**COURSE DESCRIPTION**

# Transfer Process Intensification

Academic year 2026 - 2027

**1. Programme-related data**

| | |
|---|---|
| 1.1. Higher Education Institution | Babes-Bolyai University |
| 1.2. Faculty | Faculty of Chemistry and Chemical Engineering |
| 1.3. Department | Chemical Engineering |
| 1.4. Field | Chemical Engineering |
| 1.5. Level of study | Master |
| 1.6. Degree programme / Qualification | Advanced Chemical Process Engineering |
| 1.7. Form of education | Full-time education |

**2. Course-related data**

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|---|---|---|---|---|---|
| 2.1. Course title | **Transfer process Intensification** | | | Discipline Code | **CME7323** |
| 2.2. Course coordinator | | Conf. Dr. Ing. Letiția Petrescu | | | |
| 2.3. Seminar coordinator | | Conf. Dr. Ing. Letiția Petrescu | | | |
| 2.4. Year of study | 1 | 2.5. Semester | 2 | 2.6. Type of assessment | Exam |
| 2.7. Course status | | Compulsory | | 2.8. Course type | Core subject |

**3. Total estimated time** (hours per semester of teaching activities)

| | | | | | |
|---|---|---|---|---|---|
| 3.1. Number of hours per week | 4 | of which: 3.2. course | 2 | 3.3~~. seminar~~/ laboratory/ ~~project~~ | 2 |
| 3.4. Total of hours in the curriculum | 56 | of which: 3.5. course | 28 | 3.6. ~~seminar/~~ laboratory | 28 |
| **Time allocation for individual study (IS) and self-taught activities (ST)** | | | | | **hours** |
| Learning from textbooks, course materials, bibliography, and notes (IS) | | | | | 20 |
| Additional research in the library, on subject-specific electronic platforms, and on-site | | | | | 16 |
| Preparing seminars/ laboratories/ projects, assignments, reports, portfolios, and essays | | | | | 20 |
| Tutoring (professional guidance) | | | | | 10 |
| Examinations | | | | | 3 |
| Other activities | | | | | - |
| **3.7. Total hours of individual study (IS) and self-taught activities (ST)** | | | | 69 | |
| **3.8. Total hours per semester** | | | | 125 | |
| **3.9. Number of credits** | | | | 5 | |

**4. Prerequisites** (where applicable)

| | |
|---|---|
| 4.1. curriculum-related | Not applicable |
| 4.2 skills-related | Not applicable |

**5. Specific conditions** (where applicable)

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|---|---|
| 5.1. course-related | Regular attendance is encouraged. Classes will start on time, according to the official schedule.<br>Absences: Whenever possible, unavoidable absences should be discussed with the course responsible (in person or via e-mail) before the course to take place. If you miss the exam, if you are late handing a theme or project due to an unforeseen event or a reason recognized by the university, contact the course coordinator prior to the event (if possible) to find a solution to this problem.<br>You are responsible for obtaining the information presented in |

