence, range and null spaces of a matrix, etc.)

## WHO

**Teacher:** Roy Featherstone, roy.featherstone@iit.it

## HOW

### Teaching Methods

The course will be taught by means of lectures and class exercises. Lecture notes will be provided, as well as supplementary materials for self-study.

### Exam Description

There will be an oral exam based on the lecture material.

### Assessment Methods

The course will be assessed by oral exam only. Students wishing to take the exam must make an appointment with the teacher.

## WHERE AND WHEN

### Lesson Location

IIT (via Morego).

### Lesson Schedule

Four 2.5-hour sessions in the afternoon May 17th, 18th, 19th, 21st (15:00-17:30).

### Office hours for students

The teacher is available at most times and on most days to answer students' questions face-to-face or by email. No appointment is required.

## CONTACTS

The teacher is moving to a new office in the IIT building on via San Quirico. Students can contact him via email: [roy.featherstone@iit.it](mailto:roy.featherstone@iit.it)

## Computational Robot Dynamics

**Scientific Disciplinary Sector:** ING-INF/04

**Number of hours:** 12

**Credits:** 5

### AIMS AND CONTENT

#### Learning Outcomes (short)

The course covers the fundamentals of computational robot dynamics: dynamic models of robots; inverse, forward and hybrid dynamics; and the process of dynamics simulation.

#### Learning Outcomes (further info)

Most dynamics simulation today is performed by specialized 'black-box' simulators that hide the details from the user. Unfortunately, many of these simulators are inaccurate, buggy, or suffer from a variety of limitations. This course provides students with the necessary knowledge to become competent users (and producers) of dynamics software. Topics range from equations of motion through to model-based dynamics algorithms and techniques for accurate and reliable simulation.

#### Syllabus/Content

- basic equations of motion
- inverse dynamics, and the idea of a recursive algorithm
- efficient implementation of spatial vector arithmetic
- forward and hybrid dynamics
- dynamic models of robots
- the integration process

**Prerequisites:** It is desirable, but not necessary, that students take the preceding course on spatial vectors. Students who have not taken this course should nevertheless have a basic knowledge of classical Newtonian dynamics (i.e., dynamics using 3D vectors).

### WHO

**Teacher:** Roy Featherstone, roy.featherstone@iit.it



## HOW

### Teaching Methods

The course will be taught by means of lectures, class exercises and practical exercises using the software package *spatial\_v2*. Students will need access to Matlab and Simulink in order to run this software. Lecture notes will be provided.

### Exam Description

There will be an oral exam based on the lecture material and exercises.

### Assessment Methods

The course will be assessed by oral exam only. Students wishing to take the exam must make an appointment with the teacher.

## WHERE AND WHEN

### Lesson Location

IIT (via Morego).

### Lesson Schedule

Four 3-hour sessions in the morning May 24th, 25th, 26th, 27th (10:00-13:00).

### Office hours for students

The teacher is available at most times and on most days to answer students' questions face-to-face or by email. No appointment is required.

## CONTACTS

The teacher is moving to a new office in the IIT building on via San Quirico. Students can contact him via email: [roy.featherstone@iit.it](mailto:roy.featherstone@iit.it)

## Interaction in Virtual and Augmented Reality

**Scientific Disciplinary Sector:** INF/01

**Number of hours:** 20 hours

**Credits:** 6 CFU

### AIMS AND CONTENT

#### Learning Outcomes (short)

The course will present the fundamentals of the design, implementation and assessment of virtual (VR) and augmented reality (AR) environments, and the techniques to interact within such environments. Particular attention will be paid to the perceptual issues and to the ecological interaction in VR and AR.

#### Learning Outcomes (further info)

#### Syllabus/Content

- Introduction to VR and AR: techniques and devices
- Immersivity, presence, quality of experience, and adverse symptoms: study and evaluation.
- Interaction in VR and AR: devices and software solutions. Techniques for ecological interaction.
- Perceptual issues when acting in virtual and augmented reality.
- Examples and case studies

### WHO

**Teacher(s):** Manuela Chessa, [manuela.chessa@unige.it](mailto:manuela.chessa@unige.it), +39 010 3536663

### HOW

#### Teaching Methods

Classroom lectures with theory and examples.

#### Exam Description

The exam will consist in the development of a simple virtual or augmented reality application, or in the design and execution of an experimental session to test some of the issues presented during the course.

#### Assessment Methods

Discussion about the implemented application or the about results of the experiment. A small document describing the application or the experiment is required. The developed code should be released to the teacher.

### WHERE AND WHEN

#### Lesson Location

@UNIGE (DIBRIS, via Dodecaneso 35) or remotely through Teams platform.

#### Lesson Schedule

25-26-27-28-29 January 2021 h 9-13

**Office hours for student**

The teacher will be available on appointment ([manuela.chessa@unige.it](mailto:manuela.chessa@unige.it))

<b>CONTACTS</b>
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Email: [manuela.chessa@unige.it](mailto:manuela.chessa@unige.it)

Office: Valletta Puggia - Via Dodecaneso 35, 3rd floor, room 329, 16146 Genova - ITALY

Phone: +39 010 353 6663

# Computational models of visual perception

**Scientific Disciplinary Sector:** INF/01

**Number of hours:** 12 hours

**Credits:** 4 CFU

## AIMS AND CONTENT

### Learning Outcomes (short)

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.

### Learning Outcomes (further info)

### 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.
- Case studies: models and algorithms of the literature.

## WHO

### Teacher(s):

Fabio Solari, [fabio.solari@unige.it](mailto:fabio.solari@unige.it), +39 010 3536756

## How

### Teaching Methods

Classroom lectures with theory and examples.

### Exam Description

The exam will consist in the analysis/development of a specific neural model.

### Assessment Methods

A discussion about the implemented model and a short document, which describes the analysis and implementation, are required.

## WHERE AND WHEN

### Lesson Location

Remotely through Teams platform

**Lesson Schedule**

*To be synchronized with the PhD program in Computer Science and Systems Engineering (maybe February)*

**Office hours for student**

The teachers will be available on appointment ([fabio.solari@unige.it](mailto:fabio.solari@unige.it))

<b>CONTACTS</b>
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Email: [fabio.solari@unige.it](mailto:fabio.solari@unige.it)

Office: Valletta Puggia - Via Dodecaneso 35, 3rd floor, room 303, 16146 Genova - ITALY

Phone: +39 010 353 6756

## Perceptual systems

**Scientific Disciplinary Sector:** M-PSI/01

**Number of hours:** 12

**Credits:** 4

### AIMS AND CONTENT

#### Learning Outcomes (short)

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

#### Learning Outcomes (further info)

From birth, we interact with the world through our senses. How the brain process and transform sensory signals into perceptual outputs is one of the main questions in the field of experimental psychology. The goal of the course is 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 organize complex behaviour. In the last part of the course, these topics will be described in relation with cross-sensory interaction and multisensory integration in the adult and the developing brain.

#### Syllabus/Content

Class 1 (3 hours): Visual system I.

Class 2 (3 hours): Auditory and tactile systems.

Class 3 (3 hours): Multisensory integration and development of sensory systems.

