

**Integrated Process Design**

Code: 43327  
ECTS Credits: 6

Degree	Type	Year	Semester
4314579 Biological and Environmental Engineering	OB	1	2

The proposed teaching and assessment methodology that appear in the guide may be subject to changes as a result of the restrictions to face-to-face class attendance imposed by the health authorities.

**Contact**

Name: Pau Ferrer Alegre  
Email: Pau.Ferrer@uab.cat

**Use of Languages**

Principal working language: spanish (spa)

**Prerequisites**

None

**Objectives and Contextualisation**

To combine chemical, biological and environmental engineering principles, tools and methodologies for the integrated design and intensification of processes, aiming to the design of economically, energetically and environmentally efficient and sustainable processes.

The learning objectives therefore include identifying and applying criteria (techno economic and environmental) and different approaches to define/select optimal sequences of operations for biotechnological and environmental processes, as well as their integration into biorefineries, with special emphasis in the separation operations and strategies for process intensification.

**Competences**

- Apply methods, tools and strategies to develop biotechnological processes and products with energy-saving and sustainability criteria.
- Apply specific methodologies, techniques and resources to conduct research and produce innovative results in the area of biological and environmental engineering.
- Continue the learning process, to a large extent autonomously.
- Define and design the characteristic separation sequences in chemical, biotechnological and environmental processes in order to increase separation yields, applying criteria of energy optimisation.
- Integrate and use chemical, environmental and biological engineering tools to design biological systems for the sustainable processing of waste and for industrial biotechnological processes.
- Integrate knowledge and use it to make judgements in complex situations, with incomplete information, while keeping in mind social and ethical responsibilities.
- Organise, plan and manage projects
- Seek out information in the scientific literature using the appropriate channels and integrate this information, showing a capacity for synthesis, analysis of alternatives and critical debate.

- Solve problems in new or little-known situations within broader (or multidisciplinary) contexts related to the field of study.
- Use IT tools to acquire further knowledge in the field of biological and environmental engineering.
- Use acquired knowledge as a basis for originality in the application of ideas, often in a research context.
- Work in a multidisciplinary team

## Learning Outcomes

1. Analyse separation operations in biotechnological and environmental processes, solving design and operation problems.
2. Apply specific methodologies, techniques and resources to conduct research and produce innovative results in the area of biological and environmental engineering.
3. Continue the learning process, to a large extent autonomously.
4. Identify the advantages and disadvantages of the different separation sequences in sustainable waste treatment and in industrial biotechnological processes.
5. Integrate knowledge and use it to make judgements in complex situations, with incomplete information, while keeping in mind social and ethical responsibilities.
6. Integrate the different stages of a process, choosing the appropriate alternative sequencing.
7. Optimise processes in terms of energy-use on the basis of an integrated analysis.
8. Organise, plan and manage projects
9. Seek out information in the scientific literature using the appropriate channels and integrate this information, showing a capacity for synthesis, analysis of alternatives and critical debate.
10. Solve problems in new or little-known situations within broader (or multidisciplinary) contexts related to the field of study.
11. Use IT tools to acquire further knowledge in the field of biological and environmental engineering.
12. Use acquired knowledge as a basis for originality in the application of ideas, often in a research context.
13. Use material transfer criteria in the design of continuous-contact separation operations.
14. Work in a multidisciplinary team

## Content

Unit 1: Introduction. Integrated process design and process intensification concepts. Biorefinery concept.

Unit 2: Separation operation in biotechnological and environmental process engineering. Classification, equipment and use. Calculation methods for design of separation operations.

Unit 3: Integrated design of biotechnological and environmental processes. Design of biorefineries. Case studies.

Unit 4: Process intensification. Resources (energy, water, feedstocks) optimisation and waste minimization. Case studies.

\*Unless the requirements enforced by the health authorities demand a prioritization or reduction of these contents.

## Methodology

Lectures: Master classes with ICT support.

Problem-solving-based and Case study-based teaching: Solving of problems in class and proposal of problems to be autonomously solved by the student (a collection of problems will be available to the student in the Moodle Learning Platform). In the case study-based teaching, students work together in small groups on a case study of an integrated bioprocess/biorefinery for the sustainable production of bio-based products (e.g. bioplastics, chemicals, biofuels, etc.), under the supervision of the professor. These cases will be also studied in the module of Environmental Sustainability in Processes and Products. At the end of the case studies sessions, students will have to explain and discuss key concepts and design solutions with the rest of the class.

\*The proposed teaching methodology may experience some modifications depending on the restrictions to face-to-face activities enforced by health authorities.

## Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Exercise-based and case study-based teaching	12	0.48	1, 2, 9, 4, 6, 8, 10, 14, 13, 11
Lectures	27	1.08	4, 6, 7, 5, 3, 12, 13
Type: Autonomous			
Problem solving and work on case study	32	1.28	1, 2, 9, 4, 6, 8, 5, 3, 12, 14, 13, 11
Study	62	2.48	5, 3

## Assessment

Please refer to the Catalan or Spanish version of this document

Student's assessment may experience some modifications depending on the restrictions to face-to-face activities enforced by health authorities.

## Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Exercises and work on case study in classroom	20%	5	0.2	1, 2, 9, 4, 6, 7, 8, 10, 3, 14, 13, 11
Final exam (individual)	20%	2	0.08	1, 4, 6, 7, 5, 10, 3, 12, 13
Presentation and discussion case study	30%	2	0.08	1, 4, 6, 7, 5, 10, 3, 12, 13
Written report case study	30%	8	0.32	2, 9, 4, 6, 8, 5, 10, 3, 12, 14, 11

## Bibliography

- Belter PA, Cussler EL, Hu W-S. 1988. Bioseparations. Downstream processing for biotechnology. John Wiley & Sons. ISBN 0-471-84737-2.
- Blanch HW, Clark DS. 1996. Biochemical Engineering. Marcel Dekker. ISBN0-8247-8949-0.
- Heinzle E, Biber A, Cooney C. 2006. Development of Sustainable Bioprocesses: Modelling and Assessment. John Wiley & Sons, Ltd.
- Harrison RG, Todd PW, Rudge SR, Petrides DP. 2015. Bioseparations Science and Engineering. Oxford University Press. ISBN 978-0-19-539181-7.
- Kamm B, Gruber PR, Kamm M (Eds.) 2006. Biorefineries -Industrial Processes and Products. Wiley-VCH Verlag. ISBN 3-527-31027-4.
- Marcilla Gomis A. 1999. Introducció a las operaciones de separación de contacto continuo. Publicacions de la Universitat d'Alacant.
- Shuler ML, Kargi F (Eds.) 2002. Bioprocess Engineering. Basic concepts. 2nd Edition. Prentice Hall PTR. ISBN 0-13-081908-5.
- Stuart RT, El-Halwagi MM. 2013. Integrated Biorefineries: Design, Analysis, and Optimization. CRC Press. ISBN 9781439803462.

- Ratledge C, Kristiansen B (Eds). 2006. Basic Biotechnology. 3rd Edition. Cambridge University Press.
- Recasens Baxarias F. 2018. Procesos de separación de biotecnología industrial. Publicacions Universitat Politècnica de Catalunya. Iniciativa Digital Politècnica ebook.