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|---|---|
| | courses which are not common.<br>As a classroom building policy, is not permitted to eat in the classroom. Smoking is also prohibited. Students are encouraged to shut down cell phones or other electronic communication devices (i.e., chat software) throughout the course. It is not allowed to use e-mail or web-browsing during class hours.<br>Any disruptive behaviour will be punished accordingly.<br>No part of the course (printed and online materials, lectures, workshops, discussion sessions, etc.) can be recorded (audio or video), broadcast or re-published without the written consent of the course responsible.<br>Special Needs: All reasonable efforts will be made to meet individual student needs. If there is a learning disability or other, students are asked to seek an audience with the course responsible to discuss their needs. Also, international students (or otherwise not speaking English) are encouraged to contact the course responsible if they need help to overcome the "language barrier". All discussions will be kept strictly confidential.<br>Academic Honesty: This policy can be found in the University Charter and covers plagiarism, cheating, fabrication, and facilitating dishonesty. Events in any of these practices will be dealt with according to university policy.<br>Exam Fraud is punishable by expulsion as mentioned in the University Charter.<br>Grievance procedure: If you feel that a note given is incorrect for any reason, you can challenge it by filing a written explanation with the material noted for instructor within one week of receiving the grade. |
| 5.2. seminar/laboratory-related | It is essential that students possess strong computer skills to use.<br>Special Needs: All reasonable efforts will be made to meet individual student needs. If there is a learning disability or other, students are asked to seek an audience with the course responsible to discuss their needs. Also, international students (or otherwise better not speaking English) are encouraged to contact the course responsible if they need help to overcome the "language barrier". All discussions will be kept strictly confidential.<br>Presentation of seminar assignments and projects is mandatory.<br>As a building policy for seminar halls, in classrooms eating is not permitted. Smoking is also prohibited. Students are encouraged to shut down cell phones or other electronic communication devices (e.g. chat software) during the seminar. It is not allowed to use e-mail or web-browsing during seminar hours.<br>Academic Honesty: This policy can be found in the University Charter and covers plagiarism, cheating, fabrication, and facilitating dishonesty. Events in any of these practices will be dealt with according to university policy.<br>Assignments and projects must be completed individually by each student. |

**6.1. Competencies resulting from the completion of the degree programme *(as referred to in the curriculum)*[1]**

| Professional competencies | |
|---|---|
| **Competency code** | **Competency** |
| **PC1** | Description, analysis and use of elaborate theories and concepts in the fields of chemistry and process advanced chemical engineering. |
| **PC2** | Technological design of processes, equipment and apparata specific to process engineering for the improvement of performances of biochemical and chemical processes by using computer-assisted instruments (CAD) and principles of long term development. |
| **PC4** | Development of processes, apparata and equipment specific to process engineering by promoting new solutions for process intensification, optimum operation and control. |
| | |
| **Transversal competencies** | |
| **Competency code** | **Competency** |
| **TC2** | Planning, monitoring, and assuming the duties of a subordinate professional group. Demonstrating the capacity of coordination, analytical thinking, adaptability and flexibility, collaboration with team members. |
| **TC3** | Self-assessment of professional performances and determining the continuous training needs, permanent information and documentation in the field of activity and related areas, according to the needs of the labour market. |

**6.2. Learning outcomes relevant to the degree programme** (as referred to in the curriculum)[2]

| Learning outcomes targeted by the subject | | |
|---|---|---|
| **Competency code** | **Knowledge and comprehension** | **Specific academic skills** |
| **PC1**<br>**PC4**<br>**TC1** | Formulation of solutions to solve complex chemical engineering problems based on knowledge, identification and application of advanced concepts, methods and theories in the field of chemical engineering and chemistry. | Critical analysis and application of advanced principles, methods, and techniques for the evaluation, design, and development of new products and technologies. |
| **PC2**<br>**TC1** | Performing a critical analysis based on CAD tools, to identify possible solutions to complex problems of designing equipment and plants in a chemical process. | Development of integrated projects, based on CAD tools, for the creative development of the design of devices, equipment and plants in the chemical process industries. |
| **PC1**<br>**PC3**<br>**TC1** | Explain and understand the operation of devices, equipment and processes in the chemical process industries based on software environments that describe their behaviour using complex analytical or statistical mathematical models. | Use of mathematical models for technological design and their implementation in automatic control systems, in order to obtain optimal solutions for economically and energetically operation, associated to low environmental impact. |
| **PC4**<br>**TC2** | Knowledge of advanced concepts for analysis, intensification and synthesis of processes, devices and equipment specific to process engineering. | Creative use of the analysis, intensification and synthesis of chemical processes in the development of innovative products/technologies and in the improvement of the decision-making act related to their optimal management. |

[1] The professional and/or transversal skills targeted by the subject for which the course description is prepared will be copied from the curriculum of the degree programme. For each competency, the complete entry, including the competency code, will be copied with the exact wording that appears in the curriculum, without any changes. If no competency is copied from either of the two categories, the row corresponding to that category is deleted from the table.

