Course Syllabus

Subject	SISTEM DYNAMICS, MODELLING AND SIMULATION IN ENGINEERING		
Degree	INDUSTRIAL ENGINEERING INTERNATIONAL SEMESTER		
	TRANSVERSAL COURSE FOR THE SEVEN BACHELOR'S DEGREES TAUGHT IN INDUSTRIAL ENGINEERING		
Code	75002		
Semester	Second semester		
Type	Optional		
ECTS credits	6		
Lenguage	English		
Teaching staff (contact information)	*Name*	*Location*	*email*
	Margarita Mediavilla	*Departamento de Ingeniería de Sistemas y Automática. EII. 144L*	*marga@eii.uva.es*
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Departments	*Departamento de Ingeniería de Sistemas y Automática* (Systems Engineering and Automatic Control)		

1. Sense of the Course

1.1 Contextualization

Engineers must deal with an industrial, economic, social and environmental reality that requires making decisions based on knowledge subject to a high degree of uncertainty. System dynamics is a tool that enables recognizing the main trends and dynamic relationships that exist in real life problems and helps engineers and other professionals in the task of setting numbers and mathematical models to everyday questions.

1.2 Relationship with other subjects

This subject is related to modelling and simulation in engineering, but offers a different perspective, since it's applied to non-engineering as well as to engineering problems and offers a wide perspective not limited to physical laws. Its mathematical background is based on differential equations but its knowledge is not needed to follow the subject (apart from basic numerical calculus). It can be of interest for students of social, economic, health sciences, etc. as well as students of technical degrees.

1.3 Recommended Prior Knowledge

Basic knowledge of numerical calculus (differentiation, integration, numerical functions, etc.)

2. Competences

2.1 Generic competences

CG1. Capacity of analysis and synthesis.
CG2. Capacity to organize plan.
CG3. Capacity of oral expression.
CG4. Capacity of written expression.
CG5. Capacity to learn and work autonomously.
CG6. Capacity to solve problems.
CG7. Capacity of critical/logical reasoning.
CG8. Capacity to apply knowledge.
CG9. Capacity to work in a team.
CG11. Capacity of creativity and innovation.
CG13. Capacity to act ethically and with social compromise.
CG14. Capacity to evaluate.

2.2 Specific competences

Knowledge and capacity of systems modelling and simulation.

Capacity to apply modeling techniques based on system dynamics and control theory to technological, economical, social and natural systems modelling.

3. Course goals

- Know the basis of system dynamics modeling
- Modeling systems of different nature qualitative in a and quantitative form
- Capacity to analyze the dynamics that appear in systems subject to feedback.
- Capacity to analyze the effects of non-linearity and delays in dynamic systems.
- Apply modeling techniques to technological, economic, social and natural systems.
- Work in group and in autonomously.
- Organize and plan time.
- Apply critical reasoning.

4. Learning Units

Unit 1: System Dynamics Modeling and Simulation

Workload in credits ECTS: 6

a. Course goals

- Know the basis of system dynamics modeling
- Modeling systems of different nature qualitative in a and quantitative form
- Capacity to analyze the dynamics that appear in systems subject to feedback.
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b. Contents

1. Dynamic models applied to technological, social, economic, natural systems.
2. Elements of system dynamics: stocks, flows, information and material flows, inputs, outputs, feedback and delays.
3. Basic structures.
4. Analysis methods in system dynamics
5. Examples of application of system dynamics to business, environmental and social systems.

c. Bibliography

SYSTEM DYNAMICS: THEORY AND PRACTICAL EXERCISES. JUAN MARTIN-GARCÍA. Juan Martín García, 2012. ISBN 84-607-9304-4

BUSINESS DYNAMICS: SYSTEMS THINKING AND MODELING FOR A COMPLEX WORLD / JOHN D. STERMAN McGraw-Hill Education, 2000. ISBN-10: 0071179895, ISBN-13: 978-0071179898

DYNAMIC MODELING FOR BUSINESS MANAGEMENT AN INTRODUCTION / BERNARD MCGARVEY, BRUCE HANNON Springer;. 2004, 2014, ISBN-10: 1475778651 ISBN-13: 978-1475778656

MODELING DYNAMIC ECONOMIC SYSTEMS / MATTHIAS RUTH, BRUCE HANNON, Springer; 2014, ISBN-10: 3319307649, ISBN-13: 978-3319307640

MODELING THE ENVIRONMENT/ ANDREW FORD, Island Press; 2009. ISBN-10: 1597264733, ISBN-13: 978-1597264730

d. Timing

ECTS CREDITS	EXPECTED DEVELOPMENT PERIOD
6	Weeks 1 to 14

5. Teaching and Learning Methods

Explanation of theoretical contents and practical cases with the participation of students.
Case study based on the description of classic models.
Cooperative design of models between students and teacher.
Game sessions based on systems dynamics models that show human behavior in response to feedback and complexity.
Practical exercises of modeling in group and individual and simulation with Vensim software in computer laboratory.

6. Dedication of the student to the subject

PRESENTIAL ACTIVITIES	HOURS	NON PRESENTIAL ACTIVITIES	HOURS
Sessions of theory and practical cases	26	Autonomous work on theoretical contents	20
Computer simulation	30	Autonomous work on practical contents	20
Work presentations	4	Carrying out of assignments and reports.	45
		Preparation of evaluation	5
Total presential	**60**	**Total non presential**	**90**

7. Activities evaluated and grading system

INSTRUMENT	WEIGHT IN FINAL CALIFICATION	OBSERVATIONS
Individual assignments	60%	Based on three or four assignments of modeling exercises.
Group assignment	40%	Based on the construction of a model of a complex problem by a large group of students (4-6 students group)

8. Additional Considerations

- **Ordinary evaluation:** via individual and group assignments
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- **Extraordinary evaluation:** Students who do not pass the evaluation through assignments have the right to be evaluated via an exam that will be both theoretical and practical.