GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Design of Technological Processes, PG_00060867		
Field of study	Chemical Technology		
Date of commencement of studies	October 2025	Academic year of realisation of subject	2027/2028
Education level	first-cycle studies	Subject group	Obligatory subject group in the field of study Subject group related to scientific research in the field of study
Mode of study	Full-time studies	Mode of delivery	at the university
Year of study	3	Language of instruction	Polish
Semester of study	5	ECTS credits	2.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Department of Process Engineering and Chemical Technology -> Faculty of Chemistry -> Faculties of Gdańsk University of Technology		
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Robert Aranowski	
	Teachers		

Lesson types

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	15.0	0.0	0.0	15.0	0.0	30

E-learning hours included: 0.0

eNauczanie source address: https://enauczanie.pg.edu.pl/2025/course/view.php?id=2918

Learning activity and number of study hours

Learning activity	Participation in didactic classes included in study plan	Participation in consultation hours	Self-study	SUM
Number of study hours	30	1.0	19.0	50

Subject objectives

1. Develop the ability to develop chemical process concepts and technical problems.
2. Integrate knowledge of chemistry, safety, patents, and preliminary technological feasibility.
3. Develop teamwork skills with role allocation, project responsibility and timeliness, and constructive feedback.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K6_U04] Is able to recognize and apply polymer processing methods, analyze corrosion processes of construction materials in the design of installations, taking into account systemic and non-technical aspects.	Student is able to take corrosion hazards into account when selecting materials and design solutions, including proposing basic methods for corrosion mitigation.	[SU1] Assessment of task fulfilment
[K6_W05] Has knowledge of electrical engineering, automation and computer science, including the operation of measurement and control systems	Student understands the role and position of measurement systems and automatic control systems within the structure of the designed technological process.	[SW3] Assessment of knowledge contained in written work and projects
[K6_W06] Has knowledge in the field of management, entrepreneurship, intellectual property protection and the basics of humanities and social sciences, and also knows specialized chemical nomenclature	Student has knowledge of the economic conditions of technological process design, including the impact of design decisions on capital and operating costs.	[SW3] Assessment of knowledge contained in written work and projects

Subject contents

Course content – lecture

Lecture Contents:

1. Introduction to process design. The essence of process design. The design cycle.
2. Scientific and patent sources. Industrial property protection. Literature and patent databases; novelty/ inventive step; operational freedom; the impact of patent protection on process path selection.
3. Design documentation principles and standards. Laboratory procedures, design assumptions, structure of process documentation.
4. Process chemical concept technological choices. Selection of reactions, separation methods, and process type (continuous/batch) in conjunction with operational requirements.
5. Project chemical concept assessment of the suitability of chemical transformations in terms of thermodynamics, kinetics, and cost.
6. Environmental impact of the installation. Wastewater, waste, off-gases, and their utilization.
7. Perspective flow diagram (PFD). Symbols, standards, conventions, stream numbering.
8. Process flow diagram (P&ID). Process nodes.
9. Material and energy balance. Principles of preparation and presentation in design documentation. Sankey diagram mass and heat flows.
10. Selection of construction materials and corrosion protection.
11. Health and safety and the environment: occupational health and safety, fire hazards. HAZOP hazard analysis.
12. Selection of apparatus and equipment. Primary and auxiliary equipment. Equipment cycle schedule.
13. Process control concept. Selection of measurement and actuator devices.
14. Economic analysis of the project preliminary justification. CAPEX, OPEX, manufacturing cost, simple sensitivity analysis, cost risks.
15. Project presentation.

Course content – project

Project Activities:

1. Project Selection and Conceptual Framework
2. Review of literature and patent information. Identification of known chemical synthesis pathways and industrial property restrictions.
3. Analysis of the thermodynamics and stoichiometry of proposed synthetic pathways. Preliminary assessment of the chemical feasibility of proposed reactions.
4. Kinetics, catalysis, and selectivity of proposed chemical reactions. Assessment of the yield/selectivity and catalytic requirements of product synthesis. Decision matrix of synthetic pathways.
5. Concept of possible separation and waste management methods.
6. Chemical concept selection and justification.
7. Preparation of a process schematic diagram.

