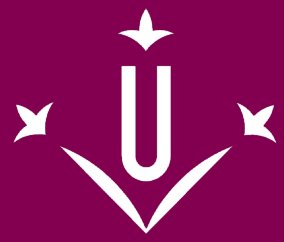

Universitat de Lleida

DEGREE CURRICULUM

DYNAMIC AND CONTROL SYSTEMS

Coordination: GARCIA RODRIGUEZ, ISAAC ANTONIO

Academic year 2017-18

Subject's general information

Subject name	DYNAMIC AND CONTROL SYSTEMS
Code	14543
Semester	2nd Q(SEMESTER) CONTINUED EVALUATION
Typology	<table><tr><th>Degree</th><th>Course</th><th>Typology</th><th>Modality</th></tr><tr><td>Master's Degree in Industrial Engineering</td><td>2</td><td>OPTIONAL</td><td>Attendance-based</td></tr></table>
ECTS credits	6
Groups	1GG
Theoretical credits	3
Practical credits	3
Coordination	GARCIA RODRIGUEZ, ISAAC ANTONIO
Department	MATEMATICA
Teaching load distribution between lectures and independent student work	40% classroom 60% homework
Important information on data processing	Consult this link for more information.
Language	English
Distribution of credits	3 theoretical credits and 3 practical credits.
Office and hour of attention	Office 1.11 EPS

Teaching staff	E-mail addresses	Credits taught by teacher	Office and hour of attention
GARCIA RODRIGUEZ, ISAAC ANTONIO	garcia@matematica.udl.cat	3	By appointment
GINE MESA, JAUME	gine@matematica.udl.cat	1,5	By appointment
GRAU MONTAÑA, MARIA TERESA	mtgrau@matematica.udl.cat	1,5	By appointment

Subject's extra information

The first part of the subject is devoted to provide a basis of equations and differential systems, stability and qualitative theory. Later, the subject specializes in control theory and students develop some of the applications of this theory.

We recommend a good basis for the subjects of first year courses Calculus and Linear Algebra. The course requires continuous work throughout the semester to achieve their goals. It is also necessary critical thinking and capacity for abstraction.

Learning objectives

Students will be introduced into the most common techniques to analyze differentiable mathematical models and apply the control theory. The course is primarily designed to provide the rudiments of the theory of differential equations and control theory, with particular emphasis on applications of methods for solving practical problems. It is a specialized course on the principles of the subject before entering into the reading of more specific texts. In this course we will study differential processes, qualitative theory and geometric tools for studying and control dynamical systems.

The needed background: It is recommended to review the concepts and basic techniques of mathematical analysis and linear algebra and a certain basis of the elementary methods in differential equations.

Learning objectives:

- To know how to solve correctly linear control problems.
- To know and to apply the qualitative theory to real cases.
- To know methodologies for the design of optimal control and to apply them to study cases.

Competences

General competences
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.

Specific competences
CE1 Knowledge and capacity for the analysis and design of systems of generation, transportation and distribution

of electrical energy.
CE6 Knowledge and capacities that allow to understand, analyse, exploit and manage the different energy sources.
CE8 Capacity to design and project automated production and advanced process control systems.
CE14 Knowledge and skills to carry out verification and control of installations, processes and products.
CE23 Capacity for research development and technological innovation management.

Cross-disciplinary competences
CT1 Appropriate skills in oral and written language.
CT2 Command of a foreign language.

Subject contents

Chapter 1. Differential equations of first order.

1. General concepts.
2. Existence and uniqueness theorems.
3. Solutions containing parameters.
4. Extension of solutions.
5. Some basic methods of integration.
6. Equations unresolved with respect to the derivative.
7. Singular solutions.

Chapter 2. Higher order differential equations.

1. Existence and uniqueness theorems.
2. Simple cases of reduction of order.
3. Linear differential equations.
4. Linear differential equations with constant coefficients.
5. Integration of differential equations by series.

Chapter 3. Systems of differential equations.

1. General concepts.
2. Phase space and first integrals.
3. Systems of linear differential equations with constant coefficients.

