Dibris

ISTITUTO ITALIANO DI TECNOLOGIA

PhD Courses offered (2018-2019)

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Ethical, Bioethical and Legal Issues in Bioengineering and Robotics

Module I - Ethical and Bioethical Issues in Bioengineering and Robotics

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

Number of hours: 9 + 6

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)

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

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 the 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, tel. 010353 – 2801, e-mail: 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 describe their case in a short report (1000-1500 words). Contributions to class discussion will be considered a part of the assessment.

WHERE AND WHEN

Lesson Location

UNIGE.

Lesson Schedule

20th, 27th February, 7th March 10-13.

Office hours for student

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

CONTACTS

Students should contact me by email.

Module II - Bioengineering, A.I. and Robotics: applicable law, contracts and liability.

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

Number of hours: 6 + 9

Credits: 5

AIMS AND CONTENT

Learning Outcomes (short)

At the end of the course students will:
- understand the basic legal issues associated with new technologies, A.I. and robotics
- be familiar with European and Italian Product Liability Law with regard to manufacturers, designers and sellers.
- learn how to develop a project that is compliant with applicable law.

- be aware of the legal implications of choices made in a bioengineering, A.I. or robotics project a project in order to make a decision.

Learning Outcomes (further info)

- *How can we develop models of human-robot interaction that comply with the principles of laws? How can set forth the liability for damages?*
- *Who bears the relevant rifsks? What kind of contracts are used between parties in bioengineering, A.I. and robotics?*

Researchers and professionals in bioengineering, A.I. and robotics often need to 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 complex scenarios in order to reach appropriate decisions.

Syllabus/Content

Topics covered will include:

- Basic concepts of European and National law
- Knowledge of legal issues
- Product Liability and Consumer Protection
- Damages
- General Principles of Contract Law and Intellectual Property Law
- Case studies

The reading list will be provided after the first session.

WHO

Teacher(s): Valentina Di Gregorio, tel. 0102099911, e-mail: 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 identify and engage with potential legal issues 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

UNIGE.

Lesson Schedule

28th February and 8th March 2018 (10-13).

Office hours for student

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

CONTACTS

Students should contact me by email.

Advanced Optical Fluorescence Microscopy Methods

Scientific Disciplinary Sector: FIS/07

Number of hours: 12

Credits: 4 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) and light sheet fluorescence microscopy (LSFM). Variations on the theme will be treated by considering the possibility of getting complementary information by including Second Harmonic Generation, Light Scattering Polarization and Force interaction measurements in AOFM schemes. A possible route to bring such approaches to super resolution methods will be critically discussed.
An overview of quantitative fluorescence-based methods, including Forster Resonance Energy Transfer (FRET), Fluorescence Lifetime Imaging (FLIM), Fluorescence Correlation Spectroscopy (FCS), will be part of the course.

Syllabus/Content

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

WHO

Teacher(s):

Paolo Bianchini, 01071781724, paolo.bianchini@iit.it

Luca Lanzanò, 01071781461, luca.lanzano@iit.it

HOW

Teaching Methods

The Course develops in about 12 hours.

Exam Description
Written test: multiple-choice questions and an open question

Assessment Methods

Evaluation of the test

WHERE AND WHEN

Lesson Location
Istituto Italiano di Tecnologia, via Morego 30, 16163 Genova

Lesson Schedule
7, 9, 14, 16, 21, 23 of May 2019 from 14.00 to 16.00
Office hours for student
appointments, email

CONTACTS

The offices of both teachers are located at the 5th floor of IIT via Morego 30, 16163 Genova

Paolo Bianchini, 01071781724, paolo.bianchini@iit.it

Luca Lanzanò, 01071781461, luca.lanzano@iit.it

Role of the visuo-motor transition in the understanding of the outside world: cells, molecules and mechanisms

Scientific Disciplinary Sector: ING-INF/06

Number of hours: 9 hours

Credits: 3 CFU

AIMS AND CONTENT

Learning Outcomes (short)

acquiring solid knowledge on the major issues and scientific achievements of the visuo-motor transition, and its neuronal and molecular correlates.

Learning Outcomes (further info)

students will also become familiar with the modalities of cellular activation resulting from sensory stimuli, the molecules involved and the circuital pathways. Emphasis will be put on translating informations taken from the natural world (specifically, the cito-biochemistry of sensory-motor coupling) into the realm of machine engineering and general project envisioning.

Syllabus/Content

Understanding vision in our eyes and brain: some historical and conceptual milestones.

A schematic view of eye and the visual cortex; the cells participating to the vision process.

Molecules and mechanisms involved in cellular activation leading to vision (general informations on the molecular biology and genetics of cellular activation; activation of photoreceptors; architecture of stimulus formation and propagation towards the cortex).

The visuo-motor coupling: history; description of mirror neurons' pathways and implications on our behaviour.

The human-environment interface: molecules and cells involved in dealing with nature around us.

Biomimicry and the human project-constructing process.

WHO

Teacher(s): name, phone number, email

Claudio Brigati: 340-2333966

claudiobrigati112@gmail.com

HOW

Teaching Methods

Frontal teaching; distance learning on Moodle platform. One additional out-of-schedule seminar on a requested issue. Journal club

Exam Description

written (multiple choice)

Journal club

Assessment Methods

by scores

80% of score provided by a written multiple choice essay.

