PERSONA CIENCIA EMPRESA
UNIVERSITAT RAMON LLULL

COURSE:
PROCESS CONTROL SYSTEMS

SEMESTER: Process and products engineering
STUDIES: Master in Chemical Engineering

GENERAL CHARACTERISTICS*

Type: ☑ Compulsory
Duration: 1 Semester **Semester**: 1
Number de ECTS credits: 3
Language: English

DESCRIPTION

BRIEF DESCRIPTION AND JUSTIFICATION

This topic provides additional knowledge to that provided in the instrumentation and control of chemical and biological processes grade topic. It introduces new useful techniques on process control and focuses on applying advanced control configuration for chemical processes.

COMPETENCES

CB6: The student has knowledge and understanding of what constitutes a basis or an opportunity to be original by developing and/or applying ideas, often in a research context.
CB7: The student can apply their knowledge and their ability to solve problems in new or unfamiliar environments within broader (or multidisciplinary) contexts related to his/her field of study.
CG1: The student can design, manage, execute and expose a project.
CE3: The student can conceptualize engineering models, apply innovative methods in problem solving and use suitable software for the design, simulation, optimization and process and system control.
CE4: The student has the ability to solve problems that are unfamiliar, incompletely defined, and have contradictory specifications, considering the possible methods of solution, including the most innovative, selecting the most appropriate, being able to correct implementation and evaluating the different design solutions.

PREVIOUS REQUIREMENTS*

Instrumentation and control of chemical and biological processes, basic operations of engineering, transport phenomena, mass balances, differential equations, algebra and Excel® and MATLAB® software.

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CONTENTS

1. Methods of analysis and design for continuous and discrete systems.
   1.1. Introduction and revision of basic concepts
   1.2. Closed-Loop Stability Analysis: Root Locus and sensitivity
   1.3. Open-Loop Stabiity Analysis: Bode and Nyquist Diagrams
   1.4. Systems with deadtime: Smith predictor
   1.5. Design of controllers in discrete systems: Method of Ragazzini-Truxal

2. Single input/output (SISO), single Input/multiple output (SIMO) and multiple input/single output (MISO) systems
   2.1. Feedback control
   2.2. Alternatives to Basic Control (Cascade, Feedforward, Ratio, Override, Selection, Split-range, Inferential, Adaptive)
   2.3. Input-Output Advanced Models: Expert Systems, Fuzzy Logics and Neural Networks

3. Multiple Input – Multiple Output (MIMO) systems
   3.1. Synthesis of alternative control configurations
   3.2. Determination of the degree of interaction: Relative Gain Array
   3.3. Controller design for multivariable systems: Decoupling Modes

4. Control systems strategies in Chemical Engineering
   4.1. Common control loops in reactors
   4.2. Common control loops in distillation columns
   4.3. Strategies of control applied to processes including several units. Control Dynamics using Aspen Hysys.

METHODOLOGY

FORMATION ACTIVITIES*

Formation Activities	ECTS	Competencies
Concept Sessions	0.72	CB6, CB7
Sessions solving exercises, problems and cases	0.30	CB7, CG1, CE3, CE4
Laboratory (PLCs)	0.30	CE3, CE4
Personal study activities of students	1.62	CB6, CB7, CE3, CE4
Evaluation activities (tests, partial exam, final exam)	0.06	CB6
TOTAL	**3.00**	

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TEACHING METHODOLOGY

The topic is mainly taught using theory lectures, which are given using common audiovisual techniques. During the class, the student is allowed to ask any question or clarification if this is required for a better understanding of the concepts explained.
Additionally, several examples and practical problems are also done during the lectures in order to help the students to better understand the concepts. These problems are partly done during the class and partly done at home. The student may ask for help on the schedule of attendance of the professor. At the end of each theme, an on-line test in Moodle is uploaded to check if the students have understood the basic ideas.
All the material provided during the course (power point presentations and a collection of problems) are given to the student through the Moodle platform. This is done to facilitate the attention of the student during the lectures, avoiding time to copy the information of the slides and focusing only on the clarifications and doubts the student could have. The collection of problems are given as a way to practice and assimilate the concepts given in the lectures. Additionally, the student has to solve a series of practical activities related to the content of the lecture working in pairs.

EVALUATION

LEARNING RESULTS

- The student must show an acceptable understanding of the knowledge of the topic [CB6]
- The student must show ability to integrate the different concepts and apply them to solve problems of different complexity [CB7,CG1, CE3, CE4]
- The student must show ability to carry out activities of process control [CG1].

QUALIFICATION

The final mark of this topic is obtained from the following items:

Final exam (Theory):	*20%*
Final exam (Problems):	*20%*
Partial Exam:	*20%*
On-line Tests:	*10%*
Follow up activities	*15%*
Lab (PLCs)	*15%*

- The final exam is divided in two sections: theory and problems. Both parts of the final exam must have a mark equal or superior to 4 points to be evaluated.
- The partial test consists on an exam of themes 1 and 2 and is also divided in two sections: theory and problems, accounting 50% each. There is not any minimum mark to be achieved. The exam is not eliminatory.

- The on-line tests are done at the end of each theme and contain specific basic questions treated during the lectures. There will be four tests and the worst mark will be removed.
- The practices and activities are done in groups of two or three people and are uploaded to Moodle on the dates that are fixed by the professor.
- The lab activity is related to practices with PLCs. A minimum mark of 5 must be attained to pass the subject.

COMPETENCES EVALUATION

The evaluation of the competences is carried out through the items specified in the different methods of evaluation employed.

BIBLIOGRAPHY

1- G. Stephanopoulos, Chemical Process Control: An introduction to Theory and Practice, Ed. Prentice-Hall, 1984.
2- C. L. Smith, Advanced Process Control: Beyond Single-Loop Control, Wiley, 2010.
3- K. Ogata, Ingeniería de Control Moderna, Pearson, 2010.

DOCUMENT HISTORY

PREVIOUS VERSIONS
September 2017 (Dr. F. Llovell)
August 2016 (Dr. F. Llovell)
February 2015 (Dr. E. Barberà)
June 2014 (Dr. E. Barberà)

LAST REVISION
September 2018 (Dr. F. Llovell)