Class 4 (2 hours): Olfactory and gustatory systems and cross-modal interaction.

Class 4 (1 hours): Final Exam.

### WHO

#### Teacher(s):

Monica Gori – Istituto Italiano di Tecnologia – +39 0108172217, [monica.gori@iit.it](mailto:monica.gori@iit.it)

Alessia Tonelli – Istituto Italiano di Tecnologia – +39 0108172232, [alessia.tonelli@iit.it](mailto: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 have to answer correctly at least at the 65% of the questions.

## WHERE AND WHEN

### **Lesson Location**

The lessons will be held at IIT – Erzelli or on Teams platform. The name of the room depends on availability and will be communicated in advance.

### **Lesson Schedule**

May 20th (08:30-11:30)

May 25th (10:00-13:00)

May 28th (15:00-18:00)

May 31st (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 can contact the teacher by email:

Monica Gori – [monica.gori@iit.it](mailto:monica.gori@iit.it)

Alessia Tonelli – [alessia.tonelli@iit.it](mailto:alessia.tonelli@iit.it)

## Electronics and Circuits

**Unit code:** (filled by Unige administrative office)

**Scientific Disciplinary Sector:** ING/INF-01

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

**Credits:** 3 each level

<b>AIMS AND CONTENT</b>
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### Learning Outcomes (short)

Level 1: analog and digital electronics

Level 2: mixed signals and data conversion

Level 3: design of electronic modules

Level 4: more advanced design techniques

### 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 third-party 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

Level 4: more advanced technical issues (e.g. circuit layout dos and don'ts), circuit design best practices, CAD tools.

### Syllabus/Content

Level 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 Level 1 module.

Level 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.

Level 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.

Level 4: with the background of the preceding modules, it is time to go the 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”. Students will also approach a CAD program to design circuits and the corresponding Printed Circuit Boards.

**WHO**

**Teacher:**

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

**How**

**Teaching Methods**

Classes will be divided into two sections:

- a taught-lesson to offer a clear explanation of the theoretical foundations and methods of circuit design (at the various Levels enumerated above)
- a practical-lesson in the Laboratories where students will be guided to practically realize the explained circuits, performing all the measurements to test and verify them.

**Exam Description**

The students will be asked to design a final circuit, realize it in the Labs and demonstrate its proper operation with the necessary measurements. They will write a report describing the application circuit 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 4 weeks (from Tuesday to Thursday) in January and February 2020 with the following schedule:

January	26th to 28th:	Level 1
February	9th to 11th:	Level 2
February	23th to 25th:	Level 3
February	9th to 11h:	Level 4

from 2 PM to 6 PM

**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](mailto:sartore@elbatech.com) or can freely phone to +393472207478 either to ask information or to arrange for an appointment.

## Advanced EEG analyses

**Scientific Disciplinary Sector:** ING-INF/06

**Number of hours:** 15 hours

**Credits:** 5 CFU

<b>AIMS AND CONTENT</b>
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### 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 ERSP. 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.*

<b>WHO</b>
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### Teacher(s):

Alberto Inuggi, +39 010 2897 219, [alberto.inuggi@iit.it](mailto:alberto.inuggi@iit.it)

Claudio Campus, +39 010 2097 208, [claudio.campus@iit.it](mailto:claudio.campus@iit.it)

<b>HOW</b>
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### 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 to 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**

According to COVID evolution, 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**

- 18/01/2021 10:00 – 13:00
- 20/01/2021 10:00 – 12:00
- 22/01/2021 10:00 – 12:00
- 25/01/2021 10:00 – 12:00
- 27/01/2021 10:00 – 13:00
- 29/01/2021 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**

Both teachers work in the Center for Human Technologies, Via Enrico Melen 83, Building B,16152 Genova, Italy, IIT Erzelli. Students should preferably interact with the teachers by e-mail.

## Research oriented structural and functional neuroimaging

**Scientific Disciplinary Sector:** ING-INF/06

**Number of hours:** 21 hours

**Credits:** 6 CFU

<b>AIMS AND CONTENT</b>
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### **Learning Outcomes (short)**

The present course will review the current neuroimaging methodologies used to extract in-vivo information over functional and structural organization of human brain. The aim of the course is teaching students how to read and understand most of the current neuroimaging literature. No practical analysis techniques will be presented. The physical basis of image formation, the specific feature of each neuroimaging method and the technical characteristics of the recording hardware (magnetic scanners and coils) will be also explained.

### **Learning Outcomes (further info)**

Medical Imaging was born in 1895 when Roentgen, while experimenting with the peculiar radiation he had just discovered, asked his wife to place the left hand over a photographic plate. Relatively little progress followed until about 1970, when the cost/performance ratio of electronics and computing equipment made digital imaging possible. As a result, almost at the same time, echography, computed tomography and nuclear medicine blossomed and then melted: radiology gave place to medical imaging. Around mid/end of 80's two further steps were done with the discovery of the BOLD effect and the development of the Diffusion MRI technique. With the former the scanner could be programmed to obtain non-invasive maps of functional brain activity, with the latter it became possible to assess the path and the integrity of the white-matter bundles that connect the different brain areas. Neuroimaging was born and rapidly became the most powerful and influencing research approach in neuroscience and a fundamental tool for clinical diagnoses.

The goal of the course is to give a broad perspective of the main neuroimaging technologies available today. Some brief explanations of the physical basis of image formation, of the specific feature of each imaging method and of the technical characteristics of the involved hardware (magnetic scanners) will be given at the beginning of the course. The course will then concentrate on the most used technique in clinical and research context with the clear aim to enable each student to easily read and understand a neuroimaging paper. Special attentions will be given to those non-invasive techniques able to estimate the structural and functional properties of human brain. Among the former, we will introduce the voxel based morphometry (VBM) and the cortical thickness to assess the status of gray matter and two post-processing approaches of the diffusion tensor imaging, the tracto-based spatial statistic (TBSS) and the tractography, used to assess the integrity of the white matter fibers bundles. Among the former, we will focus on functional MRI, introducing the independent component analysis to extract the cortical networks present at rest and the methods to assess task-related cortical activation. Finally, a comparison

between fMRI and EEG methods to reconstruct cortical activity will be shown, together with a brief introduction to structural and functional connectomics.

