



**Course Syllabus for
DAUSY National Ph.D. Program in Autonomous Systems
(year 2022-23)**

Course title	Introduction to modeling, analysis and control of complex systems
Scientific Discipline Sector	ING-INF/04
Hours of instruction	10 hours
CFU	1 CFU
Semester, period	Second semester, march-april 2023
Goal	Understanding the salient features of complex systems is a pressing open problem in science and engineering applications, as testified by the Nobel prize recently awarded to Giorgio Parisi. The aim of this course is to clarify what a complex system is, and what are the tools from dynamical systems theory and graph theory that are essential to understand and control their behavior. The course focuses on select numerical applications with the use of the Matlab/Simulink platform. Examples both from technological and socio-economic applications will be carried out during the lectures, to showcase the potential of the approach in diverse fields of science and engineering.
Syllabus	Definition of a complex systems. Examples: wireless sensor networks; compartmental systems Elements of matrix theory Elements of graph theory Linking graphs and matrices Collective behaviors: consensus dynamics Elements of control of network dynamical systems
Bibliography	- F. Bullo, Lectures on Network Systems, Edizione 1.3, 2019. - M. E. J. Newman, A. L. Barabasi, and D. J. Watts, The structure and dynamics of networks, Princeton University Press, 2006. - Additional references and lecture notes made available by the lecturer Further reading and material: - Siljak, D. D. Decentralized control of complex systems. Courier Corporation, 2011. - A. Barrat, M. Barthelemy, A. Vespignani, Dynamical Processes on Complex Networks, Cambridge University Press, 2008.
Examination method	Oral exam: discussion of a homework / short project