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

Course title	Fault Detection Techniques in Condition Monitoring: Model-Based and Data-Driven Methods
Scientific Discipline Sector	ING-INF/04
Hours of instruction	10 hours
CFU	1 CFU
Semester, period	Second semester, March-April 2023
Goal	This represents an advanced course of Automatic Nonlinear Control and Supervision techniques for complex systems, and it studies advanced elements of a control and fault diagnosis system from the dynamic point of view, by considering nonlinear dynamic processes from their input-state-output and input-output points of view. This course thus aims at presenting those control and supervision methodologies currently required and expected by modern industries and practical application activities. The main goal of the course consists of providing advanced topics and tools for the study, supervision, fault diagnosis and control of complex dynamic systems, as well as their interconnections under proper design constrains imposed by cost, speed, computational cost, robustness, reliability, sustainability, and power consumption.
Syllabus	• Issues in Model-Based Fault Diagnosis • Fault Detection and Isolation (FDI) Methods based on Analytical Redundancy • Model-based Fault Detection Methods • Issues in Model-Based Fault Diagnosis • Model Uncertainty and Fault Detection • The Robustness Problem in Fault Detection • System Identification for Robust FDI • Fault Identification Methods • Modelling of Faulty Systems • Residual Generation Techniques • The Residual Generation Problem • Fault Diagnosis Technique Integration • Fuzzy Logic for Residual Generation • Neural Networks in Fault Diagnosis

	• Residual Robustness to Disturbances • Application Examples
Bibliography	• Simani, S. and Fantuzzi, C. and Patton, R. J., "Model-based fault diagnosis in dynamic systems using identification techniques", Springer-Verlag, 2002. ISBN 1852336854. Advances in Industrial Control Series. London, UK. First Eq. November, 2002. (298 pages). • Chen, J. and Patton, R. J., "Robust Model-Based Fault Diagnosis for Dynamic Systems", Kluwer Academic Publishers, 1999. ISBN: 0792384113. • Slides and support materials from the instructor.
Examination method	The examination is divided in 2 phases that will take place in the same day. • A project regarding the simulation and the control design for a nonlinear system by using the Matlab and Simulink environments, which aims at understanding if the student has the skills in the analysis and the synthesis of a complex process. The time allowed for this test is 1.5 hours. • One test (8 open and multiple choice questions) based on all the topics tackled in the class or on the basic concepts of the course, with the aim of evaluating how deeply the student has studied the subject and how he is able to understand the topics analysed. The time allowed for this test is 0.5 hour.