### Syllabus/Content

- Class 1 (3h) Brief introduction to the physical basis of the main MRI images formation (T1, T2, EPI and Diffusion images) and their specific features. *(Teacher Danilo Greco)*
- Class 2 (3h) Introduction to the technical characteristics of the involved hardware 1: magnetic scanner and coils. *(Teacher Danilo Greco)*
- Class 3 (2h) Introduction to the technical characteristics of the involved hardware 2: magnetic scanner and coils. *(Teacher Danilo Greco)*
- Class 4 (2h). Common MRI preprocessing steps. Structural MRI. Evaluating gray matter:
  - density (VBM)  
*(Teacher Alberto Inuggi).*
- Class 5 (2h). Structural MRI. Evaluating gray matter:
  - Thickness  
Pediatric templates, longitudinal coregistration  
*(Teacher Alberto Inuggi).*
- Class 6 (3h) Structural MRI. Evaluating white matter. Diffusion Images analysis,
  - TBSS
  - Tractography  
Functional MRI. Origin of the BOLD signal, fMRI vs EEG comparison. *(Teacher Alberto Inuggi)*
- Class 7 (3h) Functional MRI at rest. Brain functional connectivity (FC).
  - Within networks FC (Melodic analysis).
  - Whole brain FC (seed-based FC)
  - simple (fslnets) and advanced (connectomics) between network FC  
*(Teacher Alberto Inuggi)*
- Class 8 (3h) Functional MRI during a task. Task-based FC (DCM, PPI) and fMRI.  
Epi correction within high field scanners  
Final Examination. *(Teacher Alberto Inuggi)*

<b>WHO</b>
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#### Teacher(s):

Alberto Inuggi, Tel. +39 010 8172219 , [alberto.inuggi@iit.it](mailto:alberto.inuggi@iit.it)

Danilo Greco, [danilo.greco@iit.it](mailto:danilo.greco@iit.it)

<b>HOW</b>
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#### Teaching Methods

Projected slides

#### Exam Description

Students will undergo a 45 minutes written examination consisting in 50 (20 for MRI physics and hardware, 30 for MRI methods) multiple selection questions.

### **Assessment Methods**

In order to obtain the 6 CFU, students are expected to correctly answer to a total of at least 30 questions.

<b>WHERE AND WHEN</b>
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#### **Lesson Location**

Lessons will be held in the IIT Center of Human Technologies. Via Enrico Melen 83, Building B  
16152 Genova, Italy. 12<sup>th</sup> floor or remotely through Teams application

#### **Lesson Schedule**

- 19 Aprile 09:00 – 12:00
- 21 Aprile 09:00 – 12:00
- 22 Aprile 11:00 – 13:00
- 23 Aprile 11:00 – 13:00
- 26 Aprile 11:00 – 13:00
- 28 Aprile 10:00 – 13:00
- 30 Aprile 10:00 – 13:00

#### **Office hours for student**

Students can contact the teachers by e-mail whenever needed.

<b>CONTACTS</b>
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Teachers' office is in the 7<sup>th</sup> floor of IIT Center of Human Technologies. Via Enrico Melen 83, Building B  
16152 Genova, Italy. Students can contact them by e-mail whenever needed.

# The 3Rs approach: Replacement, Reduction and Refinement of animal procedures in biomedical research

**Scientific Disciplinary Sector:** ING-IND/34

**Number of hours:** 9 hours

**Credits:** 3 CFU

## AIMS AND CONTENT

### Learning Outcomes (short)

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.

### Learning Outcomes (further info)

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
- Alternatives to animals in safety and quality testing

## WHO

**Teacher(s):** Laura Pastorino, 0103536547, [laura.pastorino@unige.it](mailto:laura.pastorino@unige.it)

## HOW

### Teaching Methods

Frontal lessons

### Exam Description

The course will be assessed by an oral exam

### Assessment Methods

Evaluation of the oral exam

**WHERE AND WHEN**

**Lesson Location**

@ UNIGE

If possible in presence although through Teams

**Lesson Schedule**

17-18 December 2020

**Office hours for student**

Mail or Teams

**CONTACTS**

[laura.pastorino@unige.it](mailto:laura.pastorino@unige.it)



# Nanophotonic devices: from fabrication to applications

**Scientific Disciplinary Sector:** FIS/07

**Number of hours:** 15 hours

**Credits:** 5 CFU

## AIMS AND CONTENT

### Learning Outcomes (short)

This course enables the students to have basic knowledge of: (i) Nanofabrication and cleanroom-based technologies; (ii) Electron and ion beam processing; (iii) Nanophotonic devices for ultrasensitive detection and point of care diagnostics; (iv) Vibrational spectroscopies: Raman scattering and infrared absorption in nanophotonic/biosensor systems.

### Learning Outcomes (further info)

The fabrication of complex plasmonic nanostructures integrated in innovative device architectures represents a multidisciplinary key activity at the core of most research efforts in nanoscience and technology. In particular, the possibility to manipulate and enhance electromagnetic field at the nanoscale has opened outstanding perspectives in point of care technologies and early disease diagnostics, thus enabling the detection of molecules in highly diluted liquids, and/or the spectral signature collection of single/few molecules concentrated in nanovolumes.

The “hot spot” concept, induced by localized surface plasmon resonances, will be introduced as core idea behind the surface-enhanced infrared absorption (SEIRA) and the surface-enhanced Raman spectroscopy (SERS). Within this context, we will pay attention to the state of the art nanofabrication technologies, e.g. following top-down or bottom-up methods. In details, top-down fabrication refers to approaches such as electron beam lithography or focused ion beam milling where focused electrons or ions are used to carve nanostructures into macroscopically dimensioned materials. Alternatively, in the bottom-up approach, one begins to assemble nanostructures from smaller units. Examples will include colloidal synthesis and unfocused ion beam sputtering.

An introduction (~4 hours) to both Raman and Infrared spectroscopies will be carried out. The topics will include vibrational and rotational spectra, molecular symmetries, instrumentation and sampling methods, environmental dependence of vibrational spectra.

### Syllabus/Content

- Nanofabrication technologies: top-down and bottom-up approaches for the realization of next-generation devices (~4 hours).
- Nanoplasmonics and Nanophotonics: the physics behind the applications (~2 hours).
- Nanophotonic devices: design and realization of ultrasensitive biosensors (~3 hours).
- Vibrational spectroscopies: Raman scattering and infrared absorption (~4 hours).
- SEIRA and SERS: employing nanophotonic enhancers/devices for the ultrasensitive detection both in the visible and in the infrared range (~2 hours).

## WHO

### Teacher:

Andrea Toma,  
phone number: 010 2896257, email: [andrea.toma@iit.it](mailto:andrea.toma@iit.it), web page: <http://www.iit.it/en/people/andrea-toma.html>

## How

### Teaching Methods

The main teaching methods will involve frontal lectures with a dedicated amount of time to teacher-student interactive dialogue (*i.e.* learning-by-discussion method). A tour lab into the IIT clean-room facility will bring the students in direct contact with the main top-down fabrication techniques. Lecture notes and slides will be provided to the students.

### Exam Description

The final examination consists in a journal club or a brief research project proposal.

### Assessment Methods

Teacher-students interactive dialog will provide intermediate feedback on the learning progress. A final presentation aimed at bridging the state-of-the art research in nano- bio-photonics with the students' activities (PhD project etc.) will be used as a direct assessment of the learning outcomes. Within this context, the students will be asked to reflect on their learning: a brief research proposal involving both photonics concepts and their own research program will be evaluated during the final examination.

## WHERE AND WHEN

### Lesson Location

Istituto Italiano di Tecnologia - Via Morego 30, 16163 Genova

### Lesson Schedule

Lectures will be held on April 9<sup>th</sup>, 13<sup>th</sup>, 16<sup>th</sup>, 20<sup>th</sup> and 23<sup>rd</sup>. Every lesson will be 3 hours long starting at 2pm.

