



Universidade do Minho
Escola de Engenharia

Programa Doutoral em Engenharia Industrial e de Sistemas (PDEIS)

Doctoral Program in Industrial and Systems Engineering (PDEIS)

Catalogue of Technical Scientific Doctorate Courses

(revised 2012.03.07)

The following doctorate courses are offered:

- Decomposition Methods in Integer Programming
- Approximate methods in Integer Programming and Combinatorial Optimization
- Exact and hybrid methods for Integer Programming
- Semi-Infinite Programming
- Advanced Global Optimization Techniques
- Modeling and Nonlinear Optimization I
- Specific Techniques in Optimization
- Numerical Solution of Partial Differential Equations
- Numerical Solution of ODE and DAE
- Computational Tools in FVM and FEM
- Evolutionary and Genetic Algorithms
- Heuristics Methods
- Multiobjective Optimization
- Multicriteria Analysis Applied to Energy and Environmental Planning
- Project Economic Analysis
- Resource allocation in project management
- Technology, Innovation and Development
- Eco Sustainable Production
- Decision Analysis Models and Methods
- Real Option Analysis
- Advanced Issues on Production Activity Control (AIPAC)
- Engineering and Industrial Management Web Services (EIMWS)
- Total Quality Management
- Energy Planning

If you have any questions concerning the courses or the PhD research topics in your area of interest, contact the corresponding lecturer directly. Other courses may be available upon request to the lecturer. Additional information about PDEIS can be obtained through the

following contact: Alexandra Fernandes (alex@dpi.uminho.pt) or at the PDEIS web page at <http://www.dpi.uminho.pt/Default.aspx?tabid=7&pageid=370&lang=pt-PT>.



Universidade do Minho
Escola de Engenharia

Programa Doutoral em Engenharia Industrial e de Sistemas (PDEIS) Doctoral Program in Industrial and Systems Engineering (PDEIS)

Courses

Doctorate course name:	Decomposition Methods in Integer Programming
Program(s):	Programa Doutoral em Engenharia Industrial e de Sistemas (PDEIS) and Programa Doutoral em Matemática e Aplicações (PDMA)
Semester:	course is offered in the 2nd semester (February through July)
Language:	English or Portuguese
Lecturer(s):	J.M.Valério de Carvalho
Contacts:	vc@dps.uminho.pt
Subject description and objectives	<p>This course is intended for graduate students interested in column generation and its applications. Column generation is a very successful optimization technique for addressing large scale integer programming models that arise from real world applications, in areas such as logistics, transportation, scheduling and manufacturing.</p> <p>It offers an introduction to the theory of decomposition, and covers the implementation of branch-and-price-and-cut algorithms for Cutting Stock (CSP), Bin Packing (BPP), Parallel machine scheduling and Vehicle routing. Other topics, as stabilization, cutting planes, and</p>

	practical issues, as accelerating strategies and heuristics, are also addressed.																
Pre-requisites:	Linear Programming (LP) Duality																
Program:	<table border="0"> <tr> <td>0 - Introduction</td> <td>Structure of course</td> </tr> <tr> <td>1 - Decomposition methods</td> <td>Strength of models in integer programming (IP) Dantzig-Wolfe decomposition (DW) Comparative strength of IP, DW and LP Application Example Lagrangean relaxation Lagrangean relaxation vs. DW decomposition Lower bounds</td> </tr> <tr> <td>2 - Applications</td> <td>Reasons for using decomposition Block angular structure: examples Solving LP relaxations with column generation: Application example: Cutting Stock (CSP) and Bin Packing (BPP) Problems Parallel machine scheduling Vehicle routing</td> </tr> <tr> <td>3 - Branch-and-price algorithms</td> <td>Partition and branching Compatibility between master and sub-problem Coping with changes in sub-problem Application with binary variables: generalized assignment problem Application with binary variables: parallel machine scheduling</td> </tr> <tr> <td>4 - Branch-and-price algorithms (cont.)</td> <td>Application with general integer variables: Arc-flow model for CSP and BPP Application example: cutting stock problem Multiple lengths CSP</td> </tr> <tr> <td>5 - Stabilization</td> <td>Primal and dual perspectives Stabilizing terms: examples Degeneracy and perturbation Perfect Dual Information (Weak and deep) dual-optimal inequalities Application: planar multicommodity flows Application: cutting stock problem</td> </tr> <tr> <td>6 - Practical issues, accelerating strategies and heuristics</td> <td>Pre-processing Master problem Subproblem Branch-and-bound</td> </tr> <tr> <td>7 - Primal cutting</td> <td>Separation and row generation</td> </tr> </table>	0 - Introduction	Structure of course	1 - Decomposition methods	Strength of models in integer programming (IP) Dantzig-Wolfe decomposition (DW) Comparative strength of IP, DW and LP Application Example Lagrangean relaxation Lagrangean relaxation vs. DW decomposition Lower bounds	2 - Applications	Reasons for using decomposition Block angular structure: examples Solving LP relaxations with column generation: Application example: Cutting Stock (CSP) and Bin Packing (BPP) Problems Parallel machine scheduling Vehicle routing	3 - Branch-and-price algorithms	Partition and branching Compatibility between master and sub-problem Coping with changes in sub-problem Application with binary variables: generalized assignment problem Application with binary variables: parallel machine scheduling	4 - Branch-and-price algorithms (cont.)	Application with general integer variables: Arc-flow model for CSP and BPP Application example: cutting stock problem Multiple lengths CSP	5 - Stabilization	Primal and dual perspectives Stabilizing terms: examples Degeneracy and perturbation Perfect Dual Information (Weak and deep) dual-optimal inequalities Application: planar multicommodity flows Application: cutting stock problem	6 - Practical issues, accelerating strategies and heuristics	Pre-processing Master problem Subproblem Branch-and-bound	7 - Primal cutting	Separation and row generation
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	<p>planes</p> <p>Polyhedral approaches Row generation in column generation models: compatibility Application: multicommodity flow problem Super-additive Non-decreasing Functions and Dual Feasible Functions Strengthening column generation models Application: minimization of number of set-ups in CSP</p> <p>8 - Heuristics</p> <p>Quality of models and quality of heuristics Rounding heuristics Local search based on column generation Application: binary multicommodity flows</p>
Bibliography books:	<p>Nemhauser and Wolsey, Integer and Combinatorial Optimization, Wiley Interscience, 1999.</p> <p>Column Generation, Guy Desaulniers, Jacques Desrosiers, and Marius M. Solomon (eds.), Springer, 2005.</p> <p>Ahuja, R. K., Magnanti, T. L., and Orlin, J. B., "Network flows: Theory, Algorithms and Applications". Prentice-Hall, Inc., Englewood Cliffs, New Jersey 07632, 1993.</p> <p>Martello, S., Toth, P., Knapsack Problems: Algorithms and Computer Implementations, Wiley, New York, 1990.</p>
Bibliography papers:	<p>General</p> <p>Barnhart, C., Johnson, E. L., Nemhauser, G. L., Savelsbergh, M. W. P. and Vance, P. H., Branch-and-Price: Column generation for solving huge integer programs, Operations Research, 46 (3), pp.316-329, 1998.</p> <p>Hatem Ben Amor, J.M. Valério de Carvalho, Cutting Stock Problems, in Column Generation, Guy Desaulniers, Jacques Desrosiers, and Marius M. Solomon (eds.), Springer, 2005, XVI, ISBN: 0-387-25485-4</p> <p>A. Frangioni "About Lagrangian methods in integer optimization" Annals of Operations Research 139, p. 163 - 193, 2005</p> <p>Stabilization</p> <p>H O. du Merle, D. Villeneuve, J. Desrosiers, P. Hansen, Stabilized column generation, Discrete Mathematics 194, pp. 229-297, 1999.</p>

J. M. Valério de Carvalho, Using extra dual cuts to accelerate convergence in column generation, *INFORMS Journal on Computing*, 17 (2), pp. 175–182, 2005.

Hatem Ben Amor, Jacques Desrosiers, J.M. Valério de Carvalho, Dual-optimal Inequalities for Stabilized Column Generation, *Operations Research* 54 (3) pp. 454—463, 2006.

Filipe Alvelos, J. M. Valério de Carvalho, An extended model and a column generation algorithm for the planar multicommodity flow problem, *Networks*, 50 (1) pp. 3-16, 2007.

Cláudio Alves, J.M. Valério de Carvalho, Accelerating column generation for variable sized bin-packing problems, *European Journal of Operational Research*, 183 (3) pp. 1333-1352, 2007.

O. Briant, C. Lemaréchal, Ph. Meurdesoif, S. Michel, N. Perrot, F. Vanderbeck, Comparison of bundle and classical column generation, *Mathematical Programming* 113(2) pp. 299–344, 2008.

Ben Amor, J. Desrosiers and A. Frangioni "On the choice of explicit stabilizing terms in column generation", *Discrete Applied Mathematics* 157, pp.1167-1184, 2009.

Dual Feasible Functions

Fekete, S., Schepers, J., New classes of fast lower bounds for bin packing problems. *Mathematical Programming*, 91, pp. 11-31, 2001.

Vanderbeck F., Exact algorithm for minimising the number of setups in the one-dimensional cutting stock problem. *Operations Research* 48(6), pp. 915–26, 2000.

Cláudio Alves, J.M. Valério de Carvalho, A branch-and-price-and-cut algorithm for the pattern minimization problem, *RAIRO Operations Research*, 42, pp. 435-453, 2008.

François Clautiaux, Cláudio Alves, Jose Valério de Carvalho, A survey of dual-feasible and superadditive functions, *Annals of Operations Research*, 179, 1, pp. 317-342, 2010.

	<p>Applications</p> <p>J. M. Valério de Carvalho, Exact solution of bin-packing problems using column generation and branch-and-bound, <i>Annals of Operations Research</i>, 86, pp. 629-659, 1999.</p> <p>J. M. Valério de Carvalho, LP models for bin-packing and cutting stock problems, <i>European Journal of Operational Research</i>, 141 (2) pp. 253--273, 2002.</p> <p>Manuel Pereira Lopes, J. M. Valério de Carvalho, A branch-and-price algorithm for scheduling parallel machines with sequence dependent setup times, <i>European Journal of Operational Research</i>, 176 (3) pp. 1508-1527, 2007.</p> <p>Cláudio Alves, J.M. Valério de Carvalho, A stabilized branch-and-price-and-cut algorithm for the multiple length cutting stock problem, <i>Computers and Operations Research</i>, 35 (4) pp. 1315-1328, 2008.</p> <p>J. Desrosiers, Y. Dumas, M. Solomon, F. Soumis, Time constrained routing and scheduling. In <i>Network Routing</i>. M. Ball, T. Magnanti, C. Monma, G. Nemhauser (eds.), Amsterdam, Elsevier Science: pp. 35-139, 1995.</p>
Grading	<p>The following weights will be considered:</p> <p>Homework (individual assignment involving the computer aided solution of column generation models): 30%</p> <p>Analysis of papers (individual assignment): 30%</p> <p>Final exam: 40%</p>
Other information	



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Courses

Doctorate course name:	Approximate methods in Integer Programming and Combinatorial Optimization
Program(s):	PDEIS (e outros, caso seja aplicável)
Semester:	Second
Language:	English
Lecturer(s):	Filipe Alvelos
Contacts:	falvelos@dps.uminho.pt
Subject description and objectives	<p>Approximate methods are the most successful approaches in providing good-quality solutions in reasonable amounts of time for many relevant practical problems, such as dimensioning and routing in telecommunication networks, production planning and scheduling, transportation and distribution in logistics, among many others.</p> <p>This course deals with the most prominent approximate methods, from greedy heuristics to population based metaheuristics. The aim of the course is to provide tools to allow the student to successfully implement approximate methods in real world problems. Furthermore, this course aims at introducing some recent research topics as the combination of mathematical programming and metaheuristics.</p>
Pre-requisites:	None.

Program:	<p>Modeling in optimization. Easy and difficult problems. Problem specific algorithms and dynamic programming. Mixed integer programming (MIP): compact, pseudo-polynomial and exponential-sized models.</p> <p>Approximation algorithms. Greedy heuristics. Single solution metaheuristics (MHs) based on local search. Population-based metaheuristics. Matheuristics: Integrating MIP and MHs in a common framework. Hybrid metaheuristics: Integrating components of different MHs in a common framework.</p> <p>Applications in production planning and scheduling, network routing and design in logistics and telecommunications, cutting and packing, and natural resources management. Implementing approximate methods in C++.</p>
Bibliography books:	<p>El-Ghazali Talbi, "Metaheuristics, from design to implementation", John Wiley and Sons, 2009.</p> <p>F. Glover, M. Laguna, "Tabu Search", Kluwer, 1997.</p>
Bibliography papers:	<p>F. Alvelos, A. Sousa, and D. Santos: SearchCol: Metaheuristic search by column generation, in "Hybrid Metaheuristics", M. Blesa, C. Blum, G. Raidl, A. Roli, M. Sampels (Eds.), Lecture Notes in Computer Science, Volume 6373, Pages 190-205, DOI: %10.1007/978-3-642-16054-7_14, 2010.</p> <p>C. Blum, A. Roli, "Hybrid Metaheuristics: An introduction", in Hybrid Metaheuristics, C. Blum, M J. J. Aguilera, M. Sampels (Eds.), Springer, 1--31 (2008).</p> <p>G. R. Raidl, J. Puchinger, "Combining (Integer) Linear Programming Techniques and Metaheuristics for Combinatorial Optimization, in "Hybrid Metaheuristics", C. Blum, M J. J. Aguilera, M. Sampels (Eds.), Springer, 1--31 (2008).</p>
Grading	<p>60% project in groups of two elements (from design to implementation of an approximate method);</p> <p>40% final exam (individual).</p>



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Courses

Doctorate course name:	Exact and hybrid methods for Integer Programming
Program(s):	PDEIS (e outros, caso seja aplicável)
Semester:	2nd
Language:	English or Portuguese
Lecturer(s):	Cláudio Alves
Contacts:	claudio@dps.uminho.pt
Subject description and objectives	<p>Integer Programming (IP) is a powerful optimization technique with a wide application spectrum. It has been used since quite a long time to solve many different real problems in the field of industrial and systems engineering.</p> <p>This course starts with an introduction on the basics of Integer Programming, and covers a set of new techniques both at the modeling and algorithmic level. Methods for improving the quality of the models will be explored, along with recent algorithmic approaches based on constraint programming and MIP-based heuristics.</p>

	<p>Applications on routing, packing and integrated planning problems will be explored. These applications will be addressed using software for integer programming.</p>
Pre-requisites:	None
Program:	<p>Linear Programming: formulations, geometry, duality, solution methods, degeneracy, network models (unimodularity and total unimodularity, minimum cost flow problems and variants, network simplex method);</p> <p>Integer Programming models: modeling with binary variables, standard IP models, modeling large-scale problems, quality of the formulations (relaxations, lower and upper bounds, integrality gap, strategies to improve the quality of a formulation);</p> <p>Valid inequalities: superadditivity, maximality, Chvátal-Gomory cuts, dual feasible functions, general cuts based on d-dimensional dual feasible functions;</p> <p>Exact solution methods: dynamic programming, branch-and-bound, branch-and-cut, computational issues;</p> <p>Hybrid solution methods: combining standard solution methods with constraint programming, MIP-based heuristics;</p> <p>Software for Integer Programming.</p>
Bibliography books:	<p>Nemhauser, G., Wolsey, L., Integer Programming and Combinatorial Optimization, John Wiley & Sons, 1999.</p> <p>Michele Milano, Constraint and Integer Programming: Toward a</p>

