Universidad Zaragoza

Year : 2019/20

28940 - Biochemical engineering for the agri-food industry

Syllabus Information

Academic Year: 2019/20
Subject: 28940 - Biochemical engineering for the agri-food industry
Faculty / School: 201 - Escuela Politécnica Superior
Degree: 437 - Degree in Rural and Agri-Food Engineering
583 - Degree in Rural and Agri-Food Engineering
ECTS: 6.0
Year: 3
Semester: Second semester
Subject Type: Optional
Module: ---

1.General information

1.1.Aims of the course

1.2.Context and importance of this course in the degree

1.3.Recommendations to take this course

2.Learning goals

2.1.Competences

2.2.Learning goals

2.3.Importance of learning goals

3.Assessment (1st and 2nd call)

3.1.Assessment tasks (description of tasks, marking system and assessment criteria)

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.

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)	
8	Topic 5 (2 h) Topic 6 (2 h)		
9			

10		Session 3 (EES and SOLVER) (2 h)	
11	Topic 6 (2 h)		
12	Topic 7 (2 h)	Session 5 (Problem Solving) (2 h)	
13	Topic 7 (2 h)	Session 6 (Problem Solving) (2 h)	
14	Topic 8 (2 h)	Session 4 (EES and SOLVER) (2 h)	Visit 1 (4h)
15	Topic 8 (2 h)	Session 7 (Problem Solving) (2 h)	
16	Session 8 (Problem Solving) (2 h)	Session 9 (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 Casablancas 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 Franciso 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://psfunizar7.unizar.es/br13/egAsignaturas.php?codigo=28940&Identificador=14205