Universitat de Lleida

DEGREE CURRICULUM

FEEDBACK CONTROL

Coordination: CLARIA SANCHO, FRANCISCO

Academic year 2019-20

Subject's general information

Subject name	FEEDBACK CONTROL
Code	14537
Semester	2nd Q(SEMESTER) CONTINUED EVALUATION
Typology	Degree: Master's Degree in Industrial Engineering; Course: 1; Character: OPTIONAL; Modality: Attendance-based
Course number of credits (ECTS)	6
Type of activity, credits, and groups	see table below
Coordination	CLARIA SANCHO, FRANCISCO
Department	COMPUTER SCIENCE AND INDUSTRIAL ENGINEERING
Teaching load distribution between lectures and independent student work	(40%) 60 h classroom (60%) 90 h autonomous work
Important information on data processing	Consult [this link] for more information.
Language	Catalan (40%) Spanish (40%) English (20%)
Distribution of credits	1 ECTS = 10 h classroom + 15 h autonomous work
Office and hour of attention	Arrange tutoring with teacher. Office 1.06 EPS

Typology:

Degree	Course	Character	Modality
Master's Degree in Industrial Engineering	1	OPTIONAL	Attendance-based

Type of activity, credits, and groups:

Activity type	PRAULA	TEORIA
Number of credits	3	3
Number of groups	1	1

Teaching staff	E-mail addresses	Credits taught by teacher	Office and hour of attention
CLARIA SANCHO, FRANCISCO	francisco.claria@udl.cat	0	
RIBO PABLO, JOSE	jose.ribo@udl.cat	6	

Subject's extra information

The optional subject "feedback control" is directed towards students from non-specialized degrees in electrical, electronic and control technologies, receive specific training in their academic curriculum integrates basic principles of Theory of Automatic Control and Industrial Electronics, according to the degree profile "*Industrial Engineer*".

Within the context of the Master, the subject "f*eedback control*", attending classes is taught in the second semester of the first course. Link with the subject "*Systems Engineering*"cursada in the first quarter to the subject of the second year of the master, "*Design of Electronic Systems and Control* ".

This course is divided into two parts:

The first deals with the analysis of physical systems fed back and analyze your response in the time domain and the frequency domain. It is part of the definitions and fundamentals theoretical that the feedback control, especially focused on analysis is based transient response, stability and precision analysis steady state systems.

The second addresses some compensation techniques used in automatic regulation and implementation systems, electronics in the case of continuous systems, and in the case of digital discrete-time systems.

For its development tools typical operational calculus apply to systems continuous and time discrete time, represented both internally and externally. It is assumed that the student has previously acquired and handles with ease the basics differential equations, Laplace transformations and Fourier and techniques analysis of signals and systems, which will be completed in this course with the transformations discrete and difference equations.

Learning objectives

The scope of this subject is very broad. It is considered necessary for students of the master, graduates in different fields of electrical, electronic and control technology, acquire Automatic Regulation own knowledge of the powers provided for graduates Master Industrial Engineer.

In short, it is intended that the student is able to,

- Mastering the techniques of modeling systems that allow internal representació and external.
- Simulate using appropriate simulation tools behavior systems real physical.
- Identify physical variables involved in industrial Processes and their assessment and measurement.
- Apply technical analysis of feedback systems using the appropriate tools time domain and the frequency domain.
- Compensators design analog systems in the time domain and the domain the frequency.
- Designing digital compensators suitable for controlled physical systems digital computers.

Competences

General competences set in ORDEN CIN/311/2009 and EPS criteria,

- **CG1** Capacity of planning and organizing the personal work.
- **CG3** Capacity to convey information, ideas, problems and solutions both to a specialised and no specialised public.
- **CG4** Capacity to conceive, design and implement projects and/or provide new solutions, using the tools that the engineering offers.
- **CG6** To have suitable knowledge of the scientific and technological issues of: mathematical, analytical and numerical methods in engineering, electrical engineering, energetic engineering, chemical engineering, mechanical engineering, mechanics of continuous means, industrial, electronics, automation, manufacture, material, quantitative methods of management, industrial,computing, urbanism, infrastructures, etc

Specific competences set in ORDEN CIN/311/2009

- **CE7** Capacity to design electronic and industrial instrumentation systems.

Cross-disciplinary competences approved by the Plenary Commission of the Degrees of Industrial Engineering, Computer Engineering and Building Engineering, gathered in June 16th, 2008

- **CT1** Appropriate skills in oral and written language.
- **CT3** Mastering ICT's.

Subject contents

THEME 1. Introduction to feedback control systems.

- Fundamentals of dynamic systems. Basic concepts. Temporal evolution.
- Linearity in system dynamics. Laplace transform.
- Representation and classification systems. External and internal description. State space of dynamical systems.
- Representation in continuous time or discrete time.
- Open loop systems and closed loop systems.
- Transfer function of a control system of continuous time.
- Topology block diagrams or flow signal.
- Sampling theorem. Reconstruction in discrete time. Z-transform transfer function of discrete-time systems.