### Office hours for student

From March to May, office hours are scheduled on Mondays 11am - 12 pm. During the other months office hours are by appointment or email only.

## CONTACTS

Office: room 5/10, Istituto Italiano di Tecnologia via Morego 30. Email ([andrea.toma@iit.it](mailto:andrea.toma@iit.it)) or phone (010 2896257) are the most preferred methods of communication.

## Polymers for sustainability, food packaging and biomedics

Scientific Disciplinary Sector: ING-IND/22; ING-IND/34

Number of hours: 12

Credits: 6

AIMS AND CONTENT
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### Learning Outcomes (short)

Basic concepts of polymer preparation coupled with physicochemical characterization techniques, with special focus on polymeric composites. Model applications in different fields (food packaging, circular economy, biomedical).

### Learning Outcomes (further info)

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 biomedical field and 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, circular economy and bioengineering, 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 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.

**Biomaterials:** design, development and biomedical application. Overview of the various materials used in the medical field (polymers, metals, ceramics); properties needed for specific applications (tissue regeneration, organoid formation, load bearing in prostheses), biocompatibility and biodegradation concepts, body response to a biomaterial. Alternative methods to test biomaterials; focus on nanoparticles, microneedles and microfluidic systems for targeted drug delivery.

<b>WHO</b>
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**Teacher(s):**

Giovanni Perotto, [giovanni.perotto@iit.it](mailto:giovanni.perotto@iit.it); 010 71781 773

Evie Papadopoulou, [paraskevi.papadopoulou@iit.it](mailto:paraskevi.papadopoulou@iit.it); 010 71781 705

Giulia Suarato, [giulia.suarato@iit.it](mailto:giulia.suarato@iit.it); 0102896870

<b>HOW</b>
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**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**

Lessons will be done @ IIT or remotely through Teams platform (depending on the coronavirus situation)

**Lesson Schedule**

Lessons will be in April 2021. Specific dates will be decided in February (6 sessions of 2 hours).

**Office hours for student**

Students asking info to the teachers can contact them by email anytime.

**CONTACTS**

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

## Hybrid microfluidics systems for electronics, photonics, and sensors

**Unit code:** (filled by Unige administrative office)

**Scientific Disciplinary Sector:** ING/INF 01; ING/INF 07

**Number of hours:** 9 hours

**Credits:** 3 CFU

### AIMS AND CONTENT

#### Learning Outcomes (short)

This course is intended for PhD students who are interested in getting a better understanding of how the synergistic integration of either optics or electronics with microfluidics enables new applications in several fields such as spectroscopy, microscopy, (bio)sensing, and robotics.

#### Learning Outcomes (further info)

The course illustrates operational principles and functionalities of hybrid microfluidics systems through physics and various examples. No prerequisites are required.

#### Syllabus/Content

The course is divided into 4 sections: 1) Introduction to hybrid systems: history, definitions and fundamental concepts; 2) Microfluidics: the physics of liquids below the microliter scale; 3) Fabrication technologies: materials and micromachining methods; 4) applications: sensors, optics, electronics.

### WHO

**Teacher(s):** Salvatore Surdo, +39 010 28961, [salvatore.surdo@iit.it](mailto:salvatore.surdo@iit.it)

### HOW

#### Teaching Methods

Frontal lectures with PPT.

#### Exam Description

Short thesis or project proposal dealing with the contents of the course.

#### Assessment Methods

Evaluation of the thesis/proposal

### WHERE AND WHEN

#### Lesson Location

Lesson will take place @ IIT

**Lesson Schedule**

3<sup>rd</sup>, 10<sup>th</sup>, 17<sup>th</sup> and 24<sup>th</sup> of May.

**Office hours for student**

appointments, email

<b>CONTACTS</b>
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Office: CHT Erzelli, Istituto Italiano di Tecnologia, Via Enrico Melen 83, Building B, 16152 Genova, Italy, 10th floor; E-mail: [salvatore.surdo@iit.it](mailto:salvatore.surdo@iit.it)

# Principles of Tissue Engineering and Regenerative Medicine

**Scientific Disciplinary Sector:** ING-INF06

**Number of hours:** 12 hours

**Credits:** 4 CFU

<b>AIMS AND CONTENT</b>
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## Learning Outcomes (short)

The course will provide the students the basic knowledge about:

- cell biology
- techniques to fabricate and/or characterise biomaterials for tissue engineering
- bioreactors for tissue engineering
- in vivo tests and current clinical applications

## Learning Outcomes (further info)

Tissue Engineering is a multidisciplinary field involving biology, medicine, material science and bioengineering aimed to improve the health and quality of life for millions of people worldwide by restoring, maintaining, or enhancing tissues and organs function. Tissue engineering research includes the following areas: (i) Cell biology, in fact the “tissue engineer” should know the methodologies to culture in vitro different kinds of cells, such as autologous cells, allogeneic cells, xenogeneic cells, stem cells and genetically engineered cells. (ii) Biomaterials, designed to direct the organization, growth, and differentiation of cells in the process of forming functional tissue by providing both chemical and physical (macro-micro-nano scale) cues. (iii) Biomolecules, including growth factors, differentiation factors, angiogenic factors, their synthesis and their release. (iv) Engineering Design Aspects, to guide 3D tissue growth, through the modelling of the biomaterial internal architecture and the design of dynamic culture systems (bioreactors) to provide specific physiological stimuli.

## Syllabus/Content

- Cell-Based Therapies for TE: methodologies for cells isolation, differentiation, selection of adult progenitors/stem cells.
- Biomaterials for TE: design of intelligent materials, study of their macro-micro-nano features, modulation of their chemical composition, biomechanical properties and bioactivity.
- Bioreactor systems for TE: perfusing bioreactor systems, biomechanical stimulating bioreactors, fluidodynamic stimulating bioreactors.
- Pre-clinical/Clinical models: animal models, in vivo case studies.

<b>WHO</b>
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**Teacher(s):** Alessandra Marrella

phone number: 010 6475 215; email: [alessandra.marrella@ieiit.cnr.it](mailto:alessandra.marrella@ieiit.cnr.it)



## How

### Teaching Methods

Combination of traditional lectures and classroom discussion.

### Exam Description

The examination consists in a journal club or a brief research project proposal.

### Assessment Methods

A final presentation covering the topics of the course will be used as a direct assessment of the learning outcomes.

## WHERE AND WHEN

### Lesson Location

Lessons will be done remotely through Teams platform.

### Lesson Schedule

21<sup>th</sup> September 2021, 9-11

28<sup>th</sup> September 2021, 9-11

5<sup>th</sup> October 2021, 9-11

12<sup>th</sup> October 2021, 9-11

19<sup>th</sup> October 2021, 9-11

26<sup>th</sup> October 2021, 9-11

### Office hours for student

Mail

## CONTACTS

Istituto di Elettronica e di Ingegneria dell'Informazione e delle Telecomunicazioni (IEIIT), Consiglio Nazionale delle Ricerche (CNR) - Via De Marini, 6, 16° floor. Email ([alessandra.marrella@ieiit.cnr.it](mailto:alessandra.marrella@ieiit.cnr.it)) is the most preferred method of communication.

