SAPIENZA
UNIVERSITÀ DI ROMA

Didactic Offer

First year

First semester

Denomination	E.A.C.	SSD	CFU	Hours	Type Activity	Language
1041424 - NONLINEAR SYSTEMS AND CONTROL	B	ING-INF/04	12	120	AP	ENG
1041425 - SYSTEM IDENTIFICATION AND OPTIMAL CONTROL	B	ING-INF/04	12	120	AP	ENG
Optional Group: Gruppo OPZIONALE:Lo studente deve scegliere 36 Cfu (l'acquisizione è da intendersi relativa a tutta la durata del corso di studi)	B					

Second semester

Denomination	E.A.C.	SSD	CFU	Hours	Type Activity	Language
1041424 - NONLINEAR SYSTEMS AND CONTROL	B	ING-INF/04	12	120	AP	ENG
1041425 - SYSTEM IDENTIFICATION AND OPTIMAL CONTROL	B	ING-INF/04	12	120	AP	ENG
Optional Group: Gruppo OPZIONALE:Lo studente deve scegliere 36 Cfu (l'acquisizione è da intendersi relativa a tutta la durata del corso di studi)	B					
Optional Group: Gruppo OPZIONALE: Lo studente deve scegliere 18 cfu (l'acquisizione è da intendersi relativa a tutta la durata del corso di studi)	C					
- - A SCELTA DELLO STUDENTE	D		6	60	AP	ENG

Second year

First semester

Denomination	E.A.C.	SSD	CFU	Hours	Type Activity	Language
Optional Group: Gruppo OPZIONALE:Lo studente deve scegliere 36 Cfu (l'acquisizione è da intendersi relativa a tutta la durata del corso di studi)	B					
Optional Group: Gruppo OPZIONALE: Lo studente deve scegliere 18 cfu (l'acquisizione è da intendersi relativa a tutta la durata del corso di studi)	C					
- - A SCELTA DELLO STUDENTE	D		6	60	AP	ENG

Second semester

Denomination	E.A.C.	SSD	CFU	Hours	Type Activity	Language
Optional Group: Gruppo OPZIONALE:Lo studente deve scegliere 36 Cfu (l'acquisizione è da intendersi relativa a tutta la durata del corso di studi)	B					
Optional Group: Gruppo OPZIONALE: Lo studente deve scegliere 18 cfu (l'acquisizione è da intendersi relativa a tutta la durata del corso di studi)	C					
AAF1041 - Training	F		3	30	I	ENG
AAF1025 - Final exam	E		27	270	I	ENG

Detail of optional units

Denomination	E.A.C.	SSD	CFU	Hours	Type Activity	Language
Optional Group: Gruppo OPZIONALE:Lo studente deve scegliere 36 Cfu (l'acquisizione è da intendersi relativa a tutta la durata del corso di studi)						
1041422 - PROCESS AUTOMATION *(first semester)*	B	ING-INF/04	6	60	AP	ENG
1023235 - ROBOTICS I *(first semester)*	B	ING-INF/04	6	60	AP	ENG
1041453 - ROBUST CONTROL *(first semester)*	B	ING-INF/04	6	60	AP	ENG
1055496 - Control problems in robotics *(first semester)*	B	ING-INF/04	6	60	AP	ENG
1041426 - MULTIVARIABLE FEEDBACK CONTROL *(second semester)*	B	ING-INF/04	6	60	AP	ENG
1021883 - ROBOTICS II *(second semester)*	B	ING-INF/04	6	60	AP	ENG
1041429 - CONTROL OF COMMUNICATION AND ENERGY NETWORKS *(first semester)*	B	ING-INF/04	6	60	AP	ENG
1041428 - DIGITAL CONTROL SYSTEMS *(first semester)*	B	ING-INF/04	6	60	AP	ENG
1041454 - DYNAMICS OF ELECTRICAL MACHINES AND DRIVES *(first semester)*	B	ING-IND/32	6	60	AP	ENG
1041431 - VEHICLE SYSTEM DYNAMICS *(second semester)*	B	ING-IND/13	6	60	AP	ENG
Optional Group: Gruppo OPZIONALE: Lo studente deve scegliere 18 cfu (l'acquisizione è da intendersi relativa a tutta la durata del corso di studi)						
1022775 - AUTONOMOUS AND MOBILE ROBOTICS *(first semester)*	C	ING-INF/04	6	60	AP	ENG
1021883 - ROBOTICS II *(second semester)*	C	ING-INF/04	6	60	AP	ENG
1022792 - COMPUTER AND NETWORK SECURITY *(first semester)*	C	ING-INF/05	6	60	AP	ENG
1041429 - CONTROL OF COMMUNICATION AND ENERGY NETWORKS *(first semester)*	C	ING-INF/04	6	60	AP	ENG