	Unified Methodology, Springer, 2004.
Bibliography papers:	<p>Integer Programming models</p> <p>Rita Macedo, Cláudio Alves, J. Valério de Carvalho, Arc-flow model for the two-dimensional guillotine cutting stock problem, 37(6):991-1001, 2010.</p> <p>Rita Macedo, Cláudio Alves, J. Valério de Carvalho, François Clautiaux, Said Hanafi, Solving exactly the vehicle routing problem with time windows and multiple routes using a pseudo-polynomial model, submitted, 2010.</p> <p>Valid inequalities</p> <p>Cláudio Alves, François Clautiaux, Jurgen Rietz, J. Valério de Carvalho, New bounds for the vector packing problem, in preparation, 2011.</p> <p>François Clautiaux, Cláudio Alves, Jose Valério de Carvalho, A survey of dual-feasible and superadditive functions, Annals of Operations Research, 179(1):317-342, 2010.</p> <p>Cláudio Alves, J.M. Valério de Carvalho, A branch-and-price-and-cut algorithm for the pattern minimization problem, RAIRO Operations Research, 42:435-453, 2008.</p> <p>Hybrid solution methods</p> <p><u>Hybridizing with constraint programming</u></p> <p>Cláudio Alves, Rita Macedo, J. Valério de Carvalho, New lower bounds based on column generation and constraint programming for the pattern minimization problem, 36(11):2944-2954, 2009.</p> <p><u>MIP-based heuristics</u></p> <p>Raid Mansi, Cláudio Alves, J. Valério de Carvalho, Said Hanafi, An improved hybrid heuristic for the multiple choice multidimensional</p>

	<p>knapsack problem, submitted, 2010.</p> <p>Christophe Wilbaut, Said Hanafi, New convergent heuristics for 0–1 mixed integer programming, European Journal of Operational Research, 195: 62-74, 2009.</p> <p>Fred Glover, Said Hanafi, Metaheuristic Search with Inequalities and Target Objectives for Mixed Binary Optimization Part I: Exploiting Proximity. International Journal of Applied Metaheuristic Computing, 1(1):1-15, 2010.</p> <p>Fred Glover, Said Hanafi, Metaheuristic Search with Inequalities and Target Objectives for Mixed Binary Optimization Part II: Exploiting Reaction and Resistance. International Journal of Applied Metaheuristic Computing, 2(1): 1-17, 2010.</p>
Grading	<p>Individual exercises: 40%</p> <p>Paper reading and presentation: 20%</p> <p>Exam: 40%</p>
Other information	



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Programa Doutoral em Engenharia Industrial e de Sistemas (PDEIS) Doctoral Program in Industrial and Systems Engineering (PDEIS)

Courses

Doctorate course name:	Semi-Infinite Programming
Program(s):	PDEIS and a short course on Emergent Techniques of Optimization
Semester:	First or second semester
Language:	English or Portuguese
Lecturer(s):	A. Ismael F. Vaz
Contacts:	aivaz@dps.uminho.pt www.norg.uminho.pt/aivaz
Subject description and objectives	Semi-infinite programming addresses optimization problems where the variables or constraints (but not both) are present in an infinite number. The main objectives are: to formulate and to classify nonlinear semi-infinite optimization problems; to analyse the first and second order optimality conditions; to apply discretization, interior point and sequential quadratic programming methods; to use specific software tools for semi-infinite programming.
Pre-requisites:	There are not any formal pre-requisites, but some knowledge in nonlinear optimization is a plus.

Program:	<p>1 – Introduction to Semi-Infinite Programming (SIP)</p> <p>2 – First and second order optimality conditions</p> <p>3 – Numerical methods for SIP (discretization, interior point and sequential quadratic programming)</p> <p>4 – Available software for SIP</p>
Bibliography books:	<p>1 - Goberna, M.Á.; López, M.A. (Eds.), <i>Semi-Infinite Programming: Recent Advances</i>, Springer Series: Nonconvex Optimization and Its Applications, Vol. 57, 2001, ISBN: 978-1-4020-0032-4.</p> <p>2 – Reemtsen, R.; Rückmann, J.-J. (Eds.), <i>Semi-Infinite Programming (Nonconvex Optimization and Its Applications)</i>, Springer; 1 edition (April 30, 1998), ISBN-13: 978-0-7923-5054-5.</p>
Bibliography papers:	<p>1 - A.I.F. Vaz, E.M.G.P. Fernandes and M.P.S.F. Gomes. <i>A Sequential quadratic method with a dual parameterization approach to nonlinear semi-infinite programming</i>. Top, 11 (1), 2003, pp. 109-130.</p> <p>2 - A.I.F. Vaz, E.M.G.P. Fernandes and M.P.S.F. Gomes. <i>A quasi-Newton interior point method for semi-infinite programming</i>. Optimization Methods and Software 18(6), 2003, pp. 673-687.</p> <p>3 - A.I.F. Vaz, E.M.G.P. Fernandes and M.P.S.F. Gomes. <i>Robot Trajectory planning with semi-infinite programming</i>. EJOR 53(3), 2004, pp. 607-617.</p> <p>4 - A.I.F. Vaz, E.M.G.P. Fernandes and M.P.S.F. Gomes. <i>SIPAMPL: Semi-Infinite Programming with AMPL</i>. ACM Transactions On Mathematical Software 30(1), 2004, pp. 47-61.</p>
Grading	A project where a practical problem is to be modelled, studied and solved.
Other information	



Universidade do Minho
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Programa Doutoral em Engenharia Industrial e de Sistemas (PDEIS) Doctoral Program in Industrial and Systems Engineering (PDEIS)

Courses

Doctorate course name:	Advanced Global Optimization Techniques
Program(s):	PDEIS (e outros, caso seja aplicável)
Semester:	2 nd semester
Language:	English
Lecturer(s):	Ana Maria A. C. Rocha
Contacts:	Contacts: email: mailto:arocha@dps.uminho.pt tel.: +351 253 604 753 Department: Produção e Sistemas School: Engenharia
Subject description and objectives	<p>This course is intended for graduate students interested in global optimization techniques. The objective of global optimization is to find the absolute best solution of nonlinear optimization models that may have a number of locally optimal solutions. Some example areas of application of global optimization algorithms are: Chemistry, Chemical Engineering, Biology, Medicine, Engineering, Economics and Finance, Operations Research and others.</p> <p>This course offers: deterministic and stochastic global optimization methods; constraint-handling methods. Applications.</p>

Pre-requisites:	
Program:	<ol style="list-style-type: none"> 1. Introduction <ul style="list-style-type: none"> • Local vs global optima • Convex set, convex function 2. Deterministic methods for solving global problems <ul style="list-style-type: none"> • Branch and Bound • Relaxation methods • Enumerative methods 3. Stochastic approaches to Global Optimization <ul style="list-style-type: none"> • Multistart based methods • Controlled Random Search • Simulated Annealing • Particle Swarm optimization • Electromagnetism-like algorithm • Genetic algorithms • Differential evolution 4. Hybrid methods. 5. Constraint-handling methods <ul style="list-style-type: none"> • penalty techniques • Augmented Lagrangian methods • Feasibility and dominance rules • Constraint priority-based ranking. 6. Use of Matlab packages for solving global problems
Bibliography books:	<p>A. Zhigljavsky and A. Zilinskas, Antanasz, <i>Stochastic Global Optimization</i>, Springer Optimization and Its Applications, Vol. 9 , 2008, ISBN: 978-0-387-74022-5.</p> <p>E.M.T. Hendrix and B.G.-Tóth, <i>Introduction to Nonlinear and Global Optimization</i>, in Springer Optimization and Its Applications, Vol. 37, 1st Edition., Springer, 2010.</p> <p>T. Weise, <i>Global Optimization Algorithms – Theory and Application</i>. Germany: it-weise.de (self-published), 2009. [Online]. Available: http://www.it-weise.de/</p>
Bibliography papers:	<p>A.M.A.C. Rocha, Edite M.G.P. Fernandes, <i>Modified movement force vector in a electromagnetism-like mechanism for global optimization</i>, <i>Optimization Methods and Software</i>, Vol 24, N° 2, (253-270) 2009.</p> <p>A.M.A.C. Rocha, Edite M.G.P. Fernandes, <i>Hybridizing the</i></p>

	<p><i>electromagnetism-like algorithm with descent search for solving engineering design problems, International Journal of Computer Mathematics</i>, Vol. 86, Issue 10 & 11, (1932-1946) 2009.</p> <p>A.M.A.C. Rocha, T.F.M.C. Martins, Edite M.G.P. Fernandes, <i>An augmented Lagrangian fish swarm based method for global optimization</i>, Journal of Computational and Applied Mathematics doi:10.1016/j.cam.2010.04.020, 2010.</p> <p>A.M.A.C. Rocha, Edite M.G.P. Fernandes, <i>Feasibility and dominance rules in the electromagnetism-like algorithm for constrained global optimization, Lecture Notes in Computer Science - Computational Science and Its Applications</i> (O. Gervasi et al. (eds.)), Vol. 5073 (768-783) Springer-Verlag 2008.</p> <p>Md.A.K. Azad, Edite M.G.P. Fernandes e A.M.A.C. Rocha, <i>Nonlinear continuous global optimization by modified differential evolution</i>, International Conference of Numerical Analysis and Applied Mathematics 2010, T.E. Simos, G. Psihoyios and Ch. Tsitouras (Eds.), AIP Conference Proceedings ISBN: 978-0-7354-0834-0, Vol. 1281 (955-958) Springer-Verlag 2010.</p> <p>A.M.A.C. Rocha, Edite M.G.P. Fernandes, <i>A stochastic augmented Lagrangian equality constrained-based algorithm for global optimization</i>, International Conference of Numerical Analysis and Applied Mathematics 2010, T.E. Simos, G. Psihoyios and Ch. Tsitouras (Eds.), AIP Conference Proceedings ISBN: 978-0-7354-0834-0, Vol. 1281 (967-970) Springer-Verlag 2010.</p>
Grading	<p>Homework: 30%</p> <p>Analysis of papers: 30%</p> <p>Final exam: 40%</p>
Other information	<p>Thesis proposal: Performance analysis of swarm intelligent algorithms on the Travelling Salesman Problem</p> <p>Swarm intelligence is an artificial intelligence algorithm based on the study of collective behaviour in decentralised and self-organised systems. Swarm intelligence systems are usually made up of a population of simple agents interacting locally with one another and with their environment. Examples of systems like this can be found in nature, including ant colonies, bird flocking, animal herding, bacteria growth and fish schooling.</p> <p>Swarm intelligence techniques are population-based stochastic methods that can be used to solve combinatorial and continuous problems. They represent a promising tool for solving complex NP complete problems. These problems lead to various practical real world applications such</p>

as, traffic routing, networking, games, industry and robotics.

The Traveling Salesman problem (TSP) is the problem of finding a route of a salesman who starts from a home location, visits a prescribed set of cities and returns to the original location in such a way that the total distance traveled is minimum and each city is visited exactly once. Although a business tour of a modern day traveling salesman may not seem to be too complex in terms of route planning, the TSP in its generality represents a typical “hard” combinatorial optimization problem.

The main objectives of this project are to analyze and implement several swarm intelligent systems, select the most appropriate and develop a specific algorithm to solve the TSP problem, as well as to compare its performance with approximate and exact methods known in the literature.



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Programa Doutoral em Engenharia Industrial e de Sistemas (PDEIS)

Doctoral Program in Industrial and Systems Engineering (PDEIS)

Courses

Doctorate course name:	Modeling and Nonlinear Optimization I
Program(s):	PDEIS (e outros, caso seja aplicável)
Semester:	1 st semester
Language:	English
Lecturer(s):	Ana Maria A. C. Rocha
Contacts:	Contacts: email: mailto:arocha@dps.uminho.pt tel.: +351 253 604 753 Department: Produção e Sistemas School: Engenharia
Subject description and objectives	<p>This course is intended for graduate students interested in nonlinear optimization methods. Nonlinear programming is the process of solving a system of equalities and inequalities, collectively termed constraints, over a set of unknown real variables, along with an objective function to be maximized or minimized, where some of the constraints or the objective function are nonlinear.</p> <p>This course presents and analyzes numerical methods for solving nonlinear optimization problems, together with the underlying mathematical theory on which they are based. Programming projects,</p>

	using Matlab and software libraries, will be assigned.
Pre-requisites:	
Program:	<ol style="list-style-type: none"> 1. Introduction to Nonlinear Optimization. <ul style="list-style-type: none"> • Local vs global optima • Convex set, convex function 2. Unconstrained optimization <ul style="list-style-type: none"> • Optimality Conditions • Line search methods • Gradient methods <ul style="list-style-type: none"> • Step-Length Selection Algorithms • Newton method • Convergence • Quasi-Newton method 3. Nonlinear Constrained Optimization <ul style="list-style-type: none"> • Optimality Conditions • Line search, trust-region, merit function and filter methods • Penalty, Barrier, and Augmented Lagrangian Methods • Sequential Quadratic Programming 4. Modeling mathematical languages 5. Use of Matlab packages for solving nonlinear optimization problems
Bibliography books:	<p>S.C. Chapra and R.P. Canale, Numerical Methods for Engineers: with Programming and Software Applications, 3rd. edition, McGraw-Hill, 1998.</p> <p>J. Nocedal e S.J. Wright, Numerical Optimization, Springer Verlag, 1999,</p> <p>J. F.. Bonnans, J. C. Gilbert, C. Lemaréchal, and C. A. Sagastizábal, Numerical Optimization, Theoretical and Practical Aspects, New. York: Springer-Verlag, 2003.</p> <p>Dimitri P. Bertsekas, Nonlinear Programming: 2nd Edition. Athena Scientific, 1999. ISBN 1-886529-00-0.</p> <p>Wilhelm Forst, Dieter Hoffmann, Optimization - Theory and Practice, Springer-Verlag (SUMAT series), 2010</p>
Bibliography	Rocha, Ana Maria A.C., Fernandes, Edite M.G.P., Soares, João Luís C., <i>Aplicação do algoritmo volumétrico à resolução aproximada e exacta</i>

papers:	<p><i>do problema do caixeiro viajante assimétrico</i>, Investigação Operacional, V. 25 (2) 277-294 , 2005.</p> <p>Rocha, Ana Maria A.C., Fernandes, Edite M.G.P., Soares, João Luís C., <i>A first-order ε - approximation algorithm for large linear programs and a second-order implementation</i>, em O. Gervasi et al. (Eds.), Lecture Notes in Computer Science, 3483 (488-498), Springer-Verlag, 2005.</p> <p>A.M.A.C. Rocha, T.F.M.C. Martins, Edite M.G.P. Fernandes, <i>An augmented Lagrangian fish swarm based method for global optimization</i>, Journal of Computational and Applied Mathematics doi:10.1016/j.cam.2010.04.020, 2010.</p> <p>A.M.A.C. Rocha, Edite M.G.P. Fernandes, <i>A stochastic augmented Lagrangian equality constrained-based algorithm for global optimization</i>, International Conference of Numerical Analysis and Applied Mathematics 2010, T.E. Simos, G. Psihoyios and Ch. Tsitouras (Eds.), AIP Conference Proceedings ISBN: 978-0-7354-0834-0, Vol. 1281 (967-970) Springer-Verlag 2010.</p>
Grading	<p>Homework: 30%</p> <p>Analysis of papers: 30%</p> <p>Final exam: 40%</p>
Other information	