# Cognitive Robotics for Human-Robot Interaction

**Scientific Disciplinary Sector:**

**Number of hours:** 18 hours

**Credits:** 6 CFU

<b>AIMS AND CONTENT</b>
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**Learning Outcomes (short)**

The participants will learn the key aspects regulating the interaction between human and robots, and will have an overview of good features and limitations of currently available platforms for HRI. Students will learn how to conduct an HRI study and which metrics are appropriate to characterize the interaction.

Participants will be provided with an overview of some computer vision useful to make robots able to understand the nonverbal behaviors of the human partner (e.g. facial expressions and body movements) and other perceptual models of cognitive robotics. Further the participants will be provided with an overview on how actions can close the action-perception loop with human partners and how these models integrate in broader cognitive architectures for HRI. The survey across cognitive models of perception and action will give to the participants the opportunity to successfully design new behaviors for interacting robots.

Moreover, participants will have the chance to program the humanoid robot iCub.

**Learning Outcomes (further info)**

In this course the students will learn the different roles a robot could play in the context of human-robot interaction, as for instance the tutor, the collaborator, the companion or the tool of investigation, and the corresponding different models of interaction. The course is aimed at providing a clear understanding of what are the good features and limitations of the robotic platforms currently available.

The students will learn how to use computer vision and machine learning techniques to endow the robot with the capability of understanding human behaviors (for instance motion and facial expressions) that are relevant in a natural human-robot interaction.

The participants will learn how to design and implement robot perceptual, motor abilities structured in a cognitive framework for natural human-robot interaction, and will have the chance to learn how to program the humanoid robot iCub.

**Syllabus/Content**

Taxonomy and Open Challenges for HRI

The importance of Robot Shape, Motion and Cognition

Metrics and Experimental Design

Computer Vision for HRI

Models of Robot Perception and Action in HRI

Software Development of perception and action models in HRI

<b>WHO</b>
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**Teacher(s):**

Francesco Rea, [francesco.rea@iit.it](mailto:francesco.rea@iit.it)

Ana Tanevska, [Ana.Tanevska@iit.it](mailto:Ana.Tanevska@iit.it)

Fabio Vannucci, [Fabio.Vannucci@iit.it](mailto:Fabio.Vannucci@iit.it)

## HOW

### Teaching Methods:

The course will be structured as a series of frontal lessons progressing from an introduction to the basis of HRI to the specific description of the principal methodologies supporting the analysis and the realization of effective HRI. It will be proposed to the students to proactively participate as groups in short exercise and practical sessions or in group discussions addressing the topics of the lectures.

### Exam Description:

At the end of the course the students will be involved in designing either an HRI experiment or practical solutions for specific HRI case studies. The participants will work together in small groups of 3/4 persons and will have to leverage on the methods learned during the previous lessons in order to provide an effective solution to the proposed HRI problem.

### Assessment Methods:

The teachers will assess the effectiveness and appropriateness of the HRI solution or HRI experiment designed during the exam. The assessment will take in consideration how the students selected and implemented the techniques learnt during the course.

## WHERE AND WHEN

### Lesson Location

The lessons will take place at the Italian Institute of Technology, Center for Human Technologies (room to be defined) and at the same time the students will be provided with the possibility to attend from remote.

### Lesson Schedule

Weeks: from 28th to 30th June from 9 to 13, and 1st and 2nd July from 9 to 12.

### Office hours for student

Office time is flexible and the student can agree with the teacher an appointment by sending an email either to [Francesco.Rea@iit.it](mailto:Francesco.Rea@iit.it), [Ana.Tanevska@iit.it](mailto:Ana.Tanevska@iit.it) or [Fabio.Vannucci@iit.it](mailto:Fabio.Vannucci@iit.it)

## CONTACTS

The offices are located at

Robotics Brain and Cognitive Sciences Unit (RBCS) and  
COgNiTive Architecture for Collaborative Technologies Unit (CONTACT)  
Istituto Italiano di Tecnologia  
Center for Human Technologies  
Via Enrico Melen 83, Building B  
16152 Genova, Italy

## Introduction to physical Human-Robot Interaction

**Scientific Disciplinary Sector:** ING-INF/06

**Number of hours:** 12 hours

**Credits:** 5 CFUs

### AIMS AND CONTENT

#### Learning Outcomes (short)

The present course will introduce the field of physical Human-Robot Interaction (pHRI). It will discuss current scientific and technological limitations in collaborative scenarios and methods to deal with them. Emphasis will be given to the integration of knowledge between neuroscience and robotics.

#### Learning Outcomes (further info)

Robotic technology is rapidly developing, and seemingly offers a multitude of potential near-future applications. We see robots as embodied artificial intelligence (AI), and although AI is progressing rapidly in many areas, generating efficient movement and physical interaction is still a major challenge, especially when it comes to human-like movement and interaction with humans. In line with these considerations, in the next years the field of physical human-robot interaction will be extensively studied both from human and robot side. Specific robots will be designed to cooperate with humans in different contexts such as assisted industrial manipulation, virtual training, entertainment or rehabilitation.

The first part of the course will introduce basic concepts on how the brain control movements in humans and how it is possible to design robot control strategies for interacting robots. In the second part of the course will be presented findings in collaborative scenarios both from robot and human perspective.

#### Syllabus/Content

- The concept of physical human robot interaction
- Human motor control strategies and mechanisms
- Robot control in pHRI: Compliance control, Impedance control, Force control
- Human motor skill learning during haptic interaction
- Robot learning algorithms in collaborative contexts
- Laboratory

### WHO

**Teacher:** Jacopo Zenzeri, 3408311387, jacopo.zenzeri@iit.it

### HOW

#### Teaching Methods

For the theory lessons, slide presentation and discussion of a reading list

For the lab activity direct involvement in experiment planning and data processing

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**

**Venue**

Istituto Italiano di Tecnologia, Campus Erzelli (Via Melen 83, Bldg B, 16152 Genova)

**Course dates & Schedule**

Campus Erzelli: 8 hours (theory), 13-14-15-16 September 2021, time 9-11, (10<sup>th</sup> floor - room to be decided 1 month in advance)

Campus Erzelli: 4 hours (lab); 17 September 2021, time 9-13, MLARR lab (7<sup>th</sup> floor)

**Office hours for student**

Appointments by email request

**CONTACTS**

Jacopo Zenzeri, IIT Campus Erzelli, 7th floor, 3408311387, jacopo.zenzeri@iit.it

## Optimization-based trajectory planning for legged robots

**Scientific Disciplinary Sector:** ING-INF/05

**Number of hours:** 14

**Credits:** 4

<b>AIMS AND CONTENT</b>
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### **Learning Outcomes (short)**

This course will introduce modern methods for robotics movement generation based on numerical optimal control. An introduction to approximated models is also given (Linear Inverted Pendulum and Centroidal Dynamics). It will also contain hands-on exercises for real robotic applications such as walking on flat terrain.

### **Learning Outcomes (further info)**

The student will be able to generate a locomotion trajectory for the robot via optimization and track it with the controller implemented in the previous course of “Control of legged robots”.

