



Subject card

Subject name and code	Design of Technological Processes, PG_00060867						
Field of study	Chemical Technology						
Date of commencement of studies	October 2026		Academic year of realisation of subject			2028/2029	
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						
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	The aim of the course is to develop the ability to formulate concepts for technological processes and solve related technical problems by integrating knowledge of chemistry, technology, process safety, industrial property protection, and preliminary technological feasibility assessment.						
Learning outcomes	Course outcome		Subject outcome			Method of verification	
	[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	
	[K6_W05] Has knowledge of electrical engineering, automation and computer science, including the operation of measurement and control systems		Student has knowledge of the role and place of measurement systems and automatic control systems within the structure of a designed technological process.			[SW3] Assessment of knowledge contained in written work and projects	
	[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	

Subject contents	Course content – lecture Introduction to technological process design. The concept of process design and the design cycle. Scientific and patent information sources and industrial property protection. Literature and patent databases, novelty and inventive step, freedom to operate, and the impact of patent protection on process route selection. Design documentation – principles, standards and structure. Laboratory procedures and design assumptions. Chemical process concept and technological choices: selection of reactions, separation methods, and mode of process operation (continuous or batch). Assessment of chemical transformations in terms of thermodynamics, kinetics and economics. Environmental impact of process installations: wastewater, waste and off-gases and their potential utilization. Process Flow Diagram (PFD): symbols, standards, conventions and stream numbering. Piping and Instrumentation Diagram (P&ID) and process sections. Material and energy balances and principles for their preparation and presentation in design documentation. Sankey diagrams of mass and energy flows. Selection of construction materials and corrosion protection. Occupational health and safety, fire hazards and HAZOP analysis. Selection of main and auxiliary process equipment and equipment operating schedules. Process control concept. Selection of measurement instruments and final control elements. Preliminary economic analysis: CAPEX, OPEX, production cost, sensitivity analysis and cost risks. Presentation of projects. Course content – project Selection of the project topic and definition of its conceptual framework. Review of scientific literature and patent information. Identification of known chemical synthesis routes and constraints resulting from industrial property protection. Thermodynamic and stoichiometric analysis of the proposed synthesis routes and preliminary assessment of the chemical feasibility of the proposed reactions. Analysis of reaction kinetics, catalysis and selectivity. Assessment of yield and selectivity and catalyst requirements for the proposed product synthesis routes. Development of a decision matrix supporting the selection of the synthesis route. Development of concepts for possible product separation and purification methods and waste management. Selection and justification of the chemical process concept. Preparation of a Process Flow Diagram (PFD).		
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, C_p). 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: assessment of project documentation	60.0%	50.0%
	Lecture: colloquium	60.0%	15.0%
	Lecture: activity (mini quizzes)	60.0%	15.0%
	Project: project presentation	50.0%	20.0%
Recommended reading	Basic literature	1. Marchildon, K., & Mody, D. (2018). <i>Practical process design for chemical engineers</i>. Wiley. 2. Smith, R. (2016). <i>Chemical process design and integration</i> (2nd ed.). Wiley. 3. Turton, R., Bailie, R. C., Whiting, W. B., Shaeiwitz, J. A., & Bhattacharyya, D. (2018). <i>Analysis, synthesis, and design of chemical processes</i> (5th ed.). Pearson.	
	Supplementary literature	1. Green, D. W., & Southard, M. Z. (Eds.). (2019). <i>Perry's chemical engineers handbook</i> (9th ed.). McGraw-Hill Education. 2. Seider, W. D., Seader, J. D., Lewin, D. R., Widagdo, S., Gani, R., & Ng, M. K. (2017). <i>Product and process design principles: Synthesis, analysis and evaluation</i> (5th ed.). Wiley.	

	eResources addresses	Supplementary https://webbook.nist.gov/chemistry/?utm_source=chatgpt.com - A database provided by the National Institute of Standards and Technology containing evaluated physicochemical and thermodynamic data. It provides access to thermochemical, phase-change and equilibrium data useful in technological process design and analysis. https://worldwide.espacenet.com/?utm_source=chatgpt.com - A free patent database provided by the European Patent Office. It enables searches of patents and patent applications, analysis of existing technological solutions, and retrieval of information useful for assessing novelty, prior art and industrial property constraints. https://ccps.aiche.org/?utm_source=chatgpt.com - The Center for Chemical Process Safety (CCPS) website provides resources on chemical process safety, including hazard identification, risk assessment, HAZOP analysis, safe process design and process safety management. https://patents.google.com/?utm_source=chatgpt.com - A patent search engine enabling rapid identification of existing technical and technological solutions. It can be used to review synthesis routes and product manufacturing technologies and to perform a preliminary analysis of prior art. https://pubchem.ncbi.nlm.nih.gov/?utm_source=chatgpt.com - A chemical information database covering molecular structures, physicochemical properties, identifiers, safety information and links to literature. It is useful for preliminary assessment of the properties of raw materials, products and auxiliary substances.
Example issues/ example questions/ tasks being completed	Process Description A continuous, exothermic process involving the reaction $A + B \rightarrow C$ 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: TAAH-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: $\rho=850 \text{ kg/m}^3$, $T=25 \text{ }^\circ\text{C}$; B: $\rho=970 \text{ kg/m}^3$, $T=25 \text{ }^\circ\text{C}$ Product C: nominal $T=40 \text{ }^\circ\text{C}$; R-101 reactor: 2 m³, operating 60-80% 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: AISI 316L steel for process media, carbon steel for chilled water	
Practical activities within the subject	Not applicable	