GUÍA DOCENTE
2025 - 2026

FICHA TÉCNICA DE LA ASIGNATURA

Datos de la asignatura

Nombre completo	Optimization techniques
Código	DOI-DEE-121
Impartido en	Programa de Doctorado en Energía Eléctrica [Sin Curso Doctorado] Programa de Doctorado en Modelado de Sistemas de Ingeniería [Sin Curso Doctorado]
Nivel	Doctorados 99/2011
Cuatrimestre	Semestral
Créditos	3,0 ECTS
Carácter	Obligatoria
Departamento / Área	Departamento de Organización Industrial Escuela Técnica Superior de Ingeniería (ICAI)
Responsable	Alberto Campos y Diego Tejada
Horario	cita previa
Horario de tutorías	cita previa

Datos del profesorado

Profesor	
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Profesor	
Nombre	Francisco Alberto Campos Fernández
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DATOS ESPECÍFICOS DE LA ASIGNATURA

Contextualización de la asignatura

Competencias - Objetivos

Competencias

General competences

1. To learn advanced scientific knowledge and to demonstrate, in a context of scientific and technological research highly specialized, a detailed understanding of theoretical and application aspects and the methodology of work in one or more study fields.
2. To know how to apply and integrate knowledge, the understanding of it, its scientific basis, and problem-solving capabilities in new

and loosely defined environments, including multidisciplinary contexts, both for research and highly specialized professions.

Specific competences

1. To understand the usual optimization techniques and their mathematical principles, and their potential to be used in different contexts.
2. To apply the different existing optimization techniques in the expression of problems and their solution.

Resultados de Aprendizaje

At the end of the course the student must have the following competences:

RA1. Understand where to use and concepts of optimization.

RA2. Become familiar within the several topics where optimization can be applied

RA3. Know how to build an optimization model efficiently

RA4. Achieve mathematical rigorousness

RA5. Understand the mathematical techniques used

RA6. State and solve mockup problems

RA7. Analyze the solutions

RA8. Be prepared to extend their knowledge

RA9. Become familiar with an algebraic language used professionally

BLOQUES TEMÁTICOS Y CONTENIDOS

Contenidos – Bloques Temáticos

Chapter 1. Modeling of Mixed Integer Linear Programming Problems

1. Introduction
2. Typical linear problems modeling
3. Logical conditions linear modelling. Particular functions linear modelling. Piecewise linear approximation. Convex and non-convex regions linear modelling.

Chapter 2. Linear Optimization and Mixed Integer Linear Optimization

1. Graphical simplex method. Algebraic simplex. Tabular form. Duality.
2. Reformulation and solution methods. Branch and bound. Duality gap. Primal-dual interior point method. Special ordered sets linear modelling. Preprocessing. Branch and cut.

Chapter 3. Stochastic optimization

1. Generation expansion planning case study. Manufacturing case study.

2. Decision tree and scenario tree.
3. Two-stage and multistage linear optimization. Hydrothermal coordination problem case study.

Chapter 4. Robust optimization

1. Static Robust Optimization
2. Adaptative Robust Optimization (ARO) for generation expansion planning
3. Comparison with stochastic optimization.

Chapter 5. Decomposition techniques

1. Fixed cost transportation problem.
2. Benders decomposition. Nested Benders decomposition.
3. Dantzig-Wolfe decomposition. Lagrangian relaxation.
4. Additional improvement in decomposition techniques.
5. Stochastic dual dynamic programming.
6. Scenario tree: Characterization and Generation

Chapter 6. Equilibrium Modeling and Nonlinear Programming

1. Definition of nonlinear programs and types
2. Optimality conditions and resolution methods for constrained and unconstrained nonlinear problems
3. Simple equilibrium models and solution techniques. Mixed complementarity problems.
4. Mathematical Problems with Equilibrium Constraints (MPECs) and Equilibrium Problems with Equilibrium Constraints (EPECs) and solution techniques. Diagonalization.

METODOLOGÍA DOCENTE

Aspectos metodológicos generales de la asignatura

Metodología Presencial: Actividades

Lectures (28h): presentation of the contents of the subject.

Public presentation of the assignments (2h)

Metodología No presencial: Actividades

Personal work of the student (30h): study of the contents provided in the master lectures. It requires a deep and critical analysis about modeling aspects of the optimization problems allowing different perspectives and incentivizing creativity and critical thought of the student. Preparing the assignments.

Assignments (30h): improve knowledge of the techniques presented.

EVALUACIÓN Y CRITERIOS DE CALIFICACIÓN

Case studies (80%)

- Practical case statement
- Model development
- Theoretical contribution
- Solution analysis
- Written communication skill
- Teamwork (if done in a team)

Communication skill (15%)

- Oral presentation of the case study

Classroom participation (5%)

- Attendance and active participation in class

BIBLIOGRAFÍA Y RECURSOS

Bibliografía Básica

- Notes prepared by the lecturers (available in SIFO).

Bibliografía Complementaria

- Williams, H.P. (2013) *Model Building in Mathematical Programming*. 5th Edition. Wiley
- Griva, I., Nash, S.G. and Sofer, A. (2008) *Linear and Nonlinear Programming*. 2nd Edition. McGraw-Hill.
- Nemhauser, G.L., Wolsey, L.A. (1999) *Integer and Combinatorial Optimization*. John Wiley and Sons.
- Birge, J.R. and Louveaux, F. (2011) *Introduction to Stochastic Programming*. Springer-Verlag.
- Ramos, A., A. Alonso-Ayuso, G. Pérez (eds.) (2008) *Optimización bajo Incertidumbre* Universidad Pontificia Comillas
- Gabriel, S.A., Conejo, A.J., Fuller, J.D., Hobbs, B.F. and Ruiz, C., 2012. *Complementarity modeling in energy markets* (Vol. 180). Springer Science & Business Media