Universidade do Minho
Escola de Engenharia

Programa Doutoral em Engenharia Industrial e de Sistemas (PDEIS) Doctoral Program in Industrial and Systems Engineering (PDEIS)

Courses

Doctorate course name:	Specific Techniques in Optimization
Program(s):	PDEIS and a short course on Emergent Techniques of Optimization
Semester:	First or second semester
Language:	English or Portuguese
Lecturer(s):	Maria Teresa Torres Monteiro
Contacts:	253 604747, tm@dps.uminho.pt www.norg.uminho.pt/tm
Subject description and objectives	Two distinct subjects are studied in two Modules. Module I: MPCC Mathematical Program with Complementarity Constraints (MPCC) is a very common optimization problem in Engineering and Economics areas. The complementarity concept is related to the equilibrium notion. This problem is very difficult to solve because the usual constraint qualifications, necessary to guarantee the algorithms convergence, fail in all feasible points. This complexity is caused by the disjunctive constraints which lead to some challenging issues that typically are the main concern in the design of efficient solution algorithms. A possible way to solve MPCC is to consider its reformulation as an equivalent nonlinear programming problem (NLP), which can then be solved by using standard nonlinear programming techniques, like penalty and

	<p>regularization strategies.</p> <p>The main objectives are: to formulate a MPCC, to reformulate it as a NLP, to use and compare different approaches to solve it.</p> <p>Module II: Filter methods</p> <p>The use of a merit function to enforce global convergence is a common feature of most methods for NLP. One drawback of these methods lies in the choice of the sequence of penalty parameters (associated with the violation of feasibility), including its initial value and updating formula. In order to avoid this always problematic choice, Fletcher and Leyffer introduced a new concept, the filter, which can guarantee global convergence to NLP algorithms without the use of a merit function. Nowadays there are several optimization software packages based on this philosophy.</p> <p>The main goals are to understand the filter concept in different optimization algorithms and to use filter software packages to solve NLPs.</p>
Pre-requisites:	There are not any formal pre-requisites, but some knowledge in nonlinear optimization is a plus.
Program:	<p>Module I</p> <ol style="list-style-type: none"> 1. Mathematical Program with Complementarity Constraints (MPCC) 2. Optimality conditions 3. Solving MPCC using nonlinear program (NLP): penalty and regularization strategies 4. Practical applications in engineering and economics <p>Module II</p> <ol style="list-style-type: none"> 5. Filter methods 6. Components of a filter-based approach. 7. Global convergence. 8. SLP/SQP filter methods and other general approaches. 9. Interior-point filter methods. <p>AMPL modeling language. Specific software packages</p>
Bibliography books:	<ol style="list-style-type: none"> 1. D. Bertsekas. <i>Nonlinear programming</i>. Athena Scientific, 1995 2. Z.Q. Luo, J.S. Pang, e D. Ralph. <i>Mathematical programs with equilibrium constraints</i>. Cambridge University Press, 1996 3. S.G. Nash e A. Sofer. <i>Linear and Nonlinear Programming</i>. McGRAW-HILL, 1996
Bibliography papers:	<p>H. Scheel e S. Scholtes. <i>Mathematical program with complementarity constraints: Stationarity, optimality and sensitivity</i>. Mathematics of Operations Research, 25(1):1–22, 2000.</p> <p>S. Scholtes. <i>Convergence properties of a regularization scheme for mathematical programs with complementarity constraints</i>. SIAM</p>

	<p>Journal on Optimization, 11(4):918–936, 2001.</p> <p>L.N. Vicente e P.H. Calamai. <i>Bilevel and multilevel programming: a bibliography review</i>. Journal of Global Optimization, 5:291–306, 1994.</p> <p>M. Anitescu. <i>On using the elastic mode in nonlinear programming approaches to mathematical programs with complementarity constraints</i>. SIAM Journal on Optimization, 15(4):1203–1236, 2005.</p> <p>R. Fletcher and S. Leyffer. <i>Nonlinear programming without a penalty function</i>. Mathematical Programming, A 91:239–269, 2002.</p> <p>C. C. Gonzaga, E. Karas, and M. Vanti. <i>A globally convergent filter method for nonlinear programming</i>. SIAM Journal on Optimization, 14:646–669, 2003.</p> <p>A. Wächter and L. T. Biegler. <i>Line search filter methods for nonlinear programming: Local convergence</i>. SIAM Journal Optimization, 16(1):32–48, 2005.</p> <p>A. Wächter and L. T. Biegler. <i>Line search methods for nonlinear programming: Motivation and global convergence</i>. SIAM Journal of Optimization, 16(1):1–31, 2005.</p> <p>M. Teresa T. Monteiro, José Filipe P. Meira, <i>A Penalty method and a regularization strategy to solve MPCC</i>, International Journal of Computer Mathematics, 88 (1) (2011), 145-149.</p> <p>Rodrigues, H. S.; Monteiro, M.T.T. ; Vaz, A. Ismael F., <i>A MPCC approach on a Stackelberg game in an electric power market: changing the leadership</i>, International Journal of Computer Mathematics. Vol. 86 (2009), 1921-1931.</p> <p>M. Teresa T. Monteiro, Helena S. Rodrigues; <i>Combining the regularization strategy and the SQP to solve MPCC - a MATLAB implementation</i>, Journal of Computational and Applied Mathematics, in press, (2010) DOI:10.1016/j.cam.2010.05.008.</p> <p>Cândida Elisa P. Silva, M. Teresa T. Monteiro, <i>A Filter algorithm - comparison with NLP solvers</i>, International Journal of Computer Mathematics, Vol. 85, Issue 3 & 4, March 2008, (667-689).</p> <p>Silva, C.E.P.; Monteiro, M.T.T., <i>A Filter Inexact-Restoration Method for Nonlinear Programming</i>, TOP, Springer Berlin/Heidelberg, Volume 16 (1), July, 2008, (126-146).</p>
Grading	A project where a practical MPCC problem is to be modelled, studied and solved using different approaches.

Other information	
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Programa Doutoral em Engenharia Industrial e de Sistemas (PDEIS)
 Doctoral Program in Industrial and Systems Engineering (PDEIS)

Courses

Doctorate course name:	PDEIS (e outros, caso seja aplicável)
Program(s):	Numerical Solution of Partial Differential Equations
Semester:	1st or 2nd
Language:	English
Lecturer(s):	Senhorinha Teixeira (DPS); Celina Pinto Leão (DPS), José Luís Alves (DEM)
Contacts:	Senhorinha Teixeira st@dps.uminho.pt
Subject description and objectives	Acquire specific skills in Numerical Methods for Differential Equations in the numerical solution of problems arising from engineering. Use of relevant software. Formulate problems of partial differential equations and identify the type of equation to solve. Apply the finite volume in the equations discretization. Apply the finite element method in the equations discretization. Use of specific software to solve these problems.
Pre-requisites:	Numerical Methods; Programming and Informatics.
Program:	Partial Differential Equations. Boundary conditions problems in 2D: elliptic equations. Formulation of the finite volume method. Mesh studies. Mesh generation. Unstructured grids. Solving algebraic systems resulting of the equation discretization. Nonstationary problems: 1D and 2D parabolic equations. Problems of pre and post processing. Formulation of the finite element method. Interpolation and shape functions. Examples of applications in various fields of engineering. Use of specific software (commercial and open access).
Bibliography	* Bober, W.; Tsai, C.T.; Masory, O. "Numerical and Analytical Mehtods with Matlab", CRC Press, 2009. ISBN: 978-1-4200-9356-8

books:	<ul style="list-style-type: none"> * Chapra, S.C. "Applied Numerical Methods with Matlab for engineers and scientists", 2008, McGraw-Hill, 2nd edition. ISBN: 978- 007- 125921- 7 * Versteeg H.K. and Malalasekera W., "An introduction to Computational Fluid Dynamics: The finite volume method", Longman Scientific & Technical, 1995. * Ferziger, J. H.; Peric, M. (2001) "Computational Methods for Fluid Dynamics", Springer, 3rd edition * Teixeira, SFCF; Teixeira, JCF (2003) Métodos Numéricos em Transferência de Calor, Universidade do Minho. * Teixeira, SFCF (1999) Equações Diferenciais com Derivadas Parciais: Apontamentos teóricos, Universidade do Minho. * Teixeira, SFCF (1999) Elementos Finitos Aplicados a Problemas de Transferência de Calor: Apontamentos teóricos, Universidade do Minho.
Bibliography papers:	<ul style="list-style-type: none"> * Carneiro, F.; Leão, C.P.; Teixeira, S.F.C.F (2010) Teaching differential equations in different environments: a first approach, Computer Applications in Engineering Education, Volume 18, Issue 3, pages 555–562, September 2010 * Oliveira, RF; Teixeira, S; Silva, LF; Teixeira, JC and Antunes, H (2010) Study of a pressurized metered-dose inhaler spray parameters in Fluent, Proceedings of the WCE2010 World Congress on Engineering 2010, 30 de Junho a 2 Julho 2010, London, UK, in Lecture Notes in Engineering and Computer Science, Volume 2184, S I Ao, Len Gelman, David WL Hukins, Andrew Hunter, A M Korsunsky (Eds.), Volume II, p. 1083-1087, International Association of Engineers, ISBN 978-988-18210-7-2 * A.M. Cunha; JL; J.C.F. Teixeira and S.F.C.F. Teixeira (2009) Computational fluid dynamics applicable to cloth design. ASME Mechanical Engineering Congress, paper #IMECE2009- 13042. * Gomes, P.S., C. P. Leão, A. E. Rodrigues, "Simulation of True Moving Bed Adsorptive Reactor: Detailed Particle Model and Linear Driving Force Approximations", Chemical Engineering Science 62 (4), 1026-1041, 2007. * Leão, C.P.; Rodrigues, A.E., "Transient and steady state models for SMB processes: numerical solutions", Computers & Chemical Engineering, V, 28 (9), 1725-1741, 2004.
Grading	Written examination with laboratory component; individual work project
Other information	



Programa Doutoral em Engenharia Industrial e de Sistemas (PDEIS)
 Doctoral Program in Industrial and Systems Engineering (PDEIS)

Courses

Doctorate course name:	PDEIS (e outros, caso seja aplicável)
Program(s):	Numerical Solution of ODE and DAE
Semester:	1st or 2nd
Language:	English
Lecturer(s):	Senhorinha Teixeira; Celina Pinto Leão
Contacts:	Celina Pinto Leão cpl@dps.uminho.pt
Subject description and objectives	Acquire specific skills in Numerical Methods for Differential Equations for the numerical solution of problems arising from engineering. Use of relevant software. Formulate problems of Differential Equations and identify the type of differential equation to solve. Apply Numerical Methods for solving ODE (Ordinary Differential Equations) and DAE (Differential-Algebraic Equations). Convert the Partial Differential Algebraic Equations (PDAE) in DAE. Use of specific software to solve problems.
Pre-requisites:	Numerical Methods; Programming and Informatics.
Program:	Ordinary differential equations. Time integration: explicit and implicit schemes. Adaptive control of integration error. Numerical methods of integration in space: boundary conditions problems. Definition of Differential algebraic equations (DAE). Concept Index. DAE function of time. Nonlinear systems. Application of multiple step methods. Study of convergence. Application of Methods of One Step. Systems of linear coefficients. Nonlinear systems of index one. Nonlinear systems in semi-explicit index two. Extrapolation methods. DAE resulting from partial differential equations and algebraic (PDAE). Applications in various fields of engineering. Specific algorithms and software (commercial and open access) to ODE/DAE.

Bibliography books:	<p>* Bober, W.; Tsai, C.T.; Masory, O. "Numerical and Analytical Methods with Matlab", CRC Press, 2009. ISBN: 978-1-4200-9356-8</p> <p>* Brenan, K.E.; Campbell, S.L.; Petzold, L.R. "Numerical Solution of initial-value problems in differential-algebraic equations", 1996, SIAM, New York. ISBN: 0-89871-353-6</p> <p>* Ascher, U.M.; Petzold, L.R. "Computer Methods for Ordinary Differential Equations and Differential-Algebraic Equations", 1998, SIAM, New York. ISBN: 0-89871-412-5</p> <p>* Chapra, S.C. "Applied Numerical Methods with Matlab for engineers and scientists", 2008, McGraw-Hill, 2nd edition. ISBN: 978- 007- 125921- 7</p> <p>* Teixeira, SFCF (1998) Resolução Numérica de Equações Diferenciais: Apontamentos teóricos, Universidade do Minho.</p>
Bibliography papers:	<p>* Carneiro, F.; Leão, C.P.; Teixeira, S.F.C.F (2010) Teaching differential equations in different environments: a first approach, Computer Applications in Engineering Education, Volume 18, Issue 3, pages 555–562, September 2010</p> <p>* Teixeira, SFCF, Leão, CPL, Neves, M, Arezes, P, Cunha, A, Teixeira JCF (2010) Thermal Comfort Evaluation using a CFD Study and a Transient Thermal Model of the Human Body, ECCOMAS CFD Fifth European Conference on Computational Fluid Dynamics, 14 – 17 Jun 2010, Lisbon, Portugal</p> <p>* Gomes, P.S.; Leão, C. P.; Rodrigues, A. E. "Simulation of True Moving Bed Adsorptive Reactor: Detailed Particle Model and Linear Driving Force Approximations", Chemical Engineering Science 62 (4), 1026-1041, 2007.</p> <p>* Leão, C.P.; Rodrigues, A.E., "Transient and steady state models for SMB processes: numerical solutions", Computers & Chemical Engineering, V, 28 (9), 1725-1741, 2004.</p> <p>* Leão, C.P.; Soares, F.O. "Two Different Strategies for Baker's Yeast Fermentation Process Simulation", in Recent Advances in Simulation, Computational Methods and Soft Computing, Nikos E. Mastorakis Ed., 11-16, WSEAS Press, 2002. ISBN 960-8052-50-5.</p>
Grading	Written examination with laboratory component; individual work project
Other information	



Programa Doutoral em Engenharia Industrial e de Sistemas (PDEIS)
 Doctoral Program in Industrial and Systems Engineering (PDEIS)

Courses

Doctorate course name:	PDEIS (e outros, caso seja aplicável)
Program(s):	Computational Tools in FVM and FEM
Semester:	1st or 2nd
Language:	English
Lecturer(s):	Senhorinha Teixeira (DPS); Celina Pinto Leão (DPS), José Luís Alves (DEM)
Contacts:	Senhorinha Teixeira st@dps.uminho.pt
Subject description and objectives	Acquire specific skills in Numerical Methods for Differential Equations for the numerical solution of problems arising in engineering. Use of relevant CFD software. Knowledge and identification of some open source/commercial softwares in finites element and volume. Identify and compare alternative solutions to solve an engineering problem. Specify and implement an algorithm solution. Use software to solve a single project.
Pre-requisites:	Numerical Methods; Programming and Informatics.
Program:	Introduction to simulation software for engineering problems. Geometry definition, mesh and the physical parameters. Definition of initial and boundary conditions. More appropriate numerical solution of conservation equations. Post processing and physical interpretation of obtained results. Use of CFD software to solve the final project.
Bibliography books:	* Bober, W.; Tsai, C.T.; Masory, O. "Numerical and Analytical Methods with Matlab", CRC Press, 2009. ISBN: 978-1-4200-9356-8 * Chapra, S.C. "Applied Numerical Methods with Matlab for engineers and scientists", 2008, McGraw-Hill, 2 nd edition. ISBN: 978- 007- 125921- 7 * Teixeira, SFCF; Teixeira, JCF (2003) Métodos Numéricos em Transferência de Calor, Universidade do Minho.