Denomination	E.A.C.	SSD	CFU	Hours	Type Activity	Language
1041428 - DIGITAL CONTROL SYSTEMS *(first semester)*	C	ING-INF/04	6	60	AP	ENG
1022858 - MACHINE LEARNING *(first semester)*	C	ING-INF/05	6	60	AP	ENG
1041427 - CONTROL OF AUTONOMOUS MULTI-AGENT SYSTEMS *(second semester)*	C	ING-INF/04	6	60	AP	ENG

Summary

Tip. Att. (Tipo di attestato): **AP** (Attestazione di profitto), **AF** (Attestazione di frequenza), **I** (Idoneità)

E.A.C. (Educational Activities classification): **A** BASIC TEACHING/LEARNING ACTIVITIES **B** SPECIFIC TEACHING/LEARNING ACTIVITIES **C** RELATED/SUPPLEMENTARY TEACHING/LEARNING ACTIVITIES **D** ELECTIVE TEACHING/LEARNING ACTIVITIES **E** FINAL EXAMINATION AND FOREIGN LANGUAGE SKILLS **F** OTHER ACTIVITIES **R S** TRAINING PERIODS AND INTERNSHIPS AT COMPANIES, PUBLIC AND PRIVATE BODIES, AND PROFESSIONAL ROLLS (ART.10, PAR. 5, POINT E)

Objectives of the course

DIGITAL CONTROL SYSTEMS

GENERAL GOALS. The course provides methodologies for the analysis of linear and nonlinear discrete time and sampled dynamics, the design of digital controllers with a major focus on linear systems, and implementation on embedded microcontrollers. The student will be able to compute digital models of given discrete time systems as well as digital discrete time equivalent models of continuous dynamics, to design digital control laws both for discrete and for continuous systems and to use standard microcontrollers for their implementation. SPECIFIC OUTCOMES. Analysis and design techniques for discrete time and digital systems. KNOWLEDGE AND UNDERSTANDING. The course provides methodologies for the analysis of linear and nonlinear discrete time and sampled dynamics, and for the design of digital controllers with a major focus on linear systems. CAPABILITY TO APPLY KNOWLEDGE AND UNDERSTANDING. The student will be able to compute digital models of given discrete time systems as well as digital discrete time equivalent models of continuous dynamics, to design digital control laws both for discrete and for continuous systems. MAKING AUTONOMOUS JUDGEMENTS. The student will be able to choose between different methodologies, in order to solve the given problem in the best way. COMMUNICATE SKILLS. The student will be able to explain his/her own design choices. LEARNING SKILLS. The student will be able to address autonomously the study of topics in the field of discrete time and digital systems.

Control problems in robotics

The course presents a selection of advanced topics in robot control and is intended as an introduction to research. Guided through case studies taken from the research activities of the teachers, the student will be able to fully develop a control problem for a robotic system, from its analysis to the proposal of solution methods and their implementation. The course (see http://www.diag.uniroma1.it/~lanari/CPR.html) is made of two modules of 3 credits, chosen among the four modules offered each year, two per semester, within the Elective in Robotics course (code 1056414, 12 credits, see https://corsidilaurea.uniroma1.it/en/node/2378856). Modules cover in a seminar fashion a number of research topics. Lectures/seminars are presented by instructors and/or by qualified external researchers. The four modules of the academic year 2017-18, out of which you can choose two, are: First semester Modeling and control of multi-rotor UAV (Marilena Vendittelli) Locomotion and haptic interfaces for VR exploration (Alessandro De Luca) Second semester Underactuated robots (Leonardo Lanari, Giuseppe Oriolo) Multi-robot systems (Giuseppe Oriolo) Type of exam: Evaluation of a project for a first module and of an oral presentation for the second one.

VEHICLE SYSTEM DYNAMICS

A twofold approach is proposed. On one hand the vehicle is decomposed into sub-systems: (i) propulsion (ii) transmission (iii) thrust and directional components (iv) suspension systems (v) brake systems (vi) guidance and control. On the other hand a general model of the vehicle integrating the considered sub-systems is developed able to predict the different maneuvering ability of the vehicle. The theoretical foundation to approach vehicle dynamics is provided. The objective of this course is twofold: on one hand, the student is provided with the most advanced techniques of analysis in the field of vehicle's dynamics; on the other hand, the student is guided in applying these tools to the design of real devices and in the implementation of these concepts in computer programs.

