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[Principal] [Résumé/CV] [Material docente] [Operations Management] [Mathematical Methods] [Operations Research] [Técnicas de Optimización de Sistemas] [Modelado y Simulación de Sistemas] [Applied Optimization] [Statistics II] [Quantitative Decision Methods] [Optimization Techniques] [Deterministic Optimization] [Stochastic Optimization] [Investigación] [TEPES] [ROM] [StarNet] [FLOP] [iMetro]

Operations Research (4th GITI, year 2019-20)

News:

[Operations Research & Analytics](#): enable organizations to turn complex challenges into substantial opportunities by transforming data into information, and information into insights for making better decisions and improving results.

L. Escudero y M.A. López [SEIO y la historia de la IO en España](#) Boletín de Estadística e Investigación Operativa 28 (1): 24-55, Feb 2012

The current table reflects in a realistic way the course development during the several sessions. It allows the student to know in advance what is going to happen in each session in order to prepare the subject and to organize its work adequately.

Date	Theory	Readings	Problems	Practice
Sep 3, 19	<p>Extract of the syllabus. Additional bibliography. Hand out of class notes and web page for slides. Survey (motivation, expectations, difficulty, etc.)</p>	<p>J.R. Alonso Una Universidad nueva El País 12/01/2009</p> <p>M. Bolaños Confidencias de un headhunter Anales de Mecánica y Electricidad (LXXXII) II: 38-40 Mar-Abr 2005</p> <p>M.S. Sodhi What Industry Wants From O.R. Grads OR/MS Today Aug 2005</p>		
Sep 3, 19	<p>LECTURE NOTES about Optimization mathematical modeling.</p>	<p>Operations Research Time Line</p> <p>Energy Systems Modeling (SADSE)</p> <p>esión semiplenaria</p> <p>M. Alvar, A. Arranz, A. Ramos, A. Sánchez, J. Villar Parking.pl</p>	Diet problem.	

Enlaces rápidos



Instituto de Investigación Tecnológica (IIT)



Departamento de Organización Industrial (DOI)



Escuela Técnica Superior de Ingeniería (ICAI)



Universidad Pontificia Comillas

Promoción ICAI 82



Contact





INTRODUCTION TO OPTIMIZATION AND MODELING. OR definition.

Historical introduction.
 Optimization definition.
 Classification of optimization methods. Model and modeling.
 Steps in developing a model.

J. Toczek [The PuzzlOR](#)

A. Ramos [Some IIT Operations Research Models for Electricity Markets](#) XIV Latin Ibero-American Congress on Operations Research (CLAIO 2008) Cartagena de Indias, Colombia September 2008 ([Presentation](#)) S

[ace demand and offer assignment](#) IIT-09-019A

A. Ramos, M.T. Peña, A. Fernández, P. Cucala [Mathematical programming approach to underground timetabling problem for maximizing time synchronization](#) Revista de Dirección, Organización y Administración de Empresas CEPADE 35: 88-95 Junio 2008

S. Cerisola, A. Baillo, J.M. Fernandez-Lopez, A. Ramos, R. Gollmer [Stochastic Power Generation Unit Commitment in Electricity Markets: A Novel Formulation and A Comparison of Solution Methods](#) Operations Research 57 (1): 32-46 Jan-Feb 2009

S. Lumbreras and A. Ramos [Optimal Design of the Electrical Layout of an Offshore Wind Farm: a Comprehensive and Efficient Approach Applying Decomposition Strategies](#) IEEE Transactions on Power Systems (accepted)

P. Sánchez-Martín, A. Ramos, J.F. Alonso [Probabilistic mid-term transmission planning in a liberalized market](#) IEEE

Transactions on Power Systems
20 (4): 2135-2142 Nov 2005

[ROADEF/EURO Challenge
2010: A large-scale energy
management problem with
varied constraints](#)

J.K. Delson and S.M.
Shahidehpour [Linear
Programming Applications to
Power System Economics,
Planning and Operations](#) IEEE
Transactions on Power Systems
(7) 3: 1155-1163 Aug 1992

