Detailed course description
(SUBJECT CARD)

Course title: **MASS CRYSTALLIZATION**
Course code:
Affiliation to a course group: field-specific / specialty
Course type: field-specific/ specialty
obligatory
Field of study: Industrial and Engineering Chemistry
Level of study: second-cycle programme
Study profile: general academic
Mode of study: full-time programme
Specialty (specialisation): Process Engineering in Green Chemical Technologies
Year of study: 1
Semester: I
Teaching modes and teaching hours:
lectures – 30 h;
tutorials, etc. – *not applicable*
Language/s of instruction: English
Number of ECTS credits *(according to the study programme)*: **2**
* – *leave the appropriate option*

1. Course objectives: Providing the Students with theoretical background of mass crystallization from solutions, constructions of industrial crystallizers and mathematical methods for this unit operation modelling.

2. Relating the field-specific learning outcomes to teaching modes, verification methods and assessment of student's learning outcomes:

symbol	assumed learning outcomes *a student who completed the course:*	teaching modes	verification methods and learning outcome assessment
Knowledge: a student knows and understands			
K2A_W02	Has a broaden knowledge within the scope of the physics making the understanding of the physical processes, connected with chemical technology and engineering possible	Lecture	Test exam
K2A_W04	Has a knowledge within the scope of the complex chemical processes, covering appropriate selection of the raw materials, apparatuses and devices for realization of the chemical processes and unit operations, as well as characterization of the products	Lecture	Test exam
K2A_W07	Has a knowledge within the scope of the latest chemical and material technologies, including the advanced material technologies and nanomaterials, knows the current trends in development of the chemical industry processes	Lecture, consultations	Test exam, discussion, observations
K2A_W09	Has a knowledge within the scope of the environment protection problems, related to the realization of the industrial chemical processes	Lecture, consultations	Test exam, discussion, observations
K2A_W12	Has a broaden and established knowledge within the scope of the selected specialisation	Lecture, consultations	Test exam, discussion, observations
Skills: a student can			
K2A_U01	Has the abilities of gathering and critical verification of the information from literature, databases and other sources, as well as to formulate on this basis opinions and reports	Lecture, consultations	Test exam, discussion, observations
K2A_U04	Has the abilities of communication with the specialists and non-specialists in the area of chemical technology and the related disciplines	Lecture, consultations	Test exam, discussion, observations
K2A_U09	Has the abilities of analysis and solving the problems related to chemical technology and process engineering, using for this purpose the theoretical, analytical, simulation and experimental methods	Lecture	Test exam
K2A_U10	Can verify the conceptions of the potential engineering solutions in relation to the current knowledge in chemical technology and engineering	Lecture, consultations	Test exam, discussion, observations

K2A_U13	Can make the critical analysis of the industrial chemical processes, as well as to introduce modifications and improvements within this field, using the acquired knowledge, including the information about the latest scientific and technical achievements	Lecture	Test exam
K2A_U14	Has the abilities of evaluation of the technological applicability of raw materials and matching the technological process in relation to the quality requirements of the product	Lecture	Test exam
K2A_U20	Has the abilities of usage of the knowledge acquired during the specialisation study in professional activity	Lecture, consultations	Test exam, discussion, observations
Social competences: a student is able to			
K2A_K01	Can think and act in creativity and enterprising manners	Lecture, consultations	Test exam, discussion, observations
K2A_K04	Behaves professionally, with observing the professional ethics rules	Lecture, consultations	Test exam, discussion, observations
K2A_K06	Has the awareness of permanent learning and improvement of the professional skills	Lecture, consultations	Test exam, discussion, observations

3. Study programme contents ensuring the learning outcomes *(according to the study programme)*:

- Preparation, during the group work, the design concerning introduction of a new product in the market.
- Advanced raw materials, products and processes applied in chemical industry and directions of chemical industry development in the country and in the world.
- Knows the techniques and tools of design of the apparatuses and devices, including the computer-aided design (CAD).
- Can design and match the selected devices and apparatuses representing the technological grids of chemical engineering unit operations unaided.
- Analysis of literature data, databases and other sources, as well as to formulate on this basis the opinions and reports.
- Gathering and critical evaluation of the information from the literature, databases and other sources, as well as to formulate on this basis the opinions and the reports.
- Professional ethics.
- Usage of literature data, Internet, electronic databases and the information-communication techniques in the calculation-design works.
- Determination of mass crystallization process kinetics based on the experimental data using the adequate mathematical models.
- Can make preliminary cost analysis of a discussed problem and evaluate on this basis its economy.
- Uses the rules of proper matching and integration of unit operations into technological system.
- Can apply in practice the heuristic rules concerning selection of the optimal process configuration.
- Uses the rules of proper selection and integration of unit operations into technological plant.
- Simple calculations of mass and energy balances concerning technological system of the reactor.
- Can design and synthesis of the materials with the required structural and physicochemical properties and characterize of their properties.
- Analysis of the trends in chemical industry.