Chapter 4. Theory of stability.

1. General concepts.
2. Simple types of singular points.
3. The second method of Liapunov.
4. Analysis of stability at first approximation.

Chapter 5. Qualitative analysis in the plane.

1. Planar dynamical systems.
2. Limit sets.
3. Periodic orbits. Limit cycles.
4. The center problem.
5. Bifurcation theory.

Chapter 6. Linear control systems

1. Controllability.
2. Algebraic equivalence.
3. Observability.
4. Linear Feedback.

Chapter 7. Stability and control

1. Input-Output Stability.
2. Stabilization by linear feedback.
3. Linearization of systems of nonlinear control.

Chapter 8. Optimal control

1. Hamiltonian method.
2. The linear regulator.
3. Theory of Pontryagin.

Methodology

This course consists of **Lectures**, **Resolution of problems** and some **Practices** with the help of a computer.

Lectures: The lectures will present content, demonstrate some of the key results and also will emphasize learning objectives.

Resolution of problems: These classes are designed for problem solving and discussion of specific points that the student must first work independently.

Practices: I The practices are developed with the help of computer.

Development plan

Timing of the contents of the subject:

Week	Metodology	Syllabus	Presential hours	Hours of autonomous work
1-2	Lecture	Chapter 1	4	6
1-2	Resolution of problems	Chapter 1	4	6
3-4	Lecture	Chapter 2, 3	4	6
3-4	Resolution of problems	Chapter 2, 3	4	6
4	Delivery (list of problems)	Chapters 1,2,3		
5-6	Lecture	Chapter 4	4	6
5-6	Resolution of problems	Chapter 4	4	6
7-8	Lecture	Chapter 5	4	6
7-8	Resolution of problems	Chapter 5	4	6
8	Delivery (list of problems)	Chapters 4,5		
9-10	Lecture	Chapter 6	4	6
9-10	Resolution of problems	Chapter 6	4	6
11-13	Lecture	Chapter 7	6	9
11-13	Resolution of problems	Chapter 7	6	9
14-15	Lecture	Chapter 8	4	6

14-15	Resolution of problems	Chapter 8	4	6
16	Delivery (list of problems)	Chapters 6.7.8		
16	Practices	Chapters 6.7,8	2	3
16	Test Evaluation and delivery of project	Chapters 1-8	2	

Chapter 1. Differential equations of first order. (Weeks 1, 2)

Chapter 2. Higher order differential equations. (Week 3)

Chapter 3. Systems of differential equations. (Week 4)

Chapter 4. Theory of stability. (Weeks 5, 6)

Chapter 5. Qualitative analysis in the plane. (Weeks 7, 8)

Chapter 6. Linear control systems (Weeks 9, 10)

Chapter 7. Stability and control (Weeks 11, 12, 13)

Chapter 8. Optimal control (Weeks 14, 15, 16)

Evaluation

Activities	Percentage	%	Dates	Remarks
Delivery (list of problems)		25	Week 4	
Delivery (list of problems)		25	Week 8	
Delivery (list of problems)		25	Week 16	
Test Evaluation/Delivery of project		25	Week 18	To take into consideration the delivered exercises the mark on the test **must be at least 4** over 10.
Retest Evaluation		25	Week 19 & 20	

Bibliography

Basic Bibliography

I.A. GARCIA, Teoría de estabilidad y control, Col·lecció Eines, UdL, 2005.

Recommended Bibliography

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C. CHICONE Ordinary differential equations with applications, Texts in Applied Mathematics 34, Springer 1999.

L. ELSGOLTZ, Ecuaciones diferenciales y cálculo variacional. Ed. Mir, 1977.

J. HALE and H. KOCAK, Dinamics and bifurcations, Texts in Applied Mathematics 3, Springer 1991.

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A. KISELIOV, M. KRASNOV, G. MAKARENKO, Problemas de ecuaciones diferenciales ordinarias. Ed. Mir, 1984.

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M. TENENBAUM, H. POLLARD, Ordinary Differential Equations. Ed Dover, New York, 1985.