COMPUTER AND NETWORK SECURITY

The purpose of the course is to provide the concepts needed to: (a) understand the meaning of information security and security of infrastructures and networks; (b) enable the student to analyze the basic security features of a network / infrastructure; (c) provide the basic knowledge for designing and evaluating networked solutions in the presence of security information requirements. Used methodologies and notions include cryptography, access control, protocols, security architectures, firewalls. Expected learning outcomes: (1) use the fundamental tools to ensure data integrity / confidentiality and authentication of users and applications; (2) support the analysis and definition of security policies; (3) design and implement infrastructures and applications in compliance with security policies; (4) assess the presence of significant vulnerabilities in infrastructure and applications; (5) study and understand security standards.

ROBUST CONTROL

The course is addressed to students willing to expand their knowledge on the design of control systems in presence of model uncertainties. The course covers, in a systematic manner, various fundamental methods of analysis based on the use of linear matrix inequalities and various design methods, to be used in the case of parameter uncertainties (structured uncertainties) as well as in the case of modeling uncertainties (unstructured uncertainties). The course addresses the design of control (possibly multi-input and multi-output) systems, in order to meet two basic design requirements: stability and asymptotic performance in the presence of exogenous inputs. Various analysis and design techniques are presented, to verify and guarantee that the required design performances continue to hold in the presence of parameter variations as well as in the presence of unmodeled parasitic dynamics. Most of the techniques in question repose on a systematic use of linear matrix inequalities.

CONTROL OF COMMUNICATION AND ENERGY NETWORKS

The course aims at applying advanced dynamic control methodologies to networks by adopting a technology-independent abstract approach that copes with the network control problem, leaving out of consideration the specific network technologies. Such methodologies will be applied to communication, energy and transport networks, with particular emphasis on the problems related to security. The students will be able to design network control actions suitable for communication, energy and transport networks. Moreover, the students will be aware of the main problems related to security.

DYNAMICS OF ELECTRICAL MACHINES AND DRIVES

The course aims to guide the student in the understanding of the principles of operation of electrical drives and their components. The course provides the tools for analyzing the behavior of an electrical drive at steady state and during transients. The course is completed by some design fundamentals. At the end of the course the student will be able to understand the principle of operation and analyze the behavior of an electrical drive both at steady state and during transients. The acquired knowledge will allow to addressing design and control issues of electrical drives.

ROBOTICS I

This course provides the basic tools for the kinematic analysis, trajectory planning, and programming of motion tasks for robot manipulators in industrial and service environments. The student will be able to develop kinematic models of robot manipulators, to program motion trajectories realizing the robotic task, and to design simple kinematic or decentralized control laws, verifying performance based on simulation tools.

CONTROL OF AUTONOMOUS MULTI-AGENT SYSTEMS

The course presents the basic methods for modelling, analyzing and controlling multi-agent systems, with special emphasis on distributed strategies. Applications will be presented in the control of communication, electrical and transport networks/systems, as well as of multi-robot systems. The student will be able to analyze and design architectures, algorithms, and modules for controlling multi-agent systems.

ROBOTICS II

This course provides tools for advanced kinematics and dynamic analysis of robot manipulators and for the design of feedback control laws for free motion and interaction tasks, including visual servoing. The student will be able to develop dynamic models of robot manipulators, to design control laws for motion and environment interaction tasks, and to verify the robot performance based on simulation tools.

SYSTEM IDENTIFICATION AND OPTIMAL CONTROL

The course illustrates the basic methodologies in estimation, filtering, prediction and optimal control. The student will be able to use the main estimation, filtering, and prediction techniques and to formulate, analyze, and search for solutions of optimization problems of different nature by an appropriate use of optimality conditions, with particular emphasis on optimal control problems.

MULTIVARIABLE FEEDBACK CONTROL

This course provides some basic tools for the analysis and control of multivariable linear systems. The student will be able state and solve control problems in a multi-input multi-output environment, with particular emphasis on robust stability and performance.

NONLINEAR SYSTEMS AND CONTROL

To provide a deeper understanding and to extend system analysis and control design methods proposed in the basic courses on linear systems and control to dynamical systems described by multivariable, nonlinear models that are affine in the input.

Final exam

The student will present and discuss the results of a technical activity, producing a written thesis supervised by a professor and showing the ability to master Control Engineering methodologies and/or their application.

AUTONOMOUS AND MOBILE ROBOTICS

The course presents the basic methods for achieving mobility and autonomy in robots. The student will be able to analyze and design architectures, algorithms and modules for planning, control and localization of autonomous mobile robots.

Training

The specific aim is to allow the student to use and expand the bulk of knowledge acquired during the course of study performing some activities in an industrial setting, a company, or a research laboratory.

PROCESS AUTOMATION

The course aims at providing basic concepts and methodologies related to process automation, such as internal model control, control of time-delay linear systems, model predictive control.

MACHINE LEARNING

The course goal is to provide expertise on machine learning methods, including supervised and unsupervised techniques and using probabilistic representations and modeling.