Asignatura: Systems analysis applied to civil engineering

1. General overview

UPM Code	Credits	Type	Specialization	Language
	4.5	Optional	Hydraulics, energy and environment	English

Name in Spanish	Análisis de sistemas aplicado a la ingeniería civil
Subject	Systems analysis applied to civil engineering
Department	Hydraulics, energy and environment
Web page	
Semester	First semester

2. Teaching staff

Name	Group	Office hours	Place	E-mail address
Juan Ignacio Pérez Díaz	All	J y V, 11:00-14:00	Lab. De ingeniería eléctrica	*ji.perez@upm.es*

3. Previous knowledge

Linear Algebra

Applied mathematics

4. Assigned competences

Code	Competence
CE-A1	Scientific-technical and methodological qualification for the design, analysis, planning, operation and maintenance of civil works
CE-A7	Knowledge and ability to devise innovative solutions in civil engineering systems.
CE-A8	Ability to devise innovative and sustainable for operation and management of civil engineering systems.
CG5	English language usage
CG8	Planning and organization
CB6	Possess and understand knowledge that provide a basis to be original in the development and application of ideas in a research context
CB7	Ability to apply the acquired knowledge and to resolve problems in new or barely known environments within wider contexts (or multidisciplinary) related to the area of knowledge
CB9	Communicate conclusions and knowledge to different types of audiences in a clear and concise manner
CB10	Learning abilities that allow the students to continue studying in a self-managed or autonomous manner

5. Learning results

Code	Learning results (RA)	Competences linked
RA1	Formulates and solve optimization problems in the area of civil engineering systems	CE-A1, CE-A7, CE-A8, CG8, CB7
RA2	Analyzes and understands optimization algorithms published in the technical and scientific literature.	CE-A1, CE-A7, CE-A8, CG5, CB6, CB9, CB10

6. Indicators of achievement

Code	Basic	Indicators of achievement	RA linked
IL1	Yes	Formulates optimization problems in the area of civil engineering systems.	RA1
IL2	Yes	Solves linear programming problems in the area of civil engineering systems with the help of different optimization softwares.	RA1
IL3	Yes	Solves integer programming problems in the area of civil engineering systems with the help of different optimization softwares.	RA1
IL4	Yes	Solves nonlinear programming problems in the area of civil engineering systems with the help of different optimization softwares.	RA1
IL5	Yes	Solves dynamic programming problems in the area of civil engineering systems with the help of different optimization softwares.	RA1
IL6	Yes	Analyzes and understands research articles related with the development and application of optimization algorithms to solve problems of civil engineering systems.	RA1, RA2
IL7	No	Applies optimization algorithms recently published in the scientific literature to solve problems of civil engineering systems.	RA1, RA2

NOTE. Basic: Indicator that must be achieved to pass the subject.

7. Evaluation methods and criteria

Code, name of evaluation methods, brief description of evaluation methods, criteria, place and period of evaluation	Weight

7.1. Evaluation through "continuous assessment"

EI1. Attendance and participation — **20%**

Description: Attendance and participation in the lectures.

Evaluation criteria: It will be ranked from 0 to 10 points, proportionally to the percentage of lectures attended and to the participation of the student.

Place and period: The attendance control will be carried out in the classroom during all lectures.

EI2. Resolution of practical exercises — **40%**

Description: Students shall submit several exercises related to the contents of the lectures of the first thematic block of the course.

Evaluation criteria: Exercises will be graded from 0 to 10 points, according to the degree of fulfillment of the objectives of the first thematic block of the course (block I). E.I 2 grade will correspond to the arithmetic mean of the exercises grades.

Place and period: The exercises will be done outside the class time.

EI3. Comprehensive exam — **20%**

Description: At the end of block I, students must take a comprehensive exam (test) about the lectures given since the beginning of the course.

Evaluation criteria: Exams will be graded from 0 to 10 points. The exam grade will be calculated as the average of the score of all questions.

Place and period: The exam will be done in the classroom during the class time.

EI4. Technical report (TR) — **20%**

Description: Students shall elaborate a technical report related to one or more of the lectures of the second thematic block of the course (block II). The report may be presented either in written form or in an oral session.

