Department of Food Technologies

Course title	Industrial ecology of food technologies (ОК9)
Language of teaching	English
Year and semester of study	Educational program: Food Technologies, Specialty: 181 – Food Technologies; Year of study: 1; Semester 2.
Examiner	*N. P. Buialska,* associate professor of the Department of Food Technologies, PhD, associate professor
Lecturer profile	ht.stu.cn.ua/index.php?option=com_content&view=article&id=8&Itemid=5
Contact	buialska@gmail.com

1. Abstract. The course aims at presenting the developments in research and application in the field of Industrial ecology and discussing the role of Industrial ecology in strategic sustainable development on a global scale as well as for strategies for food industries. Environmental problems in food technologies and their solutions are discussed in the course.

When teaching the course modern data and international experience are used. First of all, they were gained during participation in the **Tempus project "Establishing Modern Master-level Studies in Industrial Ecology"**, the consortium of which included **KTH Royal Institute of Technology (Sweden), TU Delft (the Netherlands), Barcelona tech UPC (Spain)**, etc.

The course gives theoretical and applied knowledge and understanding of strategies and technologies for a cleaner industrial production for food technologies:

Module 1: **Industrial ecology. Strategies for a better environment. Environmental issues for the Food, Drink and Milk Industries (FDM) sector.**

Theme 1. Introduction to Industrial Ecology. History of Industrial Ecology (IE). Principles of IE. Basic concepts of Cleaner Production. Process management, product design and material selection as components of Cleaner production development.

Theme 2. Strategies for a better environment. Dilution strategy. Site selection. The End-of-pipe approach (External cleaning, The Filter strategy). Process integrated solutions (Changed technology, the Substitution of raw materials, Integration and Environmental audits). Product strategy. The Long-term solution. Advantages and disadvantages of using different strategies.

Theme 3. Assessment Methodologies of Cleaner Production. UNEP/UNIDO Methodology. Planning and Organising of Cleaner Production. Pre-assessment. Assessment. Evaluation and feasibility study. Implementation and continuation of cleaner production activities.

Theme 4. Environmental issues for the FDM sector. Key environmental issues of the FDM sector: water consumption, quantity of wastewater, composition

of waste water; air emissions, odour; loss of materials (exceed weight/volume specification, spillage, leakage/overflow, product defects/returned product, inherent loss, retained material, heat deposited waste), energy consumption.

Module 2: **Techniques of environmental protection for the FDM sector.**

Theme 5. General techniques of environmental protection for the FDM sector. Methodology for preventing and minimising the consumption of water and energy and the production of waste. Environmental management tools. Equipment design. Production management techniques. Selection of materials. Process control techniques.

Theme 6. Techniques for minimising air emissions for the FDM sector. Air emissions control strategy. Process-integrated techniques. End-of-pipe air treatment (optimal use of air abatement equipment, collection of air emissions at source – local exhaust ventilation, transport of ducted emissions to the treatment or abatement equipment, selection of end-of-pipe odour/VOCs abatement techniques, dynamic separation techniques, electrostatic precipitators, filters, absorption, carbon adsorption, biological treatment, thermal treatment of waste gases, non-thermal plasma treatment, physical dispersion of odour/VOC emissions). Advantages and disadvantages of the different methods.

Theme 7. End-of-pipe waste water treatment for the FDM sector. Discharge of waste water from installations. Waste water treatment techniques applied. Primary treatments (screening, fat trap for the removal of FOG and light hydrocarbons, flow and load equalization, neutralisation and self-neutralisation, sedimentation, dissolved air flotation, diversion (emergency) tank, centrifugation, precipitation). Secondary treatments. Aerobic processes (activated sludge, pure oxygen systems, sequencing batch reactors, aerobic lagoons, trickling filters, bio-towers, rotating biological contactors, biological aerated flooded filters and submerged biological aerated filters, high rate and ultrahigh rate aerobic filters). Anaerobic processes (anaerobic lagoons, anaerobic contact processes, anaerobic filters, upflow anaerobic sludge blanket). Internal circulation reactors (hybrid USAB reactors, fluidised and expanded bed reactors, expanded granular sludge bed reactors). Aerobic/anaerobic combined processes, membrane bio-reactors, multistage systems, tertiary treatments – biological nitrification/denitrification, ammonia stripping, phosphorus removal by biological methods. Dangerous and priority hazardous substances removal. Filtration. Membrane filtration. Biological nitrifying filters. Disinfection and sterilization. Biocides. UV radiation. Natural treatments (integrated constructed wetlands, sludge treatment). Advantages and disadvantages of the different methods.

Theme 8. Waste Management and Co-Product Recovery in Food Processing. Optimising manufacturing to minimise waste in food processing. Key issues and technologies for food waste separation and co-product recovery. Waste management in particular food industry sectors and recovery of specific co-products. Minimising disposal: solid waste management in the food industry.

Practical works are devoted to the Industrial ecology issues in various branches of the Food industry.

2. Aim and objectives of the course. The course aim is to develop the higher education applicant's ability to solve environmental problems of the Food industry on the basis of the principles of resource conservation and environmental safety.

The main objectives of the course "Industrial ecology of food technologies" are:

1. Understanding the main principles of Industrial ecology and the application of them in Food industry.

2. Learning the strategies and methods of Cleaner production which can be used in food technologies.

3. Identification of opportunities to improve the efficiency of the use of environmental technologies in different branches of the Food industry in Ukraine.