20% of score based on the discussion of a paper (journal club).

WHERE AND WHEN

Lesson Location

http://dibris.aulaweb.unige.it/
Dibris

Lesson Schedule
4, 6, 7, 11 December 2018
Office hours for student
free contacting, any day available

CONTACTS

ask by mail or telephone to arrange appointments

Data acquisition and data analysis methods

Scientific Disciplinary Sector: -

Number of hours: 15

Credits: 5 CFU

AIMS AND CONTENT

Learning Outcomes (short)

The course is aimed at students who intend to acquire knowledge to develop measurement systems and data analysis algorithms to be adopted in general applications (robotics, test benches, sensor data acquisition). 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 of the different types of electronic noise, an overview of the more common methods to extract the signal will be presented. Then useful statistical methods to present and treat the data will be discussed. Finally some real examples of data analysis using a dedicated software framework 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 (Data Acquisition, Microcontroller programming)
- Example and applications

6 hours

- How to extract signal in presence of noise (1h)
- Introduction to Statistical methods: parameters determination and hypothesis testing (1h)
- Data analysis using a scientific software framework based on C/C++ (4h)
    - Calibration of experimental devices and sensors

- How to separate signal and noise in a given data sample

For whose that are not familiar with C/C++ languages, an extra introductory lesson (2h) will be provided.

WHO

Teacher(s):

Dr. Carlo Canali, carlo.canali@iit.it, +39.010.71781793
Dr. Alessandro Pistone, alessandro.pistone@iit.it, +39.010.71781810

HOW

Teaching Methods

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

Exam Description

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.

WHERE AND WHEN

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

Lesson Schedule

- 4 March 2019: 11 – 13
- 6 March 2019: 11 – 13
- 8 March 2019: 11 – 13
- 11 March 2019: 11 – 13
- 13 March 2019: 11 – 13
- 15 March 2019: 11 – 13
- 18 March 2019: 10 – 13

Office hours for student
Appointments, email.

CONTACTS

The Teachers' office is in front of the Reception at floor -2 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, +39.010.71781793
Dr. Alessandro Pistone, alessandro.pistone@iit.it, +39.010.71781810

Robotic Virtual Prototyping Design

Scientific Disciplinary Sector: ING-IND/34

Number of hours: 15 hours

Credits: 5 CFU

AIMS AND CONTENT

Learning Outcomes (short)

The aim of the Robotic Virtual Prototyping Design course is to give the basic knowledge about the Finite Element Analysis (FEA) and Multi-Body Simulations (MBS) applied to the robotics. These computational techniques predict the behaviour 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), Multibody Simulation (MBS)
- class 2 (C2)
  - Anthropomorphic Arm Modelling: MBS + FEA
- class 3 (C3)
  - Anthropomorphic Arm Modelling: MBS + FEA + Control
- class 4 (C4)
  - Anthropomorphic Arm Modelling: MBS + FEA + Control + Optimisation (Structure)

- class 5 (C5)
  - Anthropomorphic Arm Modelling: MBS + FEM + Control + Optimisation (Structure + Control)
- class 6 (C6) (optional)
  - Final Project Assignment

WHO

Teacher(s):

Ferdinando Cannella	*01071781562*	*ferdinando.cannella@iit.it*
Mariapaola D'Imperio	*01071781562*	*mariapaola.dimperio@iit.it*
Fabrizio Romanelli	*01071781877*	*fabrizio.romanelli@iit.it*

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
Final project for the exam will be prepared with the teachers during the 6th lectures (Optional)

Prerequisites

Basic knowledge of classical physics and programming.

MSC ADAMS, ANSYS, MatLab/Simulink and ModeFRONTIER should be already installed before the first lecture (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 5 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

Istituto Italiano di Tecnologia, Via Morego 30 (Bolzaneto), Genova.
The Meeting room will be communicate to the attendees two weeks in advance the course.

Lesson Schedule

Tuesday	02 April 2018	14:15-17:15
Thursday	04 April 2018	14:15-17:15
Tuesday	09 April 2018	14:15-17:15
Thursday	11 April 2018	14:15-17:15
Tuesday	16 April 2018	14:15-17:15
Thursday	18 April 2018	14:15-17:15 (optional)

Office hours for student

The teachers will be available (on the office or on skype) every Wednesday from 11:00 to 15:00 from the 1st April to the 30th April 2019

CONTACTS

The Teachers' office is the 107 Room (0 floor) at Istituto Italiano di Tecnologia, Via Morego 30 (Bolzaneto), Genova.