A. Meric and M.E. Ceyhan
[Operations Research
Applications in Electronic
Commerce: a Literature
Review](#)

J. Board, Ch. Sutcliffe and W.T.
Ziemba [Applying Operations
Research Techniques to
Financial Markets](#) Interfaces
Vol 33. No. 2 pp. 12-24 Mar-
Apr 2003

C. Barnhart, P. Belobaba, A.R.
Odoni [Applications of
Operations Research in the Air
Transport Industry](#)
Transportation Science Vol 37.
No. 4 pp. 368-391 Nov 2003

H.E. Romeijn et al. [A New
Linear Programming Approach
to Radiation Therapy
Treatment Planning Problems](#)
Operations Research (54) 2:
201-216 Mar-Apr 2006

Sep 10, 19 [MODELING WITH LINEAR
PROGRAMMING.](#) Transportation
problem. Transshipment
problem.

Th.A. Grossman [The
Spreadsheet Analytic Value
Chain](#) OR/MS Today Aug 2006

Sep 10, 19	Task assignment problem.		
Sep 11, 19	MODELING WITH INTEGER LINEAR PROGRAMMING. Knapsack problem. Set covering problem. Packing problem. Partition problem. Travelling salesman problem (TSP). Fixed cost problem.	TSP Art	Departmental Computer System
Sep 11, 19		Data Bases. Web server management.	Optimization cases
Sep 17, 19	Disjunctive constraints. Satisfy k of N equations. Selection among N values. Simple implications.		Regional offices.
Sep 17, 19	Equivalences among logical propositions. Complex logical propositions.		
Sep 18, 19		Selecting a basketball team.	
Sep 18, 19			Team formation. Assignment of optimization practices with GAMS. GAMS Development; Optimization: Energy Systems Modeling (SADSE); OR/MS-today Advertisement, August 2009 Algebraic modeling languages. Transportation problem: mathematical formulation and coding in GAMS .
Sep 24, 19			Execution and analysis of the results. Good Optimization Modeling Practices

Practical session with GAMS.
[NEOS Server for Optimization](#)

Sep 24, 19	Gymnastics team. Manufacturing microprocessors.
Sep 25, 19	Factory of electronic parts. Staff Selection
Sep 25, 19	
Oct 1, 19	<p>MULTICRITERIA DECISION MAKING. Multicriteria decision analysis. Pareto efficiency.</p>
Oct 1, 19	<p>Weighted-Sum Method. Epsilon-Constraint Method. Goal Attainment Method.</p>
Oct 2, 19	<p>MOCK EXAM MIDTERM EXAM_year 2014-15 MIDTERM EXAM_year 2012-13 MIDTERM EXAM_year 2011-12 MIDTERM EXAM_year 2010-11 (.TOS) MIDTERM EXAM_year 2009-10 (.TOS) MIDTERM EXAM_year 2009-10 (.MM). MIDTERM EXAM_year 2008-09 (.MM). MIDTERM EXAM_year 2007-08 (.MM).</p>
Oct 2, 19	<p>LECTURE NOTES about Linear Optimization. Mathematical Programming Glossary</p> <p>Linear and Discrete Optimization course from EPFL at coursera.org</p>



LINEAR PROGRAMMING.

[Un español resuelve un problema matemático de hace medio siglo](#) El Mundo 27/05/2010.

[Premio Fulkerson 2015](#) de la Mathematical Optimization Society (MOS) y la American Mathematical Society (AMS)

[iMetro: Subway best route calculator](#)

Oct 8, 19 Hypothesis. Geometry. Properties. Simplex algorithm. Graphical solution. Standard form.

R. Elwes [The algorithm that runs the world](#) New Scientist (2877) Aug 2012

Oct 8, 19 Algebraic solution.