	<p>* Ferziger, J. H.; Peric, M. (2001) "Computational Methods for Fluid Dynamics", Springer, 3rd edition</p> <p>* Versteeg H.K. and Malalasekera W., "An introduction to Computational Fluid Dynamics: The finite volume method", Longman Scientific & Technical, 1995.</p>
Bibliography papers:	<p>* Carneiro, F.; Leão, C.P.; Teixeira, S.F.C.F (2010) Teaching differential equations in different environments: a first approach, Computer Applications in Engineering Education, Volume 18, Issue 3, pages 555–562, September 2010</p> <p>* Silva, E; Teixeira, SFCF; Lobarinhas, P (2010) Computational Fluid Dynamics simulations: an approach to evaluate cardiovascular dysfunction, in Modelling Simulation and Optimization, Gregorio Romero Rey and Luisa Martinez Muneta (ed.), ISBN 978-953-307-048-3, INTECH, February 2010</p> <p>* Oliveira, RF; Teixeira, S; Silva, LF; Teixeira, JC and Antunes, H (2010) Study of a pressurized metered-dose inhaler spray parameters in Fluent, Proceedings of the WCE2010 World Congress on Engineering 2010, 30 de Junho a 2 Julho 2010, London, UK, in Lecture Notes in Engineering and Computer Science, Volume 2184, S I Ao, Len Gelman, David WL Hukins, Andrew Hunter, A M Korsunsky (Eds.), Volume II, p. 1083-1087, International Association of Engineers, ISBN 978-988-18210-7-2</p> <p>* A.M. Cunha; JL; J.C.F. Teixeira and S.F.C.F. Teixeira (2009) Computational fluid dynamics applicable to cloth design. ASME Mechanical Engineering Congress, paper #IMECE2009- 13042.</p>
Grading	Individual work project
Other information	



Universidade do Minho
Escola de Engenharia

Programa Doutoral em Engenharia Industrial e de Sistemas (PDEIS) Doctoral Program in Industrial and Systems Engineering (PDEIS)

Courses

Doctorate course name:	Evolutionary and Genetic Algorithms
Program(s):	PDEIS (e outros, caso seja aplicável)
Semester:	2nd semester
Language:	English
Lecturer(s):	Lino Costa
Contacts:	lac@dps.uminho.pt (http://www.norg.uminho.pt/lac) 253 604746
Subject description and objectives	This course addresses the study of optimization algorithms inspired on biological processes that occur in nature. The main learning outcomes are: understand and explain the evolutionary algorithms; describe the different components of genetic algorithms; select, understand and implement different genetic operators in genetic algorithms; describe the different components of evolution strategies; select, understand and implement different recombination operators and self-adaptive mechanisms; understand different constraint handling techniques in evolutionary algorithms; describe and explain diversity-preservation techniques; select and apply the most adequate evolutionary algorithm for a given optimization problem; and interpret critically the obtained results.

Pre-requisites:	-
Program:	Components and working of an Evolutionary Algorithms. Genetic Algorithms: representation of individuals, fitness evaluation schemes, selection mechanisms and genetic operators (recombination and mutation). Evolution Strategies: representation, mutation, recombination and self-adaptation rules. Multimodality, spatial distribution and diversity-preservation mechanisms. Hybridization techniques. Constraint handling techniques in evolutionary algorithms.
Bibliography books:	Eiben, A.E., Smith, J.E. (1998). Introduction to Evolutionary Computing, Springer. Back, T. (1996). Evolutionary Algorithms in Theory and Practice, Oxford University Press.
Bibliography papers:	L. Costa, I.A.C.P. Espírito Santo and P. Oliveira (2010), An Adaptive Constraint Handling Technique for Evolutionary Algorithms, Symposia of the International Conference of Numerical Analysis and Applied Mathematics (Theodore Simos , G. Psihoyios and Ch. Tsitouras (ed.)), 975-978, ISBN: 978-0-7354-0831-9, Springer-Verlag 4 pp, Rhodes, Greece L. Costa, I.A.C.P. Espírito Santo, R. Denysiuk and E.M.G.P. Fernandes (2010), Hybrid Genetic Pattern Search Augmented Lagrangian Algorithm: Application to WWTP Optimization, Lecture Notes in Management Science, 2nd International Conference on Applied Operational Research - ICAOR'10 (Mikael Collan (ed.)), ISSN 2008-0050, ISBN: 978-952-12-2414-0, 2, 45-56, Turku, Finland L. Costa, A. C. Braga and P. Oliveira (2009), Tuning Parameters on Evolutionary Algorithms using ROC Curves, IWPACBB-2008, Advances in Soft Computing, 49, Springer, 217-222, Salamanca, Spain Costa, L. (2006), A New Parameter-less Evolution Strategy for solving Unconstrained Global Optimization Problems, Wseas Transactions On Mathematics, 5(11), 1247-1254 Costa, L. and Oliveira, P. (2001), Evolutionary Algorithms Approach to the Solution of Mixed Integer Non-Linear Programming Problems, Computers & Chemical Engineering 25, Issues 2-3, Elsevier, 257-266
Grading	Homework, Analysis of papers, final exam.
Other information	Project areas: Hybridization of evolutionary algorithms with other techniques; Constraint handling in evolutionary algorithms; Diversity-preservation in multimodal problems;

	Application to real-world problems.
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Universidade do Minho
Escola de Engenharia

Programa Doutoral em Engenharia Industrial e de Sistemas (PDEIS) Doctoral Program in Industrial and Systems Engineering (PDEIS)

Courses

Doctorate course name:	Heuristics Methods
Program(s):	PDEIS (and MES / MIEGI)
Semester:	S1 / S2
Language:	English
Lecturer(s):	José António Oliveira
Contacts:	zan@dps.uminho.pt http://pessoais.dps.uminho.pt/zan/
Subject description and objectives	<p>Present the basic concepts of heuristics methods, provide the students with sufficient knowledge to conduct research in the area and understand its application in the industry and their research.</p> <p>Students will be introduced to recognize an optimization problem; describe the need and use of heuristics methods; describe a range of heuristic algorithms (at pseudo-code level). Apply a greedy heuristic, a local search and a meta-heuristic to the solution of a Combinatorial Optimization Problem (COP). Analyze and discuss the results of the application of a heuristic method to a COP. Be able to design</p>

	algorithms and solution representations for unseen problems.
Pre-requisites:	None
Program:	Constructive heuristics, Improvement heuristics and Local Search heuristics. Space of solutions and neighbourhood concept. Metaheuristics: Grasp, VNS, GLS, ILS, Simulated Annealing, Tabu Search, Genetic Algorithms, Ant Systems.
Bibliography books:	1) How to Solve It: Modern Heuristics, Z. Michalewicz, D. Fogel 2) Local Search in Combinatorial Optimization, Emile Aarts, Jan Karel Lenstra, J. Wiley 3) Modern Heuristic Search Methods, V.J. Rayward-Smith, I. Osman, C. Reeves, G. Smith, J. Wiley
Bibliography papers:	1) J.A. Oliveira, "A Genetic Algorithm with a Quasi-local Search for the Job Shop Problem with Recirculation". Applied Soft Computing Technologies: The Challenge of Complexity, Berlin / Heidelberg, Springer, 2006, 221-234, DOI 10.1007/3-540-31662-0_18, http://www.springerlink.com/content/4v5765t231g50363 2) J.A. Oliveira, "Scheduling the truckload operations in automatic warehouses". European Journal of Operational Research, 179, 3, 2007, 723-735. http://dx.doi.org/10.1016/j.ejor.2005.03.066 3) H Silva, J.A. Oliveira, A. Tereso, "Um Algoritmo Genético para Programação de Projectos em Redes de Actividades com Complementaridade de Recursos". Revista Ibérica de Sistemas y Tecnologías de la Información. 6, 2010, 59-72; ISSN: 1646-9895 http://www.aisti.eu/risti/RISTI%20N6.pdf
Grading	Two courseworks (30% + 30 %) One project (40%)
Other information	Themes for PhD Thesis: Planning warehouse operations Planning collecting wasting operations Scheduling and sequencing problems



Universidade do Minho
Escola de Engenharia

Programa Doutoral em Engenharia Industrial e de Sistemas (PDEIS) Doctoral Program in Industrial and Systems Engineering (PDEIS)

Courses

Doctorate course name:	Multiobjective Optimization
Program(s):	PDEIS (e outros, caso seja aplicável)
Semester:	2nd semester
Language:	English
Lecturer(s):	Lino Costa
Contacts:	lac@dps.uminho.pt (http://www.norg.uminho.pt/lac) 253 604746
Subject description and objectives	This course addresses the study of multiobjective optimization concepts and methods for nonlinear multiobjective optimization problems. The main learning outcomes are: formulate and classify multiobjective optimization problems; explain the principles and concepts of multiobjective optimization; describe and implement the main algorithms; select and apply the most adequate algorithms for a given multiobjective formulations; and interpret critically the obtained results.
Pre-requisites:	-
Program:	Principles of Multiobjective Optimization: Conflicting objectives, Dominance and Pareto optimality. Optimality Conditions. Graphical illustration of solutions. Performance metrics. A-priori, a-posteriori and interactive methods. Multiobjective algorithms: Value function method, Goal programming.

	Weighted sum method, Constraint method, Weighted Metric Methods. Non-elitist and Elitist Evolutionary algorithms.
Bibliography books:	<p>Miettinen, K. (1999). Nonlinear Multiobjective Optimization, Kluwer.</p> <p>Collete, Y., Siarry, P. (2004). Multiobjective Optimization: Principles and Case Studies, Springer.</p> <p>Deb, K. (2001). Multi-objective optimization using evolutionary algorithms, John Wiley & Sons.</p>
Bibliography papers:	<p>Lino Costa and Pedro Oliveira (2010), Biplots in Offline Multiobjective Reduction, 2010 IEEE Congress on Evolutionary Computation (IEEE CEC 2010), 8 pp, Barcelona, Spain</p> <p>Lino Costa and Pedro Oliveira (2009), Multiobjective Optimization: Redundant and Informative Objectives, 2009 IEEE Congress on Evolutionary Computation (CDROM), ISBN: 978-1-4244-2959-2, 8 pp, Trondheim, Norway</p> <p>Costa, L., Fernandes, L., Figueiredo, I., Júdice, J., Leal, R. and Oliveira, P. (2004), Multiple- and single-objective approaches to laminate optimization with genetic algorithms, Structural and Multidisciplinary Optimization, Springer-Verlag Heidelberg, ISSN: 1615-147X (Paper) 1615-1488 (Online)</p> <p>Costa, L. and Oliveira, P. (2004), An Elitist Genetic Algorithm for Multiobjective Optimization, Metaheuristics: Computer Decision-Making, ed. Mauricio G.C. Resende, Jorge Pinho de Sousa, Kluwer Academic Publishers, chapter 10, 217-236, ISBN 1-4020-7653-3</p> <p>Costa, L. and Oliveira (2003), P., An Adaptive Sharing Elitist Evolution Strategy for Multiobjective Optimization, Evolutionary Computation, MIT Press, Winter 2003, 11(4), 417-438</p>
Grading	Homework, Analysis of papers, final exam.
Other information	<p>Project areas:</p> <p>Multiobjective dimension reduction;</p> <p>Constraint handling in multiobjective problems;</p> <p>Application to real-world problems.</p>



Universidade do Minho
Escola de Engenharia

Programa Doutoral em Engenharia Industrial e de Sistemas (PDEIS) Doctoral Program in Industrial and Systems Engineering (PDEIS)

Courses

Doctorate course name:	Multicriteria Analysis Applied to Energy and Environmental Planning
Program(s):	PDEIS
Semester:	2 nd Semester
Language:	English
Lecturer(s):	Anabela Pereira Tereso (http://pessoais.dps.uminho.pt/anabelat/) and Paula Varandas Ferreira (http://pessoais.dps.uminho.pt/paulaf/)
Contacts:	e-mail: anabelat@dps.uminho.pt ; paulaf@dps.uminho.pt tel.: +351 253 510 368 / +351 253 510 347
Subject description and objectives	This course is intended for graduate students interested in the use of multicriteria techniques and their application to energy and environmental planning. The recognised complexity of energy planning, involving multiple conflicting factors and different groups of decision makers, makes multicriteria analysis a valuable tool in the decision making process. Building strategies merging cost effectiveness with environmental and social issues is the main challenge for top decision makers at global, local or even company level. Cost oriented approaches, where the monetary assessment is the only basis for the decision making, are no longer an option, and information on the ecological and social impacts of the possible plans, needs to be combined with traditional economic monetary indicators. The existence of different perspectives and values must also be acknowledged and fully incorporated in the planning process. This course starts by offering an introduction to multicriteria decision analysis, presenting some multicriteria decision methods

	like AHP, ELECTRE and PROMETHEE. Then, the sustainable energy planning process is introduced and the use of multicriteria methods combined with participative processes is addressed, focusing on energy and environmental decision making.
Pre-requisites:	None
Program:	<ol style="list-style-type: none"> 1. Introduction to Multicriteria Decision Making (MCDM) <ol style="list-style-type: none"> i. Introduction to MCDM ii. Alternatives, Criteria and Attributes, Objectives iii. Basic approaches to MDCM 2. Multicriteria Methods and tools <ol style="list-style-type: none"> i. Introduction ii. AHP – Analytical Hierarchy Process iii. ELECTRE iv. PROMETHEE 3. Sustainable energy planning <ol style="list-style-type: none"> i. Introduction and definition ii. Energy planning models 4. Multicriteria for energy and environmental planning <ol style="list-style-type: none"> i. The social and environmental dimensions as decision variables. ii. Application of the methods and specific software to selected case studies.
Bibliography books:	<p>Bana e Costa (1990) Readings in Multiple Criteria Decision Aid, Springer-Verlag, Berlin.</p> <p>Bunn D. (1984) Applied Decision Analysis, McGraw-Hill Inc., New York.</p> <p>Canada J. R. and Sullivan W.G. (1989) Economic and Multiattribute Evaluation of Advanced Manufacturing Systems, Prentice Hall College Div.</p> <p>Ehrgott M. (2005), Multicriteria Optimization, Springer.</p> <p>Figueira J., Greco S., Ehrgott M., (2005) Multiple Criteria Decision Analysis – State of the Art Surveys, Springer Science + Business Media, Inc.</p> <p>Hobbs, B. and Meier, P. (2003) Energy decisions and the environment: a guide to the use of multicriteria methods. Kluwer Academic Publishers.</p> <p>Hwang C. L. and Yoon K. (1981) Multiple Attribute Decision Making – Methods and Applications: A State of the Art Survey, Springer-Verlag, New York, USA.</p> <p>Matos M. (2005) Ajuda Multicritério à Decisão - introdução, FEUP.</p> <p>Mazer, A. (2007) Electric power planning for regulated and deregulated markets, John Wiley & sons, New Jersey, USA.</p> <p>Saaty T. L. (1980) The Analytic Hierarchy Process, McGraw-Hill.</p> <p>Tereso A., Técnicas de Decisão Multicritério, Departamento de Produção e Sistemas, Universidade do Minho, 2007.</p>

