

Academic Year/course: 2021/22

28940 - Biochemical engineering for the agri-food industry

Syllabus Information

Academic Year: 2021/22

Subject: 28940 - Ingeniería de las industrias agroalimentarias

Faculty / School: 201 - Escuela Politécnica Superior

Degree: 583 - Degree in Rural and Agri-Food Engineering

ECTS: 6.0

Year: 3 and 4

Semester: Second semester

Subject Type: Optional

Module:

1. General information

2. Learning goals

3. Assessment (1st and 2nd call)

4. Methodology, learning tasks, syllabus and resources

4.1. Methodological overview

The learning process that is designed for this subject is based on the following:

1. Participatory **masterclass** will be the method used during the development of the theory classes.
2. **Practical sessions** problem-solving.
3. For some topics, **individual tasks** are proposed. The resolution must be submitted on the dates indicated, through the teaching intranet (moodle2.unizar.es).
4. **Technical visits** will assist the students to acquire a practical and realistic view of the theoretical and practical content made throughout the course. It is expected a visit to a food industry company to include in its manufacturing process some fermentation operation.

4.2. Learning tasks

The program that the student is offered to help achieve the expected results includes the following activities:

1. **Lectures.** Classroom activity in which the contents of the proposed topics are developed. The total period of this activity throughout the course will be 30 hours.
2. **Practical sessions.** Classroom activity in which problems related to the contents of the course will be resolved, with a duration of 26 hours.
3. **Assessment Tasks.** Computer Resolution (EES and Excel solver command) problems and cases. The estimate for this personal activity time will be 4 hours for each task that the student must solve.
4. **Technical visits.** Activity that includes a visit to a food industry with biochemical reaction (3 hours).
5. **Autonomous work and study.** Before the final exam.
6. **Tutorials.** In the teacher's office or by virtual platform moodle2.unizar.es and by video conference via Google Meet.

4.3. Syllabus

The course will address the following topics:

- 1. Introduction to biotechnological processes:** historical development, biotechnological processes, biological of microorganisms, phases in the development of a bioprocess and ideal reactors.
- 2. Mass balance with biochemical reaction:** stoichiometry of microbial Growth and elemental balances, electron balances, biomass yield, product stoichiometry, theoretical oxygen demand and maximum possible yield.
- 3. Energy balance with biochemical reaction:** general energy balance equations, heats of reaction for processes with biomass production, thermodynamics of microbial growth, energy balance for cell culture.
- 4. Unsteady state mass and energy balances:** unsteady state mass and energy balance equations, solving differential equations.
- 5. Principal bioreactor types:** bioreactor configurations, bioreactors within suspension biocatalysts, bioreactors with immobilised biocatalysts and special bioreactors.
- 6. Enzyme kinetic:** enzyme catalysis, classification and nomenclature of enzymes, the kinetics of enzyme reactions in a single substrate: Michaelis-Menten and Briggs-Haldane models, determining kinetic parameters, the effect of pH and temperature on enzyme activity, enzyme regulation: inhibition and activation, substrate inhibition and integrated kinetic equations for different enzyme reactors.
- 7. Microbial kinetics:** stoichiometry, yields and reaction rate, types of kinetic models: approaches, Monod model: linearisations, environmental effects on cell growth, inhibition models and integrated kinetic equations for different fermenters.
- 8. Basic aspects of bioreactors:** discontinuous stirred tank fermenter (batch), fed-batch fermenter, continuous stirred tank fermenter (CSTF), plug flow fermenter, fermenters connected in series and CSTF with cell recycling.

Practical Programme

1. Solving mass and energy balances with software application Engineering Equation Solver (EES).
2. Find by nonlinear regression, using the Excel Solver command, rate equations representing the kinetics of enzyme reactions and/or microbial reactions.

4.4. Course planning and calendar

It is estimated that an average student should devote to this course (6 ECTS) a total number of 150 hours. Below the calendar hypothetical course is as follows:

Calendar of classroom sessions:

Week	Lectures	Practice sessions	Technical visits
1	Course presentation (1 h) Topic 1 (3 h)		
2	Topic 2 (2 h)	Session 1 (EES and SOLVER) (2 h)	
3	Topic 2 (2 h)	Session 1 (Problem Solving) (2 h)	
4	Topic 3 (2 h),	Session 2 (Problem Solving) (2 h)	
5	Topic 3 (2 h)	Session 2 (EES and SOLVER) (2 h)	
6	Topic 4 (2 h)	Session 3 (Problem Solving) (2 h)	
7	Topic 5 (2 h)	Session 4 (Problem Solving) (2 h)	Session 4 (Problem Solving) (2 h)
8	Topic 5 (2 h)	Session 3 (EES and SOLVER) (2 h)	
9	Topic 6 (2 h)	Session 3 (EES and SOLVER) (2 h)	
10			
11	Topic 6 (2 h)		
12	Topic 7 (4 h)	Session 5 (Problem Solving) (2 h)	
13	Topic 8 (2 h)	Session 6 (Problem Solving) (2 h)	

14	Topic 8 (2 h)	Session 4 (EES and SOLVER) (2 h)	Visit 1 (3h)
15	Topic 8 (2 h)	Session 7 (Problem Solving) (2 h)	
16	Session 8 (Problem Solving) (2 h)	Session 8 (Problem Solving) (2 h)	

Student workload:

Activity	On-site hours	Factor	Off-site hours
Lectures	30	1,5	45
Practice sessions	26	1,0	26
Tasks solving	-	-	12
Technical visits	3	-	-
Autonomous work and study	-	-	5
Exam	3	-	-
Total hours	62		88
Total workload	150 hours		

Finally, the following table shows the distribution of ECTS credits between educational modes.

Educational mode	Total hours of student work	ECTS
Lectures	75	3,0
Practice sessions	52	2,08
Tasks solving	12	0,48
Technical visits	3	0,12
Autonomous study and exam	8	0,32
TOTAL	150	6,0

4.5. Bibliography and recommended resources

- BB** Bailey, James E. Biochemical engineering fundamentals / James E. Bailey, David F. Ollis. 2nd. ed. New York [etc.] : McGraw-Hill, cop. 1986
- BB** Díaz, Mario. Ingeniería de bioprocesos / Mario Díaz. Madrid : Paraninfo, cop. 2012
- BB** Ingeniería bioquímica / Francesc Gòdia Casablanques y Josep López Santín (Editores) ; Carles Casas Alvero... [et al.]. Madrid : Síntesis, D.L. 1998
- BC** Doran, Pauline M. Principios de ingeniería de los bioprocesos / Pauline M. Doran ; traducción a cargo de Francisco J. García Labiano. Zaragoza : Acribia, D.L. 1998
- BC** Dutta, Rajiv. Fundamentals of biochemical engineering / Rajiv Dutta Berlin : Springer ; New Delhi : Ane Books India, cop. 2008
- BC** Hill, Charles G., Jr. Introduction to chemical engineering kinetics and reactor design / Charles G. Hill, Jr., Tatcher W. Root. 2nd ed. Hoboken (New Jersey) : Wiley, cop. 2014

The updated recommended bibliography can be consulted in :

<http://psfunizar10.unizar.es/br13/egAsignaturas.php?codigo=28940&Identificador=C73794>