28940 - Biochemical engineering for the agri-food industry

Información del Plan Docente

Academic Year	2016/17
Academic center	201 - Escuela Politécnica Superior
Degree	437 - Degree in Rural and Agri-Food Engineering
ECTS	6.0
Course	3
Period	Half-yearly
Subject Type	Compulsory
Module	---

1.Basic info

1.1.Recommendations to take this course

1.2.Activities and key dates for the course

2.Initiation

2.1.Learning outcomes that define the subject

2.2.Introduction

3.Context and competences

3.1.Goals

3.2.Context and meaning of the subject in the degree

3.3.Competences

3.4.Importance of learning outcomes

4.Evaluation

5.Activities and resources

5.1.General methodological presentation

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 clases.
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 to include in its manufacturing process some fermentation operation.

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5.2.Learning activities

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

1. **Theoretical classes** . Classroom activity in which the contents of the proposed topics are developed. The total period of this activity throughout the course will be 26 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. **Tasks solving** . 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 (4 hours).
5. **Independent study** . Before the final exam.
6. **Tutoring** . In the teacher's office or by virtual platform moodle2.unizar.es.

5.3.Program

Theoretical Programme

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 deman and massimun 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 with in suspension biocatalysts, bioreactors with immobilised biocatalysts and special bioreactors.

6. **Enzyme kinetic** : enzyme catalysis, classification and nomenclature of enzymes, kinetics of enzyme reactions in a single substrate: Michaelis-Menten and Briggs-Haldane models, determining kinetic parameters, 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 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 kinetics of enzyme reactions and / or microbial reactions.

5.4.Planning and scheduling

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	Theoretical classes	Practical sessions	Technical visits
1	Course presentation (1 h) Topic 1 (1 h)	Session 1 (EES and SOLVER) (2 h)	
2	Topic 1 (2 h)		
3	Topic 2 (2 h)	Session 1 (Problem Solving) (2 h)	
4	Topic 2 (2 h),	Session 2 (EES y SOLVER) (2 h)	
5	Topic 3 (2 h)	Session 2 (Problem Solving) (2 h)	
6	Topic 4 (2 h)	Session 3 (Problem Solving) (2 h)	

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7	Topic 5 (2 h)	Session 3 (EES y SOLVER) (2 h)	
8	Topic 6 (2 h)	Session 4 (Problem Solving) (2 h)	
9	Topic 6 (2 h)	Session 5 (Problem Solving) (2 h)	
10	Topic 7 (2 h)	Session 4 (EES y SOLVER) (2 h)	
11	Topic 7 (2 h)	Session 6 (Problem Solving) (2 h	
12	Topic 8 (2 h)	Session 7 (Problem Solving) (2 h)	
13	Topic 8 (2 h)	Session 8 (Problem Solving) (2 h)	
14			Visit 1 (4h)
15		Session 9 (Problem Solving) (2 h)	

Student workload:

Activity	**Presential hours**	**Factor**	**Non presential hours**
Theoretical classes	26	1,5	39
Practical sessions	26	1,0	26
Tasks solving	-	-	16
Technical visits	4	-	-
Independent study	-	-	9

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Exam	4	-	-
Total hours	60		90
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**
Theoretical classes	65	2.60
Practical sessions	52	2.08
Tasks solving	16	0.64
Technical visits	4	0,16
Independent study and exam	13	0,52
TOTAL	**150**	

5.5.Bibliography and recomended resources

Basic Bibliography

- Biochemical Engineering Fundamentals, J. E. Bailey and D. F. Ollis, Ed. McGraw-Hill (1986).

Additional Biliography

- Fundamentals of biochemical engineering / Rajiv Dutta Berlin : Springer ; New Delhi : Ane Books India, cop. 2008
- Introduction to chemical engineering kinetics and reactor design / Charles G. Hill, Jr., Tatcher W. Root . - 2nd ed. Hoboken (New Jersey) : Wiley, cop. 2014