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UNIVERSITÀ DEGLI STUDI DI NAPOLI FEDERICO II

PHD PROGRAM IN INFORMATION AND COMMUNICATION TECHNOLOGY FOR HEALTH

PHD PROGRAM IN INFORMATION TECHNOLOGY AND ELECTRICAL ENGINEERING

PhD Course announcement

Title: *Design and control of robotic prostheses*

Lecturers: **Prof. S. Micera**

Scuola Superiore Sant'Anna (Pisa) - Ecole Poly-technique Federale de Lausanne (EPFL)
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Prof. P. Falco

University of Padova
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Prof. G. Berselli

University of Genova - Italian Institute of Technology (IIT)
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Prof. F. Ficuciello

University of Naples Federico II
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Prof. L. Mecozzi

University of Naples Federico II
Email: laura.mecozzi2@unina.it

Credits: **4**

Short bio notes:

Silvestro Micera is currently Professor of Bioelectronics at the Scuola Superiore Sant'Anna (SSSA, Pisa, Italy) and at the Ecole Polytechnique Federale de Lausanne (Lausanne, Switzerland) where he is holding the Bertarelli Foundation Chair in Translational NeuroEngineering. He received the University degree (Laurea) in Electrical Engineering from the University of Pisa, in 1996, and the Ph.D. degree in Biomedical Engineering from the Scuola Superiore Sant'Anna, in 2000. From 2000 to 2009, he has been an Assistant Professor of BioRobotics at the Scuola Superiore Sant'Anna. In 2007, he was a Visiting Scientist at the Massachusetts Institute of Technology, Cambridge, USA with a Fulbright Scholarship. From 2008 to 2011 he was the Head of the Neuroprosthesis Control group and Group Leader at the Institute for Automation, ETH Zurich, CH. He was the recipient of the "Early Career Achievement Award" and of the "Technical Achievement Award" of the IEEE Engineering in Medicine and Biology Society in 2009 and 2021, respectively. Dr. Micera's research interests include the development of neuroprostheses based on the use of implantable neural interfaces with



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the central and peripheral nervous systems to restore sensory and motor function in disabled persons. He is author of more than 500 WoS peer-reviewed papers and several international patents. He is also member of several editorial boards of peer-reviewed journals in the fields of biomedical and neural engineering. He is the co-founder of several start-ups working on neurotechnologies and wearable systems.

Pietro Falco

Pietro Falco received the Research Doctorate degree in Electronic Engineering in 2012 and until February 2015 he held a Post-Doc position at Second University of Naples. From December 2010 to July 2011 he was a Visiting Scholar at Karlsruhe Institute of Technology (KIT) in Karlsruhe, under the supervision of Prof. Dillmann. His research interests include machine learning for robotics, observation of human manipulation, robotic mobile manipulation, and Large Language Models for Robotics. In 2011, he co-founded the company Aeromechs s.r.l, very active in the field of intelligent energy management systems for aeronautics. In order to work full time on my long-term dream, an academic career, in 2015 he left the active co-leadership of the company and moved to Munich. In March 2015 Pietro was appointed "TUM Foundation Fellow" at Technical University of Munich and in February he earned a Marie Curie Individual Fellowship for the project proposal LEACON "LEArning-CONtrol tight interaction: a novel approach to robust execution of mobile manipulation tasks". In order to gain experience in industrial research, in 2018 he joined ABB Corporate Research in Västerås Sweden working as senior scientist and project manager. In 2024, Pietro moved back to Italy at University of Padova as an assistant professor (RTDB).

