COURSE DESCRIPTION CARD - SYLLABUS

Course name
Green technologies in the removal and recovery of environmental pollutants [S2TOZ1-TSO>ZTwUiOZŚ]

Course

Field of study
Circular System Technologies

Year/Semester
1/2

Area of study (specialization)
Renewable raw material technologies

Profile of study
general academic

Level of study
second-cycle

Course offered in
Polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
15

Laboratory classes
15

Other
0

Tutorials
0

Projects/seminars
0

Number of credit points

2,00

Coordinators

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Lecturers

Prerequisites

Basic knowledge of general and inorganic chemistry and chemical technology and chemical industry equipment (core curriculum of the 1st and 2nd year of full-time 1st-cycle studies). Knowledge of basic conceptual categories and terminology used in biotechnology and related industries (chemical, pharmaceutical). Ability to solve elementary problems in the field of environmental chemistry based on the knowledge acquired, ability to obtain information from indicated sources in Polish and a foreign language. Understanding the need for further education, understanding the need to expand one's competences, willingness to cooperate within a team.

Course objective

Obtaining basic knowledge in the field of technology of processes for the removal and recovery of substances harmful to the environment. Learning about basic industrial processes and unit operations related to green technologies. Learning about examples of the application of green technologies in practical processes of removal, recovery and reuse of harmful substances. Basic knowledge in the field of selection and modeling of green technologies in environmental protection. Acquiring the ability to independently conduct basic technological processes on a laboratory scale. The ability to create modern methods of removing harmful substances.

Course-related learning outcomes

Knowledge:
K_W02 Has advanced, structured and theoretically based knowledge of the principles of the circular economy and the reasons for its implementation.
K_W05 Has in-depth and theoretically based knowledge of modern environmentally friendly technologies.
K_W07 Has in-depth knowledge allowing to design technological processes based on the principles of the circular economy.
K_W11 Has skills in classifying selected waste materials and applying appropriate recycling and recovery techniques, in accordance with applicable law.
K_W12 Has in-depth knowledge of methods of material recycling, raw material and energy recovery from waste materials necessary for design.
K_W16 Has in-depth knowledge of methods of using plants and microorganisms to produce biological substances.

Skills:
K_U02 Is able to plan, prepare and present a presentation on the implementation of a research task and conduct a substantive discussion on a given topic.
K_U04 Is able to determine and critically evaluate technical solutions for waste recycling in accordance with the principles of the circular economy.
K_U05 Is able to independently plan and implement their own lifelong learning in order to improve their personal professional competences.
K_U10 Has the ability to select methods of recycling, chemical recovery and disposal of various wastes and to formulate assumptions necessary for designing innovative solutions based on the principles of the circular economy.
K_U12 Is able to plan and conduct experiments related to closed-loop technologies and is able to interpret the obtained results and draw conclusions.
K_U15 Is able to skillfully use professional literature and expert opinion, integrate the obtained information, interpret it and critically evaluate it and formulate competent opinions and reports on this basis.
K_U16 Is able to analyse and critically evaluate new areas in circular economy technologies and related fields, assess their innovativeness and technical feasibility.

Social competences:
K_K01 Is aware of personal responsibility resulting from the professional role performed and the emergence of moral and ethical problems in the context of professional activities.
K_K02 Understands the need to popularize knowledge in the field of sustainable production and technological solutions in the circular economy.
K_K03 Critically evaluates his/her own knowledge, understands the need to educate himself/herself and improve his/her professional, personal and social competences.
K_K04 Is able to think and act in an entrepreneurial manner, while being aware of

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lecture:
Onsite form - written test; assessment criterion: 3 - 50.1%-70.0%, 4 - 70.1%-90.0%, 5 - from 90.1%;
Online form - multiple choice test using the ekursy platform; assessment criterion: 3 - 50.1%-70.0%, 4 - 70.1%-90.0%, 5 - from 90.1%.
Laboratory:
Onsite form - written test (entrance test) before each exercise; assessment criterion: 3 - 50.1%-70.0%, 4 - 70.1%-90.0%, 5 - from 90.1%;

Programme content

Familiarization with basic aspects related to green technology processes and presentation and broader discussion of specific processes in the field of green technologies used to remove and recover harmful substances from water and soil. Introduction of basic criteria for selection and design of green technology processes, as well as approximation of directions of use of recovered substances, and then discussion of renewable energy sources based on green technologies followed by indication of potential

application at home and in industry. As part of laboratory exercises, the possibility of independent conduct, on a laboratory scale, of basic technological operations classified as green technologies.

Course topics

Introduction and discussion of basic issues related to the use of green technologies in the processes of removing and recovering harmful substances. Presentation of the classic approach to green technologies, as well as presentation of an alternative in the form of biological and biotechnological processes, both microbiological and enzymatic. Familiarization with the stage of designing and modeling green technology processes in environmental protection. Indication of potential directions of application of materials recovered from sewage and contaminated soil. Presentation of the use of green technologies at home and in industry, as well as discussion of renewable energy sources in the context of the use of green technologies.

Teaching methods

Lecture - multimedia presentations.
Laboratory classes - practical exercises

Bibliography

Basic:
Geetanjali Yadav, Arpit Mishra, Parthasarathi Ghosh, Raveendran Sindhu, Vandana Vinayak, Arivalagan Pugazhendhi (2021). Technical, economic and environmental feasibility of resource recovery technologies from wastewater, Science of The Total Environment, Volume 796, 149022, ISSN 0048-9697, https://doi.org/10.1016/j.scitotenv.2021.149022.
Jakub Zdarta, Anne Meyer, Teofil Jesionowski, Manuel Pinelo (2019). Multi-faceted strategy based on enzyme immobilization with reactant adsorption and membrane technology for biocatalytic removal of pollutants: A critical review. Biotechnology Advances. doi:10.1016/j.biotechadv.2019.05.007
Huu Hao Ngo, Wenshan Guo, Zhuo Chen, Rao Y. Surampalli, Tian C. Zhang, Green Technologies for Sustainable Water Management: Introduction and Overview, http://dx.doi.org/10.1061/9780784414422.
Kumar, L., & Bharadvaja, N. (2019). Enzymatic bioremediation: a smart tool to fight environmental pollutants. Smart Bioremediation Technologies, 99-118. doi:10.1016/b978-0-12-818307-6.00006-8
Kumar, P., Jyoti, B., Kumar, A., & Paliwal, A. (2019). Biotechnological and microbial standpoint cahoot in bioremediation. Smart Bioremediation Technologies, 137-158. doi:10.1016/b978-0-12-818307-6.00008-1
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Saravanan, A., Kumar, P. S., Vo, D.-V. N., Jeevanantham, S., Karishma, S., & Yaashikaa, P. R. (2021). A review on catalytic-enzyme degradation of toxic environmental pollutants: Microbial enzymes. Journal of Hazardous Materials, 419, 126451. doi:10.1016/j.jhazmat.2021.126451

Additional:
Current scientific articles in the field of biotechnology and green technologies in environmental protection.

Breakdown of average student's workload

	Hours	ECTS
Total workload	50	2,00
Classes requiring direct contact with the teacher	30	1,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	20	1,00