Lodz University of Technology

Pharmaceutical and Cosmetological Process Engineering

Course description

Basic information

Study programme Industrial Process Engineering **Speciality/path** - **Organizational unit** Faculty of Process and Environmental Engineering **Study level** second-cycle programme (magister inżynier) **Study mode** full-time studies **Education profile** general academic	**Didactic cycle** 2026/27 **Course code** **Language of instruction** polish **Obligatory** Optional **Block** Directional subjects **Course related to scientific research** Yes

Course coordinator	Anna Klepacz-Smółka
Course instructor(s)	Anna Klepacz-Smółka, Anna Antecka, Mariola Błaszczyk, Maciej Jaskulski, Piotr Owczarz, Anna Rył

Period	**Form of verification**	**Total ECTS points**
Semester 2	Graded assignment **Classes and hours** • Lecture: 32 • Laboratory classes: 18 • Project work: 20	5

Prerequisites

Basic knowledge in engineering, microbiology, physical chemistry, fluid mechanics, heat transfer, and mass transfer.

Learning outcomes

Code	Programme outcomes	Detailed outcomes indicators
2IPP2	Possesses advanced, including specialised, knowledge in material and energy balances, fluid mechanics, momentum transfer, heat and mass transfer, reaction kinetics, separation processes, process dynamics and control, equipment design, and product manufacturing technologies; analyses and evaluates the main development trends in chemical and biochemical engineering.	2IPP2.3 Applies experimental and computational methods for the characterisation of soft matter, taking into account current development trends and nanotechnological techniques. 2IPP2.4 Develops methods for product formation using separation processes and parameter control, adapting them to industrial applications, including pharmaceutical and food sectors.
2IPP4	Formulates and tests research tasks related to modelling and design; integrates knowledge from various areas of chemical engineering and allied disciplines; performs critical analysis and evaluation of results.	2IPP4.4 Verifies research results by comparing them with literature data and theoretical models. 2IPP4.5 Critically interprets results and formulates conclusions and recommendations for further research and implementation.

Course contents

Industrial processes in pharmacy and cosmetology, multiphase systems (suspensions, colloids, emulsions), industrial technologies and equipment, principles of cleanliness and microbiological safety, product packaging and quality systems (GMP, GCP, GLP).

Complementary information

Contents - detailed selection

No.	Contents - detailed selection	Class type
1.	Pharmaceutical and cosmetic industry technologies Lecture with flipped classroom elements 10 hr • History of the pharmaceutical and cosmetic industries. • Basic legal regulations in the pharmaceutical and cosmetic industries. • Natural and synthetic active substances. • Example chemical syntheses of drugs (non-steroidal anti-inflammatory drugs, sulfonamides, etc.). • Example syntheses of biopharmaceuticals and biosimilars (antibiotics, monoclonal antibodies, etc.). • Dosage forms. • Main manufacturing technologies in pharmacy and cosmetology. • Shelf life and stability of pharmaceutical and cosmetic products. • Sustainable development and green chemistry. Project 10 hr Development of the assumptions for a process design project for the production of a selected drug or cosmetic product: chemical or biochemical concept (selection of raw materials, determination of chemical—possibly also biochemical and physical—transformations, stoichiometric calculations, selection of method), technological concept (sequencing of processes and unit operations, conceptual flowsheet, material and energy balances, equipment selection, process flowsheet). The project is carried out in groups. Other 3 hr Study visit to a selected pharmaceutical or cosmetic manufacturing plant. Discussion of observations. Project consultations. Verification of learning outcomes.	Project work, Lecture
2.	Colloids in pharmacy and cosmetics Lecture 10hr • Definition of colloids and their importance in pharmacy and cosmetology. • Types of colloids (nanoemulsions, aerosols, colloidal suspensions). • Particle size and specific surface area characterization. • Stabilization mechanisms of colloidal systems (electrostatic, electrokinetic, steric). • Methods for producing colloidal particles via precipitation and comminution (size reduction). • Elements of population balance and practical aspects of applying colloidal systems. • Drug carrier systems in pharmacy. Nanoemulsions and nanocapsules as carriers of active substances. • Examples of innovative methods for delivering active ingredients in cosmetics. Laboratory 10 hr Production of colloidal particles for selected applications. • Variants: preparation of emulsions, e.g., using surfactants for selected applications. • Determination of colloidal system properties: particle size; determination of phase transition point using rheological methods and electrophoresis (zeta potential measurement); destabilization kinetics of dispersed systems (turbidimetric measurements). Other 3 hr Consultations on preparing laboratory reports; verification of learning outcomes.	Laboratory classes, Lecture

