Course Unit	Chemical Process Optimization			Field of study	Chemical Process Simulation, Control and Optimization										
Master in	Chemical Engineering			School	School of Technology and Management										
Academic Year	2019/2020	Year of study	1	Level	2-1	ECTS credits	6.0								
Type	Semestral	Semester	2	Code	6362-354-1203-00-19										
Workload (hours)	162	Contact hours	T -	TP 15	PL 45	TC -	S -	E -	OT -	O -					

T - Lectures; TP - Lectures and problem-solving; PL - Problem-solving, project or laboratory; TC - Fieldwork; S - Seminar; E - Placement; OT - Tuturial; O - Other

Name(s) of lecturer(s): Paulo Miguel Pereira de Brito

Learning outcomes and competences

At the end of the course unit the learner is expected to be able to:
1. Understand the importance of optimisation as the final stage in the chemical processes design strategy.
2. Know the basic features that characterise the optimisation mathematical models.
3. Know the mathematical principles in which the main non-linear non-restrained optimisation numerical solution methods are based.
4. Understand the formulation and solution of typical linear programming models.
5. Understand the main solution methods for non-linear programming models.
6. Select the most suitable solution method for a particular optimisation problem and use commercial software for its application.
7. Understand the importance of the integration concept in Chemical Processes design.
8. Know the fundamentals of the heat integration procedure through pinch analysis application and understand its potential extension to other types of integration.

Prerequisites

Before the course unit the learner is expected to be able to:
1. Reveal knowledge acquired by the study of Engineering ground sciences.
2. Reveal knowledge of Engineering Sciences fundamentals.
3. Evidence experience in the use of computational tools.

Course contents

1. Introduction to optimisation and integration of Chemical Processes. 2. Basic concepts of mathematical optimisation. 3. Non-restrained non-linear optimisation. 4. Linear programming. 5. Non-linear programming. 6. Pinch analysis application to heat integration.

Course contents (extended version)

1. Introduction.
   - The importance of chemical process optimisation and integration.
   - Modelling and objective functions formulation.
   - The optimisation tree.
2. Basic concepts.
   - Concept of optimal of an one or a multidimension function.
   - Analytical approaches for the optimisation of one- and multidimension functions.
3. Non-restrained non-linear optimisation.
   - Formulation of non-linear non-restrained multidimension optimisation problems.
   - Numerical methods for non-linear optimisation.
4. Linear programming.
   - Formulation of linear restrained optimisation problems (Linear Programming).
   - Solution methods for linear programs: primal simplex algorithm in the table form.
   - Mixed integer linear programming: Branch-and-Bound method.
5. Non-linear programming.
   - Formulation of non-linear restrained optimisation problems (Non-Linear Programming).
   - Solution methods for non-linear programs: Kuhn-Tucker conditions, SLP e SQP.
6. Pinch analysis application to energetic integration.
   - Energetic integration procedure based in pinch analysis for heat-exchanger nets design.
   - Extension of pinch analysis procedures to other applications besides heat integration.

Recommended reading

1. T. F. Edgar, D. M. Himmelblau, L. S. Lasdon, Optimization of Chemical Processes, 2nd edition, McGraw-Hill (2001)
2. M. Ramalhete, J. Guerreiro, A. Magalhães, Programação Linear, Volume I, McGraw-Hill (1985)
3. J. M. Douglas, Conceptual Design of Chemical Processes, McGraw-Hill (1988)
4. R. Smith, Chemical Process. Design and Integration, John Wiley & Sons (2005)

Teaching and learning methods

Theoretical Classes: Optimisation and integration techniques analysis and discussion with case-studies solution application. Practical Classes: Tutored solution of application problems and case-studies. Non-presential work: Individual and group study, bibliography reading, problem solution and essays writing.

Assessment methods

1. Alternative 1 - (Regular, Student Worker) (Final, Supplementary)
   - Intermediate Written Test - 20% (Partial Exam.)
   - Final Written Exam - 30% (Global Exam.)
   - Case Studies - 30% (Formulation and solution of problems relating to case-studies in Chemical Processes.)
   - Practical Work - 20% (Solution of problems in the classroom.)
2. Alternative 2 - (Regular, Student Worker) (Special)
   - Final Written Exam - 100%
3. Alternative 3 - (Student Worker) (Final, Supplementary)
   - Final Written Exam - 100%

Language of instruction

English

Electronic validation

Paulo Miguel Pereira de Brito	Hélder Teixeira Gomes	Simão Pedro de Almeida Pinho	Paulo Alexandre Vara Alves
22-02-2020	23-02-2020	23-02-2020	27-03-2020