### **Syllabus/Content**

Reduced Models:

D1 Introduction to Trajectory optimization, reduced models

D2. Linear Inverted pendulum: derivation of dynamics from the centroidal dynamics

D3. Linear Inverted pendulum + flywheel: incorporation of moments about com

D4. Cart-Table model

D5. 3D ZMP Model

D6. Other locomotion models: point mass model, inverted pendulum, spring-loaded inverted pendulum (Limit cycles, Poincarè map)

D7. Single Rigid Body Centroidal Dynamics model

D8. Capture point (derivation from LIP dynamics or from orbital energy, analysis of lip dynamics, stable, unstable eigenvectors, stability analysis of COM ZMP and CP)

D9. Capture point and real robots (finite size feet, capturability regions)

Trajectory Optimization:

E1. Overview on Optimal control Problems: Single shooting / Direct collocation for CoM trajectory optimization

E2. Discretization of the LIP dynamics (forward Euler, exact discretization with matrix exponentials), assembly of the support polygon constraints

E3. Closing the loop with the whole-body controller, implementation of a real robot, from reduced models to full dynamics

E4. Idea of MPC re-planning

Lab Sessions:

L1. Trajectory optimization: CoM planning with LIP model

L2. Close the loop with the QP controller implemented in the propedeutic course "Control of legged robots" and simulate a walk for a quadruped robot

#### WHO

**Teacher(s):**

Michele Focchi

3398971902

michele.focchi@iit.it

#### HOW

**Teaching Methods:**

Taught by means of lectures. Lecture notes and slides will be provided, as well as supplementary material (python code) for self-study.

Practical on-hand lab sessions, can be considered, to give the students an understanding on practical implementations of the theoretical aspects presented during the lectures.

**Exam Description:**

There will be a written exam based on the lecture material.

**Assessment Methods:**

The course will be assessed by written exam only.

#### WHERE AND WHEN

**Lesson Location**

IIT (via Morego).

The lessons will be done both in presence and remotely. Video of the lecture will be put online on a youtube playlist.

**Lesson Schedule**

Lesson Schedule: seven 2-hour sessions in the afternoon

October 15 : 14:30 /16:30

October 20 : 14:30 /16:30

October 22 : 14:30 /16:30

October 27 : 14:30 /16:30

October 29 : 14:30 /16:30

November 4 : 14:30 /16:30

**Office hours for student**

The teacher is available at most times and on most days to answer students' questions face-to-face or by email.

No appointment is required.

<b>CONTACTS</b>
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The teacher's office is located on the 3rd floor, IIT Morego

Students can contact him via email: [michele.focchi@iit.it](mailto:michele.focchi@iit.it)



## Robotic technologies for sensorimotor rehabilitation

**Scientific Disciplinary Sector:** ING-INF/06

**Number of hours:** 16 hours

**Credits:** 5 CFUs

### AIMS AND CONTENT

#### Learning Outcomes (short)

The course will present the different concepts underlying robotic rehabilitation. It will discuss the limitation of conventional physical therapy and the potential of robotics in the field of rehabilitation. Emphasis will be given both in technological and neuroscientific aspects related to the recovery of impaired patients.

#### Learning Outcomes (further info)

Rehabilitation robotics is the application of robots to overcome disabilities and improve quality of life after brain injuries. In contrast with other areas in robotics, this course considers not only engineering design and development, but also the human factors that make some innovative technologies successful.

The first part of the course will deal with the clinical and neuroscientific aspects related to the rehabilitation. The second part will analyze the technological characteristics needed to design robots able to interact with humans.

Ultimately, the last part will present examples on how the two parts can be combined in order to optimally design robots and the related rehabilitation protocols to effectively improve subjects' recovery process.

#### Syllabus/Content

- The concept of robotic rehabilitation
- Conventional rehabilitation techniques
- Neural plasticity and sensorimotor functions
- Robots for rehabilitation: manipulators, exoskeletons
- Possible control strategies: assistive, passive, active
- Case studies and future trends
- Laboratory

### WHO

#### Teachers:

Jacopo Zenzeri, 3408311387, [jacopo.zenzeri@iit.it](mailto:jacopo.zenzeri@iit.it)

Pietro Morasso, 3281003224, [pietro.morasso@iit.it](mailto:pietro.morasso@iit.it)

### HOW

#### Teaching Methods

For the theory lessons, slide presentation and discussion of a reading list

For the lab activity direct involvement in experiment planning and data processing

No Prerequisites

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

### **Exam Description**

There will be a final examination decided by the instructors 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 instructors and communicated to the students at the beginning of the course.

<b>WHERE AND WHEN</b>
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### **Venue**

Istituto Italiano di Tecnologia, Campus Erzelli (Via Melen 83, Bldg B, 16152 Genova)

### **Course dates & Schedule**

Campus Erzelli: 12 hours (theory), 13-14-15 September 2021, time 11-13 and 14-16, (10<sup>th</sup> floor - room to be decided 1 month in advance)

Campus Erzelli: 4 hours (lab); 16 September 2021, time 11-13 and 14-16 MLARR lab (7<sup>th</sup> floor)

### **Office hours for student**

Appointments by email request

<b>CONTACTS</b>
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Jacopo Zenzeri, IIT Campus Erzelli, 7th floor, 3408311387, jacopo.zenzeri@iit.it

Pietro Morasso, IIT Campus Erzelli, 7th floor, 3281003224, pietro.morasso@iit.it

## Robotic Virtual Prototyping Design

**Scientific Disciplinary Sector:**

**Number of hours:** 18 hours

**Credits:** 6 CFU

<b>AIMS AND CONTENT</b>
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### 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 5 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 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) and Multibody Simulation (MBS)
  - FEA (Ansys/Workbench)
- class 2 (C2)
  - Anthropomorphic Arm Modelling (FEA+MBS: Ansys/Workbench)
- class 3 (C3)
  - MBS + FEA (MSC.ADAMS + MSC.Nastran)
- class 4 (C4)
  - MBS + FEA + Embedded Control (MSC.ADAMS + MSC.Nastran)
- class 5 (C5)
  - Anthropomorphic Arm Modelling: MBS+ FEM + Co-Simulation Control (MSC.ADAMS + MSC.NASTRAN + MatLab)
- class 6 (C6)
  - Anthropomorphic Arm Modelling: MBS + FEM + Control + Optimisation (MSC.ADAMS + MSC.NASTRAN + MatLab + ModeFRONTIER)
- class 7 (C7) Project Assignment (optional)

- Final Project Assignment

**WHO**

**Teacher(s):**

<i>Ferdinando Cannella</i>	01071781562	<a href="mailto:ferdinando.cannella@iit.it">ferdinando.cannella@iit.it</a>
<i>Mariapaola D'Imperio</i>	01071781562	<a href="mailto:mariapaola.dimperio@iit.it">mariapaola.dimperio@iit.it</a>
<i>Haider Abidi</i>	0102896330	<a href="mailto:syed.abidi@iit.it">syed.abidi@iit.it</a>

**HOW**

**Teaching Methods**

Methods

The course will be based on 5 traditional teacher-led mixed to hand-on lectures  
 Slides of the course will be provided before each lectures  
 (Optional) Final project for the exam will be prepared with the teachers during the 6<sup>th</sup> 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, 19971.