Giovanni Berselli is Full Professor and Chair of Design Methods for Industrial Engineering at the University of Genova, Italy, where he is the Head of the Mechanical Computer-Aided Engineering (M-CAE) Lab. He is also Affiliated Researcher with the Advanced Robotics Department at the Italian Institute of Technology (IIT). Currently, Prof. Berselli is the Referent for the Industry 4.0 Curriculum for the National Doctorate in Robotics and Intelligent Machines and the Coordinator of the PhD Degree in Mechanical, Energy and Management Engineering at the University of Genova (whose numerical consistency has been doubled since his supervision). Prof. Berselli is a Senior Member of the IEEE (Institute of Electrical and Electronics Engineers) and a Fellow of the ASME (American Society of Mechanical Engineers) as well as the Chair of ASME Italy Section. He is also the past Chair of the ASME Technical Committee on Modeling, Dynamics, and Control of Adaptive Systems. At present, he holds an Excellence Fellowship at the Technical University of Munich. He also held an Excellence Fellowship at the Institute for Anthropomatics and Robotics (IAR) of the Karlsruhe Institute of Technology. In the recent past, he has been a Visiting & Affiliated Scientist at Harvard University & Massachusetts General Hospital, at the German Aerospace Agency (DLR), at the University of Twente, at Monash University, Australia, and with the School of Advanced Studies of the University of Navarra, Spain. Within his department, comprising 120 colleagues, Prof. Berselli is the Coordinator of Research Activities, the former Delegate for International Relations and the former Erasmus Program Coordinator. He has authored more than 240 publications (including patents) in peer-reviewed international journals or conference proceedings and edited 2 international books. Recipient of several IEEE, ASME, and IFToMM Best Paper Awards and finalist for an ERC starting grant. He has been Senior Editor and Technical Editor for IEEE/ASME Transactions on Mechatronics, and he is currently Associate Editor for the ASME



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Transaction - Journal of Mechanisms and Robotics, Robotica (Cambridge University Press), International Journal of Interactive Design & Manufacturing, Mechanical Science, and Machines, as well as Scientific Committee member or Associate Editor of several international conferences and associations, here including IEEE/ASME AIM, Int. Conf. Advanced Intelligent Mechatronics and IEEE ICRA, Int. Conf. on Robotics and Automation. He has been Program Chair of the Mechanisms and Robotic Conference at ASME IDETC 2024 and General Chair of the same conference in 2025. He has served as Competition Chair of ERF 2024 – European Robotic Forum and as Local Chair of IEEE/ASME MESA 2024 Int. Conference on Mechatronic, Embedded Systems & Applications. He has been recently elected General Chair of IEEE/ASME AIM 2026 – Int. Conference on Advanced Intelligent Mechatronics, namely one of the biggest worldwide conferences in Mechatronics, as well as General Chair of the 3rd Doctoral Summer School in Robotics and Intelligent Machines (DRIMS2). He is Scientific Advisor for the company PHM Technology, based in Melbourne. Prof. Berselli's scientific activity is focused on the modelling, control and experimental evaluation of: i) robot hands and grippers; ii) compliant/soft actuators for safe human-robot interaction; iii) exoskeletons iv) energy-aware industrial robotics.

Fanny Ficuciello is Associate Professor in the Department of Electrical Engineering and Information Technology at University of Naples Federico II, where she is responsible for the MedRob (Medical Robotics) research area. She also leads the Medical Lab at the Interdepartmental Center for Advances in RObotic Surgery (ICAROS) and the Biomimetic and Biohybrid Robotics Lab (B2RL). She is Associate Editor of the Journal of Intelligent Service Robotics and the IEEE Transactions on Robotics, and she has been Program Committee member of some international conferences. She is in the Technology Committee of the European Association of Endoscopic Surgery (EAES), and she is the Treasurer of ASME Italy Section. She has published more than 90 journal articles, conference papers and book chapters. She has participated to several European research projects. She has been principal investigator of a project funded by Compagnia di San Paolo.

Laura Mecozzi is Assistant Professor at PRISMA Lab in the Department of Electrical Engineering and Information Technology at University of Naples Federico II. She received her Ph.D. degree in Materials and Structural Engineering from the University of Naples Federico II (2016). She was a Research Scientist with the Department of Medicine and Surgery at the University of Parma (2018-2020). She has participated to several research projects funded by the European Union and by the Italian Ministry of Research. She is co-author of more than 30 journal articles and conference papers.