Ferdinando Cannella	*01071781562*	*ferdinando.cannella@iit.it*
Mariapaola D'Imperio	*01071781562*	*mariapaola.dimperio@iit.it*

Interaction in Virtual and Augmented Reality

Scientific Disciplinary Sector: INF/01

Number of hours: 12 hours

Credits: 4 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, +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 (Valletta Puggia) room 217 (contact the teacher for room confirmation)

Lesson Schedule
25-26-27 June 2019 h 9-13 room 217

Office hours for student

The teacher will be available on appointment (manuela.chessa@unige.it)

CONTACTS

Email: manuela.chessa@unige.it

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

Phone: +39 010 353 6663

The optical microscope: optics, image formation and resolution

Scientific Disciplinary Sector: FIS/07

Number of hours: 9

Credits: 3 CFU

AIMS AND CONTENT

Learning Outcomes (short)

There have recently been great advances in instruments and techniques for microscopy, especially for biological and medical research and diagnostics. The course reviews the basic optical and imaging principles that form the basis of modern microscopy. Different microscopy modalities are introduced, including those based on fluorescence, and also label-free methods based on phase, polarization or non-linear optical properties.

Learning Outcomes (further info)

This course introduces the optics necessary to investigate the common properties of imaging systems, including the physical principles, hardware and algorithms. Applications in the biomedical and biophysical area are stressed.

Syllabus/Content

- Diffraction and focusing;
- effects of numerical aperture;
- polarization illumination system;
- imaging performance;
- microscope objectives;
- Phase contrast;
- Polarization imaging;
- Detectors;
- signal, signal-to-noise ratio.

WHO

Teacher(s):

Prof. Alberto Diaspro, 01071781503, alberto.diaspro@iit.it

HOW

Teaching Methods

The Course develops in about 9 hours in the classroom.

Exam Description

The examination consists in a journal club based on a selected list of papers provided to the students

Assessment Methods

Oral evaluation

WHERE AND WHEN

Lesson Location
Istituto Italiano di Tecnologia, via Morego 30, 16163 Genova

Lesson Schedule
6, 8, 13,15,20 of May 2019 from 15.30 to 17.30
Office hours for student
appointments, email

CONTACTS

The office is located at the 4th floor of IIT via Morego 30, 16163 Genova

Prof. Alberto Diaspro, 01071781503, alberto.diaspro@iit.it

Lasers and applications

Scientific Disciplinary Sector: FIS/07

Number of hours: 12

Credits: 4 CFU

AIMS AND CONTENT

Learning Outcomes (short)

This course is intended to provide students with the basic knowledge required to understand the working principle of lasers, the properties of laser radiation and the interaction of light with materials. Examples of applications where lasers are the enabling technology will also be given.

Learning Outcomes (further info)

No background in lasers is required. Emphasis is placed on the physical interpretation of lasers and on their applications, with mathematics kept at a minimum.

Syllabus/Content:

The course is divided into 3 main sections: 1-Physics of lasers: stimulated emission, properties of laser radiation, optics of laser propagation; 2-Light-matter interactions: complex refractive index, linear and nonlinear effects, 3-Applications of lasers: nonlinear microscopy, 3D printing, ablative laser processing

WHO

Teacher(s): Marti Duocastella, phone: 010 71781494, email: marti.duocastella@iit.it

HOW

Teaching Methods: Frontal lectures with PPT.

Exam Description: Written test

Assessment Methods

Weekly assignments, class participation and written test

WHERE AND WHEN

Lesson Location
Lesson will take place @ IIT

Lesson Schedule
11th, 18th and 25th of March, and 1st and 8th of April.

Office hours for student
I am available every weekday from 3 to 5 pm after appointment by e-mail

CONTACTS

Office: IIT, 5th floor; E-mail: marti.duocastella@iit.it

Computational Robot Dynamics

Scientific Disciplinary Sector: ING-INF/04

Number of hours: 12

Credits: 4

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 afternoon from Monday 18th to Thursday 21st March inclusive.

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's office is located on the 4th floor, IIT Morego, near the toilets. Students can contact him via email: roy.featherstone@iit.it

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

Scientific Disciplinary Sector: ING-INF/04

Number of hours: 10

Credits: 3

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 from Monday 4th to Thursday 7th March inclusive.

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's office is located on the 4th floor, IIT Morego, near the toilets. Students can contact him via email: roy.featherstone@iit.it

Introduction to Computer Programming for Researchers

Scientific Disciplinary Sector: INF/01

Number of hours: 15 hours

Credits: 5 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): name, phone number, email

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.

WHERE AND WHEN

Lesson Location

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

Lesson Schedule

Monday 6 May 2019, 9:00-12:00

Tuesday 7 May 2019, 9:00-12:00

Wednesday 8 May 2019, 9:00-12:00

Thursday 9 May 2019, 9:00-12:00

Friday 10 May 2019, 9:00-12:00

Office hours for student

Students can send e-mail.

