PhD Courses offered (2017-2018)

Functional Mechanical Design for Robotics

Unit code: (filled by Unige administrative office)

Scientific Disciplinary Sector: ING-IND/13

Number of hours: 15 hours

Credits: 5 CFU

AIMS AND CONTENT

Learning Outcomes (short)

The objective of the course is to develop the ability of the Ph.D. student to identify the problems relevant to robot mechanics and design, to address them with a scientifically correct approach and to solve them with sound engineering methods in order to perform an effective functional design of robotic systems.

Learning Outcomes (further info)

The Ph.D. course provides the guidelines to functional mechanical design for robotics. The course addresses the topics of mechanics of robots that are a necessary part of the basic education of a robotic engineer. The objective of the course of Functional Mechanical Design for Robotics is to provide the Ph.D. students with the necessary knowledge to properly address and solve engineering problems relevant to the mechanics of robots. Criteria and methodologies are given in order to choose, analyse, synthesize plane and spatial mechanical devices with particular reference to the field of robotic machines. Lessons are combined with practice projects in the classroom with the object of analyzing and synthesizing the systems studied. The practice personal project is developed by each Ph.D. student and deals with design problems directly linked to robotics.

Syllabus/Content

- Class 1 (C1) (3 h) - Introduction to Robot Mechanics and Robotics Design: kinematics, statics and dynamics. The functional mechanical design of a robotic system.
- Class 2 (C2) (3 h) - Legged Robots (e.g. humanoids, animaloids, etc.): overview and exercises on mechanics, kinematics, statics, dynamics, modelling and design. Personal Robotic Project (PRP) assignment and phase I.

- Class 3 (C3) (3 h) - Robotic Grasping and Manipulation (e.g. industrial robots): overview and exercises on mechanics, kinematics, statics, dynamics, modelling and design. Personal Robotic Project (PRP) phase II.
- Class 4 (C4) (3 h) - Bio-Robots (e.g. robotic-fish, -bird, etc.): overview and exercises on mechanics, kinematics, statics, dynamics, modelling and design. Personal Robotic Project (PRP) phase III.
- Class 5 (C5) (3 h) - Other Robots (e.g. mobile robots, underwater robots, etc.): overview and exercises on mechanics, kinematics, statics, dynamics, modelling and design. Personal Robotic Project (PRP) phase IV.

Readings/Bibliography

- Angeles J., Fundamental of robotic mechanical systems , Springer-Verlag, New York, seconda edizione 2003; R. Juvinall, K.M. Marshek, Fundamentals of Machine Component Design, John Wiley and Sons.
- Tsai L.W., Robot analysis: the mechanics of serial and parallel manipulators, John Wiley & Sons, New York, 1999
- Craig J.J., Introduction to Robotics: Mechanics and Control , Addison Wesley, Boston (MA, USA), 1989 Paul R., Robot Manipulator: Mathematics, Programming and Control , MIT Press, Cambridge (MA, USA), 1981.
- Erdman and Sandor, “Analysis and Synthesis of Mechanisms”, voll. 1 and 2, 1990, Prentice-Hall.
- Suh C.H. and Radcliffe C. W., “Kinematics and Mechanisms Design”, John Wiley & Sons, 1978.
- Sandler Ben-Zion, “Robotics: Designing the Mechanisms for Automated Machinery”, Academic Press, 1999.
- Rivin, E. I. “Mechanical design of Robots”, McGraw-Hill, 1988.
- Sciavicco, L., & Siciliano, B. (2012). Modelling and control of robot manipulators. Springer Science & Business Media.
- R. Murray, Z. Li, S. Sastry [Caltech & Berkeley, CA] “A mathematical introduction to robotic manipulation”, CRCPress, 1994.

WHO

Teacher: Giovanni Gerardo Muscolo, +39 010 71781 347, giovanni.muscolo@iit.it

HOW

Teaching Methods

The course consists of both theoretical and exercise classroom, where the main methods of conceptual and functional design of robots are introduced. Exercises relatively on the topics will be proposed during the course and the solutions will be developed in classroom. The Personal Robotic Project (PRP) assigned to each Ph.D. candidate at the beginning of the lesson two will be developed as homework and in the classroom.

Exam Description

The final examination will consist to conclude the personal robotic project synthetizing all study in an IEEE conference paper form.

Assessment Methods

During the Ph.D. course, each Ph.D. student will develop a personal robotics project.

WHERE AND WHEN

Lesson Location

Istituto Italiano di Tecnologia, via Morego, 30, 16163, Genova.

Lesson Schedule

Month: March 2018. Days: 1st, 8th, 15th, 22nd , 29th. Tentative Timetable: from 9:30 a.m. to 12:30 a.m.. Room:

Hack (1st floor).

