Microbiology and Environmental Biotechnology (2500211)

General Information

School	ETSECCPB
Departments	Departament d'Enginyeria Civil i Ambiental (DECA)
Credits	6.0 ECTS
Programs	GRAU EN ENGINYERIA AMBIENTAL (pla 2020)
Course	2024/25

Main teaching language at each group

- Group 10ES1 Spanish (Q1)

Faculty

Responsible Faculty: Estel Rueda Hernández
Faculty: Eva Gonzalez Flo, Artai Lage Julià, Estel Rueda Hernández, Ana Sáenz Ceniceros

Objectives of Education

The objective of this subject is the acquisition by the student of the theoretical foundations and principles of biological processes that are applied in the field of Environmental Engineering. For this, the engineering of reactors and their application to the specific case of bioreactors are studied in depth. The structure and different metabolic types of microorganisms of general interest for Environmental Engineering are detailed. The laws of microbial growth are applied to reactor theory. The knowledge acquired in this subject constitutes the theoretical base necessary for the design of biotechnological and bioremediation processes that will be studied in coordination with other subjects of the degree.

1. Understand microbial kinetics for the design of bioreactors, studying industrial microbiological processes and remediation of contaminants.
2. Know the concepts of bioaccumulation, bioaugmentation, biosensors, bioindicators and study the processes of genetic modification of microorganisms and biomaterials.

Microbiology and Environmental Biotechnology. Introduce the student to microbial kinetics for the design of bioreactors, and study microbiological processes industrial and pollutant remediation, introducing concepts such as bioaccumulation, bioaugmentation, biosensors, bioindicators, modification genetics of microorganisms, biomaterials.

1. Deep knowledge of reactors theory.
2. Capacity to perform mass balances.
3. Deep knowledge of microbial kinetics.
4. Knowledge of the main microbial processes of interest in Environmental Engineering.
5. Numerical simulation of bioprocesses.
6. Analysis and evaluation capabilities of microorganism growth data.

In particular, this subject interacts directly with the following subjects: Hydrogeology and environmental geochemistry, Water treatment, Soils and aquifers remediation, Wastewater and reuse, Solid waste, Atmospheric and acoustic pollution, and Climate change and natural risks.

Competencies

Especific

Recognize the biological bases and foundations of the plant and animal field in engineering: notions of genetics, biochemistry and metabolism, physiology, organisms and environment, population dynamics, flows of matter and energy and changes in ecosystems, biodiversity, principles of the kinetics of microbial growth and reactor theory.
Obtain basic knowledge about the use and programming of computers, operating systems, databases and basic numerical calculation and applied to engineering.
Apply the fundamental concepts of statistics and randomness of physical, social and economic phenomena, as well as uncertainty and decision-making techniques.
Enhance the capacity of spatial vision and identify the techniques of graphic representation, topography, photogrammetry, cartography, remote sensing and Geographic Information systems.
Describe and apply the techniques of analysis of physical, chemical and biological parameters; Integrate the experimental evidence found in field and / or laboratory data with the theoretical knowledge and interpret its results.
Formulate the principles of fluid mechanics and the fundamentals of continuous medium mechanics.
Identify the concepts and technical aspects linked to the conduit systems, both in pressure and in free sheet and apply them to the water supply transport networks; pumping systems; unit networks; separative networks; Avenues prevention systems in urban areas and analysis of tools for the recovery of altered river and coastal spaces.
Describe the processes linked to the water cycle: atmospheric circulation and rain formation; rain transformation into runoff; and apply them to surface and underground hydrology associated with avenues risk, surface water pollution, aquifer management and groundwater pollution.

Generic

Identify, formulate and solve problems related to environmental engineering.
Apply the functions of consulting, analysis, design, calculation, project, construction, maintenance, conservation and exploitation of any action in the territory in the field of environmental engineering.
To use in any action in the territory proven methods and accredited technologies, in order to achieve the greatest efficiency respect for the environment and the protection of the safety and health of workers and users.

Total hours of student work

		Hours	Percentage
Supervised Learning	Large group	30.0 h	50.00 %
	Medium group	15.0 h	25.00 %
	Laboratory classes	15.0 h	25.00 %
	Guided Activities	0.0 h	0.00 %
Self Study		90.0 h	

Contents

Interactions Microbial Ecology, Environmental Biotechnology and Environmental Engineering

Microbiomes. Microbial metacommunities. Trophic nets and Environmental Engineering. Ecological Engineering. Contamination and pollution. Concept of Environmental Engineering and of Environmental Biotechnology. Exercises

Reactor Engineering

Types of reactors. Theoretical hydraulic retention time. Hydraulic behavior: tracer tests. Mass balances. Complete mix reactor
Tank in series model. Plug flow reactor. Mass continuity equation
Transport equation. Diffusion. Advection. Transport equation solutions
Convergence between complete mix reactor and plug flow. Deviations from plug flow: boundary layer effect.