	<p>Vincke P. (1992) <i>Multicriteria Decision-aid</i>, John Wiley & Sons, New York.</p> <p>Zeleny M. (1982) <i>Multiple Criteria Decision Making</i>, McGraw-Hill.</p>
Bibliography papers:	<p>Brans J. P., Vincke P. A. and Mareschal B. (1986) How to select and how to rank projects: The Promethee method, <i>European Journal of Operational Research</i>, vol. 24, pp. 228-238.</p> <p>Drechsler, M (2010) “Multi-Criteria Analysis for Policy Evaluation” in <i>The European Impact Assessment and the Environment</i>, Bizer, K, Lechner, S and Führ, M (Eds), Springer Link.</p> <p>Ferreira, P.; Araújo, M. and O’Kelly, M.E.J. (2010) “The integration of social concerns into electricity power planning: A combined Delphi and AHP approach”, in <i>Handbook of Power Systems</i>, Rebennack, S.; Pardalos, P.M.; Pereira, M.V.F.; Iliadis, N.A. (Eds.), 1st Edition, pp 323-364.</p> <p>Ferreira, Paula; Araújo, Madalena; O’Kelly, M.E.J. (2010) “Electricity Power Planning: the Role of Wind Energy” <i>World Academy of Science, Engineering and Technology</i>, Vol. 71, pp. 951-955.</p> <p>Ferreira, Paula; Araújo, M.; O’Kelly, Eddie (2008) “Integrating social concerns into electricity planning” In <i>EASY-ECO Vienna Conference on Governance by Evaluation: Institutional Capacities and Learning for Sustainable Development</i>, 11-14 March, 2008.</p> <p>Kowalski, K; Stagl, S; Madlener, R and Omann, I (2009) “Sustainable energy futures: Methodological challenges in combining scenarios and participatory multi-criteria analysis” <i>European Journal of Operational Research</i>, 19 (3): 1063-1074.</p> <p>Løken E. (2007) “Use of multicriteria decision analysis methods for energy planning problems”, <i>Renewable and Sustainable Energy Reviews</i>, n. 11 pp. 1584–1595.</p> <p>Roy B. (1968) Classement et choix en présence de points de vue multiples (la méthode ELECTRE), <i>RIRO</i>, vol. 8, pp. 57-75.</p> <p>Roy B. (1978) Electre III: un algorithme de classements fondé sur représentation floue des préférences en présence de critères multiples, <i>Cahiers du CERO</i>, vol. 20 (1), pp. 2-24.</p> <p>Roy B., Bertier P. (1973) La méthode Electre II - Une application au médiaplaning, M. Ross (ed.), <i>OR’72</i>, North-Holland Publishing Company, pp. 291-302.</p> <p>Seixedo C. and Tereso A. (2010) “A Multicriteria Decision Aid Software Application for selecting MCDA Software using AHP”, 2nd International Conference on Engineering Optimization, Lisbon – Portugal, September 6 - 9, 2010.</p> <p>Wang, J., Jing, Y., Zhang, C. and Zhao, J. (2009) “Review on multi-criteria decision analysis aid in sustainable energy decision-making” <i>Renewable and Sustainable Energy Reviews</i>, Vol. 13 (9), pp. 2263-2278.</p>
Grading	The following weights will be considered:

	Individual assignment: 50% Final exam: 50%
Other information	Related PhD project proposals: <ul style="list-style-type: none">- Multicriteria decision aid for energy systems.- Designing and implementing a sustainable energy planning model.



Universidade do Minho
Escola de Engenharia

Programa Doutoral em Engenharia Industrial e de Sistemas (PDEIS) Doctoral Program in Industrial and Systems Engineering (PDEIS)

Courses

Doctorate course name:	Project Economic Analysis
Program(s):	PDEIS
Semester:	1 st or 2 nd
Language:	English
Lecturer(s):	Paula Varandas Ferreira (http://pessoais.dps.uminho.pt/paulaf/)
Contacts:	e-mail: paulaf@dps.uminho.pt tel.: +351 253 510 347
Subject description and objectives	This course is intended for graduate students interested in the economic evaluation of projects and the applications of tools and methods to these problems. The project evaluation and selection is now recognized as an interdisciplinary field requiring engineering, economic, social and financial skills. Traditional appraisal techniques are designed to assess the financial impact of an investment and hardly consider the strategic benefits of the project. Also, the non-financial aspects and externalities represent important additional risk and uncertainty dimensions not easily included in the appraisal procedure. From the private company point of view, aspects like the strategic dimension of projects, or its alignment with the company's strategy must not be overlooked. The same way, the economic perspective of the project underlines the need to properly consider and include in the analysis the social and environmental dimensions of the projects as decision variables. This

	<p>course aims to focus on the financial and non-financial analysis of the project, presenting methods and tools for the evaluation procedure. The identification and inclusion of external impacts of the projects will be addressed. Traditional financial evaluations methods will be analyzed and compared with cost/benefit analysis and multi-criteria methods. The application examples will come from large scale projects, mainly from the energy, environment and transportation sectors.</p>
Pre-requisites:	None
Program:	<p>The decision making process</p> <p>The private and public evaluation of a project</p> <p>The financial and strategic objectives of the project</p> <p>Sustainability and project evaluation</p> <p>The social and environmental dimensions of the projects as decision variables.</p> <p>Basic tools for project evaluation</p> <p>Real investment</p> <p>Cash-flow computation</p> <p>Indicators for evaluation (NPV, IRR and Payback time)</p> <p>Environmental and social externalities of a project</p> <p>The public involvement on the evaluation process</p> <p>Cost Benefit analysis</p> <p>Monetization of full costs and benefits</p> <p>The procedure of Cost/Benefit analysis</p> <p>Multicriteria for economic project evaluation</p> <p>Introduction to multi-criteria analysis</p> <p>Monetisation vs. multicriteria methods</p>

	<p>Introduction to the concept of sustainable energy planning</p> <p>Application to selected case studies</p> <p>Examples of projects from energy, environment and transportation sectors (case studies)</p> <p>Selecting sources methods for data collection</p> <p>Application of the methods and specific software to selected case studies.</p>
<p>Bibliography books:</p>	<p>Rogers, M (2001) Engineering project appraisal. Blackwell Science.</p> <p>Hobbs, B and Meier, P (2003) Energy decisions and the environment: a guide to the use of multicriteria methods. Kluwer Academic Publishers.</p> <p>Brent, R (2006) Applied cost-benefit analysis. Edward Elgar.</p>
<p>Bibliography papers:</p>	<p>Barfod, M, , Salling, K and Leleura, S (2010) “Composite decision support by combining cost-benefit and multi-criteria decision analysis” Decision Support Systems (in press).</p> <p>Diakoulaki, D, Karangelis, F (2007) “Multi-criteria decision analysis and cost–benefit analysis of alternative scenarios for the power generation sector in Greece” Renewable and Sustainable Energy Reviews , Vol. 11 (4), pp. 716-727.</p> <p>Drechsler, M (2010) “Multi-Criteria Analysis for Policy Evaluation” in The European Impact Assessment and the Environment, Bizer, K, Lechner, S and Führ, M (Eds), Springer Link.</p> <p>Ferreira, Paula; Araújo, Madalena and O’Kelly, M.E.J. (2010) “The integration of social concerns into electricity power planning: A combined Delphi and AHP approach”, in Handbook of Power Systems, Rebennack, S.; Pardalos, P.M.; Pereira, M.V.F.; Iliadis, N.A. (Eds.), 1st Edition, pp 323-364.</p> <p>Ferreira, Paula; Vieira, Filipa (2010) “Evaluation of an Offshore Wind Power Project: Economic, Strategic and Environmental value” World Academy of Science, Engineering and Technology, Vol. 71, pp. 938-943.</p> <p>Ferreira, Paula; Araújo, M.; O’Kelly, Eddie (2008) “Integrating social concerns into electricity planning” In EASY-ECO Vienna Conference on Governance by Evaluation: Institutional Capacities and Learning for Sustainable Development, 11-14 March, 2008.</p> <p>Ferreira, Paula; Araújo, M and O’Kelly, M (2004) “Including non-financial aspects in project evaluation – a survey” in 15th Mini-EURO conference</p>

	<p>Managing Uncertainty in Decision Support Models. Coimbra, Portugal, September 2004.</p> <p>Holz-Rau, C e Scheiner, J (2010) “Safety and travel time in cost-benefit analysis: A sensitivity analysis for North Rhine-Westphalia” Transport Policy (in press)</p> <p>Kannan, R, Leong, K, Osman, R and Ho, H (2007) “Life cycle energy, emissions and cost inventory of power generation technologies in Singapore” Renewable and Sustainable Energy Reviews, Vol.11 (4), pp. 702-715.</p> <p>Kowalski, K; Stagl, S; Madlener, R and Omann, I (2009) “Sustainable energy futures: Methodological challenges in combining scenarios and participatory multi-criteria analysis” European Journal of Operational Research, 19 (3): 1063-1074.</p> <p>Macharis, C; de Witte, A e Ampe, J (2009) “The multi-actor, multi-criteria analysis methodology (MAMCA) for the evaluation of transport projects: Theory and practice” Journal of Advanced Transportation, Vol. 43 (2); pp. 183-202</p> <p>Söderholm , P and Sundqvist, T (2003) “Pricing environmental externalities in the power sector: ethical limits and implications for social choice”, Ecological Economics, Vol. 46 (3), pp 333-350.</p> <p>Tudela, A , Akiki, N e Cisternas, R (2006) “Comparing the output of cost benefit and multi-criteria analysis: An application to urban transport investments” Transportation Research, vol. 40 (5), pp. 414-423.</p>
Grading	<p>The following weights will be considered:</p> <p>Individual assignment: 50%</p> <p>Final exam: 50%</p>
Other information	<p>Related PhD project proposals:</p> <p>The economic evaluation of large scale projects: cost-benefit and multicriteria analysis</p> <p>Sustainability assessment of R&D projects and support programs.</p>



Universidade do Minho
Escola de Engenharia

Programa Doutoral em Engenharia Industrial e de Sistemas (PDEIS) Doctoral Program in Industrial and Systems Engineering (PDEIS)

Courses

Doctorate course name:	Resource allocation in project management
Program(s):	PDEIS
Semester:	1 st
Language:	English
Lecturer(s):	Anabela Pereira Tereso (http://pessoais.dps.uminho.pt//anabelat/)
Contacts:	e-mail: anabelat@dps.uminho.pt tel.: +351 253 510 368
Subject description and objectives	<p>This course is intended for graduate students interested in project scheduling and resource allocation in project management. This is an important topic for practitioners, since it is extremely important to correctly allocate the resources and schedule the activities to achieve success in project management. It is also an interesting topic for researches since there is a vast interest in the literature to find new ways of improving the existing models and addressing new problems, like the inclusion of risk in project management decisions.</p> <p>This course offers an introduction to project scheduling, explaining several methods to allocate resources and structure the activities in a way to achieve the best possible times and costs.</p>
Pre-requisites:	None
Program:	1. Introduction to Project Management <ol style="list-style-type: none">Attributes of a projectThe essence of project management

	<ul style="list-style-type: none"> iii. The project management process 2. Introduction to Project Scheduling <ul style="list-style-type: none"> i. Work breakdown structure (WBS) ii. Organisational breakdown structure (OBS) iii. Activity networks <ul style="list-style-type: none"> a. Activity-on-arc (<i>AoA</i>) representation b. Activity-on-node (<i>AoN</i>) representation iv. Types of resources v. Estimating task times <ul style="list-style-type: none"> a. Deterministic activity durations b. Stochastic activity durations vi. Specifying time-lags vii. Creating a feasible base schedule 3. Minimization of Project Duration <ul style="list-style-type: none"> i. Critical path analysis in <i>AoN</i> networks ii. Critical path analysis in <i>AoA</i> networks 4. The Resource Constrained Project Scheduling Problem <ul style="list-style-type: none"> i. Exact procedures <ul style="list-style-type: none"> a. Linear programming based approaches b. Branch-and-bound procedures ii. Heuristic procedures iii. Lower bound calculations 5. Proactive/Reactive Scheduling <ul style="list-style-type: none"> i. Robustness types and measures ii. Proactive/reactive scheduling solutions 6. Special Resource Allocation Problems <ul style="list-style-type: none"> i. The multimode resource allocation problem ii. The resource complementarity allocation problem iii. Resource allocation under stochastic conditions on projects with multimodal activities iv. Multiple resources allocation under stochastic conditions on projects with multimodal activities v. Multiobjective resource allocation in stochastic activity networks
Bibliography books:	<p>Demeulemeester E.L. and Herroelen W.S. (2002) Project Scheduling – a research handbook, Kluwer Academic Publishers.</p> <p>Herroelen W.S. (2007) Project and Production Scheduling, Acco – Leuven.</p> <p>Neumann K., Schwindt C. and Zimmermann J. (2003) Project Scheduling with Time Windows and Scarce Resources, 2nd edition, Springer.</p> <p>Klein R. (2000) Scheduling of Resource-Constrained Projects, Kluwer Academic Publishers.</p> <p>Tereso A. P. (2002) PhD Thesis: "Project Management – Adaptive Resource Allocation in Multimodal Activity Networks" (in Portuguese),</p>

	University of Minho.
Bibliography papers:	<p>Tereso A. P., Araújo M.M. and Elmaghraby S.E. (2004) “Adaptive Resource Allocation in Multimodal Activity Networks”, <i>International Journal of Production Economics</i>. Vol 92, Issue 1, pp. 1-10, Nov. 8, 2004.</p> <p>Tereso A. P., Mota J. R. M. and Lameiro R. J. T. (2006) “Adaptive Resource Allocation to Stochastic Multimodal Projects: A distributed platform implementation in Java”, <i>Control and Cybernetics Journal</i>, Vol. 35, Issue 3, pp. 661-686, 2006.</p> <p>Tereso A.P., Novais R.A., Araújo M.M., Elmaghraby S.E. (2009) “The optimal resource allocation in stochastic activity networks via the electromagnetic approach: a platform implementation in Java”, <i>Control & Cybernetics</i>, Vol. 38, Issue 3, pp. 745-782.</p> <p>Silva H. C., Oliveira, J. A. and Tereso, A. P. (2010) Um Algoritmo Genético para Programação de Projectos em Redes de Actividades com Complementaridade de Recursos, <i>Revista Ibérica de Sistemas e Tecnologias de Informação (RISTI)</i>, nº 6, 12/2010, pp. 59-72.</p> <p>Peter Brucker, Andreas Drexl, Rolf Möhring, Klaus Neumann, Erwin Pesch (1999) Resource-constrained project scheduling: Notation, classification, models, and methods, <i>European Journal of Operational Research</i>, 112, pp. 3-41.</p> <p>James H. Patterson (1984) A Comparison of Exact Approaches for Solving the Multiple Constrained Resource, Project Scheduling Problem, <i>Management Science</i>, Vol. 30, No. 7 (Jul., 1984), pp. 854-867.</p> <p>Van de Vonder et al. (2007) Heuristic procedures for reactive project scheduling, <i>Computers & Industrial Engineering</i>, Vol. 52, pp. 11–28.</p> <p>Van de Vonder et al. (2007) A classification of predictive-reactive project scheduling procedures, <i>Journal of Scheduling</i>, Vol. 10, pp. 195–207.</p>
Grading	The grading will be based on an individual assignment consisting of applying some of the methods presented to a specific problem.
Other information	<p>PhD Topics proposals:</p> <ol style="list-style-type: none"> 1. Risk management in construction projects. 2. Project management – the multimode resource allocation problem. 3. Project management – risk management in multimodal projects. 4. The proactive/reactive scheduling problem.