Office hours for student

The teacher may be contacted (for helping in homeworks) by mail or by phone (see contacts)

CONTACTS

Giovanni Gerardo Muscolo (Ph.D., Msc. Applied Mechanics, Machine Desing, Robotics)

Postdoctoral Research Fellow

Advanced Industrial Automation Lab (AIAL) - Advanced Robotics Research Line (ADVR) - Italian Institute of Technology (IIT) - Via Morego, 30, 16163 Genova (Italy)

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Industrial Robotics

Unit code: (filled by Unige administrative office)

Scientific Disciplinary Sector: ING-IND/13

Number of hours: 12 hours

Credits: 4 CFU

AIMS AND CONTENT

Learning Outcomes (short)

The course aims at giving to the Ph.D. candidate theoretical and applied concepts of industrial robotics.

Learning Outcomes (further info)

This Ph.D. course provides an overview of the field of industrial robots. Topics are mainly focused on aspects of representation, planning and control of motion of robotic manipulators. The student acquires theoretical and applied concepts of kinematics, statics, dynamics, simulation and basics of control architectures. Additionally, the course provides an outline of actuators and sensors that are typically employed in industrial robots. During the Ph.D. course, the student learns to build simplified PC-based models of a robots and to handle problems for the design and control of robotic manipulators.

Syllabus/Content

- Class 1 (C1) (3h) Introduction to robotics;
- Class 2 (C2) (3h) Representation of rigid body position:
  - Representations of orientation - Homogeneous Transformation Matrix
- Class 3 (C3) (3h) Serial manipulators:
  - Direct kinematics
  - Inverse kinematics
  - Differential kinematics
  - Statics
  - Dynamics
  - Trajectory planning and control (basics)
- Class 4 (C4) (3h) Exercises (e.g. PUMA manipulator, Stanford manipulator, etc…).

References

- B. Siciliano, L. Sciavicco, L. Villani, G. Oriolo [Univ. Napoli & Roma] “Industrial Robotics”, Mc-Graw Hill.

- Sciavicco, L., & Siciliano, B. (2012). Modelling and control of robot manipulators. Springer Science & Business Media.
- Legnani, G., Fassi, I., & Visioli, A. (2003). Robotica industriale. Casa Editrice Ambrosiana, Milano: CEA.
- Craig, J., Introduction to Robotics: mechanics and control.
- Siciliano, B., Khatib, O. (Eds.) Springer handbook of robotics. Springer.

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- R. Murray, Z. Li, S. Sastry [Caltech & Berkeley, CA] "A mathematical introduction to robotic manipulation", CRCPress, 1994.
- Angeles, Jorge. Fundamentals of robotic mechanical systems: theory, methods, and algorithms. Vol. 124. Springer Science & Business Media, 2013.

WHO

Teacher: Giovanni Gerardo Muscolo, (+39) 010 71781 347, giovanni.muscolo@iit.it

HOW

Teaching Methods

- Frontal classes;
- Exercise sessions;

Exam Description

Written examination: test of the fundamentals and methods of calculation of the kinematics and dynamics of robots, trajectory planning, feedback controls dealt with in the course and of their application to cases of study. **Assessment Methods**

Requirements for the student:

- to study and learn theoretical material;
- to learn to autonomously use PC-tools for solving modelling problems;

WHERE AND WHEN

Lesson Location

Istituto Italiano di Tecnologia, via Morego, 30, 16163, Genova.

Lesson Schedule

Month: October 2018. Days: 5th, 12th, 19th, 26th. Tentative Timetable: from 9:30 a.m. to 12:30 a.m.. Room:

Hack (1st floor).

Office hours for student

The teacher may be contacted (for helping in homeworks) by mail or by phone (see contacts)

CONTACTS

Giovanni Gerardo Muscolo (Ph.D., Msc. Applied Mechanics, Machine Desing, Robotics)

Postdoctoral Research Fellow

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Multibody Dynamics

Unit code: (filled by Unige administrative office)

Scientific Disciplinary Sector: ING-IND/13

Number of hours: 15 hours

Credits: 5 CFU

AIMS AND CONTENT

Learning Outcomes (short)

The course aims at giving to the Ph.D. candidate theoretical knowledge on modelling of robots conceived as multi body systems which interact with the environment.

Learning Outcomes (further info)

The course is based on dynamics of multibody systems, with emphasis on multi degree of freedom systems and distributed parameter systems. First, the techniques for writing the equations of motion of a multi-d.o.f. system are introduced and the solutions for free undamped, free damped and forced motion of the system are derived. Then, beam-type distributed parameter systems are introduced and their motion is determined under the assumption of small displacements from the un-deformed state. Techniques for the discretisation of distributed parameter systems are also covered by the course with special reference emphasis on the finite element method. The final part of the course treats the analysis of stability for mechanical systems subjected to field forces, also introducing some examples from real robotic applications. The Ph.D. course ends showing the foundations and the state of the art in research on multibody dynamics in the frame of computational mechanics, and applications to various robotic fields (e.g. humanoids, soft robotics, etc…).