CONTACTS

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

Advanced EEG analyses

Scientific Disciplinary Sector: ING-INF/06

Number of hours: 15 hours

Credits: 5 CFU

AIMS AND CONTENT

Learning Outcomes (short)

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

Learning Outcomes (further info)

The present course will introduce the student to the most advanced technique to process the EEG signal and infer over the cortical areas that create it. The course will consists 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. Introduction to RBCS's *EEG Tools* analysis framework. *Teacher Alberto Inuggi and Claudio Campus*.
- Class 2 (2h) Electrode analysis of ERP. Peak analysis, clustering electrodes and averaging time interval. Subject and group level analysis. Statistical analysis in EEGLAB and R. *Teacher Claudio Campus.*
- Class 3 (2h) Spectral analysis of ER**S**P. Peak analysis, clustering electrodes and averaging time interval. Subject and group level analysis. Statistical analysis in EEGLAB and R. *Teacher Claudio Campus.*
- Class 4 (2h) Introduction to EEG source analysis. Theory, forward model and inverse problem resolution. Differences between dipoles and distributed source analysis. Alternative models. *Teacher Alberto Inuggi*.
- Class 5 (3h) Results post-processing (dimensionality reduction) approaches. Source analysis in Brainstorm. *Teacher Alberto Inuggi.*
- Class 6 (3h). Statistical analysis in SPM. Comparison between EEG, fMRI and TMS tools. Practical day on the RBCS's *EEG Tools* analysis framework. Final Examination. *Teacher Alberto Inuggi and Claudio Campus.*

WHO

Teacher(s):

Alberto Inuggi, +39 010 8172 219, alberto.inuggi@iit.it

Claudio Campus, +39 010 8172 208, claudio.campus@iit.it

HOW

Teaching Methods

Projected slides

Exam Description

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

Assessment Methods

In order to obtain the 5 CFU, students are expected to correctly answer 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

Lessons will be held in the Center for Human Technologies, Via Enrico Melen 83, Building B,16152 Genova, Italy, IIT Erzelli. The exact room will be later indicated.

Lesson Schedule

- 01/04/2019 10:00 – 13:00
- 03/04/2019 10:00 – 12:00
- 05/04/2019 10:00 – 12:00
- 08/04/2019 10:00 – 12:00
- 10/04/2019 10:00 – 13:00
- 12/04/2019 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: 18 hours

Credits: 6 CFU

AIMS AND CONTENT

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 tractograpy, 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) Brief introduction to the technical characteristics of the involved hardware: magnetic scanner and coils. *(Teacher Danilo Greco)*
- Class 3 (3h). Common MRI preprocessing steps. Structural MRI. Evaluating gray matter:
  - density (VBM)
  - thickness

  (Teacher Alberto Inuggi).
- Class 4 (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 5 (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 6 (3h) Functional MRI during a task. Task-based FC (DCM, PPI) and fMRI. Final Examination. *(Teacher Alberto Inuggi*

WHO

Teacher(s):

Alberto Inuggi, Tel. +39 010 8172219 , alberto.inuggi@iit.it

Danilo Greco, danilo.greco@iit.it

HOW

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.

WHERE AND WHEN

Lesson Location

Lessons will be held in the IIT Center of Human Technologies. Via Enrico Melen 83, Building B

16152 Genova, Italy. 12th floor

Lesson Schedule

- 6 Maggio 09:00 – 12:00
- 8 Maggio 09:00 – 12:00
- 10 Maggio 10:00 – 13:00
- 13 Maggio 10:00 – 13:00
- 15 Maggio 10:00 – 13:00
- 17 Maggio 10:00 – 13:00

Office hours for student

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

CONTACTS

Teachers' office is in the 7th 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.

Principles of Tissue Engineering and Regenerative Medicine

Scientific Disciplinary Sector: ING-INF06

Number of hours: 12 hours

Credits: 4 CFU

AIMS AND CONTENT

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 tissue and organ function. Tissue engineering research includes the following areas: (i) Cell biology: including enabling methodologies for the proliferation and differentiation of cells, acquiring the appropriate source of cells such as autologous cells, allogeneic cells, xenogeneic cells, stem cells, genetically engineered cells, and immunological manipulation. (ii) Biomaterials: including novel 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. Biomechanical Aspects of Design: including properties of native tissues, identification of minimum properties required of engineered tissues, mechanical signals regulating engineered tissues, and efficacy and safety of engineered tissues. (iii) Biomolecules: including growth factors, differentiation factors, angiogenic factors, their synthesis and their release. (iv) Engineering Design Aspects: including 3D tissue growth, modeling of scaffold internal architecture, bioreactors to offer specific stimulation to living tissues, design of organ on chip technologies.

Syllabus/Content

- Cell-Based Therapies for TE: methodologies for isolation, differentiation, selection of adult progenitors/stem cells.
- Biomaterials for TE: design of intelligent materials; study or the proper macro-micro-nano-structures, chemical compositions, biomechanical properties; cell-biomaterials interfaces, bioactivation of surfaces.
- Bioreactor systems for TE: perfusing bioreactor systems, biomechanical stimulating bioreactors, fluido-dynamic stimulating bioreactors.
- Pre-clinical/Clinical models: in vivo case studies, implant of cell-biomaterials constructs, animal models.

WHO

Teacher(s): Alessandra Marrella

phone number: 010 6475 201; email: 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
(CNR) - Via De Marini, 6, 16° floor

Lesson Schedule

5th March 2019, 14-17

12th March 2019, 14-17

19th March 2019, 14-17

26th March 2019, 14-17

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) is the most preferred method of communication.

