COURSE DESCRIPTION CARD - SYLLABUS

Course name
TECHNOLOGIES IN BIOECONOMY [S5ISGIE>TWB]

Course

Proposed by Discipline
–

Year/Semester
3/6

Level of study
Doctoral School

Course offered in
English

Form of study
full-time

Requirements
elective

Number of hours

Lecture
8

Laboratory classes
0

Other
0

Tutorials
0

Projects/seminars
0

Number of credit points

2,00

Coordinators

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Lecturers

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Prerequisites

Knowledge of chemistry, biology (microbiology or biochemistry) and process engineering at the level of second-cycle studies in engineering or natural sciences. Ability to read and critically evaluate scientific literature in English (at least B2 level).

Course objective

1. To present the state of the art and the main development trends of technologies for converting biomass, organic residues and wastewater into food, feed, chemicals, materials and energy. 2. To develop the doctoral student's ability to assess bioeconomy technologies critically, in terms of technology readiness, techno-economic performance, environmental impact and regulatory conditions. 3. To show how knowledge from biotechnology, chemical and environmental engineering and economics can be combined to identify, formulate and solve research problems relevant to the doctoral dissertation. 4. To discuss the role of research in the transition to a sustainable, circular bioeconomy, including knowledge transfer to industry and society.

Course-related learning outcomes

Knowledge. The doctoral student knows and understands:

W1 the state of the art and theoretical foundations of biomass and organic waste conversion technologies

(biochemical, thermochemical and electrochemical) to an extent enabling revision of existing paradigms; SzD_W01; P8S_WG

W2 the main development trends of the bioeconomy, including the biorefinery concept, mixed culture fermentation, the carboxylate platform and the production of bio-based chemicals and fuels; SzD_W02; P8S_WG

W3 research methodology used to develop and evaluate bioprocesses, including mass and energy balances, techno-economic analysis (TEA) and life cycle assessment (LCA); SzD_W03; P8S_WG;

W4 the role of the bioeconomy in addressing fundamental dilemmas of contemporary civilisation: climate change, resource scarcity and food security; SzD_W05; P8S_WK

W5 the economic, legal and ethical conditions of the bioeconomy (EU Bioeconomy Strategy, Green Deal, RED III, waste legislation) and the principles of transferring bio-based technologies to industry; SzD_W06, SzD_W07; P8S_WK

Skills. The doctoral student is able to:
U1 use knowledge from various disciplines to identify, formulate and propose innovative solutions to research problems in valorising biomass and organic residues, with reference to their own doctoral research; SzD_U01; P8S_UW

U2 critically analyse and assess published results, technology readiness level and scale-up potential of bioeconomy technologies; SzD_U02; P8S_UW;

U3 communicate on specialist bioeconomy topics in English and take part in scientific discussion in an international environment; SzD_U04, SzD_U07; P8S_UK

Social competences. The doctoral student is ready to:
K1 critically assess achievements in the bioeconomy field and their own contribution to it; SzD_K01, SzD_K02; P8S_KK;

K2 recognise the social responsibility of researchers for a sustainable and circular economy, and think and act in an entrepreneurial manner when transferring research results; SzD_K04, SzD_K06; P8S_KO.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

• Knowledge (W1–W5): written test after the last lecture, 10 open or multiple-choice questions on the lecture content. Pass threshold: 50% of points.

• Skills and social competences (U1–U3, K1–K2): short written essay (max. 2 pages) critically assessing one bioeconomy technology in relation to the student's doctoral research — its research gap, technology readiness level, techno-economic and environmental constraints. Assessed for accuracy, depth of critical analysis, use of literature and clarity of argument. Activity in lecture discussions is also taken into account.

Programme content

The bioeconomy as a response to climate and resource challenges: definitions, EU and national policy framework, value chains and markets. Biomass and organic residues as feedstocks. The biorefinery concept and its platforms (e.g. sugar, syngas, biogas, carboxylate). Biochemical conversion technologies. Downstream processing and upgrading of bio-based intermediates. Bio-based products: platform chemicals, biopolymers, biofuels. Resource recovery from wastewater and organic waste in a circular economy. Assessment of bioeconomy technologies: TRL, scale-up, techno-economic analysis and life cycle assessment. Knowledge transfer, commercialisation and research funding.

Course topics

1. The bioeconomy and circular bioeconomy: concepts, policy framework (EU Bioeconomy Strategy, Green Deal), feedstocks and value chains; the biorefinery concept and its platforms.

2. Biochemical conversion: pure vs mixed culture fermentation, anaerobic digestion.

3. From intermediates to products: downstream processing, product recovery and upgrading; bio-based chemicals, materials and fuels.

4. Evaluating and implementing bioeconomy technologies: TRL and scale-up, TEA and LCA, case studies of industrial biorefineries, knowledge transfer and commercialisation; final test.

Teaching methods

Informative and problem-based lecture with multimedia presentation; analysis of case studies from research projects and industrial biorefineries; moderated discussion relating the lecture content to the doctoral students' own research topics.

Bibliography

1. Kamm B., Gruber P.R., Kamm M. (eds.), Biorefineries – Industrial Processes and Products: Status Quo and Future Directions, Wiley-VCH, Weinheim, 2006.
2. Clark J.H., Deswarte F.E.I. (eds.), Introduction to Chemicals from Biomass, 2nd ed., John Wiley & Sons, Chichester, 2015.
3. Cherubini F., The biorefinery concept: Using biomass instead of oil for producing energy and chemicals, Energy Conversion and Management 51 (2010) 1412–1421.
4. European Commission, A Strategic Framework for a Competitive and Sustainable EU Bioeconomy, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, Brussels, 27.11.2025.
5. National Security Commission on Emerging Biotechnology (NSCEB), Charting the Future of Biotechnology: An Action Plan for American Security and Prosperity, Final Report, Washington, D.C., April 2025.

Breakdown of average student's workload

	Hours	ECTS
Total workload	50	2,00
Classes requiring direct contact with the teacher	8	0,50
Doctoral student's own work (literature studies, preparation for laboratory classes/tutorials, preparation for tests/exam, project preparation)	42	1,50