Syllabus/Content

- Class 1 (C1) (3 h) - Dynamics and vibration of single, two and multi-degree-of-freedom systems
- Class 2 (C2) (3 h) - Vibrations in continuous systems
- Class 3 (C3) (3 h) - Introduction to finite element method
- Class 4 (C4) (3 h) - Stability of mechanical systems subjected to non-linear force fields
- Class 5 (C5) (3 h) - Multibody System Dynamics

References

- Shabana, Dynamics of Multi Body Systems, Anno edizione: 1998
- M. Gerardin, A. Cardona, Flexible multibody dynamics: a finite element approach, Anno edizione: 2001

- O. Bauchau, Flexible Multibody dynamics, Anno edizione: 2010
- F.Cheli, E. Pennestrì, Cinematica e dinamica dei sistemi multicorpo, Editore: casa editrice ambrosiana, Anno edizione: 2005
- Javier García de Jalón and Eduardo Bayo, Kinematic and Dynamic Simulation of Multibody Systems: The Real-Time challenge ISBN 0387-94096-0, 440 pp. Springer-Verlag, New-York, 1994. L. Sciavicco and B. Siciliano, Modelling and Control of Robot Manipulators,Springer,London,UK,2ndedition,2000.

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WHO

Teacher: Giovanni Gerardo Muscolo, (+39) 010 71781 347, giovanni.muscolo@iit.it

HOW

Teaching Methods

The course consists of both theoretical and exercise classroom, where the main methods of kinematic and dynamic analysis are introduced. Some homeworks will be assigned for individual practice. The homeworks consist of solving problems of medium complexity using the elements learn at lessons.

Exam Description

The exam is oral. The exam will verify both the theoretical knowledge and the ability to use the knowledge for problem solving.

Assessment Methods

Some homeworks will be assigned for individual practice.

WHERE AND WHEN

Lesson Location

Istituto Italiano di Tecnologia, via Morego, 30, 16163, Genova.

Lesson Schedule

Month: October 2018. Days: 1st, 8th, 15th, 22nd , 29th. Tentative Timetable: from 9:30 a.m. to 12:30 a.m.. Room:

Hack (1st floor).

Office hours for student

The teacher may be contacted (for helping in homeworks) by mail or by phone (see contacts)

CONTACTS

Giovanni Gerardo Muscolo (Ph.D., Msc. Applied Mechanics, Machine Desing, Robotics)

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Advanced EEG analyses

Unit code: (filled by Unige administrative office)

Scientific Disciplinary Sector:

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 60 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

- 10/04/2018 10:00 – 13:00
- 11/04/2018 10:00 – 12:00
- 12/04/2018 10:00 – 10:00
- 17/04/2018 10:00 – 12:00
- 18/04/2018 10:00 – 13:00
- 19/04/2018 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.

C++ programming techniques

Unit code: (filled by Unige administrative office)

Scientific Disciplinary Sector: INF/01

Number of hours: 18 hours

Credits: 5 CFU

AIMS AND CONTENT

Learning Outcomes (short)

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

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

5-6-7-12-14-15 June 2018, 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

Electric circuits for Electrochemistry

Course at a Glance

The aim of this course is to give an introduction to the electric circuit theory and to the electrochemical techniques in order to allow the students to correctly perform and interpret the measurements. The course will start from lumped circuits basics and moving through transient and frequency analyses of linear circuits. Basics of electrochemical measurements and typical measurement configurations will be introduced. Finally, lumped element modelling of typical equivalent circuits will be discussed and examples of simulations by common tools (Spice, EC-Lab) will be performed. The course will comprehend some hands on experience on potetiostat and battery analyser as well.

Instructors

Alberto Ansaldo alberto.ansaldo@iit.it
Simone Monaco simone.monaco@iit.it

Hours and Credits

15 hours 5 credits

Synopsis

- Introduction to electric circuits
- Electrical measurements
- Introduction to electrochemistry
- Electrochemical systems modelling and simulation
- An introduction to EC-Lab

Tools used:

Hardware

- Bioscope potentiostat/galvanostat/battery analyser

Software

- LT-Spice
- EC-lab

Syllabus

The course cover all the aspect of circuit modelling significant for electrochemical circuits modelling in order to allow a comprehensive understanding of both the electrical and the chemical aspects involved.

