UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Ingegneria
ACADEMIC YEAR	2023/2024
MASTER'S DEGREE (MSC)	CHEMICAL ENGINEERING
SUBJECT	CHEMICAL AND BIOCHEMICAL PROCESS CONTROL
TYPE OF EDUCATIONAL ACTIVITY	B
AMBIT	50352-Ingegneria chimica
CODE	21900
SCIENTIFIC SECTOR(S)	ING-IND/26
HEAD PROFESSOR(S)	CIPOLLINA ANDREA Professore Ordinario Univ. di PALERMO
OTHER PROFESSOR(S)	
CREDITS	9
INDIVIDUAL STUDY (Hrs)	144
COURSE ACTIVITY (Hrs)	81
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	
YEAR	1
TERM (SEMESTER)	2° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**CIPOLLINA ANDREA** Monday 13:00 14:00 Studio personale Tuesday 13:00 14:00 Studio personale Wednesday 13:00 14:00 Studio personale Thursday 13:00 14:00 Studio personale

DOCENTE: Prof. ANDREA CIPOLLINA

PREREQUISITES	Basic knowledge of chemistry, physics, thermodynamics, transport phenomena, chemical plant design
LEARNING OUTCOMES	Knowledge and understanding skills At the end of the course the student will know: • the dynamic behavior of the basic components of chemical process control systems: both simple and complex processes, gauges, actuators, controllers; • control techniques commonly used in the chemical industry and some advanced control techniques. • some of the main definitions of system stability and some of the methods for its determination; • control schemes commonly used for the most common chemical industry pieces of equipment. • one of the methodologies used for the design of plant-wide control systems. Ability to apply knowledge and understanding The student will have the ability to: • build the dynamic model of simple process systems by applying the fundamental laws of physics and chemistry; • obtain simplified models for process systems using experimental data; • perform the stability analysis for non-controlled and controlled processes; • design control loops for the major process variables of a process or equipment. • use Matlab and Simulink for dynamic process simulation and analysis and design of controllers. These skills will be gained through the presentation and discussion of several examples and the development of several classroom and laboratory exercises. Judgment autonomy Particular attention will be paid to the development of an autonomous capacity for: • analyzing a process from the point of view of its dynamic behavior based on experimental data or a theoretical model; • choosing the most suitable control scheme for a process or equipment; • choosing the most suitable controllers for the most common process variables and evaluating any process changes that can help improve their control. These skills will be gained through the presentation and discussion of several examples and the development of several classroom and laboratory exercises. Communication skills The student will be able to discuss, with language skills, problems related to the dynamics and the control of chemical processes and communicate with scientific and / or technical language both with process or control engineers and instrumentation technicians; This will be achieved mainly through a project that will be concluded with a written report and an oral presentation with slides. Learning ability At the end of the course, the student will be able to deal with more complex dynamic and control problems through an in-depth study of particular processes and non-traditional control techniques. Particular attention will be given during the course to a critical approach in finding the solution to a given problem, using all the knowledge already acquired but also looking for new possibilities in the scientific and technical literature.
ASSESSMENT METHODS	The final assessment will be based on: • a written examination consisting in specific question and practical exercises on the dynamic simulation and control systems design, also via the use of MATLAB and Simulink; • An oral examination, consisting in the presentation of a design project on the dynamic simulation and control systems design for a typical equipment of chemical engineering (that will be assigned to groups, during the course), plus various questions on specific topics covered within the course. The final assessment, properly graded, will be made on the basis of the following conditions: a) sufficient knowledge of subjects and theories addressed in the course; sufficient degree of awareness and autonomy in the application of theories to solve problems (rating 18-21); b) Good knowledge of subjects and theories addressed in the course; fair degree of awareness and autonomy in the application of theories to solve problems (rating 22-25); c) Good knowledge of subjects and theories addressed in the course; good degree of awareness and autonomy in the application of theories to solve problems (rating 26-28); d) Excellent knowledge of subjects and theories addressed in the course;

	excellent level of awareness and autonomy in the application of theories to solve problems (rating 29-30L). As an alternative to the final written exam, interim written checks will be proposed at the end of each of the two modules.
EDUCATIONAL OBJECTIVES	The course aims to provide the basic notions necessary for the analysis of the dynamics of processes and the design of their control systems. A first part of the course is devoted to the development of dynamic models of the most common processes and equipment of the chemical industry. In the second part, the basic concepts of the process control are introduced and the most commonly used techniques for the design of controllers are described. A third part is dedicated to advanced control systems, computer control, the importance of controlling processes for economic optimization, safety of chemical plants, environmental and workers protection. In the tutorials, some examples will be developed, using specific software (MATLAB and its Toolbox) for dynamic simulation and design of control systems.
TEACHING METHODS	Frontal lectures 6 CFU (54 hours) Tutorials 3 CFU (27 hours)
SUGGESTED BIBLIOGRAPHY	D.E. Seborg, T.F. Edgar, D.A. Mellichamp, F.J Doyle III, “Process Dynamics and Control”, 4th Ed., Wiley Global Education UK, 2020.

SYLLABUS

Hrs	Frontal teaching
2	Introduction to Chemical Process Control
4	Dynamic mathematical modeling of chemical processes
4	Dynamics of 1st and 2nd order systems
2	Dynamics of high order systems and dead time
4	Laplace Transform - Transfer Functions
3	Feedback control
5	Dynamic Behavior of feedback controlled systems
4	Tuning of feedback controllers (P, PI, PID)
2	Cascade control - Ratio control
2	Feedforward control
2	Selective Control
3	Stability Analysis
3	Multivariable systems - Interaction of control loops - Decoupling
1	Adaptive control
5	Instrumentation of control loops
4	Control of the main equipment of the chemical industry
4	Dynamic simulation of simple chemical engineering systems

Hrs	Practice
3	Dynamics of 1st order systems
3	Dynamics of 2nd and higher order systems
6	Dynamic mathematical modeling of chemical processes
3	Feedback control and Dynamic behavior of controlled systems
3	Cascade control - Ratio control
3	Feedforward Control
3	Model-based control
3	Multivariable systems - Interaction of control loops - Decoupling