

[MSA003] Digital twins for Energy Systems

GENERAL INFORMATION

Studies	MASTER DEGREE IN SMART ENERGY SYSTEMS		Subject	Modelling and Simulation of energy systems
Semester	1	Course	1	Mention / Field of specialisation
Character	COMPULSORY		Language	ENGLISH
Plan	2022	Modality	Face-to-face	Total hours
Credits	4,5	Hours/week	0	68 class hours + 44.5 non-class hours = 112.5 total hours

PROFESSORS

GOIKOETXEA ARANA, ANDER
GONZALEZ JIMENEZ, DAVID

REQUIRED PREVIOUS KNOWLEDGE

Subjects	Knowledge
(No specific previous subjects required)	(No previous knowledge required)

LEARNING RESULTS

LEARNING RESULTS	KC	SK	AB	ECTS
MSR011 - Analyse, model and simulate the dynamic behaviour of multivariable energy systems for the implementation of digital twins.	x	x		2,48
MSR012 - Using data pre-processing tools in the field of energy	x		x	1,54
MSR171 - Ability to work in multidisciplinary teams and in a multilingual environment	x		x	0,16
MSR222 - Exhibits, argues and defends the results obtained in the work carried out before a panel of judges			x	0,08
MSR251 - Develops a project in the field of energy systems in a practical application context		x		0,24
			Total:	4,5

KC: Knowledge or Content / SK: Skills / AB: Abilities

SECONDARY LEARNING RESULTS

RMS101 [!] *Analizar, modelar y simular el comportamiento dinámico de sistemas energéticos multivariables para la implementación de gemelos digitales*

LEARNING ACTIVITIES

	CH	NCH	TH
Development and writing of records, reports, presentations, audiovisual material, etc. on projects/work experience/challenges/case studies/experimental investigations carried out individually and/or in teams	8 h.	6 h.	14 h.
Personal study and flexible development of concepts and subjects using active dynamics, to foster more meaningful learning		8 h.	8 h.
Conducting tests, giving presentations, presenting defences, taking examinations and/or doing checkpoints	5 h.		5 h.
Computer simulation exercises, individually and/or in teams	8 h.	4 h.	12 h.
Presentation by the teacher in the classroom, in participatory classes, of concepts and procedures associated with the subjects	14 h.		14 h.
Practical work in workshops and/or laboratories, individually and/or in teams	9 h.		9 h.

EVALUATION SYSTEM

	W
Reports on the completion of exercises, case studies, computer exercises, simulation exercises, laboratory exercises, term projects, challenges and problems	17%
Presentation and defence of exercises, case studies, computer practical work, simulation practical work, laboratory practical work, term projects, end of degree project, master's thesis, challenges and problems	33%
Individual written and/or oral tests or individual coding/programming tests	50%

MAKE-UP MECHANISMS

Reports on the completion of exercises, case studies, computer exercises, simulation exercises, laboratory exercises, term projects, challenges and problems

Individual written and/or oral tests or individual coding/programming tests

CH - Class hours: 44 h.
NCH - Non-class hours: 18 h.
TH - Total hours: 62 h.

RMS102 [!] *Utilizar herramientas de preprocesado de datos en el ámbito de la energía*

LEARNING ACTIVITIES	CH	NCH	TH
Development and writing of records, reports, presentations, audiovisual material, etc. on projects/work experience/challenges/case studies/experimental investigations carried out individually and/or in teams	8 h.	9 h.	17 h.
Conducting tests, giving presentations, presenting defences, taking examinations and/or doing checkpoints	2 h.	1 h.	3 h.
Computer simulation exercises, individually and/or in teams	8 h.	4,5 h.	12,5 h.
Presentation by the teacher in the classroom, in participatory classes, of concepts and procedures associated with the subjects	6 h.		6 h.

EVALUATION SYSTEM	W	MAKE-UP MECHANISMS
Reports on the completion of exercises, case studies, computer exercises, simulation exercises, laboratory exercises, term projects, challenges and problems	17%	Reports on the completion of exercises, case studies, computer exercises, simulation exercises, laboratory exercises, term projects, challenges and problems
Presentation and defence of exercises, case studies, computer practical work, simulation practical work, laboratory practical work, term projects, end of degree project, master's thesis, challenges and problems	33%	Individual written and/or oral tests or individual coding/programming tests
Individual written and/or oral tests or individual coding/programming tests	50%	

CH - Class hours: 24 h.
NCH - Non-class hours: 14,5 h.
TH - Total hours: 38,5 h.

RMS171 [!] *Es capaz de trabajar en equipos multidisciplinares y en un entorno multilingüe*

LEARNING ACTIVITIES	CH	NCH	TH
Development and writing of records, reports, presentations, audiovisual material, etc. on projects/work experience/challenges/case studies/experimental investigations carried out individually and/or in teams		4 h.	4 h.

EVALUATION SYSTEM	W	MAKE-UP MECHANISMS
Reports on the completion of exercises, case studies, computer exercises, simulation exercises, laboratory exercises, term projects, challenges and problems	100%	(No mechanisms)

CH - Class hours: 0 h.
NCH - Non-class hours: 4 h.
TH - Total hours: 4 h.

RMS222 [!] *Expone, argumenta y defiende ante un tribunal los resultados obtenidos en el trabajo desarrollado*

LEARNING ACTIVITIES	CH	NCH	TH
Development and writing of records, reports, presentations, audiovisual material, etc. on projects/work experience/challenges/case studies/experimental investigations carried out individually and/or in teams		2 h.	2 h.

EVALUATION SYSTEM	W	MAKE-UP MECHANISMS
Reports on the completion of exercises, case studies, computer exercises, simulation exercises, laboratory exercises, term projects, challenges and problems	100%	(No mechanisms)

CH - Class hours: 0 h.
NCH - Non-class hours: 2 h.
TH - Total hours: 2 h.

RMS251 [!] *Desarrolla un proyecto del ámbito de los sistemas energéticos en un contexto de aplicación práctica*

LEARNING ACTIVITIES

CH

NCH

TH

Development and writing of records, reports, presentations, audiovisual material, etc. on projects/work experience/challenges/case studies/experimental investigations carried out individually and/or in teams

6 h.

6 h.

EVALUATION SYSTEM

W

MAKE-UP MECHANISMS

Reports on the completion of exercises, case studies, computer exercises, simulation exercises, laboratory exercises, term projects, challenges and problems

100%

(No mechanisms)

CH - Class hours: 0 h.
NCH - Non-class hours: 6 h.
TH - Total hours: 6 h.

CONTENTS

Introduction to digital twins

Definition and evolution of digital twins
 Digital twin components: models and data

Physics-based dynamic models

Electric systems
 Electronic systems
 Fluid systems
 Mechanical systems
 Thermal systems

Data processing tools

Data visualization
 Centrality measures
 Distributions
 Linear regression
 Interpolation

Coursework: Digital twin of electric scooter

LEARNING RESOURCES AND BIBLIOGRAPHY

Learning resources

Bibliography

Class presentations
 Moodle Platform

Acceso online a bibliografía: <https://labur.eus/EjP7v>