INGEGNERIA INFORMATICA (LM75)

(Lecce - Università degli Studi)

Insegnamento SISTEMI MULTI-AGENTE E RETI DI ROBOT

GenCod A006811

Docente titolare GIANFRANCO PARLANGELI

Insegnamento SISTEMI MULTI-AGENTE E RETI DI ROBOT **Anno di corso** 2

Insegnamento in inglese MULTI-AGENT SYSTEMS AND ROBOTIC NETWORKS **Lingua** ITALIANO

Settore disciplinare ING-INF/04 **Percorso** Automazione per applicazioni industriali

Corso di studi di riferimento INGEGNERIA INFORMATICA

Tipo corso di studi Laurea Magistrale **Sede** Lecce

Crediti 9.0 **Periodo** Secondo Semestre

Ripartizione oraria Ore Attività frontale: 81.0 **Tipo esame** Orale

Per immatricolati nel 2022/2023 **Valutazione** Voto Finale

Erogato nel 2023/2024 **Orario dell'insegnamento** https://easyroom.unisalento.it/Orario

BREVE DESCRIZIONE DEL CORSO

This course offers a broad overview of fundamental and emerging topics in the area of control and systems theory. Applications are illustrated in the fields of robotics, multi-agent systems and cyber-physical systems. It is aimed at providing principles and tools to state and solve optimal control problems eventually seeking distributed control architectures in several technological systems, and the solution is sought both analitically through direct computation and also numerically with the aid of a suitable software (Mathworks Matlab is used in the course).

PREREQUISITI

Sufficiency in calculus, linear algebra, systems and signals, systems theory.

OBIETTIVI FORMATIVI

Learning Outcomes; after the course the student should be able to:
(**Conoscenze e comprensione**) Describe and explain the main peculiarities (both advantages and disadvantages) of the classical and modern control theory considered in the course.
(**Capacità di applicare conoscenze e comprensione**)+ (**Abilità comunicative) + (Autonomia di giudizio)** Be aware of, describe and explain practical problems of controlling complex systems, and how to overcome these drawbacks using modern approaches.
(**Capacità di applicare conoscenze e comprensione**)+ (**Capacità di apprendimento)** For a given practical problem at hand, the student should be able to state a control problem in a natural mathematical setting, eventually seeking distributed architectures, based on the problem assumptions.
(**Capacità di applicare conoscenze e comprensione**) +(**Abilità comunicative) + (Autonomia di giudizio)** Starting from a theoretical formulation of a problem, the student should be able to build a simulation framework to find a computer-aided solution of the stated mathematical problem with the use of a suitable software.
(**Abilità comunicative)+**(**Capacità di apprendimento)** Willing students may develop a project on an application of interest where to apply the methodologies developed along the course.

METODI DIDATTICI

Lezioni frontali svolte in aula dal docente tramite l'ausilio di gesso e lavagna. Nel corso delle lezioni saranno occasionalmente illustrati e discussi software commerciali.

MODALITA' D'ESAME	The exam is a written exam and an oral discussion, and it is aimed to determine to what extent the student has: 1) the ability to identify and use data to formulate responses to well-defined problems, 2) problem solving abilities to seek an analytical solution. Additionally, willing students may have a seminar or a project on an application of interest where the methodologies of the course are applied.
PROGRAMMA ESTESO	Introduction. Mathematical background and connections with other courses (4 hours). Background on Systems theory and linear algebra. Jordan form of a matrix. Linear systems, unforced response and forced response. Exponential and raise to a power of a square matrix. Stability of a linear system and Lyapunov Equation. (12 hours). Linear systems controllability and observability. Eigenvalues placement through state feedback. Kalman decomposition of a linear system (7 hours). Introduction to optimal control. Functionals. as a tool for control design, extremum seeking techniques. The LQ optimal control problem. (5 h) Multi agent systems: an introduction. Examples, main definitions. Centralized architectures vs decentralized ones. Supervisory control, distributed control. (4 hours).Some notions of Graph theory. Dynamical systems over graphs. (10 hours). The importance of consensus in various emerging fields. Consensus protocols. Consensus networks. Analysis of consensus within a multi-agent dynamical system. (6 hours). Consensus problems for directed graphs. Leader-follower multi-agent systems. Symmetries and equitable partitions (3 hours). Directed weighted graphs: a model for consensus networks and cyber-physical systems. Analysis, properties. Differences between directed weighted graphs and undirected weighted graphs. Examples (7 hours). Misbehaving nodes and intruders in a collaborative network . System zeros and output-nulling inputs. Rosenbrock's system matrix. Unobservable zeros and transmission zeros. (5 hours).
TESTI DI RIFERIMENTO	Bullo, F. *Lectures on Network Systems*, with contributions by J. Cortes, F. Dorfler and S. Martinez, Kindle Direct Publishing, 2018.