First part: Introduction to electric circuits

- Lumped element circuits
- Kirchhoff lows
- Basic lumped elements
- Examples of typical electric circuits
- Nyquist (Cole Cole) and Bode plots
- Transient response and frequency response of LCR circuits
- Introduction to the distributed models
- Generalised lumped elements

Second part: Electrical measurements

- Typical instruments and measurement configurations
- The potentiostat/galvanostat
- Examples of typical measurements mistakes

Third part: Introduction to electrochemistry

- The electrochemical cell
- Reference electrodes
- Electrochemical cell measurement configurations
- Introduction to electrochemistry (second part - 2h)
- Impedance spectroscopy
- Cyclic voltammetry
- Differential pulse voltammetry

Fourth part: Electrochemical systems modelling and simulation

- Typical circuits
- Extraction of lumped parameters from transient response and frequency response of physical systems (black box approach)
- Electrochemical lumped elements (CPE, Warburg, etc…)
- Introduction to circuit modelling and simulation by Spice (LTspice)
- The potentiostat: a simulated model
- Examples of the influence of the electrical parameters on the typical electrochemical measurements.
- The examination consists in discuss and simulate a typical electrochemical measurement.

Fifth part: An introduction to EC-Lab

- the EC-lab user interface
- typical measurement and data representations
- data analysis and simulation tools

Final exam

The examination consists in discuss and simulate a typical electrochemical measurement.

Reading List

- Basic Circuit Theory, Charles A. Desoer and Ernest S. Kuh, McGraw Hill, New York, 1969.
- Linear and Nonlinear Circuits, Leon O. Chua, Charles A. Desoer and Ernest S. Kuh, McGraw Hill, New York, 1987.
- Analytical Electrochemistry, Joseph Wang, John Wiley & Sons, 2006.

Venue

Istituto Italiano di Tencologia- Via Morego, 30 16163 Genova

Course dates

February-May 2017

Elements of Biomechanics

Unit code: (filled by Unige administrative office)

Scientific Disciplinary Sector:

Number of hours: 9 hours

Credits: 3 CFU

AIMS AND CONTENT

Learning Outcomes (short)

The short course aims at conveying basic biomechanics knowledge to students who do not possess engineering skills. It provides the basic concepts of motor system modeling and the main methods to analyze human motion.

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 environment.

Syllabus/Content

- Kinematics of rigid 2D and 3D bodies and their transformations in space;
- Global and local reference systems;
- Instant kinematics: angular velocity, instantaneous axis rotation, pivot point;
- Introductory notions on the modeling of the neuro-muscle-skeletal system: physiology and functional anatomy of the muscles, motor control models;
- Articular kinematics: relative motion between two rigid articulated bodies; characterization of relative kinematics by means of roto-translation axes for fixed amplitude rigid displacements; the choice of articular joint axes;
- Data and signals processing related to the motor system: linear and nonlinear estimation methods, digital filters.

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 demonstrating familiarity with the concepts and methods presented in the course.

Assessment Methods

WHERE AND WHEN

Lesson Location

Lessons will be done @ IIT Erzelli.

Lesson Schedule

The lessons will be done on the 8th, 9th, 10th, 11th May 2018. The exam will be scheduled in any day within the range of 15-18th May 2018: 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

Interaction in Virtual and Augmented Reality

Unit code: (filled by Unige administrative office)

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 3536626

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.

WHERE AND WHEN

Lesson Location

@UNIGE (Valletta Puggia)

Lesson Schedule

18-20-21-22 June 2018, each morning h 10-13

Office hours for student

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

CONTACTS

Email: manuela.chessa@unige.it

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Lasers and applications

Unit code: (filled by Unige administrative office)

Scientific Disciplinary Sector:

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, 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 April, and 2nd and 9th of May.

Office hours for student

I am available every weekday from 9 to 11 am after appointment by e-mail

CONTACTS

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

Research Oriented Structural and Functional Neuroimaging

Unit code: (filled by Unige administrative office)

Scientific Disciplinary Sector:

Number of hours: 12 hours

Credits: 4 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 minimal physical basis of image formation and the specific feature of each neuroimaging method 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 and the specific feature of each imaging method 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 Prof. Franco Bertora)*
- Class 2 (2h). Common MRI preprocessing steps. Structural MRI. Evaluating gray matter:
  - density (VBM)
  - thickness

  (Teacher Alberto Inuggi).
- Class 3 (2h) 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 4 (2h) 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 5 (3h) Functional MRI during a task. Task-based FC (DCM, PPI) and fMRI. Final Examination. *(Teacher Alberto Inuggi)*

WHO

Teacher(s):

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

Franco Bertora, bertora@iol.it

HOW

Teaching Methods

Projected slides

Exam Description

Students will undergo a 45 minutes written examination consisting in 40 (10 for MRI physics, 30 for MRI methods) multiple selection questions.

Assessment Methods

In order to obtain the 4 CFU, students are expected to correctly answer to a total of at least 24 questions.

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. Exact room will be later indicated.