No.	Contents - detailed selection	Class type
3.	Cleanliness and Microbiological Safety in Production Areas Lecture 4 hr • Definitions and classification of clean environments (cleanrooms). • Principles of cleanroom design and construction. • Air and water purification technologies. • Cleanroom environmental monitoring. • HACCP as a tool for microbiological control. • Disinfection. • Response to microbiological incidents. Laboratory 8 hr Determination of the microbiological cleanliness of air and surfaces using selected methods. Other 2 hr Laboratory consultations for reading and interpreting experimental results.	Laboratory classes, Lecture
4.	Packaging and protection of pharmaceutical and cosmetic products Lecture 2 hr • Definition of packaging in the context of pharmacy and cosmetology. • Stages of the packaging process. • Selection of appropriate packaging and materials. • Protecting products against external factors. • Packaging of products with special properties.	Lecture
5.	Quality management systems (GMP, GLP) in pharmacy and cosmetology Lecture with flipped classroom elements 4 hr • Definition of quality in pharmacy and cosmetology. • Importance and objectives of quality management systems. • Brief overview of GMP and GLP. • Key GMP principles in pharmaceutical and cosmetic manufacturing. • GMP inspections and their significance. GLP in laboratory testing in pharmacy and cosmetology. Other 2 hr Participation in consultations preparing for the flipped classroom session. Verification of learning outcomes.	Lecture

Teaching methods and techniques, passing conditions

Class type	Teaching methods and techniques	Passing conditions
Lecture	Lecture	A passing grade in the course tests. A minimum score of 60% is required. The tests may consist of multiple-choice questions or open-ended questions and may be supplemented by an oral examination.
Laboratory classes	Laboratory/computer-based exercises	Completion of laboratory exercises and preparation of reports.
Project work	Project execution	Preparation and defense of the project (presentation).

Examination methods, weighed grades

Class type	Examination methods and weighed grades
Lecture	Written assignment: 40%
Laboratory classes	Research results: 15% Speaking assignment: 15%
Project work	Multimedia presentation: 10% Design Project: 20%

Verification of learning outcomes

Detailed outcome indicators	Verification criteria	Assesment tool (class type)
2IPP2.3	1) Written assessment A pass is awarded when the student: • selects appropriate experimental and computational methods for the given soft-matter system and justifies the choice; • correctly interprets typical results (parameters, curves, relationships) and identifies the limitations of the methods; • provides examples of current trends/nanoengineering techniques and explains their impact on the system’s properties. 2) Oral assessment (during the laboratory class) A pass is awarded when the student: • can explain the purpose of the measurements/calculations, the principles of the method, and key settings/parameters; • justifies the selection of experimental conditions and can identify sources of error as well as ways to minimize them; • relates the observed results to soft-matter properties and nanoengineering solutions. 3) Analysis of research results A pass is awarded when the student: • presents results in a clear format (tables/plots) and performs correct calculations/analyses; • draws conclusions linked to the system’s properties (e.g., structure–property relationships) and compares them with a model/expectations; • explains the significance of the results in the context of current trends and nanoengineering applications.	Written assignment (Lecture), Speaking assignment (Laboratory classes), Research results (Laboratory classes)