Prerequisites and co-requisites

1. Stoichiometry and Balances: Simple mass balances for systems with and without reactions; concepts of conversion, selectivity, and yield.
2. Chemical Thermodynamics (Basic): ΔH, ΔG, chemical equilibrium, and the T/P effect (Le Châtelier's Principle); basic properties of mixtures (ρ, μ, Cp).
3. Basic Kinetics and Reactor Science: Reaction Orders, Rates.
4. Safety: Ability to analyze SDSs, basic hazards (flammability, toxicity), and DNSH principles.
5. Working with Literature and Patents: Searching for publications/patents, identifying novel and similar solutions.
6. Calculations: Spreadsheet proficiency (tables, graphs, simple formulas); basic knowledge of Scilab/ Matlab is desirable.
7. Team Communication: Working in groups of 23 people, basic role allocation.
8. Software Knowledge: Spreadsheet (Excel/LibreOffice) + word processing (Word/LaTeX). Schematic sketching tool (AutoCAD). Bibliography manager (Zotero/Mendeley).
9. Access to online university libraries (literature, optional databases).

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Project presentation	60.0%	70.0%
Colloquium - lecture	60.0%	15.0%
Activity (mini quizzes)	60.0%	15.0%

Recommended reading

Basic literature	1. Marchildon, K., & Mody, D. (2018). *Practical process design for chemical engineers*. Wiley. 2. Smith, R. (2016). *Chemical process design and integration* (2nd ed.). Wiley. 3. Turton, R., Bailie, R. C., Whiting, W. B., Shaeiwitz, J. A., & Bhattacharyya, D. (2018). *Analysis, synthesis, and design of chemical processes* (5th ed.). Pearson.
Supplementary literature	1. Green, D. W., & Southard, M. Z. (Eds.). (2019). Perrys chemical engineers handbook (9th ed.). McGraw-Hill Education. 2. Seider, W. D., Seader, J. D., Lewin, D. R., Widagdo, S., Gani, R., & Ng, M. K. (2017). Product and process design principles: Synthesis, analysis and evaluation (5th ed.). Wiley.
eResources addresses	

Example issues/ example questions/ tasks being completed	**Process Description** A continuous, exothermic process involving the reaction A + B C is conducted in a stirred-tank reactor equipped with a cooling jacket. The two liquid raw materials (A and B) are transferred from storage to a buffer tank and then pumped into the reactor. The temperature is maintained by a cooling loop (chilled water). Product C flows by gravity into the receiver. The process is conducted under a nitrogen atmosphere. Overpressure protection is provided by a safety valve. The reactor is degassed via a carbon column. **A process flow diagram (P&ID) must be designed and drawn, including:** Equipment: R-101: 2 m³ stirred-tank reactor, SS316L, PN16, jacketed; Agitator on M-101 (motor) E-101: heat exchanger (reactor jacket medium: chilled water 510°C) P-101A/B: feed pump (duplex, A/B) TK-101: buffer tank (raw materials) TK-102: product receiver N2 cylinder: regulator + pressure maintaining valve AC-101: activated carbon filter on the vent Process line: A and B supply, emergency discharge, product discharge, vent. Media line: chilled water (CWch), nitrogen, compressed air for instruments (I/A). Fittings: shut-off valves, check valves, control valves (including cooling), drains, bypasses. Instrumentation and Control (ISA): TIC-101: Reactor temperature control (TIR-101 measurement in the reaction mass, TV-101 actuator on the jacket cooling) LIC-101: Reactor level control, controls the LV-101 discharge valve FIC-101/102: A and B flow rate control (with FE-X flow meters and FV-X valves). A B/A flow ratio controller can be added. PIC-101: N overpressure maintenance (PV-101 valve on N supply) Alarms: TAHH-101 (HH temperature), LAHH-101 (HH level), LALL-101 (LL level) Safety: PSV-101 + RD-101 to AC-101 (venting) ESD-101: emergency shutdown (pump stop, FV-101/102 closure, QV-101 emergency discharge opening) **Input Data** Raw material A: ρ=850 kg/m³, T=25 °C; B: ρ=970 kg/m³, T=25 °C Product C: nominal T 40 °C; R-101 reactor: 2 m³, operating 6080% full Operating pressure 1.3 bar(g), test pressure 6 bar(g), connection class PN16 Media: Chilled water 510°C, nitrogen 3 bar(g) (after reduction), I/A 6 bar(g) Required flow rates (operating point): A = 200 kg/h, B = 300 kg/h Materials: ASI 316L steel for process media, carbon steel for chilled water
Practical activites within the subject	Not applicable

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