Lesson Schedule

- 07/06/2018 10:00 – 13:00
- 12/06/2018 11:00 – 13:00
- 14/06/2018 10:00 – 13:00
- 19/06/2018 11:00 – 13:00
- 21/06/2018 11:00 – 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.

Computational Robot Dynamics

Unit code: (filled by Unige administrative office)

Scientific Disciplinary Sector: ING-INF/04

Number of hours: 10

Credits: 3

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
- 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 2.5-hour sessions in the morning from Monday 19th to Thursday 22nd 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 Mixed Effect Models in R

Unit code: (filled by Unige administrative office)

Scientific Disciplinary Sector:

Number of hours: 15 CFU

Credits: min 3 CFU

AIMS AND CONTENT

Learning Outcomes (short)

The course intend to provide an introduction to modern statistical methods that have gained a lot of attention in recent years thanks to the development of statistical software. In particular, starting from a reminder on linear model (multiple regression) and generalized linear model (logistic regression), you will get an introduction linear mixed models (LMM) and generalized mixed models (GLMM) from an applied point view. Each statistical model will be briefly presented with some examples. The course assumes that you have some experience with R and/or that you are familiar with other programming languages (e.g., Python, Matlab) so that you are able to learn the basis of R quickly.

Learning Outcomes (further info)

Syllabus/Content

A review of R and some experimental designs

Multiple regression (LM)

Generalized Linear Model (GLM)

Linear mixed models (LMM)

GLMMs

WHO

Teacher(s): name, phone number, email

Gabriel.baud-bovy@iit.it

348 172 40 45

HOW

Teaching Methods

Different statistical models will be introduced during the classes. The students will have to analyze a new dataset during each the week, summarizing the results and diagnostic plots. You will need to install R on your computer before the first class.

Exam Description

At the end of the course, you will need to write a report where you analyze your own data.

Assessment Methods

To pass the course, it is necessary to complete the exercises and return the final report.

WHERE AND WHEN

Lesson Location

Please indicate whether lessons will be done @ UNIGE. If you have an available room, please indicate!

IIT- ERZELLI

Lesson Schedule

It is mandatory to fill this field. It is not enough indicate the period, but the exact days and (possibly) hours.

The classes will last 3 hours. The schedule is Wednesday 21 feb, 28 feb, 7 mar, 14 mar, 21 mar

Office hours for student

How students can ask info to the teacher (appointments, mail, days reserved for students, etc.)

CONTACTS

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

Office: IIT-Erzelli

Contact by email.

Advanced Optical Fluorescence Microscopy Methods

Unit code: (filled by Unige administrative office)

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 in the classroom.

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

8, 10, 15, 17, 22, 24 of May 2018 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

Data Acquisition and Data Analysis Methods

Unit code: (filled by Unige administrative office)

Scientific Disciplinary Sector:

Number of hours: 15 hours

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 (Real Time systems and Data Acquisition)
- Example and applications

6 hours

- How to extract signal in presence of noise
- Introduction to Statistical methods
- Data analysis using a scientific software framework based on C/C++

WHO

Teacher(s):

Dr. Carlo Canali, carlo.canali@iit.it, +39.010.71781793

Dr. Alessandro Pistone, alessandro.pistone@iit.it, +39.010.71781793

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

5/march/2018 10-12

8/march/2018 10-12

12/march/2018 10-12

15/march/2018 10-12

19/march/2018 10-12

22/march/2018 10-12

26/march/2018 10-13

Office hours for student

Appointments, email.

CONTACTS

The Teachers' office is in Room 107 (floor 0) 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, +39.010.71781793

Brain Connectivity

Unit code: (filled by Unige administrative office)

Scientific Disciplinary Sector: ING-INF/06

Number of hours: 12 hours

Credits: 4 CFU

AIMS AND CONTENT

Learning Outcomes (short)

The course should illustrate some prototypical studies in this field and provide the students with basic methods and critical understanding to autonomously carry out brain connectivity studies.

Learning Outcomes (further info)

A central paradigm in modern neuroscience is that anatomical and functional connections between brain regions are organized in a way such that information processing is near optimal. Functional interactions seem to be provided by synchronized activity, both locally and between distant brain regions. Brain networks thus consist of spatially distributed but functionally connected regions that in concert process information. Brain connectivity analysis rests upon three different but related forms of connectivity: *structural*, *functional* and *effective*.

The course is organized as follow. First, the student will be introduced to the so called structural connectivity and white matter fibre tracts representing the anatomical backbone for functional and effective connectivity. A representative selection of algorithms in use in diffusion-weighted MRI (dwMRI) will be presented. Then recent computational methods dealing with functional connectivity and some illustrative applications are reported. This is followed by a short survey of recent studies on effective connectivity. Finally, the course will discuss the important concepts of graph theory and their application to brain networks characterization. The course is not meant to be fully comprehensive.