Detailed outcome indicators	Verification criteria	Assesment tool (class type)
2IPP2.4	1) Written assessment (test/exam) A pass is awarded when the student: • selects appropriate separation/purification processes for the given product/system (e.g., filtration, extraction, distillation, crystallization, membrane processes, centrifugation, etc.) and justifies the choice based on the properties of the product/mixture; • identifies key process parameters (e.g., temperature, pH, pressure, time, mixing intensity, concentrations, flow rates) and explains how controlling them affects yield, purity, and product quality; • proposes a simplified process flow scheme and identifies points for control/monitoring of parameters and quality; takes industrial specifics into account (scale-up, process safety, quality requirements/contamination risk, including in pharmaceutical and food contexts). 2) Laboratory report(s) A pass is awarded when the report includes: • a correct description of the applied separation method/operation and operating conditions (parameters, equipment), linked to the objective: product recovery/purification; • processing and interpretation of results: calculations/plots/tables, assessment of process performance/quality (e.g., yield, degree of separation, stability, purity), and conclusions related to parameter control; • an analysis of errors/sources of uncertainty and proposals for changes in parameters/method to improve the process; • a brief reference to industrial practice requirements (e.g., repeatability, contamination risk, technological constraints). 3) Project A pass is awarded when the project (and its defense) demonstrates that the student: • developed a concept for a product manufacturing process (selection of unit operations, including separation and purification) and their sequence in the process system; • identified and justified operating and control parameters (what is controlled, why, and how) as well as product quality criteria; • prepared a conceptual/process scheme and (to the extent required in the course) mass balances and/or equipment selection; • adapted the solution to industrial constraints (scalability, quality requirements, hygiene/safety, material and organizational limitations). 4) Multimedia presentation A pass is awarded when the student: • presents the designed product manufacturing method clearly and logically (sequence of stages, separation operations, parameters and their control); • justifies engineering decisions (why this method and these parameters) and relates them to industrial requirements (including pharmaceutical/food); • answers questions substantively, defends assumptions made, and uses sources (standards/guidelines/industry literature—within the scope required in the course).	Written assignment (Lecture), Design Project (Project work), Multimedia presentation (Project work)

Detailed outcome indicators	Verification criteria	Assesment tool (class type)
2IPP4.4	Laboratory report(s) A pass is awarded when the report: includes a comparison of experimental results with at least one literature source and/or a theoretical model (in the form of tables/plots); presents the comparison method (e.g., relative error, uncertainty intervals, curve fitting) and correct calculations; includes an interpretation of discrepancies, considering the influence of experimental conditions, model simplifications, measurement quality, uncertainty, and systematic errors; formulates conclusions on whether the results agree within an acceptable range and what this implies for the validity of the study/method. Project A pass is awarded when the project: uses literature to define reference values / the expected range of results and to select an appropriate theoretical model; includes validation of results: comparison with literature and/or a model, together with an assessment of agreement (error metric, difference analysis); provides a critical evaluation of sources and comparison conditions (comparability of systems, parameters, measurement methods); identifies limitations (of the model and the data) and recommendations, i.e., what additional measurements/method modifications would increase the reliability of the verification. Multimedia presentation A pass is awarded when the student: clearly presents the results plus the reference point (literature/model) and the comparison approach (plots, summaries, error metrics); justifies the selection of sources and the model, stating assumptions and the range of applicability; interprets agreement/discrepancies and defends conclusions during discussion (answers questions substantively); cites sources correctly and demonstrates an understanding of how uncertainty and experimental conditions affect the comparison.	Design Project (Project work), Research results (Laboratory classes), Multimedia presentation (Project work)

Detailed outcome indicators	Verification criteria	Assesment tool (class type)
2IPP4.5	1) Analysis of research results A pass is awarded when the student: • interprets the results in relation to the objective and hypothesis and explains their significance; • identifies limitations (uncertainty, errors, assumptions) and assesses the reliability of the conclusions; • formulates specific recommendations on what should be repeated/changed/refined in further studies. 2) Project A pass is awarded when the student: • presents conclusions derived from the data/analyses and justifies them; • proposes possible directions for implementation or further development, including conditions/limits of applicability; • identifies risks, constraints, and corrective actions (e.g., additional tests, validation, optimization). 3) Multimedia presentation A pass is awarded when the student: • clearly communicates key results and conclusions and justifies the recommendations; • can defend the interpretation during discussion, referring to limitations and alternative explanations; • presents proposed next steps (research and/or implementation) in a specific and realistic manner.	Design Project (Project work), Research results (Laboratory classes), Multimedia presentation (Project work)