[George B. Dantzig](#), the father of linear programming LP Problem Set ([1](#), [2](#), [3](#), [4](#))

R.W. Cottle [George B. Dantzig: A Legendary Life in Mathematical Programming](#) Mathematical Programming (105) 1: 1-8 Jan 2006

R.W. Cottle [George B. Dantzig: Operations Research Icon](#) Operations Research (53) 6: 892-898 Nov-Dec 2005

J.C. Nash [The \(Dantzig\) Simplex Method for Linear Programming](#) Computing in Science & Engineering (2) 1: 29-31 Jan-Feb 2000

R.E. Bixby [Solving Real-World](#)

[Linear Programs: a Decade and More of Progress](#) Operations Research (50) 1: 3-15 Jan-Feb 2002

Oct 9, 19		LP Problem Set (8 , 9 , 22 , 24)
Oct 9, 19	Multiple optima.	
Oct 15, 19	Degeneracy. Characterizing the solutions. Tabular form.	<p>Practical case report. Hand in of optimization practical cases with GAMS.</p> <p>Comments about the modeling difficulties and GAMS practical case and spent time.</p>
Oct 15, 19	Obtaining an initial basic feasible solution: two-phase method.	
Oct 16, 19	DUALITY. Dual problem. Fundamental properties of duality. Economical interpretation. Graphical interpretation of dual variables and of reduced costs.	<p>Javascript SimpleX PHPSimplex WinQSB, Version 1.0</p>
Oct 16, 19	Sensitivity analysis. Changes in constraint bounds. Change in a coefficient of a non basic variable. Introduction of a new variable. Change in a coefficient of a basic variable. Introduction of a new constraint. Dual simplex method.	
Oct 22, 19	LECTURE NOTES about Mixed integer linear programming.	R.E. Gomory Early Integer Programming Operations Research (50) 1: 78-81 Jan-Feb 2002
		MIP Problem set (2 , 4 , 1)



[INTEGER LINEAR PROGRAMMING.](#) Example case.
Branch and bound method.

[LECTURE NOTES about Nonlinear optimization.](#)



Oct 22, 19

H.W. Kuhn [Being in the Right Place at the Right Time](#)
Operations Research (50) 1:
132-134 Jan-Febr 2002

[Entrevista a Mar Hershenson](#)
Anales de Mecánica y
Electricidad (LXXXII) II: 3-10
Mar-Abr 2005

Modeling NLP.

[NONLINEAR PROGRAMMING.](#)
Introduction. Problems without
constraints: optimality
conditions.

Oct 23, 19

Problems with constraints:
optimality conditions.
Necessary and sufficient
Karush-Kuhn-Tucker
conditions.

Problem set [Inventarios](#),
[Función cúbica con hiperplanos](#),
[Chequeo de puntos](#),
[Objetivo lineal](#),
[Problema 2, 3, 4A, 4B, 4C](#),
[Triatlón](#),
[Función cúbica](#),
[Ciencias de la complejidad](#))

Oct 23, 19

[MOCK EXAM](#)
[MIDTERM EXAM_year 2014-15](#)
[MIDTERM EXAM_year 2012-13](#)
[MIDTERM EXAM_year 2011-12](#)
[MIDTERM EXAM_year 2010-11](#)
(TOS).

[MIDTERM EXAM_year 2009-10](#)
 (.TOS)
[MIDTERM EXAM_year 2009-10](#)
 (.MM)
[MIDTERM EXAM_year 2008-09](#)
 (.MM)
[MIDTERM EXAM_year 2007-08](#)
 (.MM)

[LECTURE NOTES about](#)
[Decision theory.](#)



Oct 29, 19

[DECISION THEORY.](#)
 Decision criteria. Example.

G.M. Fernández and M.C. Escribano [La Teoría de la Decisión: desde sus orígenes hasta comienzos del siglo XIX](#) Boletín de Estadística e Investigación Operativa (30) 3: 292-312, Nov 2014.

[Leonid Hurwicz, Eric S. Maskin y Roger B. Myerson 2007 Nobel Price in Economic Sciences](#) "for having laid the foundations of mechanism design theory"

A. Mas-Colell [Leo Hurwicz, el pionero](#) El País. 21 Octubre 2007

Oct 29, 19 Decision trees. Example.

Oct 30, 19 Bayesian analysis. Example.

