Lodz University of Technology

Mixing Liquids and Granular Materials

Course description

Basic information

Study programme Industrial Process Engineering **Speciality/path** - **Organizational unit** Faculty of Process and Environmental Engineering **Study level** first-cycle programme (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	Remigiusz Modrzewski
Course instructor(s)	Remigiusz Modrzewski, Andrzej Obraniak, Piotr Owczarz, Jacek Stelmach

Period Semester 5	**Form of verification** Graded assignment **Classes and hours** • Lecture: 20 • Laboratory classes: 40	**Total ECTS points** 4

Prerequisites

Knowledge and skills in physics, fluid mechanics and technical mechanics

Learning outcomes

Code	Programme outcomes	Detailed outcomes indicators
1IPP2	Has knowledge of key chemical and process engineering processes, including: (1) momentum, heat and mass exchange mechanisms and their application in unit operations and process apparatus; (2) principles of mass, energy and momentum balancing in process engineering processes; (3) product separation, separation and purification processes; (4) fundamentals of chemical and biochemical reaction engineering.	1IPP2.1 Explain the mechanisms of momentum, heat and mass exchange and describe their role in basic unit operations and process apparatus.
1IPP4	Applies analytical and critical thinking to identify, formulate, and solve complex and atypical engineering problems related to industrial processes and process installations, selecting appropriate computational, technological, and organisational methods.	1IPP4.1 Can identify and accurately define a problem occurring in industrial processes or process plants, identifying key technological variables and operational constraints.

Course contents

Fundamentals of liquid and granular material mixing, including hydrodynamic and mechanical mechanisms and the operating characteristics of mixers. The course introduces the selection of mixing equipment and process parameters in process engineering installations.

Complementary information

Contents - detailed selection

No.	Contents - detailed selection	Class type
1.	LECTURE Theory of mixing, Mixers and agitators. Rheological properties of granular materials. Granulation mechanisms. Granulation kinetics. Storage of bulk materials and liquids. Transport of granular materials. LABORATORY Measurement of mixing power of liquids. Measurement of mixing power of granular materials. Examination of the distribution of liquid velocity in a mixer. Measurement of the axial force at the bottom of the mixer. Examination of the effect of mixing on dissolution kinetics. Mixing of granular materials in a drum mixer. Mixing of granular materials in a mixer with a stirrer. Examination of the rheological properties of granular materials. Granulation screening and milling of granular materials. Encapsulation of granular materials.	Laboratory classes, Lecture

Teaching methods and techniques, passing conditions

Class type	Teaching methods and techniques	Passing conditions
Lecture	Lecture	Correctly answering at least 50% of the questions in the written test
Laboratory classes	Laboratory/computer-based exercises	Completion of all laboratory reports

Examination methods, weighed grades

Class type	Examination methods and weighed grades
Lecture	Written assignment: 50%
Laboratory classes	Lab report(s): 50%

Verification of learning outcomes

Detailed outcome indicators	Verification criteria	Assesment tool (class type)
1IPP2.1	Student is able to discuss the course of phenomena occurring during the mixing operation of liquids and granular materials, is able to perform process calculations to obtain the desired final effect of the mixing operation, is able to describe the principles of construction and operation of typical devices for carrying out mixing operations, is able to select the right mixing equipment for a specific task, is able to demonstrate elementary knowledge of the process of wear of equipment used for mixing operations.	Written assignment (Lecture), Lab report(s) (Laboratory classes)
1IPP4.1	Student is able to discuss the course of phenomena occurring during the mixing operation of liquids and granular materials, is able to perform process calculations to obtain the desired final effect of the mixing operation, is able to describe the principles of construction and operation of typical devices for carrying out mixing operations, is able to select the right mixing equipment for a specific task, is able to demonstrate elementary knowledge of the process of wear of equipment used for mixing operations.	Written assignment (Lecture), Lab report(s) (Laboratory classes)

Literature

Compulsory reading

1. A. Heim, Procesy mechaniczne i urządzenia do ich realizacji, Wydawnictwo Poli-techniki Łódzkiej, Łódź 1996.

Other reference materials

1. R. Koch, A. Noworyta, Procesy mechaniczne w inżynierii chemicznej, WNT, Warszawa 2000

Student workload

Activity type	Average number of hours* needed to complete an activity
Lecture	20
Laboratory classes	40
Literature analysis	20
Participation in academic consultations	20

Preparation for tutorials	20
Total student workload	**No. of hours** 120
Workload involving teacher	**No. of hours** 60
Total ECTS points	**ECTS** 4

* activity hour equals to 45 minutes

Directional learning outcomes

Code	Content
1IPP2.1	Explain the mechanisms of momentum, heat and mass exchange and describe their role in basic unit operations and process apparatus.
1IPP4.1	Can identify and accurately define a problem occurring in industrial processes or process plants, identifying key technological variables and operational constraints.