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Programa Doutoral em Engenharia Industrial e de Sistemas (PDEIS) Doctoral Program in Industrial and Systems Engineering (PDEIS)

Courses

Doctorate course name:	Technology, Innovation and Development
Program(s):	PDEIS
Semester:	1
Language:	English
Lecturer(s):	Fernando Romero
Contacts:	fromero@dps.uminho.pt Tel: + 351 253 510 352 Fax: + 351 253 510 343
Subject description and objectives	In this course, the student will develop an in-depth understanding of the Economics of Technological Change. Topics include: how to measure technological change; the microeconomic foundations of technological change; the impact of technology on growth and economic performance; technology policymaking in governments and international organizations; and relationships between technical change and location advantages. The course will proceed through a combination of several lectures, based on readings the students are expected to have absorbed prior to each class.
Pre-requisites:	None
Program:	Part 1. Technical change and economic theory

	<p>Classical school</p> <p>Neo-classical school</p> <p>Neo-Schumpeterian school</p> <p>Institutionalist school</p> <p>Evolutionary school</p> <p>Part 2. Technology and economic development</p> <p>Micro foundations of innovation theory</p> <p>Industrialization and technology Localized innovation</p> <p>Globalization and innovation</p> <p>Institutions and innovation</p> <p>Part 3. Conceptualising and Measuring innovation</p> <p>Innovation as a process</p> <p>Innovation models</p> <p>Knowledge production models</p> <p>Technology diffusion models</p> <p>Part 4. Science and Technology Policy</p> <p>Theory of S&T policy</p> <p>Science and technology policy modes</p> <p>Evaluation</p> <p>Infrastructure policy</p> <p>Institutional arrangements for S&T policy</p>
<p>Bibliography books:</p>	<p>Fagerberg, J., D. Mowery. and R. Nelson (eds.) The Oxford Handbook of Innovation, Oxford University Press, Oxford, 2005.</p> <p>Grupp, H. (1998) Foundations of the Economics of Innovation: Theory, Measurement and Practice, Edward Elgar, Cheltenham.</p> <p>Dosi, G., C. Freeman, R. Nelson, G. Silverberg and L. Soete (eds.) Technical</p>

	Change and Economic Theory, Pinter Publishers, London, 1988.
Bibliography papers:	<p>Part 1 and 2</p> <p>Cantwell, J., and S. Iammarino (2001) EU regions and Multinational Corporations: Change, Stability and Strengthening of Technological Comparative Advantage, <i>Industrial and Corporate Change</i>, 10, p. 1007- 1037.</p> <p>Martin Bell (2006) Time and technological learning in industrialising countries, <i>International Journal of Technology Management</i>, 36, p. 25-39.</p> <p>Patel, P. and Keith Pavitt (1997) The technological competencies of the world's largest firms, <i>Research Policy</i>, 26, p. 141-156.</p> <p>Peneder, M. (2003) Industrial structure and aggregate growth, <i>Structural Change and Economic Dynamics</i>, 14, p. 427-448.</p> <p>Nelson, R. (1995) Recent evolutionary theorising about technological change, <i>Journal of Economic Literature</i>, 33, p. 48-90.</p> <p>Romero, F.C.C. (1992) Research and Development and firm size. The Portuguese electric/electronic industrial sector: a survey, MERIT Research Memoranda 92-001, University of Maastricht, The Netherlands.</p> <p>Vieira, F. and Romero, F. (2008) Networks and industrial clusters, in Putnik, G. D. and M. M. Cunha (eds.). <i>Encyclopaedia of Networked and Virtual Organizations</i>, Information Science Reference, Hershey.</p> <p>Van Cayseele, P. (1998) Market structure and innovation: a survey of the last twenty years, <i>De Economist</i>, 146, p. 391-417.</p> <p>Part 3 and 4</p> <p>Borras, S. and B.A Lundvall (2005) Science, Technology and Innovation Policy, in Fagerberg, J., Mowery. D. and RR. Nelson (eds), <i>The Oxford Handbook of Innovation</i>, Oxford University Press.</p> <p>Archibugi, D. and Alberto Coco (2005) Measuring technological capabilities at the country level, <i>Research Policy</i>, 34, p. 175-194.</p> <p>Kastrinos, N. and Romero, F. (1997) Policies for competitiveness in less-favoured regions of Europe: a comparison of Greece and Portugal, <i>Science and Public Policy</i>, 24, p.189-196.</p> <p>Khan, B. Z. and Kenneth Sokoloff (2004) Institutions and technological innovation during early economic growth: evidence from the great inventors</p>

	<p>of the US, 1790-1930, NBER Working paper No. 10966.</p> <p>Kline, S.J. and N. Rosenberg (1989) An overview of innovation, in Landau, R. and Rosenberg, N. (eds) <i>The Positive Sum Strategy: Harnessing Technology for Economic Growth</i>, The National Academy Press, Washington.</p> <p>Martin, S. and Scott, J. (2000) The nature of innovation market failure and the design of public support for private innovation, <i>Research Policy</i>, 29, p. 437-447.</p> <p>Metcalf, L.S. (1994) Evolutionary economics and technology policy, <i>The Economic Journal</i>, 104, p. 931-944.</p> <p>Romero, F. (2010) The social dimension of the integration of manufacturing systems: the role of institutions, <i>International Journal of Computer Integrated Manufacturing</i>, 23, p. 819-831.</p> <p>Vavakova, B. (2006) Reconceptualising innovation policy. The Case of France. <i>Technovation</i>, 26, p. 444-462.</p>
Grading	Homework assignments
Other information	



Universidade do Minho
Escola de Engenharia

Programa Doutoral em Engenharia Industrial e de Sistemas (PDEIS) Doctoral Program in Industrial and Systems Engineering (PDEIS)

Courses

Doctorate course name:	Eco Sustainable Production
Program(s):	PDEIS
Semester:	2nd semester
Language:	Portuguese (if required, the course can be offered in English language)
Lecturer(s):	Francisco Moreira
Contacts:	Email: fmoreira@dps.uminho.pt Phone number: +351 253 510 767
Subject description and objectives	<p>Traditional economic models based upon increased production volumes challenges nature's capacity to supply abundant and sustainable resource flows, while products use, end-of-life and industrial emissions represent a considerable burden to nature and human wellbeing. The course uncovers the tradeoffs of modern lifestyle and human development progress, sets the context for the need to redesign products and processes, and provides LCA methodologies and tools to methodically assess and support the development of strategies to advance industrial systems and products. Objectives:</p> <ol style="list-style-type: none">1. Understand the vectors of sustainable development and major threats for its progress.2. Identify trends on population growth, human lifestyle, global energy

	<p>system, fossil fuels use and dependency and emissions.</p> <p>3. Apply LCA methodologies to assess products and processes.</p> <p>4. Develop strategies to improve products life-cycle.</p>
Pre-requisites:	No pre-requisites.
Program:	<p>1. Sustainable development Concept of development. The Human Development Index. Economic Growth. Ecological footprint. Sustainable development; historical context; the Brundtland Report.</p> <p>2. Population, Energy and Natural Resources World population, historical developments and future forecasts. Wealth distribution; energy intensity; sustainable consumption. Global energy system, energy consumption and its sustainability. Fossil fuels; dependency and security; estimated reserves and production peak. Fossil fuels carbon contents. Nuclear energy: fusion and fission. Renewable energy. Energy efficiency; negawatt concept. Natural resources. Biodiversity.</p> <p>3. Climate Change and pollutant emissions The Kyoto protocol: goal, regional and national targets, implementation mechanisms. Perspectives on future emissions reduction targets. The Greenhouse phenomenon; Greenhouse gases; GWP coefficient; Climate change scenarios and consequences; global warming mitigation measures.</p> <p>4. Waste from industrial activity Background on waste reduction strategies in industrial activity. Waste from packaging; types, classes; packaging functionalities; economic justification; EU targets for recycling of packaging waste. The Portuguese SIGRE system. The 3Rs principles. Waste treatment; energetic valorisation and landfill deposition.</p> <p>5. Eco-efficiency and Eco-design The concept of eco-efficiency; eco-efficiency ratios and strategies; Competitive index vs environmental legislation; energy productivity; Eco-design;</p> <p>6. Life cycle assessment Quantitative methods; the ISO14040/14044 LCA methodology; assessment categories; assessment stages. Qualitative methods; MET matrix; eco-design</p>

	<p>strategies diagrams; life cycle eco-design checklists.</p> <p>7. Sustainable mobility and end-of-life vehicles</p> <p>Transportation means; fuels types and propulsion technologies; ICE vehicles; electric vehicles (plug-in); hybrid vehicles; Fuel cell vehicles (FCV).</p> <p>Alternative concepts on vehicle ownership and use. UE directives on end-of-life vehicles.</p> <p>8. Eco Labelling</p> <p>The EU eco-label scheme; product groups and product group criteria; awarding scheme; eco-label validity. Other eco-labeling schemes.</p>
Bibliography books:	<p>Ferrão, P. (1998). Introdução à gestão ambiental: a avaliação do ciclo de vida de produtos. Coleção Ensino da Ciência e da tecnologia, IST Press, Lisboa.</p> <p>Hendrickson, Chris T., Lave, Lester B., Matthews, H. Scott (2006). Environmental Life Cycle Assessment of Goods and Services: An Input-Output Approach, RFF Press.</p> <p>Weizsäcker, E., Lovins, A., Lovins, L. (1997). Factor Four: Doubling Wealth-Halving Resource Use, Earthscan Publications Ltd.</p>
Bibliography papers:	<p>Moreira, F., Alves, A. C. and Sousa, R. M. (2010) "Towards Eco-efficient Lean Production Systems", Proceedings of 9th IFIP WG 5.5 International Conference, BASYS 2010, (Eds.) A. Ortiz, R. D. Franco and P. G. Gasquet, Polytechnical University of Valencia, ISBN-13: 978-3-642-14340-3 Springer Berlin Heidelberg New York, pp. 100-108</p>
Grading	Written exam: 50%; Individual Project: 30%; Papers review: 20%
Other information	



Universidade do Minho
Escola de Engenharia

Programa Doutoral em Engenharia Industrial e de Sistemas (PDEIS) Doctoral Program in Industrial and Systems Engineering (PDEIS)

Courses

Doctorate course name:	Decision Analysis Models and Methods
Program(s):	PDEIS
Semester:	2nd
Language:	English
Lecturer(s):	Anabela Pereira Tereso (http://pessoais.dps.uminho.pt/anabelat/)
Contacts:	e-mail: anabelat@dps.uminho.pt tel.: +351 253 510 368
Subject description and objectives	<p>This course is intended for graduate students interested in decision analysis models and methods and their applications. In the business world, a good decision may be the success of an organization. To decide, sometimes, is not an easy task, mainly when we have multiple criteria. A bad decision can mean the collapse of an organization. In the current climate of turbulence, the companies, in order to become competitive in an increasing demanding market, have to know how to make decisions right.</p> <p>This course offers an introduction to decision analysis, explains how to structure decisions and to make choices using influence diagrams and decision trees. It also covers multicriteria decision methods like AHP, ELECTRE and</p>

	PROMETHEE, considering the decision maker preferences. Available software in the area will also be used to allow practical applications of the topics covered.
Pre-requisites:	None
Program:	<p>Introduction to Decision Analysis</p> <p>Why is it difficult to make decisions?</p> <p>Why to study decision analysis?</p> <p>Decision making and subjective judgment</p> <p>The decision making process</p> <p>Decision analysis applications</p> <p>Decision analysis software</p> <p>Elements of a Decision Problem</p> <p>Values and objectives</p> <p>Decisions</p> <p>Uncertainty events</p> <p>Consequences</p> <p>Structuring Decisions</p> <p>Structuring values and objectives</p> <p>Influence diagrams</p> <p>Decision trees</p> <p>Using Precision Tree Software for structuring decisions</p> <p>Making Choices</p> <p>Using decision trees</p> <p>Using influence diagrams</p> <p>Using Precision Tree Software for making choices</p> <p>Introduction to Multicriteria Decision Making (MCDM)</p> <p>Introduction to MCDM</p> <p>Alternatives, Criteria and Attributes, Objectives</p> <p>Basic approaches to MDCM</p> <p>Using Precision Tree Software for MCDM</p> <p>Decision maker preferences</p> <p>Graphical representation</p> <p>Dominance analysis</p>

	<p>Rates of Substitution</p> <p>Aggregation functions</p> <p>Indifference curves</p> <p>Decision maker preferences</p> <p>Multicriteria value functions</p> <p>Introduction</p> <p>Individual value functions</p> <p>Global value functions</p> <p>AHP – Analytical Hierarchy Process</p> <p>Construction of the decision hierarchy</p> <p>Priority evaluation</p> <p style="padding-left: 40px;">Saaty’s preference scale</p> <p>Pair-wise comparison</p> <p style="padding-left: 40px;">Consistency Ratio</p> <p>Evaluating results</p> <p>Using Web-Hipre Software</p> <p>Outranking Methods</p> <p>Introduction</p> <p>Attributing weights to decision criteria</p> <p>Outranking analysis</p> <p>Indifference, preference and veto thresholds</p> <p>ELECTRE</p> <p>Using ELECTRE III-IV Software</p> <p>PROMETHEE</p> <p>Using DECISION LAB Software</p>
<p>Bibliography books:</p>	<p>Bana e Costa (1990) Readings in Multiple Criteria Decision Aid, Springer-Verlag, Berlin.</p> <p>Behn R. D. and Vaupel J. W. (1982) Quick Analysis for Busy Decision Makers. New York: Basic Books.</p> <p>Bunn D. (1984) Applied Decision Analysis, McGraw-Hill Inc., New York.</p> <p>Canada J. R. and Sullivan W.G. (1989) Economic and Multiattribute Evaluation of Advanced Manufacturing Systems, Prentice Hall College Div.</p> <p>Clemen R. T. and Reilly T. (2001) Making Hard Decisions with DecisionTools®. Duxbury, Thoson Learning.</p>

