Última modificación: 13-06-2019

820542 - PSCPQ - Planificación y Programación de Operaciones de Procesos Químicos

Unidad responsable: 295 - EEBE - Escuela de Ingeniería de Barcelona Este

Unidad que imparte: 713 - EQ - Departamento de Ingeniería Química

Curso: 2019

Titulación: GRADO EN INGENIERÍA QUÍMICA (Plan 2009). (Unidad docente Optativa)
GRADO EN INGENIERÍA QUÍMICA (Plan 2009). (Unidad docente Optativa)

Créditos ECTS: 6 Idiomas docencia: Catalán, Inglés

Profesorado

Responsable: MOISES GRAELLS SOBRE

Otros:

Competencias de la titulación a las cuales contribuye la asignatura

Específicas:

3. Capacidad para el análisis, diseño, simulación y optimización de procesos y productos.

4. Capacidad para diseñar, gestionar y operar procedimientos de simulación, control e instrumentación de procesos químicos.

Transversales:

1. SOSTENIBILIDAD Y COMPROMISO SOCIAL - Nivel 3: Tener en cuenta las dimensiones social, económica y ambiental al aplicar soluciones y llevar a cabo proyectos coherentes con el desarrollo humano y la sostenibilidad.

6. TERCERA LENGUA: Conocer una tercera lengua, que será preferentemente inglés, con un nivel adecuado de forma oral y por escrito y en consonancia con las necesidades que tendrán las tituladas y los titulados en cada enseñanza.

Metodologías docentes

M

Objetivos de aprendizaje de la asignatura

O

Horas totales de dedicación del estudiantado

Dedicación total: 150h	Horas grupo grande:	60h	40.00%
	Horas grupo mediano:	0h	0.00%
	Horas grupo pequeño:	0h	0.00%
	Horas actividades dirigidas:	0h	0.00%
	Horas aprendizaje autónomo:	90h	60.00%

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Contenidos

(CAST) -

Dedicación: 50h

Grupo grande/Teoría: 10h
Grupo pequeño/Laboratorio: 10h
Aprendizaje autónomo: 30h

Descripción:

(CAST) 1. Introduction to Modelling and Optimization (2h). Decision-making and tools: modelling, simulation, optimization. Definitions: Model, variable, parameters, constraints and objective function. Model limitations and model levels. Optimality and sub-optimal results. Divide and conquer. Computing time as a problem variable. Preliminary calculations: estimating, bounding and heuristics. Exercises.

2. Introduction to Process Planning and Scheduling (2h). Process flexibility and resource allocation. The Design-Operation Paradigm. Time independent problems and time dependent problems: continuous processes, semi-continuous processes and batch processes. Short-term decisions and long-term decisions. Reactive scheduling. Information flow through levels and models. Review exercises.

3. Continuous Processes (4h). Blending and flowsheeting problems. Introduction to linear programming (LP) and optimization: graphical interpretation. Importance of constraints. Problem definition. Modelling and solving with MS-Excel (Solver). Optimization tools: LP sensitivity analysis. Exercises using EXCEL (Blending.xls, Refynery.xls, Alkyl.xls).

4. Semi-Continuous processes (4h). Standard problems: the transportation problem. Formulation and solution using Solver. Semi-continuous processes: parallel production lines (extruders, fed-batch reactors, etc.). Assignment of time to lines. Model limitations (changeovers and sequencing, etc.). Study and discussion of possible objective functions. Analysis and decision-making. Exercises using EXCEL (Transport.xls, Production_lines.xls, Solver_tester.xls).

5. Assignment problems (4h). Introduction to GAMS. Solving the transport and the parallel lines problems using GAMS. Comparing GAMS and the Excel Solver. Standard problems: the knapsack problem. Introduction to integer programming (MIP). Exercises using GAMS (Trnsport.gms, knpsk.gms).

6. Sequencing problems I (4h). Introduction to set-up and cleaning needs. Constant and sequence dependent changeover times. The changeover matrix. Simulation using EXCEL.

7. Dynamic processes (4h). A first-order kinetics model. Ordinary Differential Equations using Excel (Euler Method). Optimization of the operation of a batch reactor. Objective function: introduction to cyclic operations, idle time and cycle time. Maximum operation performance. Maintenance planning. Exercises using Excel (Maintenance.xls).

8. Introduction to discontinuous processes (4h). Need for the batch-wise operation mode: batch chemical process industries. Concepts and definitions: batch size, cycle time and size factor. Debottlenecking: identification of time and size limiting stages. The Gantt chart. Detail of the model and granularity. Exercises and preliminary hand calculations.

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(CAST) -	Dedicación: 50h Grupo grande/Teoría: 10h Grupo pequeño/Laboratorio: 10h Aprendizaje autónomo: 30h

Descripción:
(CAST) 11. Storage. Storage needs for adjusting production sub-trains: matching continuous and batch processes. Storage policies in batch processing: ZW, FW, UIS, FIS. Storage location and sizing. The Lowest Storage Level Rule (LSL). Exercises using Excel (Roblon.xls, B&B.xls) and GAMS (batchdes.gms).

12. Sequencing problems II (4h). The Travelling Salesman Problem (TSP). Problem formulation. Limitation of the solution time, decision making and need for sub-optimal solutions. Greedy heuristics. Metaheuristics and stochastic methods. Developing and programming algorithms: the MSES method. Exercises using Excel (TSP.xls).

13. Scheduling of batch processes I (4h). Elementary formulations for the multiproduct case. Basic sequencing and assignment variables. Binary variables and problem size. Time discretization. Enhanced formulations: time slots, the State Task Network (STN). Formulation exercises using GAMS.

14. Scheduling of batch processes II (4h). Advanced model development. Representing logical constraints: from Big-M to disjunctive programming. Enhanced formulations and tricks: introducing cuts, tightening relaxations, breaking symmetry, tuning parameters, etc. Formulation exercises using GAMS.

15. Detailed scheduling of batch chemical processes (8h). Review of available commercial software: BatchPlus (AspenTech), SuperPro & SchedulePro (Intelligen Inc.), etc. Recipe management standards: the ISA88. Development of a case study simulation and debottlenecking problem in the biotechnological or pharmaceutical industry.

(CAST) TEMES 11-15	Dedicación: 50h Grupo grande/Teoría: 10h Grupo pequeño/Laboratorio: 10h Aprendizaje autónomo: 30h

Sistema de calificación

S

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Bibliografía

Básica:

Edgar, Thomas F.; Himmelblau, David Mautner; Lasdon, Leon S. Optimization of chemical processes. 2nd ed. Boston [etc.]: McGraw-Hill, cop. 2001. ISBN 0070393591.

Biegler, Lorenz T.; Grossmann, Ignacio E.; Westerberg, Arthur W. Systematic methods of chemical process design. Upper Saddle River (New Jersey): Prentice Hall PTR, cop. 1997. ISBN 0134924223.

Mah, Richard S. H. Chemical process structures and information flows. Boston [Mass.] [etc.]: Butterworths, cop. 1990. ISBN 0750692308.