Literature

Compulsory reading

1. Somasundaran, P. (Ed.). (2016). Encyclopedia of surface and colloid science (3rd ed.). CRC Press/Taylor & Francis Group – dostępna w bibliotece PŁ
2. Torčilin, V. P. (Ed.). (2016). Smart pharmaceutical nanocarriers. Imperial College Press - dostępna w bibliotece PŁ
3. Chmiel A., Grudziński S.: Biotechnologia i chemia antybiotyków, PWN 1998
4. Synoradzki, L., Wisialski, J., & Kowalski, J. M. (Eds.). (2012). Projektowanie procesów technolo-gicznych. Oficyna Wydawnicza Politechniki Warszawskiej – dostępna biblioteka chemiczna PŁ
5. Hickey A., Ganderton D.; Pharmaceutical Process Engineering; Informa Healthcare2010 – dostępna online
6. Shayne Cox Gad; Pharmaceutical manufacturing handbook: Production andprocesses; John Wiley & Sons 2008
7. Brud, W. S., & Glinka, R. (2001). Technologia kosmetyków : wybrane zagadnienia. “MA” Oficyna Wydawnicza - – dostępna BG PŁ

Other reference materials

1. Patrick, G. (2017). An introduction to medicinal chemistry (6th ed.). Oxford University Press.

Research and publications

Czylkowska A., Pitucha M., Lanka S., Raducka A., Rogalewicz B., Szczesio M., Świątkowski M., Żarczyński A., Klepacz-Smółka A., Szczytko J., Camargo B., Drabińska A., Szymański P., Triazole-based Mn(II), Fe(II), Ni(II), Cu(II) and Zn(II) complexes as potential anticancer agents – Physicochemical properties, in silico predictions and in vitro activity, Polyhedron, 261, art. no. 117106, 2024, DOI: 10.1016/j.poly.2024.117106

Antecka A., Klepacz-Smółka A., Szeląg R., Pietrzyk D., Ledakowicz S. Comparison of three methods for thermostable C-phycocyanin separation and purification, Chemical Engineering and Processing - Process Intensification, 171, art. no. 108563, 2022
DOI: 10.1016/j.cep.2021.108563

Paczkowska-Walendowska, M., Rył, A., Kwiatek, J., Rosiak, N., Szarzyński, K., Wawrzyniak, W., ... & Owczarz, P., Cielecka-Piontek, J. (2025). Baicalein-Loaded Chitosan Films for Local Treatment of Oral Infections. Polymers, 17(16), 2167. DOI: 10.3390/polym17162167
Owczarz P. Inżynieria koloidalnych układów chitozanowych wrażliwych na zmianę temperatury, Wydawnictwo Politechniki Łódzkiej, 2019

Student workload

Activity type	**Average number of hours* needed to complete an activity**
Lecture	32
Laboratory classes	18
Project work	20
Participation in written or practical forms of verification	4
Preparation for the final exam	10
pk: Study visits	10
Participation in academic consultations	4
Preparation of the project	15
Preparation of a report	15
Total student workload	**No. of hours** 128
Workload involving teacher	**No. of hours** 80
Total ECTS points	**ECTS** 5

* activity hour equals to 45 minutes

Directional learning outcomes

Code	Content
2IPP2.3	Applies experimental and computational methods for the characterisation of soft matter, taking into account current development trends and nanotechnological techniques.
2IPP2.4	Develops methods for product formation using separation processes and parameter control, adapting them to industrial applications, including pharmaceutical and food sectors.
2IPP4.4	Verifies research results by comparing them with literature data and theoretical models.
2IPP4.5	Critically interprets results and formulates conclusions and recommendations for further research and implementation.