	<p>Dias L. M. C. (2001), A Informação Imprecisa e os Modelos Multicritério de Apoio à Decisão, Dissertação de Doutoramento, Faculdade de Economia – Universidade de Coimbra.</p> <p>Ehrgott M. (2005), Multicriteria Optimization, Springer.</p> <p>Figueira J., Greco S., Ehrgott M., (2005) Multiple Criteria Decision Analysis – State of the Art Surveys, Springer Science + Business Media, Inc.</p> <p>Hwang C. L., Yoon K. (1981) Multiple Attribute Decision Making – Methods and Applications: A State of the Art Survey, Springer-Verlag, New York, USA.</p> <p>Keeney R. and Raiffa H. (1993), Decision with Multiple Objectives: preferences and value tradeoffs, Cambridge University Press.</p> <p>Keeney R. L. (1992) Value-Focused Thinking. Cambridge, MA: Harvard University Press.</p> <p>Matos M. (2005) Ajuda Multicritério à Decisão - introdução, FEUP.</p> <p>Saaty T. L. (1980) The Analytic Hierarchy Process, McGraw-Hill.</p> <p>Tereso A., Técnicas de Decisão Multicritério, Departamento de Produção e Sistemas, Universidade do Minho, 2007.</p> <p>Vincke P. (1992) Multicriteria Decision-aid, John Wiley & Sons, New York.</p> <p>Zeleny M. (1982) Multiple Criteria Decision Making, McGraw-Hill.</p>
Bibliography papers:	<p>Brans J. P., Vincke P. A. and Mareschal B. (1986) How to select and how to rank projects: The Promethee method, European Journal of Operational Research, vol. 24, pp. 228-238.</p> <p>Covaliu Z. and Oliver R. (1995) "Representation and Solution of Decision Problems Using Sequential Decision Diagrams", Management Science, Vol. 41, No. 12 (Dec., 1995), pp. 1860-1881.</p> <p>Hussain D., Figueiredo M., Tereso A. and Ferreira F. (2010) "A Study of Textile & Clothing Supply Chain in Pakistan" (this paper presents an application of AHP applied to a practical problem), 2nd International Conference on Engineering Optimization, Lisbon – Portugal, September 6 - 9, 2010.</p> <p>Roy, B. (1968) Classement et choix en présence de points de vue multiples (la méthode ELECTRE), RIRO, vol. 8, pp. 57-75.</p> <p>Roy, B. (1978) Electre III: un algorithme de classements fondé sur représentation floue des préférences en présence de critères multiples, Cahiers</p>

	<p>du CERO, vol. 20 (1), pp. 2-24.</p> <p>Roy, B., Bertier, P. (1973) La méthode Electre II - Une application au médiaplaning, M. Ross (ed.), OR'72, North-Holland Publishing Company, pp. 291-302.</p> <p>Seixedo C. and Tereso A. (2010) "A Multicriteria Decision Aid Software Application for selecting MCDA Software using AHP", 2nd International Conference on Engineering Optimization, Lisbon – Portugal, September 6 - 9, 2010.</p> <p>Shachter R. (1986) "Evaluating Influence Diagrams", Operations Research, 34, 871-882.</p>
Grading	<p>The following weights will be considered:</p> <p>Individual assignment: 50%</p> <p>Final exam: 50%</p>
Other information	<p>Related PhD project proposals:</p> <ol style="list-style-type: none"> 1. Selection and evaluation of multicriteria decision tools (Supervisor: Anabela Tereso). 2. Multicriteria model to support the selection of financing options (Supervisors: Anabela Tereso and Jorge Cunha) 3. The use of multicriteria tools to diagnose and select production systems (Supervisors: Anabela Tereso and Anabela Alves) 4. The use of multicriteria tools to select cell operational configurations (Supervisors: Anabela Tereso and Anabela Alves)



Universidade do Minho
Escola de Engenharia

Programa Doutoral em Engenharia Industrial e de Sistemas (PDEIS) Doctoral Program in Industrial and Systems Engineering (PDEIS)

Courses

Doctorate course name:	Real Option Analysis
Program(s):	PDEIS
Semester:	course is offered in the 2nd semester (February through July)
Language:	English
Lecturer(s):	Jorge Cunha
Contacts:	jscunha@dps.uminho.pt
Subject description and objectives	This course is intended for graduate students interested in advanced investment appraisal methods. In fact, the methods and techniques for investment appraisal have become increasingly complex. This course aims to impart updated knowledge in this field, namely: to distinguish real options from financial options; to understand the importance of the characteristics of irreversibility, uncertainty and timing associated with an investment decision; to identify the options embedded in an investment project; to model the cash flows associated with a real investment.
Pre-requisites:	Basic investment appraisal
Program:	I. Introduction I.1 Options Valuation I.2 Basic Nature of Options I.3 From Financial to Real Options Valuation I.4 Irreversibility, Uncertainty, and Investment I.5 The Options Approach to Capital Investment

	<p>I.6 Models for Real Options Valuation</p> <p>II. Valuing Real Options</p> <p>II.1 The Value of Waiting to Invest</p> <p>II.2 Time to Build, Option Value, and Investment Decisions</p> <p>II.3 Abandonment Value and Project Life</p> <p>II.4 Irreversible Investment, Capacity Choice, and the Value of the Firm</p> <p>II.5 The Nature of Options Interactions and the Valuation of Investments with Multiple Real Options</p> <p>III. Analysis of application examples and case studies</p> <p>III.1 Valuing Natural Resource Investments</p> <p>III.2 Valuing Firm Strategy</p> <p>III.3 Valuing Investment in Technological Innovations</p> <p>III.4 Valuing a Research and Development Program</p> <p>III.5 Valuing Offshore Oil Concessions</p> <p>III.6 Valuing Infrastructure Investment</p>
<p>Bibliography books:</p>	<p>Brealey, R. and S. Myers (1998) <i>Principles of Corporate Finance</i>. 5th Edition, McGraw-Hill.</p> <p>Damodaran A. (2001) <i>Corporate Finance: Theory and Practice</i>, 2nd Edition, John Wiley & Sons.</p> <p>Dixit, A.; Pindyck, R. (1994) <i>Investment under Uncertainty</i>, Princeton University Press, New Jersey.</p> <p>Smit, H.T.; Trigeorgis, L. (2004) <i>Strategic Investment: Real Options and Games</i>, Princeton University Press.</p> <p>Schwartz, E.S.; Trigeorgis, L. (2001) <i>Real Options and Investment under Uncertainty: Classical Readings and Recent Contributions</i>, MIT Press.</p>
<p>Bibliography papers:</p>	<p>Abdelhamid, M.; Aloui, C.; Chaton, C. (2009) A real options approach to investing in the first nuclear power plant under cost uncertainty: comparison with natural gas power plant for the Tunisian case, <i>International Journal of Oil, Gas and Coal Technology</i>, 2(1), pp. 44 – 57.</p> <p>Benaroch, M; and R. Kaufman (1999) Justifying Electronic Banking Network Expansion Using Real Options Analysis, <i>MIS Quarterly</i>, 24(2), 197-225.</p> <p>Brennan, M.; Schwartz, E. (1985) Evaluating Natural Resource Investments, <i>Journal of Business</i>, 58: 135-157.</p> <p>Bulana, L; Mayerb, C.; Somerville, C. (2009) Irreversible investment, real options, and competition: Evidence from real estate development, <i>Journal of Urban Economics</i>, 65(3), pp. 237-251.</p> <p>Busby, J. and C. Pitts (1997) Real Options in Practice: An Exploratory Survey of How Finance Officers Deal with Flexibility in Capital Appraisal, <i>Management Accounting</i>, 8(2), 169-186.</p> <p>Busby, J. and C. Pitts (1997) Real Options and Capital Investment Decisions, <i>Management Accounting</i>, 75(10), 38-39.</p> <p>Eckhause, J.; Hughes, D.; Gabriel, S. (2009) Evaluating real options for mitigating technical risk in public sector R&D acquisitions, <i>International Journal of Project Management</i>, 27(4), pp. 365-377.</p> <p>Estrada, I.; Fuente, G.; Martín-Cruz, N. (2010) Technological joint venture formation under the real options approach, <i>Research Policy</i>, 39(9), pp. 1185-1197.</p> <p>Farragher, E., R. Kleiman and A. Sahu (2001) “The association between the use of sophisticated capital budgeting practices and corporate performance.”</p>

	<p><u>The Engineering Economist</u> 46(4): 300-311.</p> <p>Graham, J. and C. Harvey (2002). "How Do CFOs Make Capital Budgeting and Capital Structure Decisions?" <u>Journal of Applied Corporate Finance</u>, 15(1): 8-23.</p> <p>Reuer, J.J.; Tong, T.W. (2007) How Do Real Options Matter? Empirical Research on Strategic Investments and Firm Performance, in Professor Brian Silverman (ed.) <i>Real Options Theory (Advances in Strategic Management, Volume 24)</i>, Emerald Group Publishing Limited, pp.145-173.</p> <p>Morelleca, E.; Schürhoff, N. (2011) Corporate investment and financing under asymmetric information, <i>Journal of Financial Economics</i>, 99(2), pp. 262-288.</p> <p>Paddock, J.; Siegel, D.; Smith, J. (1988) Option Valuation of Claims on Real Assets: The Case of Offshore Petroleum Leases, <i>Quarterly Journal of Economics</i>, 103: 479-508</p> <p>Pereiro, L. (2006). "The practice of investment valuation in emerging markets: Evidence from Argentina." <u>J. of Multi. Fin. Manag.</u> 16: 160–183.</p> <p>Quigg, L. (1993) Empirical Testing of Real Option-Pricing Models, <i>Journal of Finance</i>, 48: 621-639.</p> <p>Sahaym, A.; Steensma, H.; Barden, J. (2010) The influence of R&D investment on the use of corporate venture capital: An industry-level analysis, <i>Journal of Business Venturing</i>, 25(4), pp. 376-388.</p> <p>Trigeorgis L. (1993), "Real options and interactions with financial flexibility", <i>Financial Management</i>, Vol.22, No.3 pp.202-224.</p> <p>Verbeeten, F. (2006) "Do organizations adopt sophisticated capital budgeting practices to deal with uncertainty in the investment decision? A research note." <u>Management Accounting Research</u> 17: 106-120.</p> <p>Xie, F. (2009) Managerial flexibility, uncertainty, and corporate investment: The real options effect, <i>International Review of Economics & Finance</i>, 18(4), pp. 643-655.</p>
Grading	<p>The following weights will be considered: Analysis of papers (individual assignment): 50% Final exam: 50%</p>
Other information	



Universidade do Minho
Escola de Engenharia

Programa Doutoral em Engenharia Industrial e de Sistemas (PDEIS) Doctoral Program in Industrial and Systems Engineering (PDEIS)

Courses

Doctorate course name:	Advanced Issues on Production Activity Control (AIPAC)
Program(s):	PDEIS
Semester:	Course offered in the 2nd semester (February through July)
Language:	English
Lecturer(s):	S. Carmo-Silva
Contacts:	email: scarmo@dps.uminho.pt tel.: +351 253 604745
Subject description and objectives	<p>This course is designed for students interested in the control of production activity of industrial companies for the manufacture and the supply of goods. It aims to acquire knowledge and competences in the domain of Production Activity Control towards providing effective customer service and efficient use of manufacturing and production logistic resources.</p> <p>Production Activity Control (PAC) is an emerging subject that aims to integrate several strategies for the control of manufacturing operations and the flow of materials according to the patterns of demand and the manufacturing flexibility. These strategies fall under the two main approaches to manufacture that have been referred as Lean and Agile Manufacturing. The first focuses on</p>

	repetitive production of a variety of products; the second is mainly concerned with Make to Order and customized products with due date promises.
Pre-requisites:	Knowledge of Production Organization and Management Fundamentals
Program:	<p>0. Introduction Course structure</p> <p>1. Evaluation of the performance of manufacturing operations Measures and measuring of effectiveness and efficiency of manufacturing operations and materials flow. The customer service and manufacturing resources perspectives.</p> <p>2. Production paradigms for satisfying demand Repetitive and Customized Production Make to Stock(MTS), Make to Order (MTO), Hybrid and Variants of MTO and MTS paradigms. The case of Make-to-Plan Product Customization Paradigms Mass production and mass customization.</p> <p>3. Establishing Due dates The critical production control cycle: from order negotiation to order delivery. Establishing due dates of customer orders: critical production planning and control tasks and milestones</p> <p>4. Production Systems balancing Load Balancing. Concurrent/Simultaneous Production. Materials flow leveling.</p> <p>5. Production activity control tasks and phases Releasing, authorization, activation, dispatching and monitoring.</p> <p>6. Production activity control approaches and strategies Base-stock replenishment approaches: continuous and periodic. Base-workload replenishment approaches: continuous and periodic.</p>

	<p>The role of MRP systems.</p> <p>7. Applications - I Mechanisms for base-stock replenishment: card and non-card based mechanisms. Examples are: TKS, CONWIP and Base-stock.</p> <p>Mechanisms for base-workload replenishment: card and non-card based mechanisms. Examples are: PBC, Generic KS and Generic POLCA.</p> <p>MRP based mechanisms.</p> <p>8. Applications - II Fitting Production Activity Control mechanisms to Production Paradigms for Satisfying Demand.</p>
Bibliography books:	<p>Hopp W. J., Spearman, M. L, (1996), “Factory Physics – Foundations of Manufacturing Management”, Irwin/McGraw-Hill.</p> <p>John A. Buzacott, J. George Shanthikumar (1993), Stochastic models of manufacturing systems, Prentice Hall,</p> <p>Peter Nyhuis, Hans-Peter Wiendahl (2009) Fundamentals of production logistics-theory, tools and applications, Springer</p> <p>Yasuhiro Monden (1998) Toyota production system an integrated approach to just-in-time, Institute of Industrial Engineers</p>
Bibliography papers:	<p>Almeida, A., Ramos, C., Carmo-Silva, S. (2002), ”Toward Dynamic Scheduling of Manufacturing” The International Journal For Manufacturing Science & Production, Vol.4 Vol.No.3 pp169-179</p> <p>Carmo-Silva, S., Alves, .A.C. , Moreira, F., (2006), Linking production paradigms and organizational approaches to production systems, D T Pham, E E Eldukhhr, Soroka, A. J., Intelligent Production Machines and Systems, 2nd I*PROMS Virtual Conference 3-14 July 2006, Elsevier</p> <p>Fernandes, N.O., Carmo-Silva, S. (2005), A Generic Workload Control Model for Order Release and Workflow Control 18th International Conference on Production Research, July 2005, Salerno, Italy</p> <p>Fernandes, N.O., Carmo-Silva, S (2010), Order release in a workload controlled flow-shop with sequence-dependent set-up time, International Journal of Production Research, http://dx.doi.org/10.1080/00207541003720376, , 2010</p>