Syllabus/Content

- Brain Connectivity fundaments: physics and physiology.
- Neural Mass Models.
- Structural Connectivity.
- Functional Connectivity.
- Effective Connectivity.
- Graph theory.

WHO

Teacher(s):

Gabriele Arnulfo mail: gabriele.arnulfo@unige.it phone: TBD

Andrea Canessa mail: andrea.canessa@unige.it phone: TBD

How

Teaching Methods

Frontal lessons

Exam Description

The exam modality will be discussed/defined with the instructors

Assessment Methods

To be defined

Where and When

Lesson Location

@ UNIGE. Aula Viola Pad E Via Opera Pia 13

Lesson Schedule

4/06 – 10:00/12:00

11/06 – 10:00/12:00

18/06 – 10:00/12:00

25/06 – 10:00/12:00

02/07 – 10:00/12:00

09/07 – 10:00/12:00

Office hours for student

Appointment can be asked by e-mail for any type of questions and info

Contacts

Our lab is at BioLab Pad E 1st floor Via Opera Pia 13

Introduction to Computer Programming for Researchers

Unit code: (filled by Unige administrative office)

Scientific Disciplinary Sector: INF/01 (non sono sicuro, da confermare)

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):

Marcello Goccia, Tel. (+39) 010 8172 216, email: m.goccia@gmail.com

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 instructors.

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 Morego 30, Bolzaneto, Genova

Lesson Schedule

Tuesday 8 May 2018, 9:00-11:00

Thursday 10 May, 9:00-11:00

Tuesday 15 May 2018, 9:00-11:00

Thursday 17 May, 9:00-11:00

Tuesday 22 May 2018, 9:00-11:00

Thursday 24 May, 9:00-11:00

Tuesday 29 May, 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

Preparation and Characterization of Polymeric Materials

Unit code: (filled by Unige administrative office)

Scientific Disciplinary Sector: FIS/07 (fisica applicata)

Number of hours: 12 hours

Credits: 4 CFU

AIMS AND CONTENT

Learning Outcomes (short)

Basic concepts of polymer preparation coupled with physicochemical characterization techniques, with special focus on polymeric bulk materials.

Learning Outcomes (further info)

Bulk polymers are ubiquitous materials in multiple fields of industry and research. Their extensive range of properties facilitates their use in very diverse applications. In this PhD course, we show the main techniques and methodologies in the preparation and characterization of their useful properties as materials. The preparation methods include standard synthetic and manufacturing (e.g., extrusion, injection molding…) processes. The characterization includes the determination of the chemical composition and structure and the potential reactivity as well as the determination of the polymeric structure and its implication on the final physic properties.

The objective of this course is to describe both 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 to the test design and interpretation of results.

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.

Chemical characterization: main spectroscopy techniques, such us UV/VIS, infrared and Raman spectroscopies and nuclear magnetic resonance.

Physic and structural characterization: the order of the macromolecules in terms of amorphous and crystalline domains will be depicted. Standard methods for the determination of the polymeric structures will be described. The main methodologies for the thermos-mechanical characterization of polymers will be explained.

Determination of molecular weight of polymers: the number and weight average molecular weight and the distribution of molecular weights will be explained and the usual methodologies for their determination will be described.

WHO

Teacher(s):

Gianvito Caputo, gianvito.caputo@iit.it

Jose Alejandro Heredia-Guerrero, 010 71781 276, jose.guerrero@iit.it

HOW

Teaching Methods

Lecturing and demonstrating (visits to the lab).

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 March 5th-8th 2018 (Monday to Thusday) from 10.00h to 13.00h (4 sessions of 3 hours).

Office hours for student

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

Modeling Neuronal Structures

Unit code: (filled by Unige administrative office)

Scientific Disciplinary Sector: ING-INF/06

Number of hours: 10 hours

Credits: min 3 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:
13th, 20th, 27th November 2017 at 10.00-12.00.
14th, 28th November 2017 at 14.30-16.30.

Office hours for student

Appointment by e-mail

CONTACTS

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

Industrial Analytics: Theory and Practice of Learning from Data

Unit code: (filled by Unige administrative office)

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

- 2 July 2018 from 8 to 12
- 3 July 2018 from 8 to 12
- 4 July 2018 from 8 to 12
- 5 July 2018 from 8 to 12
- 6 July 2018 from 8 to 12

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

Nanoplasmonic devices: from fabrication to applications

Unit code: (filled by Unige administrative office)

Scientific Disciplinary Sector: FIS/03

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 collision with multilayer solids (i) Surface plasmon polaritons (SPPs) as electromagnetic waves at metal-dielectric interfaces, (ii) Nano-optical applications of SPPs, i.e. optical energy transfer at the nanoscale, (iii) Phases of local electromagnetic fields and Fano resonances, (iv) Giant enhancement of Raman scattering and infrared absorption in nanoplasmonic 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 promote giant electromagnetic field enhancement has gained increasing attention over the last few years, 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 (LSPR), 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 (EBL) or focused ion beam lithography (FIB) 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 Monte Carlo simulation tools for electron and ion collisions in solids will be carried out. Stopping powers, range and straggling distributions for ions and electrons in multilayer target will be calculated via CASINO (http://www.gel.usherbrooke.ca/casino/) and SRIM (http://www.srim.org) software packages.