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

##### Lesson Schedule

Tuesday 01st June 2021 14:30-17:30  
Thursday 03rd June 2021 14:30-17:30  
Tuesday 08th June 2021 14:30-17:30  
Thursday 10th June 2021 14:30-17:30  
Tuesday 15st June 2021 14:30-17:30  
Thursday 17th June 2021 14:30-17:30  
Tuesday 22nd June 2021 14:30-17:30 (optional)

##### Office hours for student

The teachers will be available (on the office or on skype) every Wednesday morning from 11:00 to 14:30 from 1<sup>st</sup> July to the 31<sup>st</sup> July 2020

#### CONTACTS

The Teachers' office is in Unità di Robotica Industriale at -2 floor at Istituto Italiano di Tecnologia, Via Morego 30 (Bolzaneto), Genova.

<i>Ferdinando Cannella</i>	0102896562	<a href="mailto:ferdinando.cannella@iit.it">ferdinando.cannella@iit.it</a>
<i>Mariapaola D'Imperio</i>	0102896562	<a href="mailto:mariapaola.dimperio@iit.it">mariapaola.dimperio@iit.it</a>
<i>Haider Abidi</i>	0102896330	<a href="mailto:syed.abidi@iit.it">syed.abidi@iit.it</a>

# Trustworthy AI: Learning from Data with Safety, Fairness, Privacy, and Interpretability Requirements

**Scientific Disciplinary Sector:** ING-INF/05

**Number of hours:** About 20

**Credits:** 5

## AIMS AND CONTENT

### Learning Outcomes (short)

Students will acquire the basic notions of Trustworthy AI and how it is possible to learn from data with safety, fairness, privacy, and interpretability requirements.

### Learning Outcomes (further info)

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 safety, 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

- Trustworthy AI;
- Safety in AI: Sensitivity Analysis and Adversarial Learning;
- Fairness in AI: from Pre-, In-, and Post-Processing Models to Learn Fair Representations;
- Privacy in AI: Federated Learning and Differential Privacy;
- Interpretability/Explainability of AI: making models more understandable.

## WHO

### Teacher(s):

Luca Oneto

[luca.oneto@unige.it](mailto:luca.oneto@unige.it)

<https://www.lucaoneto.it/teaching/tai>

## How

**Teaching Methods:** Frontal Lesson on Teams

**Exam Description:** Presentation of how methods/tools presented in the course can be used to improve the research project of the PhD student

**Assessment Methods:** Oral Exam scheduled by email

**WHERE AND WHEN**

**Lesson Location**

Please check <https://www.lucaoneto.it/teaching/tai>

**Lesson Schedule**

Please check <https://www.lucaoneto.it/teaching/tai>

**Office hours for student**

On appointment by email with [luca.oneto@unige.it](mailto:luca.oneto@unige.it)

**CONTACTS**

On appointment by email with [luca.oneto@unige.it](mailto:luca.oneto@unige.it)

# Fluorescence Super-Resolution Microscopy: Basis, Applications and Perspectives

**Scientific Disciplinary Sector:** ING-INF/06

**Number of hours:** 9 hours

**Credits:** 3 CFU

<b>AIMS AND CONTENT</b>
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## **Learning Outcomes (short)**

Is the promise of fluorescent super-resolution microscopy in the 21st-century to reveal the spatial organization of all bio-molecules inside a cell and directly observe their interactions at the highest spatial and temporal levels of detail. This course will explain the basis of fluorescent super-resolution and will introduce all the most important techniques. The course will cover both coordinate-targeted and coordinate-stochastic (also known as single-molecule-localization) approaches. Particular attention will be addressed to stimulated-emission-depletion (STED) microscopy and image scanning microscopy (ISM). The course will discuss about different bio-applications of fluorescence super-resolution microscopy, focusing on the quantitative ability of the techniques to characterize specific bio-molecular properties.

## **Learning Outcomes (further info)**

Introduced at the beginning of the 20th-century the fluorescent probes had truly revolutionized optical microscopy. The high sensitivity and specificity of the fluorescent probes in combination with optical microscopy allow understanding life at the molecular level. After one century fluorescent probes become again the major players of a new revolution in optical microscopy. Until the end of the 20th-century, it was widely accepted that due to the diffraction of light the optical microscopes can not visualize details much finer than about half the wavelength of light. The photo-physical mechanisms of the fluorescent probes, in particular the possibility to drive the probes in distinguishable states, set up the basis for overcoming the limiting role of diffraction. This breakthrough has led to readily applicable and widely accessible fluorescence microscopes with nanometer scale spatial resolution (fluorescence super-resolution microscopy), which can potentially play a relevant role in the groundbreaking progress of life science and neuroscience.

This course will start explaining the reason why diffraction of light imposes a limitation to the spatial resolution of an optical microscope and how this limit can be overcome taking advantages of the photo physical properties of the fluorescent probes. The course will introduce the most important and mature fluorescence super-resolution microscopy techniques. The course will continue focusing on two particular approaches, the STED microscopy and ISM microscopy. The major advantages, limitations and challenges of these two techniques will be deeply discussed and bio-medical applications will be presented. The course will highlight their ability to provide not only spatial information but also correlate them with temporal information (time-resolved spectroscopy), for



example the combination of STED microscopy with fluorescence-correlation-spectroscopy will be discussed and ISM with fluorescence lifetime.

Finally, the course will present general perspective about fluorescence super-resolution microscopy.

### **Syllabus/Content**

- The resolution and the diffraction limit
- Basis of coordinate-stochastic (single-molecule-localization) and coordinate-targeted approaches
- Advances in STED microscopy
- Advances in ISM microscopy
- Applications of STED microscopy and ISM and their combination with time-resolved spectroscopy

<b>WHO</b>
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**Teacher(s):** Dr. Giuseppe Vicidomini, Molecular Microscopy and Spectroscopy, +39 010 2897607, [giuseppe.vicidomini@iit.it](mailto:giuseppe.vicidomini@iit.it)

<b>How</b>
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### **Teaching Methods**

This course requires the active participation of all class members through active listening, debate, and discussion. Other instructional methods potentially employed in the course include visiting to the microscopy labs and participation to workshops.

### **Exam Description**

The examination consists in a brief research project proposal or in an oral presentation, and a short test.

### **Assessment Methods**

Class attendance and regular participation is required for this course. Assessment will be in both written and oral form.

<b>WHERE AND WHEN</b>
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### **Lesson Location**

Lessons will be done at the IIT-Center for Human Technology, Via Enrico Melen 83 Edificio B, Genoa. Room will be specified one week before the beginning of the course. Remote option via Teams will be also provided. In case of “social distancing” rules the course will be done only remotely.

### **Lesson Schedule**

The course will be organized in 4 lessons of two hours each. Every lesson will start at 10.00 am and will finish at 12.00 am, except the last one which will finish at 13.00. The lessons are scheduled for 4<sup>th</sup>, 6<sup>th</sup>, 11<sup>th</sup>, and 13<sup>th</sup> of May 2021. The calendar will be confirmed one month before the beginning of the course.