Modeling Neuronal Structures

Scientific Disciplinary Sector: ING-INF/06

Number of hours: 10 hours

Credits: CFU

AIMS AND CONTENT

Learning Outcomes (short)

- Single neuron models
- Synaptic models
- Large-scale neuronal network models

Learning Outcomes (further info)

Goal of the teaching is to provide the theoretical contents for modeling neuronal structures at different scale, from single neuron up to large-scale complex networks. For this reason, the course will be focused on how to model and simulate the electrophysiological activity of neuronal structures.

Syllabus/Content

The topics of the course will deal with the computational properties of neuronal structures, from single neurons up to large-scale neuronal networks. Knowledge about the physiological properties of neuronal structures are necessary to understand the entire course.

- Biophysical Models of Neurons
    - Introduction to equivalent membrane circuit and membrane electric properties
    - Passive models and propagation equation
    - Hodgkin and Huxley Model
    - Modeling the neuronal morphology
    - Reduced models: Morris Lecar, Integrate and Fire, Izhikevich model
- Synaptic Models
    - Exponential synapses
    - Destexhe model
    - Spike-timing dependent plasticity (STDP)
- Network Models
    - Firing Rate models
    - Modeling network connectivity
    - Interplay between dynamics and connectivity

WHO

Teacher(s): Paolo Massobrio, 010-3532761, paolo.massobrio@unige.it

HOW

Teaching Methods

Combination of traditional lectures, classroom discussion.

Exam Description

Oral exam about the topics of the teaching and/or journal club on papers dealing with the topics of the course.

Assessment Methods

Oral exam about the basic and advanced techniques for modeling neuronal structures from single neuron up to large-scale neuronal networks.

WHERE AND WHEN

Lesson Location
Lessons will be done @ Aula Viola at DIBRIS, Via Opera Pia 13, third floor.

Lesson Schedule
Lessons will be:
13^{th}, 14^{th}, December 2018 at 10.00-16.00.

Office hours for student
Appointment by e-mail

CONTACTS

Paolo Massobrio
010-3532761
paolo.massobrio@unige.it
Via Opera Pia 13

Elements of Biomechanics

Scientific Disciplinary Sector: ING-INF/06 e ING-IND/34

Number of hours: 12 hours

Credits: 4 CFU

AIMS AND CONTENT

Learning Outcomes (short)

The short course aims at conveying basic biomechanics knowledge to students who do not possess engineering background. It provides the basic concepts to analyze human motion starting from motion capture data.

Learning Outcomes (further info)

The short course aims at providing the basic concepts to describe a motion in 3D of the human body with particular attention to instant and articular kinematics of muscles. The human motion will be analyzed in Matlab/Octave environment.

Syllabus/Content

- Definition of biomechanics; instruments to measure kinematics and dynamics of human motion;
- Global and local reference systems;
- Determination of local reference systems starting from motion capture data;
- Kinematics of rigid bodies in 2D and 3D, Euler angles;
- Instant kinematics: angular velocity, instantaneous axis rotation, pivot point;

Reading suggested *Research Methods in Biomechanics*, by Gordon Robertson, Graham Caldwell, Joseph Hamill, Gary Kamen, Saunders Whittlesey.

WHO

Teacher(s): Mariacarla Memeo, +39 010 8172 239, mariacarla.memeo@iit.it

HOW

Teaching Methods

The course consists in 9h of lessons (including both lectures and practice sessions).

Exam Description

During this course, the student will have to analyse his own data. The final grade will consist in the evaluation of a report or a Matlab/Octave script demonstrating familiarity with the concepts and methods presented in the course.

WHERE AND WHEN

Lesson Location

Lessons will be done @ IIT Erzelli.

Lesson Schedule

The lessons will be done on the 6th, 7th, 8th, 9th May 2019. The exam will be scheduled the last day of the course: it will last approximately an hour.

Office hours for student

Students can ask info to the teacher by email (no limitation in time) or by appointment (every Tuesday afternoon).

CONTACTS

Mariacarla Memeo, +39 010 8172 239, mariacarla.memeo@iit.it

Industrial Analytics: Theory and Practice of Learning from Data

Scientific Disciplinary Sector: ING-INF/05

Number of hours: 20

Credits: 6 CFU

AIMS AND CONTENT

Learning Outcomes (short)

The course provides advanced skills related to data analysis. It provides insights on data mining methodologies and the applications of these methodologies to knowledge extraction from data. The student will learn both the theoretical background and the practical issues for data analysis.

Learning Outcomes (further info)

This course aims at providing an introductory and unifying view of information extraction and model building from data, as addressed by many research fields like DataMining, Statistics, Computational Intelligence, Machine Learning, and PatternRecognition. The course will present an overview of the theoretical background of learning from data, including the most used algorithms in the field, as well as practical applications in industrial areas such as transportation, manufacturing, etc.

Syllabus/Content

• Data, information and models: induction, deduction, abduction, transduction and retroduction.

• Statistical inference: Bayesians vs. Frequentists.

• Exploratory Data Analysis.

• Problem taxonomy: Classification, Regression, Clustering, Novelty Detection, Ranking.

• Naive and linear models: Association rules, Naive Bayes, k-NN, Perceptron, LS/RLS, LASSO, L1-L2, k-means.

• From linear to nonlinear models: Neural Networks, Trees and Forests, Kernelization and Support Vector Machines, RKLS, Spectral clustering.

