



Project of the subject

Subject	SISTEM DYNAMICS, MODELLING AND SIMULATION IN ENGINEERING		
Topic	SYSTEMS ENGINEERING		
Module	International Semester. Engineering School		
Degree	International Semester EII		
Plan		Code	75002
Dates	February – June (second semester)	Type	OPTIONAL
Cicle	International Semester EII	Course	4º
ECTS Credits	6 ECTS		
Lenguaje	ENGLISH		
Profesors	Margarita Mediavilla Pascual Luis Javier Miguel González Fernando Tadeo		
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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 real life problems and helps engineers and other professionals in the task of setting numbers and mathematical models to everyday questions.

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 Specific

CE25. Knowledge and capacity of systems modelling and simulation.

COPT10. Capacity to apply modeling techniques based on system dynamics and control theory to technological, economical, social and natural systems modelling.





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. 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.

5. Teaching methods and methodological principles

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. Table of students dedication

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

7. Evaluation

INSTRUMENT	WEIGHT IN FINAL CALIFICATION	OBSERVATIONS
Individual assignments	70%	Based on three or four assignments of modeling exercises.
Group assignment	30%	Based on the construction of a model of a complex problem by a group of students.



CALIFICATION CRITERIA

- **Ordinary evaluation:** via individual and group assignments
 - ...
- **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.
 - ...

8. Final Considerations





Bloc 1: System Dynamics

Work load in ECTS:

a. 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.

b. Learning objectives

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

c. Contents

6. ems.

d. Teaching methods

Explanation of theoretical contents and practical cases with the participation of students. Practical exercises and simulations with the software Vensim and MATLAB 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: behavior 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: Sessions of theory: system identification and model validation. Practical sessions: work on final project.

Week 15: finalization and presentation of the final Project.

f. Evaluation

Individual assignment (50%) group assignment (50%).

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 Springer;. 2004, ISBN-10: 1475778651 ISBN-13: 978-1475778656

MODELING DYNAMIC ECONOMIC SYSTEMS / MATTHIAS RUTH, BRUCE HANNON

MODELING THE ENVIRONMENT/ ANDREW FORD

i. Resources needed

Añada tantas páginas como bloques temáticos considere realizar.





6. Schedule

BLOC	ECTS	PERIOD
SISTEM DYNAMICS	6	weeks 1-15

7. Evaluation

INSTRUMENT	Weight in final grade	OBSERVATIONS
Practical exercise (week 5)	10%	
Practical exercise (week 8)	10%	
Practical exercise (week 10)	15%	
Practical exercise (week 12)	15%	
Final group project (week 15)	50%	

CALIFICATION
<ul style="list-style-type: none">• First summons: individual assignments 50%, group project 50%<ul style="list-style-type: none">○ ...• Second summons: individual assignments 50%, written exam 50%<ul style="list-style-type: none">○ ...

8. Final considerations