### **Office hours for student**

Dr. Giuseppe Vicidomini receive students on Tuesday from 14.30 to 16.00. For the students it is highly request to fix an appointment by e-mail of phone few days in advance and to wait confirmation from the professor.

<b>CONTACTS</b>
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Dr. Giuseppe Vicidomini

Molecular Microscopy and Spectroscopy

Italian Institute of Technology

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

Office: 12<sup>th</sup> floor

tel: +39 010 2897607

e-mail: [giuseppe.vicidomini@iit.it](mailto:giuseppe.vicidomini@iit.it)

# Advanced Optical Fluorescence Microscopy Methods, practice

**Scientific Disciplinary Sector: FIS/07**

**Number of hours: 9**

**Credits: 3 CFU**

## AIMS AND CONTENT

### Learning Outcomes (short)

This course considers, as starting point, those implementations in advanced optical fluorescence microscopy (AOFM) and fundamental aspects of fluorescence spectroscopy (absorption/ emission spectra, lifetime, energy transfer, intensity fluctuations, etc). The course will consider theoretical and experimental aspects within a critical discussion related to focused applications. The methods of analysis will also be discussed.

### Learning Outcomes (further info)

The course will address the methods that allow to get 4D(x-y-z-t) information like computational optical sectioning microscopy (COSM), confocal laser scanning microscopy (CLSM), two-photon excitation microscopy (2PEM), light sheet fluorescence microscopy (LSFM), and super-resolution microscopy. Variations on the theme will be treated by considering the possibility of getting complementary information by including Second Harmonic Generation, Light Scattering Polarization, quantitative fluorescence-based methods like Fluorescence Lifetime Imaging (FLIM), and force interaction measurements in AOFM schemes. A possible route to bring such approaches to super resolution methods will be critically discussed.

### Syllabus/Content

- Optical sectioning
- Spatial and Temporal Resolution in image formation
- Laser sources in microscopy
- Overview of advanced fluorescence spectroscopy/microscopy methods
- Critical discussion related to the biological, medical or materials science questions

## WHO

**Teacher(s):**

**Paolo Bianchini**, +39 010 2897 613, [paolo.bianchini@iit.it](mailto:paolo.bianchini@iit.it), [paolo.bianchini@unige.it](mailto:paolo.bianchini@unige.it)

## How

### Teaching Methods

The Course develops in about 9 hours by integrated digital teaching (Microsoft Teams)

### Exam Description

Written test: multiple-choice questions and an open question

## Assessment Methods

Evaluation of the test

<b>WHERE AND WHEN</b>
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### Lesson Location

Integrated digital teaching: remote location or 9<sup>th</sup> floor Istituto Italiano di Tecnologia (CHT- Erzelli), Via E. Melen 83 - Edificio B, 16152 Genoa Italy

### Lesson Schedule

18, 20, 25, 27 of May 2020 from 14.00 to 16.15

### Office hours for student

appointments, email, Microsoft Teams

<b>CONTACTS</b>
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The offices are located at the 10<sup>th</sup> floor of IIT via E. Melen 83 - Edificio B, 16152 Genoa Italy

**Paolo Bianchini**, 010 2897 613, [paolo.bianchini@iit.it](mailto:paolo.bianchini@iit.it), [paolo.bianchini@unige.it](mailto:paolo.bianchini@unige.it)

## CVCC - Computer Vision Crash Course

**Scientific Disciplinary Sector:** INF/01

**Number of hours:** 20

**Credits:** 6

### AIMS AND CONTENT

#### Learning Outcomes (short)

This crash course will present the basic principles of computer vision and visual perception in artificial agents. It will include theoretical classes, application examples, hand-on activities. Students will be provided with an overview of state-of-the-art methods for modelling and understanding the surrounding scene or an image content. In the first part we will present elements of classical computer vision (feature detection, depth estimation, motion analysis). In a second part, students will get acquainted with the problem of representing and understanding the image content adaptively by means of shallow or deep machine learning algorithms.

#### Learning Outcomes (further info)

More info will be provided at <https://ml.unige.it/>

#### Syllabus/Content

1. Introduction: computer vision main tasks, digital images fundamentals, and image formation principles
2. Image filters and image features
3. Video analysis: motion estimation
4. Multi-view systems: depth estimation
5. Image understanding: classification and detection of objects in images

### WHO

#### Teacher(s):

Francesca

Odone

MaLGa Machine Learning Genoa Center & DIBRIS

0103536667

francesca.odone@unige.it

### HOW

**Teaching Methods:** theory classes and laboratory sessions

**Exam Description:** report on lab activities

**Assessment Methods:** passed / not passed

<b>WHERE AND WHEN</b>
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**Lesson Location**

The course will be offered via Teams.

Should it be possible, classes in person will be organized at DIBRIS Via Dodecaneso

**Lesson Schedule**

It is a one-week crash course which will take place in summer 2021 (to be confirmed date)

Each day: Theory 2 hours (morning) – Labs 2 hours (afternoon)

**Office hours for student**

Contact the instructor via email [Francesca.odone@unige.it](mailto:Francesca.odone@unige.it)

<b>CONTACTS</b>
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Francesca Odone, DIBRIS Via Dodecaneso 35, office n. 333, 0103536667

## RegML: Regularization Methods for Machine Learning

**Unit code:** (filled by Unige administrative office)

**Scientific Disciplinary Sector:** ING-INF/04 OR ING-INF/05 OR ING-INF/06

**Number of hours:** 20

**Credits:** 6

### AIMS AND CONTENT

#### Learning Outcomes (short)

Students will learn the statistical foundations and the fundamental algorithms of Machine Learning, with a focus on regularization methods, and they will gain practical knowledge of all algorithms implementing them in parallel laboratory sessions.

#### Learning Outcomes (further info) Syllabus/Content

Introduction to Statistical Machine Learning, Tikhonov Regularization and Kernels, Binary classification and model selection, Early Stopping and Spectral Regularization, Regularization for Multi-task Learning, Spectral filters and multi-class classification, Sparsity Based Regularization, Structured Sparsity, Sparsity-based learning, Data Representation: Dictionary Learning, Data Representation: Deep Learning.

### WHO

#### Teacher(s):

Lorenzo Rosasco, (+39) 010353 - 6607,

[lorenzo.rosasco@unige.it](mailto:lorenzo.rosasco@unige.it)

### HOW

#### Teaching Methods:

Theory classes and laboratory sessions

#### Exam Description: Report on labs Assessment Methods:

Report evaluation: passed / failed

### WHERE AND WHEN

#### Lesson Location

Online / Via Dodecaneso

#### Lesson Schedule

Monday, June 21 - Friday, June 24

**Office hours for student**

by e-mail

**CONTACTS**

Lorenzo Rosasco, room 201, phone (+39) 010353 - 6607, e-mail: [lorenzo.rosasco@unige.it](mailto:lorenzo.rosasco@unige.it)

course webpage: <http://lcs1.mit.edu/courses/regml/regml2021/>