• Model selection and error estimation: out-of-sample techniques (Hold Out, Cross Validation, Bootstrap).

• Advances in model selection and error estimation: Statistical Learning Theory, Union Bound, Vapnik-Chervonenkis, Rademacher Complexities, Algorithmic Stability, PAC Bayes, Compression Bound, Differential Privacy.

• Applications in industrial areas such as transportation, manufacturing, etc.

• Implementations and computational issues.

WHO

Teacher(s):

Davide Anguita, +39-010-3532192, davide.anguita@unige.it

Luca Oneto, +39-010-3532192, luca.oneto@unige.it

HOW

Teaching Methods

The course consists of lectures and practical lab sessions using MATLAB.

Exam Description

Small presentation about the application of the learned concepts to the field of research of the PhD student

Assessment Methods

Oral

WHERE AND WHEN

Lesson Location
@UNIGE

Lesson Schedule
To be defined in agreement with the schedule of the PhD Courses of Computer Science and Systems Engineering PhD Program, indicatively mid July 2019

Office hours for student
Students can ask an appointment to the teacher by email

CONTACTS

Davide Anguita, 2° Floor, Via Opera Pia 11a, 16145, Genova, Italy, +390103532192, davide.anguita@unige.it

Luca Oneto, 2° Floor, Via Opera Pia 11a, 16145, Genova, Italy, +390103532192, luca.oneto@unige.it

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

HOW

Teaching Methods

Frontal lessons

Exam Description

The course will be sassed by an oral exam

Assessment Methods

Evaluation of the oral exam

WHERE AND WHEN

Lesson Location

@ DIBRIS, Via Opera Pia.

Lesson Schedule

25th, 26th, 27th, 28th June 2019

Office hours for student

Appointments, mail, days reserved for students, etc.)

CONTACTS

Info regarding where teacher's office is, and how student can interacts with him (telephone, mail)

Polymers for sustainability, food packaging and biomedics

Scientific Disciplinary Sector: FIS/07; ING-IND/34

Number of hours: 18 hours

Credits: 6 CFU

AIMS AND CONTENT

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 (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. History of biomaterial design and development. Applications in orthopedics, ophthalmology, cardiovascular systems, dentistry, wound healing.

WHO

Teacher(s):

Giovanni Perotto, giovanni.perotto@iit.it

Evie Papadopoulou, paraskevi.papadopoulou@iit.it

Giulia Suarato, giulia.suarato@iit.it

Phone number: 010 71781 705 (Evie Papadopoulou and Giovanni Perotto)

01071781870 (Giulia Suarato)

HOW

Teaching Methods

Lectures.

Exam Description

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

Assessment Methods

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

WHERE AND WHEN

Lesson Location

Lessons will be done @ IIT.

Lesson Schedule

Lessons will be in April 2019. More specifically, from the 2nd to the 23rd of April (Tuesday and Thursday) from 10.00 h to 13.00 h (4 sessions of 3 hours and 3 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 5th floor of the IIT building (via Morego 30, 16163, Genova). Students asking info to the teachers can contact them by email anytime.

Human-Robot Interaction

Scientific Disciplinary Sector:

Number of hours: 15 hours

Credits: 5 CFU

AIMS AND CONTENT

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. Moreover, a broad survey across cognitive models of perception and action will give to the participants the opportunity to successfully design new behaviors for interacting robots.

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 participants will learn how to design and implement robot perceptual, motor abilities structured in a cognitive framework for natural human-robot interaction.

Syllabus/Content

- Taxonomy and Open Challenges for HRI.
- The importance of Robot Shape, Motion and Cognition.
- Metrics and Experimental Design.
- Models of Robot Perception in HRI
- Models of Robot Action in HRI
- Attention System

WHO

Teacher(s):

Francesco Rea, +393383468679, francesco.rea@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 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 lesson will take place at the Italian Institute of Technology. (Room to be defined)

Lesson Schedule
28 and 30th May (9-12), 4, 6, 7th June (9-12)

7th June (9-12) Final exam .

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

CONTACTS

The office is located at

Researcher, Robotics Brain and Cognitive Sciences Unit
Istituto Italiano di Tecnologia
Center for Human Technologies
Via Enrico Melen 83, Building B
16152 Genova, Italy

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.
- Integrating algorithms for planning and perception within the ROS framework
- Applying the ROS navigation stack to enable autonomous mobile robot navigation.
- Simulating robot models in real physics environments

Learning Outcomes (further info)

ROS is a robotic middleware which 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, such as model simulation, localization and mapping, motion planning. 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, the students will be working with their own standalone Ubuntu-Linux installation.

Syllabus/Content

- Class I (C1) (3 hours) - Introduction to ROS Topics, Services, Actions, and Nodes. Class examples.
- Class II (C2) (3 hours) - Software representation of a Robot using Unified Robot Description Format (URDF), ROS parameter server and adding real-world object representations to the simulation environment. Simulating a robot model with Gazebo. Class examples. Assignment I
- Class III (C3) (3hours) - Map creation with GMapping package, autonomously navigate a known map with ROS navigation, analysis of the OctoMap package. Class examples.
- Class IV (C4) (3 hours) – The robotic simulator VRep and its interface with ROS. Class examples. Assignment II
- Class V (C5) (3 hours) –Different robots (drones, wheeled robot, humanoids,…), ROS and simulators. Class examples and real applications.