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.
- Nanoplasmonic 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 plasmonics 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 10th, 13th, 17th and 20th. 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 Nanoscopy: Basis, Applications and Perspectives

Unit code: (filled by Unige administrative office)

Scientific Disciplinary Sector:

Number of hours: 12 hours

Credits: min 3 CFU

AIMS AND CONTENT

Learning Outcomes (short)

Is the promise of fluorescent nanoscopy 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 nanoscopy 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 (f)PALM and STORM in the context of coordinate-stochastic approaches and STED microscopy in the context of coordinate-stochastic approaches. The course will discuss about different bio-applications of fluorescence nanoscopy, 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 cannot 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 nanoscopy), 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 nanoscopy techniques. The conventional classification between coordinate-stochastic and coordinate-targeted techniques will be used to explain such a techniques under the common "switching ON-OFF" principle. The course will continue focusing on two particular approaches, the (f)PALM/STORM and STED microscopy. The major advantages, limitations and challenges of these two techniques will be deeply discussed and bio-medical applications will be presented. In the context of (f)PALM/STORM approaches, the course will highlight their ability in quantifying protein copy numbers and extending the three dimensional imaging capabilities in biological systems. In the context of STED microscopy, the course will highlight its ability to provide not only spatial information but also correlate them with temporal information, for example the combination of STEE microscopy with fluorescence-correlation-spectroscopy will be discussed.

Finally, the course will present general perspective about fluorescence nanoscopy.

Syllabus/Content

- The resolution and the diffraction limit
- Basis of coordinate-stochastic (single-molecule-localization) approaches
- Advances in (f)PALM and STORM
- Applications of (f)PALM and STORM
- Basis of coordinate-targeted approaches
- Advances in STED microscopy
- Applications of STED microscopy and combination with fluorescence-correlation-spectroscopy (FCS)

WHO

Teacher(s): Dr. Francesca Cella Zanacchi, Nanoscopy and NIC@IIT, +39 01071781320, francesca.cella@iit.it and 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. The lessons are scheduled on 29th and 31st May, 5th,7th, 19th, 21st June 2018. The calendar will be confirmed on month before the beginning of the course.

Office hours for student

Dr. Francesca Cella Zanacchi and 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.

CONTACTS

Dr. Francesca Cella Zanacchi
Nanoscopy and NIC@IIT
Italian Institute of Technology
Via Morego, 30, 16163, Genoa, Italy
Office: 5th floor
tel: +39 010 71781320
e-mail: francesca.cella@iit.it

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

Robotic Virtual Prototyping Design

Unit code: (filled by Unige administrative office)

Scientific Disciplinary Sector:

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 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/Workbanch)
- class 2 (C2)
  - Anthropomorphic Arm Modelling (FEA+MBS: Ansys/Workbanch)
- class 3 (C3)
  - MBS + FEA (MSC.ADAMS + MSC.Nastran)
- class 4 (C4)

- Anthropomorphic Arm Modelling: MBS+ FEM + Control (MSC.ADAMS + MSC.NASTRAN + MatLab)
- class 5 (C5)
  - Anthropomorphic Arm Modelling: MBS + FEM + Control + Optimisation (MSC.ADAMS + MSC.NASTRAN + MatLab + ModeFRONTIER)
- 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*

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 6th lectures

Prerequisites

Basic knowledge of classical physics and programming.

MSC ADAMS, ANSYS, 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 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

martedì 20 marzo 2018 14:30-17:30
giovedì 22 marzo 2018 14:30-17:30
venerdì 23 marzo 2018 14:30-17:30
lunedì 26 marzo 2018 09:00-12:00
martedì 27 marzo 2018 09:00-12:00
mercoledì 28 marzo 2018 09:00-12:00 (optional)

Office hours for student

The teachers will be available (on the office or on skype) every Wednesday morning from 11:00 to 15:00 from the 21st March to the 18th April 2018

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*

Electric Circuits for Electrochemistry

Unit code: (filled by Unige administrative office)

Scientific Disciplinary Sector: ING-INF/06

Number of hours: 15

Credits: 5 CFU

AIMS AND CONTENT

Learning Outcomes (short)

The aim of this course is to give an introduction to the electric circuit theory and to the electrochemical characterization techniques in order to allow the students to correctly perform and interpret the electrochemical measurements.