	<p>Fernandes, N.O., Carmo-Silva, S (2010), Workload control under continuous order release, International Journal of Production Economics, doi:10.1016/j.ijpe.2010.09.026, , 2010</p> <p>Fernandes, N.O., Carmo-Silva, S (2006), Generic POLCA—A production and materials flow control mechanism for quick response manufacturing, International Journal Production Economics 104 (2006) No.1 pp. 74–84 http://www.sciencedirect.com/science/journal/09255273</p>
Grading	<p>LEARNING METHODOLOGY</p> <p>The learning methodology is based on the development of essays for each of the Program topics (from 1 to 8).</p> <p>The essays will be mostly based on the study of critical bibliography, mainly books and papers, and should have each ten pages or less (arial 10, space 1.5 and 6 pts between paragraphs).</p> <p>GRADING</p> <p>Grading is based on the quality of students’ essays, one for each of the program topics (from 1 to 8), having each one the same grading weight.</p>
Other information	<p>Doctorate project research theme:</p> <p>“Production Activity Control Solutions for Integrated Make-to-Order and Make-to-Stock of Aluminium Profiles”</p>



Universidade do Minho
Escola de Engenharia

Programa Doutoral em Engenharia Industrial e de Sistemas (PDEIS) Doctoral Program in Industrial and Systems Engineering (PDEIS)

Courses

Doctorate course name:	Engineering and Industrial Management Web Services (EIMWS)
Program(s):	PDEIS
Semester:	2nd
Language:	English
Lecturer(s):	Dr. Leonilde Varela
Contacts:	leonilde@dps.uminho.pt
Subject description and objectives	<p>Definition and frameworking of Web Services within the Internet environment. Functional architecture of Web Services. Protocols, languages and standards for specification, implementation, communication and management of Web Services: http, https, ftp, smtp, etc., xml, ebxml, wsdl, saml, etc., soap, uddi, etc. Definition of Engineering and Industrial Management Web Services (EIMWS): products and orders specification, bill of materials, process planning, production planning and control, scheduling, information and knowledge resources, etc. User interfaces and applications.</p> <p>Case studies.</p> <p>Ability for:</p> <p>1) Identification of the enterprise's requirements for Web Services for</p>

	<p>Engineering and Industrial Management.</p> <p>2) Specification of EIMWS using Web Services description languages.</p> <p>3) Implementation of EIMWS.</p> <p>4) Conception of user-interfaces and applications for EIMWS.</p>
Pre-requisites:	---
Program:	<p>Detailed Program</p> <p>1. Fundamentals of web technologies and standards (HTML, communication protocols, etc)</p> <p>2. Fundamentals of XML and related technologies</p> <p>3. Fundamentals of Web Services</p> <p>4. Use of Engineering and Industrial Management Web Services. Case studies</p> <p>5. Integration of technologies for developing Web Services for Engineering and Industrial Management</p> <p>6. Web services implementation:</p> <p> 6.1 Specification of Industrial Management knowledge</p> <p> 6.2 Development of user interfaces</p> <p> 6.3 Use of Web tools and communication protocols for Web Services invocation</p>
Bibliography books:	<p>Hand-outs prepared by the lecturer. Books and papers selected from the UM's Library and from other sources, including handbooks and Internet sources.</p> <p>1. Vollmann, T., et al. (2004). Manufacturing Planning and Control Systems, Irwin.</p> <p>2. Browne, J., et al. (1991). Production Management Systems: A CIM Perspective, Addison-Wesley.</p> <p>3. Scheer, A.W. (1991). CIM - Computer Integrated Manufacturing, Towards the Factory of the Future, Springer-Verlag.</p> <p>4. Ballinger, K. (2004), .Net Web Services: Architecture and Implementation, Addison-Wesley, Pearson Education, Inc., Boston.</p>
Bibliography papers:	<p>- Varela, M. L. R., Carmo-Silva, S. (2010). A P2P Web Decision Support System for Manufacturing Scheduling. In Putnik, G. D., Ávila, P. (eds.), Business Sustainability I, Management Technology and Learning for Individuals, Organisations and Society in Turbulent Environments (pp. 147-152). University of Minho & ISEP, (ISBN: 147-152, 978-972-8692-48-3, 978-</p>

989-95907-1-7).

- Varela, M. L. R., Carmo-Silva, S. (2008). An Ontology for a Model of Manufacturing Scheduling Problems to be Solved on the Web. In Azevedo, A. (ed), Innovation in Manufacturing Networks, 8th IFIP International Conference on Information Technology for Balanced Automation Systems (pp. 197-204), Porto, Portugal, June 23-25, 2008, Springer. ISSN: 1571-5736 / 1861-2288 (Internet), ISBN: 978-0-387-09491-5; eISBN: 978-0-387-09492-2.

- Carmo-Silva, S., Varela, M. L. R., Lemos, A., Garcia, A., Ribeiro, C., Carvalho, J. (2007). Collaborative Production Scheduling. In Pham, D. T., Eldukhr, E. E., Soroka, A. J., (eds.), Intelligent Production Machines and Systems, 2nd I*PROMS Virtual Conference, 2nd – 13th July 2007, Elsevier.

- Varela, M. L. R., Aparício, J. N., Carmo-Silva, S. (2005). A Scheduling Web Service. In Kendall G., Burke E., Petrovic S., Gendreau M. (Eds.), Multidisciplinary Scheduling - Theory and Applications. Nottingham, UK. Springer. ISBN 0-387-25266-5.

- Varela M. L. R., Aparício, J. N., Carmo-Silva, S. (2004). A Web Interface for Accessing Scheduling Methods in a Distributed Knowledge Base. In Virtual Enterprises and Collaborative Networks, Kluwer Academic Publishers, ISBN: 1-4020-8138-3.

- Varela, M. L. R., Aparício, J. N., Carmo-Silva, S. (2003). A Web Service for Production Scheduling. In Business Excellence I: Performance Measures, Benchmarking and Best Practices in new Economy, pp: 523-528, , University of Minho, ISBN: 972-8692-08-0.

- Varela, M. L. R., Aparício, J. N., Carmo-Silva, S. (2002). Developing a Web Scheduling System Based on XML Modelling. In Marik V., Camarinha-Matos, L., Afsarmanesh H. (Eds.), Knowledge and Technology Integration in Production and Services: Balancing Knowledge and Technology in Product and Service Life Cycle, pp: 61-70, Kluwer Academic Publishers, ISBN: 1-4020-7211-2.

- Varela, M. L. R., Aparício, J. N., Carmo-Silva, S. (2002). An XML Knowledge Base System for Scheduling Problems. In Innovative Internet Computing Systems Conference (I2CS) - Lecture Notes in Computer Science, pp: 63-74, Springer-Verlag, Berlin-Heidelberg, June 2002. ISBN: 3-540-43790-08.

Grading	Grading is based on a final report or a paper regarding literature review about the topics focused on the course and/ or web services specification and implementation.
Other information	



Universidade do Minho
Escola de Engenharia

Programa Doutoral em Engenharia Industrial e de Sistemas (PDEIS) Doctoral Program in Industrial and Systems Engineering (PDEIS)

Courses

Doctorate course name:	Total Quality Management
Program(s):	Doctoral Program in Industrial and Systems Engineering
Semester:	2 nd semester (February through July)
Language:	Portuguese and/or English
Lecturer(s):	Paulo Sampaio and Sérgio Sousa
Contacts:	Systems and Production Department, School of Engineering, University of Minho E-mail: paulosampaio@dps.uminho.pt ; sds@dps.uminho.pt Phone: +351 253 604 756 (Paulo Sampaio); +351 253 604 762 (Sérgio Sousa)
Subject description and objectives	Management Systems and Business Excellence Models International and global standards and business excellence models are widely used in many organizations around the globe in order to give guidance on good management. This course focuses on the importance of these standards and excellence models as a means to ensuring the organizational sustained success. Additionally we will discuss how organizations could use these approaches as a basis for assessment and continuous improvement to attain superior organizational results. Performance Measurement Systems and Quality Improvement Performance Measurement Systems (PMS): PMS are not new but with the increasing

	<p>use of non-financial performance measures (PMs) and with their ability to support decisions, some recent advances will be studied. PMs are related with company's strategy, and can contribute to quality improvement. This module provides techniques for the design and use of the PMS. Uncertainty and errors associated with PMs will be discussed.</p> <p>Quality Improvement Techniques (QIT): There is a plethora of quality improvement methodologies, techniques and tools. Some relevant tools will be studied and a framework to select the most appropriate for each scenario will be provided.</p>
Pre-requisites:	Quality Management
Program:	<p>Management Systems and Business Excellence Models <i>Paulo Sampaio</i></p> <ol style="list-style-type: none"> 1. Introduction, Concepts and Definitions. 2. Quality Management Standards Research. 3. Quality Management Systems Economic Impact. 4. Management Systems Integration. 5. The ISO 9004 Standard 6. Business Excellence Models <p>Performance Measurement Systems and Quality Improvement <i>Sérgio Sousa</i></p> <ol style="list-style-type: none"> 1. Introduction to performance measurement systems (PMS): definitions; traditional and non-traditional PMs; quality costs; importance and barriers to performance measurement; from performance measurement to performance management; integration with other systems. 2. PMS: the balanced scorecard, the performance prism, the EFQM model and Kanji's Business Excellence Model; strategy maps; strategic and maturity alignment between PMs and the organisation. 3. PMS Design: top-down, bottom-up e customer-inside approaches; PMS review. Data quality and uncertainty of PMs: identification of methods to represent uncertainty. 4. Quality Improvement Techniques (QIT): 5S, kaizen, benchmarking, motivation for quality; teamwork; quality circles; 6 sigma, 8D; and DOE.
Bibliography	<p>Management Systems and Business Excellence Models - Juran, J. and De Feo, J. (2010, 6th Edition), <i>Juran's Quality Handbook</i>. McGraw-</p>

books:	<p>Hill.</p> <ul style="list-style-type: none"> - <i>Manual Prático para a Gestão e Qualidade nas Organizações</i>, Verlag Dashöfer. - Oakland, J.S. (2001), “Total Organizational Excellence: Achieving World-Class Performance”, 2nd ed., Butterworth-Heinemann, Oxford. - Paiva, A. L., Capelas, L., Sampaio, P., Saraiva, P. (2009), <i>ISO 9001:2008 – Implementação e Certificação</i>. Verlag Dashöfer. - Stoner, J. and Werner, F. (1994), <i>Managing Finance for Quality</i>. American Society for Quality, Milwaukee, Wisconsin, USA. <p>Performance Measurement Systems and Quality Improvement</p> <ul style="list-style-type: none"> - Bourne, M. (2004). Handbook of performance measurement. London, Gee Publishing. - Neely, A. (editor), (2002). Business Performance Measurement- theory and practice, Cambridge University Press. - Niven, P. R. (2002). Balanced scorecard step-by-step: maximizing performance and maintaining results, John Wiley & Sons. - Juran, J. and De Feo, J. (2010, 6th Edition), <i>Juran’s Quality Handbook</i>. McGraw-Hill. - Kolarik, W., “Creating Quality: Concepts, Methods, Strategies and Tools”, McGraw Hill Book Co.
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Grading	<p>Management Systems and Business Excellence Models Group work (30%): Presentation (30%) + Final Report (70%).</p> <p>Performance Measurement Systems and Quality Improvement Homework and analysis of papers: 30%</p> <p>Course final exam: 40%</p>
Other information	<p>PhD theses proposals</p> <p>PhD 1 – Title Quality management and supply chain management impact in organizational performance</p> <p>Supervisors Professor Paulo Sampaio and Professor Maria Sameiro Carvalho University of Minho / Systems and Production Department</p> <p>E-mail paulosampaio@dps.uminho.pt sameiro@dps.uminho.pt</p> <p>PhD 2 – Title Approaches to Quality used by the Organizations</p> <p>Supervisors Professor Paulo Sampaio¹ and Professor Pedro Saraiva² ¹University of Minho / Systems and Production Department ²University of Coimbra / Chemical Engineering Department</p> <p>E-mail paulosampaio@dps.uminho.pt</p>



Universidade do Minho
Escola de Engenharia

Programa Doutoral em Engenharia Industrial e de Sistemas (PDEIS) Doctoral Program in Industrial and Systems Engineering (PDEIS)

Courses

Doctorate course name:	Energy Planning
Program(s):	PDEIS
Semester:	1st or 2nd
Language:	English
Lecturer(s):	Paula Varandas Ferreira (http://pessoais.dps.uminho.pt/paulaf/)
Contacts:	Contacts: e-mail: paulaf@dps.uminho.pt tel.: +351 253 510 360
Subject description and objectives	This course is intended for graduate students interested in the energy planning models and tools. The increasing acceptance of the principle of sustainable development has been a major driving force towards new approaches to energy planning. The focus of energy planning is now on the prospective evaluation of energy projects integrated in a whole energy system rather than independent projects. Decisions support models and energy planning tools must be able not only to accommodate different criteria but also to recognize the technical

	<p>restrictions of each technology, the demand variations and to properly consider the legal environment. This course aims to introduce energy system analysis resourcing to planning models and tools. After the course the participants are expected to be able to understand the different methodologies and to be able to use some models and software applied to energy system modelling, resourcing to real examples or case studies.</p>
Pre-requisites:	None
Program:	<p><i>Introduction to energy planning</i></p> <p>Energy systems and markets. Sustainable energy systems The social, environmental and economic dimensions of the energy systems. Criteria assessment: Monetisation and multicriteria methods</p> <p><i>Tools and methods for energy planning</i></p> <p>Discrete models: scenario analysis. Single or multiobjective programming models: scenario construction. Computer tools for analyzing energy system.</p> <p><i>Application to selected case studies</i></p> <p>Selection and characterization of case studies. Data collection. Application of the computer tools to the selected cases studies.</p>
Bibliography books:	<p>Hobbs, B and Meier, P (2003) Energy decisions and the environment: a guide to the use of multicriteria methods. Kluwer Academic Publishers.</p> <p>Mazer, A (2007) “Electric power planning for regulated and deregulated markets”, John Wiley & Sons, New Jersey, USA.</p>
Bibliography papers:	<p>Connolly, D; Lund, H; Mathiesen, B; Leahy, M (2011) “A review of computer tools for analysing the integration of renewable energy into</p>

various energy systems” Applied Energy, Vol. 87, pp. 1059-1082.

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Pereira, Sérgio; Ferreira, Paula; Vaz, A.I. (2011) “Strategic Electricity Planning Decisions” in Dubrovnik Conference on Sustainable Development of Energy, Water and Environment Systems, Dubrovnik, Croatia, 25-29 September 2011.

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Ferreira, Paula; Araújo, Madalena and O’Kelly, M.E.J. (2010) “The integration of social concerns into electricity power planning: A combined Delphi and AHP approach”, in Handbook of Power Systems, Rebennack, S.;Pardalos, P.M.; Pereira, M.V.F.; Iliadis, N.A. (Eds.), 1st Edition, pp 323-364.

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	<p>Pereira, Sérgio; Ferreira, Paula; Vaz, A.I. (2011) “Strategic Electricity Planning Decisions” in Dubrovnik Conference on Sustainable Development of Energy, Water and Environment Systems, Dubrovnik, Croatia, 25-29 September 2011.</p> <p>Ribeiro, Fernando; Ferreira, Paula; Araújo, Madalena (2011) "The inclusion of social aspects in power planning" Renewable and Sustainable Energy Reviews, Vol. 15, pp. 4361-4369</p>
Grading	<p>The following weights will be considered:</p> <p>Individual assignment: 50%</p> <p>Final exam: 50%</p>
Other information	