COURSE DESCRIPTION
SYSTEMS AND CONTROL FUNDAMENTALS

SSD: AUTOMATICA (ING-INF/04)

DEGREE PROGRAMME: TRANSPORTATION ENGINEERING AND MOBILITY (P55)
ACADEMIC YEAR 2022/2023

COURSE DESCRIPTION

TEACHER: SANTINI STEFANIA
PHONE: 081-7683914
EMAIL: stefania.santini@unina.it

GENERAL INFORMATION ABOUT THE COURSE

INTEGRATED COURSE: NOT APPLICABLE
MODULE: NOT APPLICABLE
CHANNEL: FG A-Z
YEAR OF THE DEGREE PROGRAMME: I
PERIOD IN WHICH THE COURSE IS DELIVERED: SEMESTER I
CFU: 9

REQUIRED PRELIMINARY COURSES

none

PREREQUISITES

Basic knowledge of analysis of linear dynamical systems. Software tools for analysis and simulation of dynamical systems.

LEARNING GOALS

This engineering course introduces to the theory and practice of feedback control and provides a glimpse into the subject. The final aim is to learn the basics of systems analysis and control design. Feedback control is a remarkably pervasive engineering principle. Feedback control uses sensor data (e.g. position, velocity, acceleration) to adjust or correct actuation (e.g. steering angle, motor acceleration). The subject is an uncommonly compelling example of mathematical theory guiding practical design. Hence, the training objective is to introduce students to the design and the analysis of mathematical models and their use for the prediction of the dynamic behavior of

linear and non-linear systems, as well as for deriving control algorithms.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)

Knowledge and understanding

The course provides the methodological tools to provide the bases of theory, methodology, and technology for the development of intelligent algorithms for the modeling, analysis, and control of dynamical systems. The teaching is structured in such a way as to develop the skills needed for designing, developing, and testing control systems with specific applications to ITS (Intelligent Transportation Systems) and CCAM (Cooperative, Connected, and Automated Mobility). Particular attention is paid to proposing practical experiences of the concepts learned.

Applying knowledge and understanding

The course delivers the ability and tools needed to apply the knowledge in practice and introduces to the theory and practice of feedback control fostering the ability to use methodological tools to design and develop control architectures. The Matlab / SimulinK software will be used to support the controllers design and to verify the achieved performance.

COURSE CONTENT/SYLLABUS

1. Introduction
2. Mathematical Foundations
3. Systems fundamentals:

•Models for linear Dynamical Systems.
• State-Space models.
• Analysis Methods
• Stability of linear systems
• Analysis and Design Methods for Nonlinear Systems.
• Stability analysis of non-linear systems. Linearization. Lyapunov Theory; Case Studies.
• Software for Modeling and Simulating dynamical Systems.

4. Linear Control fundamentals:

•Introduction to control; Motivating examples; Definition of a control problem.
• Single-input, single-output control essentials.
• From open- to closed-loop control architectures.
• Robustness issue with respect to additive disturbances.
•State Feedback Control and control tuning via Pole-Placement technique.
• State Observers. Combining state feedback control with an observer.
• Output Feedback control: PID and Relè Control.

5. Applications to ITS and CCAM
6. Computer-aided control systems design:

•Software for modeling and simulating Control Systems.

READINGS/BIBLIOGRAPHY

Textbooks: Gene F. Franklin, J. David Powell, Abbas Emami-Naeini, Feedback Control of Dynamic Systems (Inglese), ISBN-10 : 0133496597
Lecture notes available on the teachers' websites.

TEACHING METHODS OF THE COURSE (OR MODULE)

The teaching activities will be organized as follows: a) lectures for about 60% of the total hours, b) practical exercises in the classroom (about 40% of the total hours) also based on the software Matlab (https://www.mathworks.com/). The final part of the Course activities follows an interactive approach where students, divided in teams, are encouraged to take advantage of the learned tools to successfully tackle and solve a specific problem posed by the latest technological developments in the field of intelligent and connected transport systems.

EXAMINATION/EVALUATION CRITERIA

a) Exam type

- [x] Written
- [x] Oral
- [ ] Project discussion
- [ ] Other

In case of a written exam, questions refer to

- [x] Multiple choice answers
- [x] Open answers
- [x] Numerical exercises

b) Evaluation pattern

The evaluation is obtained according to the scores achieved by the student during the written and oral part of the exam when the ability to leverage the software Matlab for modelling and control design will be also tested