[2] The learning outcomes relevant for the degree programme and targeted by the subject for which the course description is prepared will be listed. The entries, copied without any changes from the Curriculum by subject type (Core Subject/Specialisation Subject/Complementary Subject), are listed under the corresponding competency.

**7. Subject-specific learning outcomes**

| **Knowledge and comprehension** |
|---|
| 1. The student knows how to represent chemical processes using various types of diagrams; |
| 2. The student knows the operation of the main equipments for momentum transfer, heat transfer, mass transfer; |
| 3. The student knows the necessary steps to carry out a chemical process; |
| 4. The student knows the main equipments used to intensify chemical processes. |
| **Specific academic skills** |
| 1. The student is able to realize, using the CHEMCAD program, a simulation of a chemical/biochemical/energy generation process; |
| 2. The student is able to parameterize traditional and intensification equipments using the CHEMCAD process simulator; |
| 3. The student is able to perform several variants/design alternatives of the same process; |
| 4. The student is able to compare and interpret the results obtained after the simulation. |

**8. Contents**

| **8.1. Course** | **Teaching and learning methods** | **Remarks[3]** |
|---|---|---|
| *8.1.1. Basic concepts, key words:* Sustainability concept, Process intensification (PI) context, a bit of history, PI definitions, PI facets, PI characteristics | Explanation, Conversation, Description, Problematization | |
| *8.1.2. Basic concepts, key words:* PI principles, classification, benefits, tools Process System Engineering, Process Integration, Process Intensification (definition, comparison, scale, advantages, challenges, disadvantages) | Explanation, Conversation, Description, Problematization | |
| *8.1.3. Basic concepts, key words:* PI problem statement, challenges, barriers, potential problems, Intensification of transport processes (mass, heat, momentum) | Explanation, Conversation, Description, Problematization | |
| *8.1.4. Basic concepts, key words:* Process intensification equipment (for chemical reactions and operations not involving chemical reactions) | Explanation, Conversation, Description, Problematization | |
| *8.1.5. Basic concepts, key words:* Process intensification methods: general overview, novel processing methods (multifunctional reactors, hybrid separation) | Explanation, Conversation, Description, Problematization | |
| *8.1.6. Basic concepts, key words:* Process intensification methods: use of alternative energy sources (centrifugal field, ultrasound, microwaves, solar energy, electric field, plasma technology) other methods | Explanation, Conversation, Description, Problematization | |
| *8.1.7. Basic concepts, key words:* PI in process separation systems: | Explanation, Conversation, Description, Problematization | |

[3] For example, organisational aspects, recommendations for students, specific aspects relating to the course/seminar, such as inviting experts in the field, etc.

| | | |
|---|---|---|
| distillation; Plate/tray column configuration; Packed column configuration; (Characteristics, description of PI elements, advantages, disadvantages) | | |
| *8.1.8. Basic concepts, key words:* PI in process separation systems: distillation; Multiple effect methods, thermal integration; Direct vapor recompression; Heat integrated distillation column | Explanation, Conversation, Description, Problematization | |
| *8.1.9. Basic concepts, key words:* Reaction-separation systems: reactive distillation (General aspects, classification, benefits, constrains, drawbacks, applications) | Explanation, Conversation, Description, Problematization | |
| *8.1.10. Basic concepts, key words:* Reaction-separation systems: Reactive absorption (mechanism, examples, PI in absorption); Membrane separation processes | Explanation, Conversation, Description, Problematization | |
| *8.1.11. Basic concepts, key words:* Reaction-separation systems: Reaction-separation systems: reactive adsorption (mechanism, challenges, Adsorption vs. Absorption, classification, PSA, TSA, PI in adsorption) | Explanation, Conversation, Description, Problematization | |
| *8.1.12. Basic concepts, key words:* Minimization of wastes from chemical processes through Process Intensification and Process Integration; Environmental evaluation through Life Cycle Assessment (LCA) | Explanation, Conversation, Description, Problematization | |
| *8.1.13. Basic concepts, key words:* Microreactors (general aspects, comparison with traditional reactors (batch, CSTR), advantages, disadvantages, classification, fabrication, construction materials, applications), modelling of microreactors | Explanation, Conversation, Description, Problematization | |
| *8.1.14. Basic concepts, key words:* PI in Industrial Practice | Explanation, Conversation, Description, Problematization | |