When studying the course, higher education applicant (HEA) can acquire or expand the following general (GC) and professional (PC) competencies provided by the educational program:

GC 4. The ability to act responsibly and knowingly.

PC 7. The ability to develop innovative food technologies and / or products and implement them, taking into account the principles of cleaner production and industrial safety.

3. Learning outcomes. When studying the course, higher education applicant should achieve or improve the following program outcomes of studying (POS) provided by the educational program:

POS 7. To possess specialized conceptual knowledge that includes the latest scientific achievements in the field of food technology, clearly and unambiguously convey own knowledge, conclusions and arguments to specialists and non-specialists.

POS 9. To be fluent in the state and foreign languages to discuss professional activities, research results and innovations in the field of food technologies.

POS 12. To develop and implement technical and technological solutions based on the principles of resource conservation, environmental safety and labor protection requirements.

4. Course capacity.

Credits – 6. Total amount of hours – 180 h.

Learning activities	Amount of hours
Lecture	30
Practical work	20
Outside class work	130

5. Prerequisites. A prerequisite for the successful study of the course "Industrial ecology of food technologies" is the study the course "Innovation technology of food production" in Semester 1.

6. Assessment and requirements:

General assessment of the course	The assessment components of the course contribute to the final grade as follows: 25 % Final Control (Exam), 40 % Results of current control of the practical works; 35 % Project Work (outside class

	work, presentation).
Requirements for Project Work	The maximum grade for presentation (environmental assessment of the activities of some food processing enterprise) is 35 points: 32–35 points: Demonstrating a superior application of industrial ecology concepts and analytical tools to assess the metabolism of selected manufacturing and to recommend on improving its sustainability. Clear evidence of preparedness; notable originality in the presentation; depth of subject matter and research; excellent command of language; superior oral performance and team work spirit. 27–31 points: Demonstrating good application of industrial ecology concepts and analytical tools to assess the metabolism of selected manufacturing and to recommend on improving its sustainability. Overall preparedness, originality, subject matter and research, language command, oral performance and team work spirit are all at an above average level. 24–26 points: Demonstrating an average application of industrial ecology concepts and analytical tools to assess the metabolism of selected manufacturing and to recommend on improving its sustainability. Overall preparedness, originality, subject matter and research, language command, oral performance and team work spirit are all at an average level. 19–23 points: Demonstrating a weak application of industrial ecology concepts and analytical tools to assess the metabolism of selected manufacturing and to recommend on improving its sustainability. Overall preparedness, originality, subject matter and research, language command, oral performance and team work spirit are all at a below average level. 0–18 points: Lacking competent application of industrial ecology concepts and analytical tools to assess the metabolism of selected manufacturing and to recommend on improving its sustainability. Overall preparedness, originality, subject matter and research, language command, oral performance and team work spirit lack competence.
Practical works	8 practical works (5 points each): Class participation (1 point each) Written reports (1 point each) The independence of the implementation of practical works (1 point each)

	The timeliness of practical works completion (1 points each) Answers to questions during the practical works (1 points each)
Requirements for admission to the exam	All types of work provided for by the curriculum are compulsory. Minimum number of required points for admission to the exam is 35: 16 points for practical work (min 2 points each) and min 19 points for presentation (outside class work).

7. Course policy. In the case when the minimum number of points (35) was scored during the semester, in order to improve a final grade a better preparation for the exam is only possible.

Academic integrity policy

Violations of the rules of academic integrity are not allowed (Academic integrity is based on the "Code of Academic Integrity of the Chernihiv Polytechnic National University" https://stu.cn.ua/wp-content/uploads/2021/06/kodeks-akademichnoyi-dobrochesnosti-nova-redakcziya.pdf

Policy of student class attendance and working off missed classes

An attendance of all classes are mandatory. HEA studying on an individual schedule can only be exempted from attending lectures. There is a procedure of working off missing practical works for those HEA who missed them. In the case of objective reasons (for example, illness, international internship), learning can take place online or in a mixed form in agreement with the lecturer.

Recognition of the credits of previous education

Course credits can be credited (recalculated) when the student studied such a course (or a similar course that forms the learning outcomes provided by the course "Industrial ecology of food technologies") in another educational institution y відповідності до «The procedure for determining the difference in academic requirements and recognition of the results of previous education» https://stu.cn.ua/wp-content/uploads/2021/07/poryadok-vyznachennya-akademichnoi-riznyczi-ta-vyznannya-rezultativ-poperednogo-navchannya.pdf

8. Recommended Literature.

1. Barbera M., Gurnari G. Wastewater Treatment and Reuse in the Food Industry. Springer International Publishing, 2018. 54 p.

2. Cheremisinoff P. N. Air Pollution Control and Design for Industry. Taylor and Francis, 2017. 606 p.

3. The Interaction of Food Industry and Environment / Charis M. Galanakis (Ed.). Academic Press, 2020. 448 p.

4. Food Waste to Valuable Resources: Applications and Management / J. Banu (Ed.). Academic Press, 2020. 455 p.

5. Brunner P. H., Rechberger H. Handbook of material flow analysis: For environmental, resource, and waste engineers. 2d ed. New York : CRC Press, 2017. 442 p.