Guide of the subject

Subject	SYSTEM DYNAMICS, MODELLING AND SIMULATION IN ENGINEERING		
Topic	SYSTEMS ENGINEERING		
Module	International Semester. Engineering School		
Degree	International Semester EII		
Plan	900	**Code**	75002
Dates	February – June (second semester)	**Type**	OPTIONAL
Cicle	International Semester EII	**Course**	4º
ECTS	6 ECTS		
Languaje	ENGLISH		
Professors	Margarita Mediavilla Pascual Fernando Tadeo Rico		
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Optional tutorials	Margarita Mediavilla, Fernando Tadeo: contact by email to confirm place and time.		
Department	Ingeniería de Sistemas y Automática. (Systems Engineering and Automatic Control)		
Fecha de revisión por la Comisión de Relaciones Externas	5 July 2024		

1. Situation / Meaning of the subject

1.1 Context

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 that reality and helps engineers and other professionals in the decision taking processes.

1.2 Relation 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 Requirements

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

2. Competences

2.1 General

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 Especific

CE21 Comprehension of the quantitative methods, algorithms, optimization, queue theory, decision taking, modelling and simulation, validation in the field of industrial, economic and social systems.
COp4. Capacity to analyze the dynamics of hybrid systems with imprecise information of different sources.
COp5. Capacity to apply the system dynamics modeling techniques and control theory to the modeling of technological, economic, social and natural systems.

3. Objectives

- 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. Dedication of the student to the subject

ON-SITE ACTIVITIES	HOURS	HOMEWORK ACTIVITIES	HORAS
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 on-site	**60**	**Total not on-site**	**90**

5. Thematic blocks

Block 1: System Dynamics

Work load in ECTS: 6

a. Context

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b. Learning objectives

Know the basic element of system dynamics modelling and be able to use it.

c. 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. Model validation
6. Examples of application of system dynamics to business, environmental and social systems.

d. Teaching methods

Explanation of theoretical contents and practical cases with the participation of students. Practical exercises and simulations with the software Vensim in the laboratory.

e. Work plan

Weeks 1 and 2. Theory sessions: introduction and basic notions of system dynamics. Practical sessions: introduction to the Vensim program and examples.

Weeks 3, 4 and 5: Sessions of theory: basic elements of system dynamics modelling, model structure, stocks, flows, feedbacks. Practical sessions: elaboration of simple models and causal diagrams.

Weeks 6, 7 and 8: Sessions of theory: behaviour patterns and its corresponding models. Practical sessions: elaboration of the first models of students (first assignments).

Weeks 9, 10 and 11: Sessions of theory: archetype models, scenario generation, decision taking. Practical sessions: models of stocks and sales management, models of populations' dynamics.

Weeks 12, 13, and 14: Practical sessions: work on final project.

Week 15: finalization and presentation of the final Project.

f. Evaluation

Individual assignments (70%) group assignment (30%).

g. Bibliography

Autor Martín García, Juan
Título System Dynamics: theory and practical exercises
Publicac Barcelona : Juan Martín García, 2012
ISBN 84-607-9304-4

BUSINESS DYNAMICS: SYSTEMS THINKING AND MODELING FOR A COMPLEX WORLD / JOHN D. STERMAN

DYNAMIC MODELING FOR BUSINESS MANAGEMENT: AN INTRODUCTION / BERNARD MCGARVEY, BRUCE HANNON

MODELING DYNAMIC ECONOMIC SYSTEMS / MATTHIAS RUTH, BRUCE HANNON

MODELING THE ENVIRONMENT/ ANDREW FORD

i. Resources needed

6. Schedule

BLOC	ECTS	PERIOD
SYSTEM DYNAMICS	6	weeks 1-15

7. Evaluation

INSTRUMENT	Weight in final grade	OBSERVATIONS
Practical exercise (week 5)	70%	
Practical exercise (week 8)		
Practical exercise (week 10)		
Practical exercise (week 12)		
Final group project (week 15)	30%	

CALIFICATION
• **First summons:** individual assignments 70%, group project 30% • **Second summons:** written theoretical and practical exam 100%

8. Final considerations

Calendar and schedule
Consult the EII website https://www.eii.uva.es/alumnos/foreign/timetable_International_Semester.pdf