Bibliography

1. Luis Puigjaner, Georges Heyen, (2006) Computer Aided Process and Product Engineering, Hardcover, Wiley-VCH Verlag GmbH, ISBN 3527308040 (3-527-30804-0)
2. Frerich Johannes Keil, (2007) Modeling of Process Intensification, Hardcover, Wiley-VCH Verlag GmbH, ISBN 3527311432
3. David Reay, Colin Ramshaw and Adam Harvey, (2008), Process Intensification Engineering for Efficiency, Sustainability and Flexibility, Elsevier, ISBN 978-0-7506-8941-0 (978-0-080-55808-0)
4. Andrzej Stankiewicz, Jacob A. Moulijn, (2003), Re-engineering the Chemical Processing Plant: Process Intensification (Chemical Industries), CRC Press, ISBN-10: 0824743024 (13: 978-0824743024)
5. Kmelia Boodhoo and Adam Harvey (2013). Process Intensification for green chemistry, Wiley, ISBN 9780470972670
6. Ben-Guang Rong (2017). Process Synthesis and process intensification, De Gruyter, ISBN 978-3-11-046505-1
7. Fernando Israel Gomez-Castro, Juan Gabriel Seovia-Hernandez (2019). Process Intensification, De Gruyter, ISBN 978-3-11-059607-6

| **8.2. Laboratory** | **Teaching and learning methods** | **Remarks** |
|---|---|---|
| *8.2.1 Basic concepts, key words:* Process simulation using CHEMCAD | Explanation, Conversation, Description, Problematization | |

| | | |
|---|---|---|
| (review of concepts of CHEMCAD software usage) | | |
| *8.2.2 Basic concepts, key words:* Process simulation using CHEMCAD (review of concepts of CHEMCAD software usage) | Explanation, Conversation, Description, Problematization | |
| *8.2.3 Basic concepts, key words:* benzene-toluene separation, CHEMCAD application | Explanation, Conversation, Description, Problematization | |
| *8.2.4 Basic concepts, key words:* Absorption-desorption process, CHEMCAD application | Explanation, Conversation, Description, Problematization | |
| 8.2.5 *Basic concepts, key words:* Acid gas removal (AGR), CHEMCAD application | Explanation, Conversation, Description, Problematization | |
| 8.2.6 *Basic concepts, key words:* Azeotropic distillation, CHEMCAD application | Explanation, Conversation, Description, Problematization | |
| 8.2.7 *Basic concepts, key words:* Multiple effect method CHEMCAD application | Conversation, Description, Problematization | |
| *8.2.8 Basic concepts, key words:* Volatile organic compounds (VOC) removal, CHEMCAD application | Conversation, Description, Problematization | |
| *8.2.9 Basic concepts, key words:* Heat distillation integrated columns, CHEMCAD application | Conversation, Description, Problematization | |
| *8.2.10 Basic concepts, key words:* Divided wall columns, CHEMCAD application | Conversation, Description, Problematization | |
| *8.2.11 Basic concepts, key words:* Reactive distillation, CHEMCAD application | Conversation, Description, Problematization | |
| *8.2.12 Basic concepts, key words:* Extractive distillation, CHEMCAD application | Conversation, Description, Problematization | |
| *8.1.13 Basic concepts, key words:* Membrane separation, CHEMCAD application | Conversation, Description, Problematization | |
| *8.1.14 Basic concepts, key words:* Waste minimization using PI | Conversation, Description, Problematization | |