Hydraulic retention time distribution function
Tracer test examples. Semi-batch reactor. Reactor scale-up
Reactor exercises

Environmental bioreactors

Bioreactor applications: wastewater treatment, solid waste treatment, gas treatment, soil and groundwater treatment. Visit to a wastewater treatment plant

Stoichiometry of Microbial Reactions

Enzimatic reactions: Michaelis-Menten kinetics. Microbial growth phases. Exponential growth

Ecology and Environmental Engineering

Monod kinetics. Substrate kinetics. Productivity. Gross and net growth. Lysis. Temperature effect. Exercises

Microbial kinetics

Aerobic Degradation of Organic Matter (Aerobic Chemosynthetics)

Mass balances in cultures with biomass recycling. Effect of recycling on hydraulic and cellular retention time
Exercises of aerobic suspended cultures
Nitrification, denitrification and annamox. Exercises
Anaerobic cultures: anaerobic digestion. Exercises
Phosphorus removal. Exercises

N Cycle Reactions (Nitrification and Denitrification)

Biofilm processes and kinetics. Sulphate reduction and sulphide oxidation. Exercises

Anaerobic Degradation of Organic Matter (Anaerobic Chemosynthetics)

Simultaneous processes: Petersen matrix. Activated sludge models (ASM)
Anaerobic digestion model (ADM). Constructed wetland model (CWM)

Processes related to the cycle of P

Simulation of unestady processes

Seminars

Research related to environmental biotechnology

Laboratory practices: photosyntetic production award

Preparation of culture plates. Isolation of colonies. Microscopic observation. Simulation tools: model BIO_ALGAE. Preparation of culture medium. Inoculation. Culture monitoring: pH, DO, SST, turbidity, optical density, cell count, alkalinity, nitrate, phosphate

Teaching Methodology

2 sessions of 2 hours every week including mastery explanation on the board, slides projection, exercises resolution and practical cases presentation.
12 hours of laboratory practices over 3 weeks.
6 hours of directed activities consisting in a technical visit to a wastewater treatment plant.
Course notes and materials available in ATENEA

The language in which the course is taught will depend on the teacher. In particular, professors Enrica Uggetti, Etiele Greque and Marta Bellver will teach their classes in Spanish, professors Eva González and Beatriz Altamira will teach in Catalan

Although most of the sessions will be given in the language indicated, sessions supported by other

occasional guest experts may be held in other languages.

To do the laboratory practices you need the following personal protective equipment (PPE):
* White lab coat UPC Chemical
* Protection gloves - Chemical

Grading Rules

(*) The evaluation calendar and grading rules will be approved before the start of the course.

Examination I (40%) + Examination II (40%) + Laboratory Practice Examination (15%) + Practice Report (5%). To pass you must get a global rating 4.9

Examinations have a part of test theory and a part of numerical exercises and problems.

5% of Examination I (of the total 40%) will refer to the technical visit to a wastewater treatment plant. Attendance to the visit is mandatory. Students who will not attend the visit will have a 0 in the part corresponding to 5%.

Attendance to all laboratory practices is mandatory in order to carry out the examination of practices and delivery of the report. Students who do not attend any of the practices will have a 0 rating on the exchequer and the report.

Students who have carried out all the evaluation acts have not approved will be able to carry out a re-evaluation examination that will be exclusively test-type. Students who have not attended any of the practices and/or the technical visit will not be able to perform the requalification examination. Approve reassessment means having a rating of 5.0

Office Hours

Agreed directly with the teacher.

Bibliography

Basic

- Levenspiel, O. Chemical reactors engineering. 3rd ed. New York ètc.]: Wiley, 1999. ISBN 047125424X.
- Rittmann, B.E.; McCarty, P.L. Environmental biotechnology: principles and applications. Boston: McGraw-Hill, 2001. ISBN 0071181849.

Complementary

- Kennes, C.; Veiga, M.C. (eds.). Bioreactors for waste gas treatment. Dordrecht: Springer Science+Business Media, 2001. ISBN 9789401709309.
- Henze, M.; van Loosdrecht, M.C.M.; Ekama, G.A.; Brdjanovic, D. Biological wastewater treatment: principles, modelling and design. London: IWA, 2008. ISBN 9781780401867.
- IWA task group on mathematical modelling for design and operation of biological wastewater treatment; Henze, M. [et al.]. Activated sludge models ASM1, ASM2, ASM2d and ASM3. London: IWA Publishing, 2000. ISBN 9781780402369.
- IWA Task Group for Mathematical Modelling of Anaerobic Digestion Processes; Batstone, D.J. [et al.]. Anaerobic digestion model no. 1 (ADM1). London: IWA Publishing, 2002. ISBN 1900222787.

Resources

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You can buy them at UPC Shop (upc-shop.com) or any specialty store."