Oct 30, 19

DT Problem set ([I+D, Contrato de móvil, Pañuelos, El huerto, El sondeo, Concurso](#))

Nov 5, 19 [LECTURE NOTES about Game theory.](#)

H. Singh [Introduction to Game Theory and Its Application in Electric Power Markets](#) IEEE Computer Applications in Power (12) 4: 18-22 Oct 1999

M. Shubik [Game Theory and Operations Research: Some Musings 50 Years Later](#) Operations Research (50) 1: 192-196 Jan-Feb 2002



[GAME THEORY.](#)

P. Horner [Game Theory: A 'Nobel' Pursuit](#) OR/MS Today (32) 6 Dec 2005

[Aumann's Work in Game Theory Leads to von Neumann Prize](#) OR/MS Today (32) 6 Dec 2005

[Robert J. Aumann and Thomas C. Schelling 2005 Nobel Prize in Economic Sciences](#) "for having enhanced our understanding of conflict and cooperation through game-theory analysis"

[John C. Harsanyi, John F. Nash Jr. and Reinhard Selten 1994 Nobel Prize in Economic Sciences](#) "for their pioneering analysis of equilibria in the theory of non-cooperative games"

John F. Nash [Non-Cooperative Games](#) PhD Thesis. Princeton University. May 1950


A. Meca [Génesis y Evolución de la Teoría de Juegos. Sus Orígenes en España](#) Boletín de Estadística e Investigación Operativa Vol 22 No 1 / Enero 2006

D. Ríos [Varoufakis en los juegos \(no\) olímpicos](#) El País 26-jul-2015

[Game Theory course from Stanford University at coursera.org](#)

[Game Theory courses in Open Education DataBase](#)

Nov 5, 19	Equilibrium on pure and mixed strategies.	GT Problem set (Móviles , Caperucita , Suma nula 3x4 , Suma nula 2x4 , Suma nula 3x5 , Suma nula 4x5)	
Nov 6, 19	Cournot equilibrium. Bertrand equilibrium.		
Nov 6, 19	Cournot equilibrium. Bertrand equilibrium.		
Nov 12, 19	DISCRETE EVENT SIMULATION MODELING Components and Processes. Modeling by Simulation	Simulation Software Survey . OR/MS Today Winter Simulation Conference 2018	J. Banks and R.R. Gibson The ABCs of Simulation Practice Analytics Magazine 16-21 Spring 2009
Nov 12, 19	Simulation languages		Arena Arena Industry Solutions Rockwell Arena simulation 3D - manufacture Rockwell Arena simulation 3D - Bike manufacturer Arena Simulation of Cobequid Blood Clinic
Nov 13, 19			
Nov 13, 19			Arena
Nov 19, 19		Problem set Simulation Questions Class	
Nov 19, 19			Case study development
Nov 20, 19			Case study development
Nov 20, 19	SIMULATION OUTPUT ANALYSIS Finite-Horizon Analysis		
Nov 26, 19	Infinite-Horizon Analysis. Comparison of System Designs		Practice OUT. Preview

Nov 26, 19			Practice OUT. Computer lab
Nov 27, 19			Practice OUT. Computer lab
Nov 27, 19	QUEUEING THEORY Poisson processes	C. Moler The world's largest matrix computation Matlab News & Notes Oct 2002	
Dec 3, 19	Queueing models	Problem set Local administration, Two processors, Download platforms, Printer, Fair, Bank consultations, Boat engines, Classroom computers	Case study report. Hand in of simulation case study.
Dec 3, 19	LECTURE NOTES about Program Evaluation and Review Technique (PERT). 		OpenProject GanttProject Microsoft Project
Dec 4, 19	PROJECT PLANNING AND CONTROL. Critical path. PERT. Introducing costs. Ending date under risk or uncertainty	Problems 4, 5 and 6	
Dec 4, 19		Problems 4, 5 and 6. Problem set Task sequencing, Training course, Seven activities with acceleration cost, Activities with random duration, Investment with randomness	
Dec xx, 19		FINAL EXAM year 2014-15 FINAL EXAM year 2012-13 FINAL EXAM year 2011-12 FINAL EXAM year 2010-11	

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[FINAL EXAM year 2009-10](#)
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[FINAL EXAM year 2008-09](#)
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[FINAL EXAM year 2007-08](#)
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[FINAL EXAM year 2006-07](#)
[\(MM\)](#)

Jun xx, 20

[RESIT EXAM year 2014-15](#)
[RESIT EXAM year 2012-13](#)
[RESIT EXAM year 2011-12](#)
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