



UNIVERSITÀ DI PISA
DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE
Dottorato di Ricerca in Ingegneria dell'Informazione

Doctoral Course

“Analysis and Control of Dynamical Systems: a State Space Approach”

Prof. Mario Innocenti

Dipartimento di Ingegneria dell'Informazione (retired)
Università di Pisa

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Short Abstract: The objective of the course is to provide the students with a comprehensive background on the analysis and control of continuous dynamical systems, using a state variable approach in the time domain. The analysis will overview nonlinear dynamics from a qualitative geometric point of view, and advantages/disadvantages of linearization. The full systemic solution of linear systems is addressed, using linear algebra background. Control approaches are based on full state as well as output (static and dynamic) feedback in the deterministic domain. A brief introduction of optimal control is included. Numerical worked examples will accompany the mathematical material.

Course Contents in brief:

- Part 1: Motivation, main definitions, examples of nonlinear systems (fixed point computation, vector fields), linearization (review of Taylor series and power series).
- Part 2: Linear systems solution, state transition matrix, Cayley-Hamilton theorem, role of eigenvalues and eigenvectors. Structural properties. Numerical examples
- Part 3: Full state feedback (regulation, servomechanism), eigensystem assignment, static and dynamic output feedback state reconstruction.
- Part 4: Optimal control generalities, linear quadratic regulator, Riccati equation and its relationship with Lyapunov stability, robustness of the closed loop system.

Total hours of lecture: 16 hours (4 credits)

References:

[1] Class notes

CV of the Teacher

Mario Innocenti received the Laurea degree in Aeronautical Engineering from the University of Pisa in 1977, and the PhD degree from the School of Aeronautics and Astronautics, Purdue University, Indiana, USA in 1982. From 1982 to 1992 he was assistant and tenured associate professor in the Department of Aerospace Engineering, Auburn University, AL, USA. From 1993 he has been at the University of Pisa as an associate professor until 1999 and full professor since the year 2000. He reached his mandatory retirement in 2022. Mario Innocenti has been a US National Academies Senior Fellow and a visiting professor in several American and European institutions. His main research is in the areas of guidance and control of aerospace and marine systems.

Final Exam: written test

Room and Schedule

Room: *Aula Riunioni del Dipartimento di Ingegneria dell'Informazione, Via G. Caruso 16, Pisa – Ground Floor*

Schedule:

Day1 – June 10, 2025, 14:00 -18:00

Day2 – June 11, 2025, 14:00 -18:00

Day3 – June 12, 2025, 14:00 -18:00

Day4 – June 13, 2025, 14:00 -18:00