Overview

The course deals with anthropomorphic hands and robotic prostheses. Five teachers will deal with design, control, bio-interfaces for control and learning techniques for grasping and manipulation.

There will be a final assessment.

Venue: Lectures will be held at Piazzale Tecchio (room *CSIF GIARDINO*) and Agnano (room *NA-I-A11*) as detailed below



Schedule

Lecture	Date	Time	Room	Topics	Lecturer
1	11/04/2025	9:00 - 11:00	CSIF GIARDINO	Introduction to robotic hands and prostheses: overview on design and control strategies	Ficiucello
2		11:30 - 13:30	CSIF GIARDINO	Computer-Aided Methods for Designing Soft Robotic Hands – Part 1: Materials and Manufacturing Methods	Berselli
3	14/04/2025	9:00 - 11:00	CSIF GIARDINO	Computer-Aided Methods for Designing Soft Robotic Hands – Part 2: Comparative Evaluation of the State of the Art	Berselli
4		11:30 - 13:30	CSIF GIARDINO	Robot learning approaches with stability guarantees	Falco
5	15/04/2025	9:00 - 11:00	NA-I-A11	Robot learning approaches with robustness to irreversible events	Falco
6		11:30 - 13:30	NA-I-A11	3D Bioprinting: process, technologies and applications	Mecozzi
7	16/04/2025	9:00 - 11:00	CSIF GIARDINO	Implantable neural interfaces for reading and writing the nervous system	Micera
8		11:30 - 13:30	CSIF GIARDINO	Implantable neurotechnologies for bidirectional artificial limbs	Micera
9		15:30 - 17:00		LabVisit @ICAROS Center	

Content details

I Lesson – Introduction to robotic hands and prostheses: overview on design and control strategies

II–III Lesson – *Computer-Aided Methods for Designing Soft Robotic Hands - Materials and Manufacturing Methods*: the main class of compliant mechanisms currently employable for realizing better-behaved robotic hands for prosthetic usage are introduced. The lecture will focus on theoretical and numerical methods for the optimal sizing of the hand mechanical structure and for the selection of the actuation systems. Subsequently, we shall focus on Computer-Aided Design and Engineering tools (both commercial and open source), that can help the hand designer during the conception of novel device, the material selection and technologies employed in the manufacturing phase; *Computer-Aided Methods for Designing Soft Robotic Hands - Comparative Evaluation of the State of the Art*: On the basis of the content provided in the previous lecture, some well-known devices will be compared, with the aim of highlighting advantages, disadvantages and possible directions of improvement. Particular focus will be directed towards a comparative evaluation of under-actuated devices and highly dexterous hands, tackled from the mechatronic designer viewpoint.

IV–V Lesson – *Robot learning approaches with stability guarantees*: Fundamentals of reinforcement learning, Challenges in RL, Consider stability in RL problems, Challenges and future work; *Robot learning approaches with robustness to irreversible events*: Problem of safety in reinforcement learning, Definition of irreversible events during the learning process, Approaches to increase the robustness to irreversible events

VI lesson – 3DBioprinting: process, technologies and applications



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VII–VIII lesson – Implantable neural interfaces for reading and writing the nervous system;
Implantable neurotechnologies for bidirectional artificial limbs

IX Lesson – Lab visit @ ICAROS Center

The course is in presence. However, students pursuing their PhD period abroad (for research purposes) have the option to request remote attendance for classes via MS Teams:

https://teams.microsoft.com/l/team/19%3AD-XPR52ZUBeNAiZJSnhGw_NXpKNG2pyY8Jfn4td1Xc1%40thread.tacv2/conversations?groupId=0fcb1d50-47fc-4159-9eb6-c40db0c4494e&tenantId=2fcfe26a-bb62-46b0-b1e3-28f9da0c45fd

MS Teams code: 0vfe77o

ASSESSMENT TEST: Doctoral Students are requested to provide a final report on one of the topics of the course illustrating the state of the art and a research proposal that includes the application of a particular tool learned with possible future developments.

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