Bibliography

1. Luis Puigjaner, Georges Heyen, (2006) Computer Aided Process and Product Engineering, Hardcover, Wiley-VCH Verlag GmbH, ISBN 3527308040 (3-527-30804-0)
2. Frerich Johannes Keil, (2007) Modeling of Process Intensification, Hardcover, Wiley-VCH Verlag GmbH, ISBN 3527311432
3. David Reay, Colin Ramshaw and Adam Harvey, (2008), Process Intensification Engineering for Efficiency, Sustainability and Flexibility, Elsevier, ISBN 978-0-7506-8941-0 (978-0-080-55808-0)
4. Andrzej Stankiewicz, Jacob A. Moulijn, (2003), Re-engineering the Chemical Processing Plant: Process Intensification (Chemical Industries), CRC Press, ISBN-10: 0824743024 (13: 978-0824743024)
5. Kmelia Boodhoo and Adam Harvey (2013). Process Intensification for green chemistry, Wiley, ISBN 9780470972670
6. Ben-Guang Rong (2017). Process Synthesis and process intensification, De Gruyter, ISBN 978-3-11-046505-1
7. Fernando Israel Gomez-Castro, Juan Gabriel Seovia-Hernandez (2019). Process Intensification, De Gruyter, ISBN 978-3-11-059607-6

**9. Evaluation**

| Type of activity | 9.1 Evaluation criteria[4] | 9.2 Evaluation methods[5] | 9.3 Percentage in the final grade |
|---|---|---|---|
| 9.4. Course | Acquiring and understanding of the course content information | Exam | 50% |
| 9.5. Seminar/ laboratory | Fairness issues - learning and understanding of issues addressed in the seminar / laboratory | Assignments | 50% |
| 9.6 Minimum standard for passing | | | |
| ➢ Understanding of the concept and framework of Process Intensification<br>➢ Demonstrate knowledge and understanding of application of intensification techniques to a basic range of processes related to heat and mass transfer.<br>➢ In order to participate to the written exam each student should have submitted the assignments. | | | |

**10. SDG labels (Sustainable Development Goals)[6]**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | ○ Sustainable Development Generic Label | | | | | | | |
| 1 FĂRĂ SĂRĂCIE | 2 FOAMETE „ZERO" | 3 SĂNĂTATE ȘI BUNĂSTARE | 4 EDUCAȚIE DE CALITATE | 5 EGALITATE DE GEN | 6 APĂ CURATĂ ȘI SANITAȚIE | 7 ENERGIE CURATĂ ȘI LA PREȚURI ACCESIBILE | 8 MUNCĂ DECENTĂ ȘI CREȘTERE ECONOMICĂ | 9 INDUSTRIE, INOVAȚIE ȘI INFRASTRUCTURĂ |
| ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ◉ |
| 10 INEGALITĂȚI REDUSE | 11 ORAȘE ȘI COMUNITĂȚI DURABILE | 12 CONSUM ȘI PRODUCȚIE RESPONSABILE | 13 ACȚIUNE CLIMATICĂ | 14 VIAȚA ACVATICĂ | 15 VIAȚA TERESTRĂ | 16 PACE, JUSTIȚIE ȘI INSTITUȚII EFICIENTE | 17 PARTENERIATE PENTRU REALIZAREA OBIECTIVELOR | No label applies |
| ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

Date of entry:
7.04.2025

Signature of course coordinator

Conf. Dr. Ing. Letiția Petrescu

Signature of seminar coordinator

Conf. Dr. Ing. Letiția Petrescu

Date of approval in the department:
21.04.2026

Signature of the head of department

Prof. habil. dr. eng. Graziella L. Turdean

[4] The evaluation criteria must directly reflect the learning outcomes targeted at the level of the degree programme respectively at the level of the subject. More specifically, the learning outcomes set out in the expected learning outcomes are assessed.

[5] Both final evaluation methods and ongoing evaluation strategies should be established.

[6] Select a single label which, according to the *Implementation of SDG labels in the academic process*, best matches the subject. If the subject addresses sustainable development in a generic manner (i.e. by presenting/introducing the general framework of sustainable development, etc.), then the Sustainable Development generic label may be applied. If none of the labels describe the subject, select the last option: *"No label applies."*