Learning Outcomes (further info)

The course will start from lumped circuits basics and moving through transient and frequency analyses of linear circuits. Basics of electrochemical measurements and typical measurement configurations will be introduced. Finally, lumped element modelling of typical equivalent circuits will be discussed and examples of simulations by common tools (Spice, EC-Lab) will be performed. The course will comprehend some hands on experience on potetiostat and battery analyser as well.

Syllabus/Content

The course cover all the aspect of circuit modelling significant for electrochemical circuits modelling in order to allow a comprehensive understanding of both the electrical and the chemical aspects involved.

First part: Introduction to electric circuits

- Lumped element circuits
- Kirchhoff lows
- Basic lumped elements
- Examples of typical electric circuits
- Nyquist (Cole Cole) and Bode plots
- Transient response and frequency response of LCR circuits
- Introduction to the distributed models
- Generalised lumped elements

Second part: Electrical measurements

- Typical instruments and measurement configurations
- The potentiostat/galvanostat
- Examples of typical measurements mistakes

Third part: Introduction to electrochemistry

- The electrochemical cell
- Reference electrodes
- Electrochemical cell measurement configurations
- Introduction to electrochemistry (second part - 2h)
- Impedance spectroscopy
- Cyclic voltammetry
- Differential pulse voltammetry

Fourth part: Electrochemical systems modelling and simulation

- Typical circuits
- Extraction of lumped parameters from transient response and frequency response of physical systems (black box approach)
- Electrochemical lumped elements (CPE, Warburg, etc…)
- Introduction to circuit modelling and simulation by Spice (LTspice)
- The potentiostat: a simulated model
- Examples of the influence of the electrical parameters on the typical electrochemical measurements.
- The examination consists in discuss and simulate a typical electrochemical measurement.

Fifth part: An introduction to EC-Lab

- the EC-lab user interface
- typical measurement and data representations
- data analysis and simulation tools

WHO

Teacher(s): Alberto Ansaldo, tel. 010 71781564, alberto.ansaldo@iit.it

HOW

Teaching Methods

Frontal lectures (12h), and practical exercitations (3h) on the simulation software

Exam Description

The examination consists in discuss and simulate a typical electrochemical measurement.

Assessment Methods

Oral interrogation.

WHERE AND WHEN

Lesson Location

Istituto Italiano di Tencologia- Via Morego, 30 16163 Genova

Lesson Schedule

Tuesday 6 May 2018, 14.00-16.00

Thursday 8 May 2018, 14.00-16.00

Tuesday 13 May 2018, 14.00-16.00

Thursday 15 May 2018, 14.00-16.00

Tuesday 20 May 2018, 14.00-16.00

Thursday 22 May 2018, 14.00-16.00

Tuesday 27 May 2018, 14.00-17.00

Office hours for student

On appointment or by mail

CONTACTS

The teacher office is located in the Graphene labs of iit, Morego 30, Genova, third floor

Phone: 010 71781 564

Mail: alberto.ansaldo@iit.it

Human-Robot Interaction

Unit code: (filled by Unige administrative office)

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

Alessandra Sciutti, +393297263118, alessandra.sciutti@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

Weeks: from the 28 May to 1 June, from 4 May to 8 June .

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 or alessandra.sciutti@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.

Robotic technologies for sensorimotor rehabilitation

Unit code: (filled by Unige administrative office)

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

Teacher(s): name, phone number, email

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 Morego (Via Morego 30, 16163, Genova) & Campus Erzelli (Via Melen 83, Bldg B, 16152 Genova)

Course dates & Schedule

May 2018

Campus Morego: 12 hours (theory), 9-11-14-16-18-21, time 10-12, room to be decided 2 months in advance)

Campus Erzelli: 4 hours (lab); 23-25 May; time 10-12; MLRR lab (7th floor)

Office hours for student

Appointments by email request

CONTACTS

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

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

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

Introduction to physical Human-Robot Interaction

Unit code: (filled by Unige administrative office)

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(s): name, phone number, email

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 Morego (Via Morego 30, 16163, Genova) & Campus Erzelli (Via Melen 83, Bldg B, 16152 Genova)

Course dates & Schedule

Campus Morego: 8 hours (theory), 3-4-5-6 April, time 10-12, room to be decided 2 months in advance)

Campus Erzelli: 4 hours (lab); 9-10 April; time 10-12; MLARR lab (7th floor)

Office hours for student

Appointments by email request

CONTACTS

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

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

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

Unit code: (filled by Unige administrative office)

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 morning from Monday 5th to Thursday 8th 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

The Visuo-Motor Transition Landscape

Unit code: (filled by Unige administrative office)

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

claudio.brigati@hsanmartino.it

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
june: 6, 8, 12, 14, 19

Office hours for student
free contacting, any day available

Contacts

ask by mail or telephone to arrange appointments