WHO

Teacher(s): Dr. Carmine Tommaso Recchiuto, +390103532801, 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 2nd and of the 4th 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
@UNIGE.

Lesson Schedule
Wednesday 29 May 2019, 10:00-13:00
Wednesday 5 June 2019, 10:00-13:00
Wednesday 12 June 2019, 10:00-13:00
Wednesday 19 June 2019, 10:00-13:00
Wednesday 26 June 2019, 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, Postdoctoral Research Fellow, Laboratorium (DIBRIS, E building 2nd floor)

Phone: +390103532801

Mail: carmine.recchiuto@dibris.unige.it

Theatrical techniques for Scientific Presentation

Scientific Disciplinary Sector: Soft Skills

Number of hours: 12

Credits: 4

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 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

University of Genova, Villa Bonino, Viale Francesco Causa, 13, 16145 Genova GE

Lesson Schedule

9:30 – 12:30 on April 8, 15, 22, 29.

Office hours for student

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

CONTACTS

Students should contact teachers by email.

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, +39 010 3536756

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

HOW

Teaching Methods

Classroom lectures with theory and examples.

Exam Description

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

Assessment Methods

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

WHERE AND WHEN

Lesson Location
@UNIGE (DIBRIS, via Dodecaneso 35)
Lesson Schedule
11-13-14-17-18-19 June 2019, each morning h 10-13

Office hours for student

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

CONTACTS

Email: 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

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

Phone: +39 010 353 6626

Computational models of visual perception

Scientific Disciplinary Sector: INF/01

Number of hours: 10 hours

Credits: 3 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 systems to allow a natural perception and interaction.
- Case studies: models and algorithms of the literature.

WHO

Teacher(s):

Fabio Solari, 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 or development of a specific neural model.

Assessment Methods

Discussion about the implemented model and a short document that describes the analysis and implementation are required.

WHERE AND WHEN

Lesson Location
@UNIGE (DIBRIS, via Dodecaneso 35)
Lesson Schedule

1st, 2nd, and 3rd July June 2019 (9-13)

Office hours for student
The teachers will be available on appointment (fabio.solari@unige.it)

CONTACTS

Email: fabio.solari@unige.it

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

Phone: +39 010 353 6756

Optofluidics and Electrofluidics for Lab-on-a-Chip

Scientific Disciplinary Sector: ING/INF 01

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 imaging, optics, (bio)sensing and environmental monitoring.

Learning Outcomes (further info)

The course illustrates lab-on-a-chip (LoC) operational principles and functionalities through fluid physics and various examples. No prerequisites are required.

Syllabus/Content

The course is divided into 4 sections: 1) Introduction to LoC: history, definitions and fundamental concepts; 2) Microfluidics: the physics of liquids below the microliter scale; 3) Fabrication technologies: materials and micromachining methods for LoC; 4) LoC applications: (bio)sensors, optofluidics and electro-fluidics.

WHO

Teacher(s): Salvatore Surdo, +39 010 71781, 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
20th and 27th of March, and 3rd and 10th of April.

Office hours for student
appointments, email

CONTACTS

Office: IIT, 5th floor; E-mail: salvatore.surdo@iit.it

Nanophotonic devices: from fabrication to applications

Scientific Disciplinary Sector: FIS/07

Number of hours: 12 hours

Credits: 4 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) Giant enhancement of 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.

A brief introduction 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.
- Nanoplasmonics and Nanophotonics: the physics behind the applications.
- Nanophotonic devices: design and realization of ultrasensitive biosensors.
- SEIRA and SERS: employing plasmonic devices for the ultrasensitive detection both in the visible and in the infrared range.

WHO

Teacher:

Andrea Toma,
phone number: 010 71781257, email: 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 nanophotonics 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 plasmonic 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 5th, 9th, 12th and 16th. 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 only.

CONTACTS

Office: room 5/10, Istituto Italiano di Tecnologia via Morego 30. Email (andrea.toma@iit.it) is the most preferred method of communication.

Fluorescence Super-Resolution Microscopy: Basis, Applications and Perspectives

Scientific Disciplinary Sector: FIS/07

Number of hours: 9 hours

Credits: 3 CFU

AIMS AND CONTENT

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 overcame 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

WHO

Teacher(s): Dr. Giuseppe Vicidomini, Molecular Microscopy and Spectroscopy, +39 01071781976, giuseppe.vicidomini@iit.it

HOW

Teaching Methods

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

Exam Description

The examination consists in a brief research project proposal or in an oral presentation.

Assessment Methods

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

WHERE AND WHEN

Lesson Location

Lessons will be done at the IIT, Via Morego 30, Genova. Room will be specify one week before the beginning of the course.

Lesson Schedule

The course will be organized in 6 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 11.00. The lessons are scheduled on 28th and 30st May, 4th,6th and 7th June 2019. The calendar will be confirmed one month before the beginning of the course.