Evaluation criteria: Technical reports will be graded from 0 to 10 points, according to the skills for analysis, discussion and drawing conclusions, demonstrated by the students in their respective reports.

Place and period: The final work will be done outside the class time.

Result of the evaluation through "continuous assessment"

The final score will be the weighted average of the results obtained in the evaluation items 1 to 4, previously described. The course will be passed if the final score is equal or greater than 5.

7.2. Evaluation through "final exam only"

There is no final exam in this course.

8. Course content

Units, sections and descriptors	Indicator of achievement linked
Topic 1. Formulation of optimization problems	IL1
Topic 2. Linear programming	IL1, IL2
Topic 3. Integer linear programming.	IL1, IL3
Topic 4. Nonlinear programming.	IL1, IL4
Topic 5. Optimization models with GAMS.	IL1-IL4
Topic 6. Dynamic programming.	IL5
Topic 7. Multi-objective optimization.	IL6
Topic 8. Stochastic dynamic programming.	IL1, IL5-6
Topic 9. Applications.	IL6, IL7

9. Description of teaching methodology

Theory lessons:

The teacher will explain the concepts necessary to understand the course contents in order for the student to achieve the expected indicators. The teacher will use appropriate practical examples and logical reasoning to develop the scientific and technical abilities of the student. The participation of students will be encouraged by means of discussions on the taught topics.

Practice lessons:

Practice lessons will be aimed at solving exercises and case-studies. Practice lessons are intended as a correlation between the content of theory lessons and engineering practice, in order for the student to achieve the ability to apply the acquired knowledge in the future career. A special emphasis will be put on the use of commercial software tools.

Laboratory classes:

Tutorials of the optimization software used in the course will be given during practice lessons.

Independent work:

As indicated in section 7, in case of choosing continuum assessment, the student shall submit several practical exercises related with the contents taught during the sessions.

Group work:

There is no group work in the course.

Office hours:

Office hours are intended as a complement for the students to ask questions on the course content. The students can attend to office hours on the places and hours indicated above, as well as ask their questions by email.

10. Bibliography and resources

Basic bibliography:

Bertsekas, D.P., Dynamic Programming: Deterministic and Stochastic Models. Prentice-Hall, 1987

Castillo, E. et al., Building and solving mathematical programming models in engineering and science. Wiley, 2002.

Revelle, C.S. et al., Civil and environmental systems engineering. New Jersey, Prentice Hall, 1997.

Rosenthal, R.E., GAMS - A user's guide. GAMS Development Corporation, Washington DC, USA, 2008. (http://www.gams.com/)

Complementary bibliography:

Several complementary readings are uploaded in Moodle periodically.

Web resources:

Web site of the course, virtual platform (MOODLE).

Specific equipment:

Library of the laboratory of electrical engineering (EICCP).

Table 1. Time schedule

Week (see Note 1)	Theory lessons	Practice lessons	Laboratory classes	Independent work	Evaluation activities	Other activities	Hours
	Topic 1			Study Topic 1	Exercise 1 (E.I. 2)		
	3 h			7 h			
	Topic 2			Study Topic 2	Exercise 2 (E.I. 2)		
	4h 30 min			6 h			
	Topic 3			Study Topic 3	Exercise 3 (E.I. 2)		
	2 h 30 min			6 h			
	Topic 4			Study Topic 4	Exercise 4 (E.I. 2)		
	2 h			6 h			
	Topic 5		Topic 5	Study Topic 5	Exercise 5 (E.I. 2)		
	3 h		3 h	10 h			
	Topic 6			Study Topic 6	Exercise 6 (E.I. 2)		
	3 h			7 h			
	Topic 7			Study Topic 7	E.I. 3		
	6 h			3 h			
	Topic 8			Study Topic 8			
	6 h			3 h			
	Topic 9			Study Topic 9 + TR	E.I. 4		
	6 h			3 h + 35 h			
Horas	**36 h**		**3 h**	**86 h**			**125 h**

NOTE 1. Exact dates are shown in the academic calendar.