Wrocław University of Science and Technology
Doctoral School

COURSE CARD

1. Basic information

Course name in English:	Biorefineries in Sustainable Development	
Course name in Polish:	Biorafinerie w zrównoważonym rozwoju	
Number of hours:	30	
Type of course:	Elective course	
Form of course:	mixed forms (combination of lecture, seminar and laboratory)	
Code of course:	W03INC-SD0104W / CIQ100399W	
Course leader:	assoc. prof. Izabela Pawlaczyk-Graja, PhD, DSc, Eng	
Faculty of the course leader:	W3 Faculty of Chemistry	
Email address of the course leader:	izabela.pawlaczyk@pwr.edu.pl	
Scientific discipline(s) assigned to the course (doctoral students representing the marked disciplines can participate in the course):	Architecture and urban planning	☐
	Automation, electronic, and electrical engineering	☐
	Information and communication technology	☐
	Biomedical engineering	☐
	Chemical engineering	☒
	Civil engineering and transport	☐
	Mechanical engineering	☐
	Environmental engineering, mining, and energy	☒
	Mathematics	☐
	Chemical sciences	☒
	Physical sciences	☐
	Management and quality studies	☐

2. Objectives

C1 To acquaint PhD students with the principles of economic analysis and appropriate selection of processes unit used in technologies for processing renewable raw materials.

C2 Develop the ability to draw conclusions and synthetic thinking in terms of selection of unit processes in refineries, taking into account sustainable principles development.

C3 To acquaint PhD students with the latest achievements in the field of biomass utilization for the production of chemicals and modern technology products.

3. Content

Detailed information about the course content, including topics and form of classes.

No.	Topic	Number of hours	Form of classes
1	Biorefinery concept. Economic challenges.	2	lecture
2	Methodologies for the economic analysis of biorefineries.	2	lecture
3	Basic principles of biorefinery design including heat integration.	2	lecture
4	Life cycle analysis (LCA) in biorefineries.	2	lecture
5	Analysis of the biorefinery impact on the environment and society. Monitoring of indicators.	2	lecture
6	Unit processes in biorefineries - reaction strategies.	2	lecture
7	Unit processes in biorefineries - bioreactors.	2	lecture
8	Unit processes in biorefineries - bioproduct separation techniques.	2	lecture
9	Methods for optimizing technological processes.	2	lecture
10	Renewable raw materials for biorefining processes.	2	lecture
11	Biomass processing technologies - lignocellulose biorefineries.	2	lecture
12	Biomass processing technologies - cereal biorefineries.	2	lecture
13	Biomass processing technologies - biooils.	2	lecture
14	Biomass processing technologies - case studies including sustainable development rules.	2	seminar
15	Biomass processing technologies - case studies including sustainable development rules.	2	seminar

4. Prerequisites

List of prerequisites relating to knowledge, skills and other competences for course participants.

1. Basic knowledge of chemical processes.

2. General knowledge in the field of organic chemistry and chemical engineering.

5. Learning outcomes

List of learning outcomes at level 8 of the Polish Qualifications Framework assigned to the course (mark the learning outcomes in the last column).

Symbol	**Learning outcome**	
	KNOWLEDGE. Doctoral student knows and understands:	
SzD_W3	the main trends in the development of the scientific or artistic disciplines covered in the curricula;	☒
SzD_W4	research methodology;	☒
SzD_W5	the rules for the dissemination of scientific results, including in open access mode;	☐
SzD_W6	the fundamental dilemmas of modern civilization;	☒
SzD_W7	the legal and ethical conditions of scientific activity;	☐

SzD_W8	the economic and other relevant conditions of scientific activity;	☐
SzD_W9	basic principles of knowledge transfer to the economic and social spheres and commercialisation of results of scientific activity and know-how related to these results.	☒
	SKILLS. Doctoral student is able to:	
SzD_U2	use knowledge from different fields of science or art to creatively identify, formulate and innovatively solve complex problems or perform research tasks, in particular: - define the purpose and subject of scientific research, formulate a research hypothesis, - develop research methods, techniques and tools, and use them creatively, - draw conclusions on the basis of scientific research; critically analyse and evaluate the results of scientific research, expertise and other creative work and their contribution to knowledge development; transfer the results of scientific activities to the economic and social spheres;	☒
SzD_U3	communicate on specialised topics to the extent that they enable an active participation in the international scientific community;	☒
SzD_U4	disseminate research results, including in popular forms;	☐
SzD_U5	initiate debates and participate in a scientific discourse;	☒
SzD_U6	be able to speak a foreign language at B2 level of the Common European Framework of Reference for Languages to a level that enables them to participate in the international scientific and professional environment;	☐
SzD_U7	plan and implement an individual or collective research or creative activity, including in an international environment;	☐
SzD_U8	independently plan and act for one's own development and inspire and organize the development of others;	☐
SzD_U9	plan classes or groups of classes and implement them using modern methods and tools.	☐
	SOCIAL COMPETENCES. Doctoral student is ready to:	
SzD_K3	fulfilling the social obligations of researchers and creators, initiate public interest activities, thinking and acting in an entrepreneurial way;	☒
SzD_K4	maintaining and developing the ethos of research and creative environments, including: - carrying out scientific activities in an independent manner, - respecting the principle of public ownership of research results, taking into account the principles of intellectual property protection.	☐

6. Evaluation

Short description of the method(s) used to evaluate the learning outcomes assigned to the course, e.g., exam, test, report, presentation, etc.

Preparation of a selected example on biorefinery in the form of a multimedia presentation

7. Teaching methods

Short description of the teaching methods used during the course, e.g., multimedia presentation, discussion, literature studies, developing written documents, own work, etc.

Informative lecture with elements of a problem lecture, multimedia presentation, discussion, literature studies, own work.

8. Literature

List of primary and secondary literature used to prepare the course and including additional knowledge for participants, e.g., books, textbooks, research papers, standards, web pages, etc.

[1] Burczyk B., Biomasa. Surowiec do syntez chemicznych i produkcji paliw. Wyd. 2, Wydawnictwo Politechniki Wrocławskiej, Wrocław, 2019.
[2] Sadhukhan J., Ng K.S., Hernandez E.M., Biorefineries and Chemical Processes Design, Integration and Sustainability Analysis. John Wiley & Sons, Ltd., 2014.
[3] Rabaçal M., Ferreira A.F., Silva C.A.M., Costa M., Biorefineries. Targeting Energy, High Value Products and Waste Valorisation. Springer International Publishing AG, 2017.
[4] Bastidas-Oyanedel J.-R., Schmidt J.E., Biorefinery. Integrated Sustainable Processes for Biomass Conversion to Biomaterials, Biofuels, and Fertilizers. Springer Nature Switzerland AG, 2019.
[5] Burczyk B.: Zielona chemia. Zarys. Wydawnictwo Politechniki Wrocławskiej, Wrocław, 2006.
[6] Bergeron C., Carrier D. J., Ramaswamy S.: Boirefinery Co-products. Phytochemicals, Primary Metabolites and Value-Added Biomass Processing. John Wiley & Sons, Ltd., 2012.
[7] Kamm B., Gruber P. R., Kamm M.: Biorefineries – Industrial Processes and Product. WILEY-VCH Verlag GmbH & Co., 2006.
[8] Figoli A., Cassano A., Basile A., Membrane Technologies for Biorefining. Woodhead Publishing, Elsevier Ltd., 2016.

9. Other remarks

Additional remarks, comments, (e.g., language of the course)