Office hours for student

Dr. Giuseppe Vicidomini receives 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.

CONTACTS

Dr. Giuseppe Vicidomini
Molecular Microscopy and Spectroscopy
Italian Institute of Technology
Via Morego, 30, 16163, Genova, Italy
Office: 5th floor
tel: +39 010 71781976
e-mail: giuseppe.vicidomini@iit.it

Mathematical Methods for Robotics

Scientific Disciplinary Sector:

Number of hours: 21 hours

Credits: 6 CFU

AIMS AND CONTENT

Learning Outcomes (short)

This course is intended to be an introduction to the different mathematical tools used for the modelling, analysis and control of robotic systems. Each tool is introduced in a formal fashion through its definition, properties and numerical implementation. In this course, the students will acquire an extensive mathematical background that will be useful for a better understanding of the kinematics and dynamics of robotic systems that, in turn, will allow them to formulate and solve several theoretical and practical problems related to these fields.

Learning Outcomes (further info)

Robotics is a practical discipline that is constructed out of other disciplines such as mechanical, mechatronics and computer engineering among others. However, it is also constructed from a robust mathematical base that, sometimes, is not completely exploited. Because of this, the present course intends to provide a mathematical background covering the main topics in algebra, geometry and dynamical systems theory as well as their applications to robotics. The first part of the course is dedicated to the algebraic and geometrical tools used in robot kinematics. The advantages for the students will include the introduction of several techniques for the forward kinematics, inverse kinematics and singularity problem. The second part is dedicated to the study of dynamical systems and its applications to the control of robotic systems. Notions related to the behavior and the stability of the orbits of a dynamical system will be introduced. The advantages for the students include, among others, different techniques for analyzing the stability of control schemes defined by particular dynamical systems. Finally, the implementation of different numerical algorithms will be performed in two practical sessions.

Syllabus/Content

- Review of linear algebra (1h)
- Lie groups and Lie algebras (2h)
- Screw theory (2h)
- Geometric algebra (2h)
- Applications to robot kinematics (3h)
- Practical session: Robot kinematics using Matlab (3h)
- Review of function analysis (1h)
- Dynamical systems and their stability (2h)
- Applications to control theory (2h)
- Practical session: Dynamical systems simulation and stability analysis using Matlab (3h)

WHO

Teacher(s):

Dr. Isiah Zaplana, isiah.zaplana@iit.it, +39 010 71781 797

HOW

Teaching Methods

- Lectures (Material for following the lectures will be provided)
- Practical demonstration of coding and programming (Matlab files will be provided)

Exam Description

A list of short projects will be delivered at the beginning of the course. Each project consists of a problem of robot kinematics/control that should be solved using the tools explained in the course (both theoretical and computational tools). The students should:

- Formulate the problem,
- Analyze which tools could be used for solving it,
- Decide if solving the problem using an analytical o closed-form approach, a numerical approach or a combination of both approaches (justifying why) and
- Solve it.

Assessment Methods

The students can decide between two assessment methods:

- Written report: In which the problem stated in the project should be mathematically formulated and solved. If numerical methods are used, the code should be included (in the report or as .m file). Rigor and formality in the use of the different mathematical tools will be a key aspect of the assessment.
- Oral presentation: In which the formulation and solution of the problem should be explained in detail. If numerical methods are used, the code should be included as .m file. Rigor and formality in the explanation will be a key aspect of the assessment.

WHERE AND WHEN

Lesson Location

@ IIT

Lesson Schedule

- 5 – March – 2019: 11 – 12
- 7 – March – 2019: 10 – 12
- 12 – March – 2019: 10 – 12
- 14 – March – 2019: 10 – 12
- 19 – March – 2019: 9 – 12
- 21 – March – 2019: 9 – 12
- 26 – March – 2019: 11 – 12
- 28 – March – 2019: 10 – 12

- 2 – April – 2019: 10 – 12
- 4 – April – 2019: 9 – 12

Office hours for student

By appointment or by email.

CONTACTS

The teacher' office is located within the AIAL Lab (floor -2) at Istituto Italiano di Tecnologia, Via Morego 30 (Bolzaneto), Genova.

The teacher can be contacted by email or by phone to arrange an appointment.

Dr. Isiah Zaplana, isiah.zaplana@iit.it, +39 010 71781 797

Introduction to physical Human-Robot Interaction

Scientific Disciplinary Sector: ING-INF/06

Number of hours: 12 hours

Credits: 4 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), 14-15-16-17 January 2019, time 9-11, (12th floor - room to be decided 1 month in advance)

Campus Erzelli: 4 hours (lab); 18 January 2019, time 9-13, MLARR lab (7th floor)

Office hours for student

Appointments by email request

CONTACTS

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

Pietro Morasso, 3281003224, 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.

WHERE AND WHEN

Venue

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

Course dates & Schedule

Campus Erzelli: 12 hours (theory), 14-15-16 January 2019, time 11-13 and 14-16, (12th floor - room to be decided 1 month in advance)

Campus Erzelli: 4 hours (lab); 17 January 2019, time 11-13 and 14-16, MLARR lab (7th floor)

Office hours for student

Appointments by email request

CONTACTS

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

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