THEME 2. Analysis of continuous-time systems and discrete time.

- Modeling and simulation of dynamic systems: mechanical, hydraulic, electrical and thermal.
- Linearization of nonlinear models.
- Simulations. Linear dynamic systems in continuous time external and internal description.
- Time response. Sources Test.Sistemes first order. Second order systems.
- Specifications transient response.
- Higher order systems.
- Transient response of discrete systems. Control system discrete-time closed loop.
- Absolute stability of nonlinear systems. Stability in continuous time systems. Stability of discrete-time systems.
- Steady state analysis. Error steady state.
- The locus of the roots. Classical rules of construction of the root locus continuous time and discrete time.
- Correspondence between the plane S and Z. plan

THEME 3. Frequency analysis of systems with feedback.

- Frequency response of continuous-time systems.
- Representation of the frequency response.

- Nyquist stability criterion. Conformal transformation.
- Relative stability. Phase margin and profit margin.
- Frequency response of discrete-time systems.
- Characterization of the frequency response.

THEME 4. Design of Control Systems in continuous and discrete time.

- Design of closed loop control. Controller design in the time domain and the frequency domain. General features.
- Design of regulators by the method of root locus.
- Compensation phase lead networks.
- Compensation phase delay networks.
- Compensation belatedly networks advancement.
- Proportional control. Integral control action proportional integral action. Proportional integral control.
- Derivative control action. Proportional derivative control.
- Block diagram of the discrete control. PI control, PD and PID.

THEME 5. Design of Control Systems in the frequency domain.

- Introduction.
- Compensation phase lead networks.
- Compensation phase delay networks.
- Compensation networks belatedly phase lead.
- Relationship between frequency response and specifications in the time domain.
- Normalized profit. Phase margin and maximum overshoot.
- Cutoff frequency and speed of response time.
- Discretization of compensating frecuenciales

THEME 6. Implementation of Electronic Control Systems

- Introduction to analog control circuits.
- The operational amplifier.
- Basic circuits with operational amplifiers.
- Control systems with operational amplifiers.
- Nonlinear applications of operational amplifiers.
- Discrete-time control microcontrollers

Methodology

- **Lectures:** In the lectures the contents of the subject are presented by teachers without the active participation of students.
- **Colloquia:** activities consist exchange of views among students under the direction of teacher.
- **Group work**: Learning activity to be conducted through collaboration between members of a group.
- **Written work:** consisting of the submission of a written document activity.
- Problem-based Learning as problem-based learning method of promoting from selected real-life problems learning is used.
- **Troubleshooting:** In the problem-solving activity, the teacher presents a complex issue that students must solve, either working individually or in teams.
- **Project development:** active teaching methodology that promotes learning from the realization of a project idea, design, planning, development and evaluation.
- **Practices:** Let you apply and configure a practical level, the theory of a field of knowledge in a particular context.

Development plan

Week	Methodology	Topic	Lecture hours	Autonomous work hours
1-2	Lecture	THEME 1	8	12
3	Lecture. Simultation Problems resolution	THEME 1	4	6
4-5	Lecture	THEME 2	8	12
6	Lecture. Simultation Problems resolution	THEME 2	4	6
7-8	Lecture. Simultation Problems resolution	THEME 1-2-3	8	12
9	Written test evaluation	**THEME 1-2-3**	2	
10-11	Lecture	THEME 4	8	12
12	Lecture Simultacion Problems resolution	THEME 5-6	4	6
13-14	Lecture. Simultation Problems resolution	THEME 5-6	8	12
15	Simultation Problems resolution	THEME 6	4	6
16	Written test evaluation	THEME 4-5-6	2	

Evaluation

Evaluation activities	%	Dates	C/V (1)	I/G (2)	Remarks
PA1: Written exam	30	Week 9	C	I	1 or more points
PA2: Written exam	50	Week 17	C	I	2,5 points or more
PA3: Proposed work	20	Before each evaluation	C	I	
PA5: Voluntary work			V		Could increase by 10% the final evaluation note.
PA6:Recovery exam		Week 19			

C: Compulsory; V: Voluntary

I: Individual; G: Group.

Bibliography

REFERENCES

- Sistemas de Control Automático. Benjamin Kuo. Prentice Hall
- Ingeniería de Control Moderna. Katsuhiko Ogata. Prentice Hall.
- Teoría de Control. Diseño Electrónico. Gomariz. Edicions UPC
- Linear Control System Analysis and Design with MATLAB. John D'Azzo. Dekker
- Modern Control Systems Analysis and Design Using MATLAB. Bishop. Addison- Wesley
- Linear Systems Control, deterministic ans stochastic methods. Hendricks. Springer
- Sistemas de Control de Procesos. Aplicación, Diseño y Sintonización. Shinskey. McGraw Hill
- Classical Feedback Control with Matlab.Lurie.TKFeBOOK