4. Description of methods to determine the ECTS credits:

Type of activity	Number of hours / ECTS credits
Number of course hours regardless of a teaching mode	30/1
Student workload 1* - preparation for the examination	30/1
Student workload 2*	-
Student workload n*	-
Other**	-
Total hours:	**60/2**
Number of ECTS credits allocated for a course	**2**

Description:
* – student workload, types of activities need to be provided, e.g. preparation for the course, interpretation of results, preparation of a course report, preparation for the examination, getting familiar with the literature, preparation of a project, presentation, written work, report, etc.
** – other e.g. additional course hours

5. Summary indicators:
   - number of course hours and ECTS credits at the course with a direct participation of academic teachers or other persons teaching the course and students: 30 h / 1 ECTS
   - number of course hours and ECTS credits at the course related to the scientific activity conducted at the Silesian University of Technology in a discipline or in disciplines to which a field of study is assigned - in

the case of studies with a general academic profile: 30 h /1 ECTS

– number of course hours and ECTS credits at the course shaping practical skills- in the case of practical studies: *not applicable*

– number of course hours conducted by academic teachers employed by the Silesian University of Technology as their primary workplace: 30 h

6. Persons conducting particular types of courses (name, surname, academic degree or degree in arts, title of professor, business e-mail address):

   Dr hab. inż. Krzysztof PIOTROWSKI, prof. Pol. Śl., e-mail: krzysztof.piotrowski@polsl.pl

7. Detailed description of teaching modes:

   1) lectures:

   – detailed programme contents:

   Fundamentals of mass crystallization from solution. Mass crystallization as a unit operation. Definition of crystal size and shape. Solubility and supersaturation. Nucleation phenomena – their mechanisms and possible sources of nuclei in industrial crystallizers. Primary nucleation – homogeneous and heterogeneous. Origin of secondary nuclei. Crystal growth – mass transport through the film, surface integration processes and their kinetics. Size-dependent crystal growth. Growth rate dispersion. Crystal growth rate expressions. Mathematical modeling of the crystallizing systems. Population balance concept. General population balance equation. Moments of the crystal size distribution. Average crystal sizes. Coefficient of variation – CV. The MSMPR crystallizer model – concept of an idealized configuration. Population balance for MSMPR configuration. Population density distribution function – for size independent and size-dependent growth kinetics. Deviations from MSMPR crystallizer configuration: internal classification of solids, external classification, attrition, agglomeration. Derivation of pure mass crystallization kinetics. Derivation of mass crystallization kinetics from the distributions affected by population events. Physical transport phenomena in mass crystallization – influence of hydrodynamics on the system performance and crystal product quality. Sampling and analyzing the crystallizing systems. Crystallizer design (batch and continuous). Reaction–crystallization (precipitation) systems – their design and practical application.

   – teaching methods, including distant learning:

   Lecture with multimedia presentation.

   – form and criteria for successful semester completion, including retakes, as well as the conditions for admission to the examination:

   Credit of the test exam (MCQ – Multiple Choice Questions, questions in a closed form) – gaining min. 50% of the max scoring,

   – course organisation and rules of participation in the course, with an indication whether a student ‘s attendance is obligatory

   Weekly lectures (15 weeks, 2h each), not obligatory presence of student during the lecture. Weekly consultations.

   2) description of other teaching methods:

   Not applicable

8. Description of the method to determine the final grade (rules and criteria for evaluation, as well as a calculation method for the evaluation in the case of a course which includes more than one teaching mode, including all teaching modes and all examination and credit dates including retake examinations):

   One form of the teaching mode (lecture). Final mark is a mark from the test exam resulting from the gathered score (the mark resulting from location of the gathered scoring within the appropriately uniformly distributed sections corresponding to the marks from 3 to 5), minimal scoring for the credit is 50% of max scoring.

9. Method and procedure for filling up arrears resulting from:

   - student's absence from the course,

   - differences in study programmes for persons changing a field of study, changing university or resuming

studies at the Silesian University of Technology,

Consultations and familiarizing with the recommended literature in the field and material presented during the lectures. Completion of the knowledge is verified by the test exam.

10. Prerequisites and additional requirements, taking into account the course sequence:

Knowledge from the following thematic fields: fluid mechanics, physics, transport phenomena, unit operations and chemical technology. Introductory subjects: Physics, Fluid Mechanics, Transport Phenomena, Chemical Technology, Unit Operations.

11. Recommended sources and teaching aids:

1. Jančić S.J., Grootscholten P.A.M., Industrial Crystallization, Delft University Press, D. Reidel Publishing Company (1984).
2. Nývlt J., Industrial Crystallization – the Present State of the Art. Verlag Chemie, Weinheim – New York (1978).
3. Nývlt J., Söhnel O., Matuchová M., Broul M., The Kinetics of Industrial Crystallization. Elsevier, Amsterdam–Oxford–New York–Tokyo (1985).
4. Current scientific literature from ELSEVIER and SPRINGER databases, CD materials from Industrial Crystallization conference.

12. Description of teacher's competences (e.g. publications, professional experience, certificates, trainings etc. related to the programme contents implemented as part of the course):

Professional experience (e.g. PhD or higher concerning mass crystallization problems and reaction crystallization problems), scientific publications and conference presentations concerning mass crystallization problems, crystallizer constructions and new technologies based on mass crystallization processes.

13. Other information:

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