![Università di Pavia logo] UNIVERSITÀ DI PAVIA

Anno Accademico 2018/2019

ADVANCED AUTOMATION AND CONTROL	
Anno immatricolazione	2018/2019
Anno offerta	2018/2019
Normativa	DM270
SSD	ING-INF/04 (AUTOMATICA)
Dipartimento	DIPARTIMENTO DI INGEGNERIA INDUSTRIALE E DELL'INFORMAZIONE
Corso di studio	INDUSTRIAL AUTOMATION ENGINEERING - INGEGNERIA DELL'AUTOMAZIONE INDUSTRIALE
Curriculum	PERCORSO COMUNE
Anno di corso	1°
Periodo didattico	Annualità Singola (01/10/2018 - 14/06/2019)
Crediti	9
Ore	84 ore di attività frontale
Lingua insegnamento	English
Tipo esame	SCRITTO E ORALE CONGIUNTI
Docente	FERRARA ANTONELLA (titolare) - 3 CFU ANNASWAMY ANURADHA MANDAYAM - 1 CFU CIARAMELLA GABRIELE - 1 CFU RAIMONDO DAVIDE MARTINO - 2 CFU RAIMONDO DAVIDE MARTINO - 2 CFU
Prerequisiti	Basic knowledge on algorithms. System and control theory for linear systems.
Obiettivi formativi	The course is structured into two modules: Industrial Automation and Nonlinear Systems. The goal of the Industrial Automation module is to let students familiarize with basic techniques for process planning and management. In particular, methods and algorithms of management science for modelling and solving complex decision problems will be presented. The goal of the Nonlinear Systems module is to discuss methods for the analysis of nonlinear systems using tools from system

and control theory. Theory will be illustrated by means of examples from, e.g., mechanical engineering, electrical engineering and aeronautics. In addition, techniques for the synthesis of feedback regulators for nonlinear systems will be introduced.

Programma e contenuti	Industrial Automation module

Industrial Automation module

AUTOMATION OF PRODUCTION PROCESSES. Modelling of production processes. Flexible production systems. Management science. Operations research for decision problems.

MATHEMATICAL PROGRAMMING FOR DECISION PROBLEMS. Modelling of decision problems: variables, cost and constraints. Basics of convex programming. Examples of decision problems including product mix, resource allocation, transport and portfolio selection problems.

LINEAR PROGRAMMING (LP) PROBLEMS. Geometry of LP. Fundamental theorem of LP. Algorithms for LP problems. The simplex method: phase 1 and 2. Tableau form of the simplex method. Interior Point method.

Sensitivity analysis.

MIXED-INTEGER LINEAR PROGRAMMING (MILP). The use of binary variables in optimization programs. Branch and bound algorithm.

OPTIMIZATION PROBLEMS ON GRAPHS. Basics of computational complexity theory. Shortest spanning tree problem: Kruskal's algorithm. Shortest path problem: Dijkstra's and Floyd-Warshall algorithms. Flow networks: maximum flow problems and Ford-Fulkerson algorithm. Project planning: AOA models and the critical path method. PERT analysis. Dynamic programming: Bellman principle, cost-to-go and Bellman iterations. Application of dynamic programming to optimal control of finite state machines and shortest path problems.

Dynamic programming applied to mobile robotics.

Nonlinear Systems module

INTRODUCTION TO NONLINEAR PHENOMENA. Multiple equilibria, limit cycles, complex dynamics and chaos. Existence and uniqueness of state trajectories.

ANALYSIS OF SECOND-ORDER SYSTEMS. The phase plane: classification of equilibria. Lymit cycles and Poincaré-Bendixon theorem.

STABILITY THEORY. Lyapunov functions: theorems for checking stability and instability of equilibria. Global stability analysis. LaSalle theorems. Stability for time-varying systems.

NONLINEAR CONTROL. Methods based on Lyapunov functions.

	Backstepping techniques. Sliding Mode Control.
Metodi didattici	Lectures (hours/year in lecture theatre): 68 Practical class (hours/year in lecture theatre): 0 Practicals / Workshops (hours/year in lecture theatre): 0
Testi di riferimento	Recommended textbooks for Industrial Automation (IA) and Nonlinear Systems (NL) modules W. L. Winston, M. Venkataramanan. Introduction to Mathematical Programming: Applications and Algorithm. 4th ed., Duxbury Press, 2002. (IA). C. Vercellis. Ottimizzazione: Teoria, metodi, applicazioni. McGraw-Hill, 2008. (IA - in Italian). J.-J. E. Slotine, W. Li. Applied nonlinear control. Prentice-Hall, 1991. (NL). H.K. Khalil. Nonlinear systems - third edition. Prentice-Hall, 2002. (NL). S. Sastry. Nonlinear systems - Analysis, Stability and Control. Springer-Verlag, 1999. (NL).
Modalità verifica apprendimento	Closed-book, closed-note written exam. Both knowledge of theory and skills in solving simple exercises will be tested.
Altre informazioni	Closed-book, closed-note written exam. Both knowledge of theory and skills in solving simple exercises will be tested.
Obiettivi Agenda 2030 per lo sviluppo sostenibile	$lbl_legenda_sviluppo_sostenibile