SYLLABUS

1. Information regarding the programme

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 of study	Chemical engineering
1.5 Study cycle	Master
1.6 Study programme / Qualification	Advanced Chemical Process Engineering

2. Information regarding the discipline

2.1 Name of the discipline	**Process intensification – CME7323**						
2.2 Course coordinator	Lect. Dr. Ing. Letiția Petrescu						
2.3 Seminar coordinator	Lect. Dr. Ing. Letiția Petrescu						
2.4. Year of study	**I**	2.5 Semester	**II**	2.6. Type of evaluation	**E**	2.7 Type of discipline	**Ob**

3. Total estimated time (hours/semester of didactic activities)

3.1 Hours per week	3	Of which: 3.2 course	2	3.3 seminar/laboratory	1
3.4 Total hours in the curriculum	42	Of which: 3.5 course	28	3.6 seminar/laboratory	14
Time allotment:					hours
Learning using manual, course support, bibliography, course notes					40
Additional documentation (in libraries, on electronic platforms, field documentation)					15
Preparation for seminars/labs, homework, papers, portfolios and essays					40
Tutorship					10
Evaluations					3
Other activities:					

3.7 Total individual study hours	108
3.8 Total hours per semester	150
3.9 Number of ECTS credits	6

4. Prerequisites (if necessary)

4.1. curriculum	• Not applicable
4.2. competencies	• Not applicable

5. Conditions (if necessary)

5.1. for the course	• Regular attendance is encouraged and courses will be recorded. Classes will start on time, according to schedule. • 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. • You are responsible for obtaining the information presented in courses which are not common. • As a classrooms 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 (eg chat software) throughout the course. It is not allowed to use e-mail or web-browsing during class hours. • Any disruptive behaviour will be punished accordingly. • 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. • 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. • 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. • Exam Fraud is punishable by expulsion as mentioned in the University Charter. • 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. for the seminar /lab activities	• This seminar / lab is mandatory and will be recorded. • It is essential that students possess strong computer skills to use. • 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. • Presentation of seminar assignments and projects is mandatory. • 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. • 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. • 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. • Assignments and projects must be completed individually by each student.

6. Specific competencies acquired

Professional competencies	• Define notions, concepts, theories and models in chemistry and advanced chemical engineering process and their appropriate use in professional communication • Use extensive knowledge of chemistry and chemical engineering process for explanation and interpretation of chemical processes • Identify and apply the concepts, methods and advanced theories to solve new complex chemical process engineering • Critical analysis and use of principles, methods and advanced techniques for quantitative and qualitative evaluation of chemical engineering processes • Application of advanced concepts and theories of chemical process engineering for process drafting and problem solving • Use advanced concepts of analysis and process synthesis, machines and specific equipment of process engineering • Use in a creative manner expertise, methods and concepts for analysis and synthesis of new chemical processes • Use integrated analysis and synthesis of chemical processes to develop processes and to obtain innovative products • Application of modern means of evaluation of new systems performance and improvement of the decisional act in the synthesis of processes • Creative use of analysis and synthesis in developing product / technology innovation

Transversal competencies	• Independence in execution of complex professional duties and conduct independent research and design activities using computer-assisted techniques and respecting the rules of professional ethics and moral conduct • Planning, monitoring and taking professional duties of a professional group reports. Demonstrate the ability to coordinate the work, analytical thinking, adaptability and flexibility, collaboration with team members • Self-assessment of their professional performance and determining training needs, information and documentation in its constant activity and related fields, in line with labor market needs

7. Objectives of the discipline (outcome of the acquired competencies)

7.1 General objective of the discipline	• The course aims to communicate the principles of Process Intensification, whilst providing recommendations for process design and implementation, enabling students to apply these principles and recommendations to their PI processes/problems, and discuss specifications for the selection and operation of PI equipment from an independent standpoint.
7.2 Specific objective of the discipline	• To provide an understanding of the concept of Process Intensificatio • To provide knowledge and understanding of application of intensification techniques to a range of processes e.g. heat and mass transfer, separation processes • To provide an understanding of basic operating principles of a variety of intensified process equipment such as spinning disc reactor, rotary packed beds, oscillatory flow reactors, compact heat exchangers and micro-reactors etc. • To introduce the PI methodology and the 'tool kits' of laboratory and process plant knowledge specific for PI implementation. Students would see how problems can be solved with a range of different equipment types from the traditional to those which push the boundaries of mixing and heat transfer capabilities • To discuss cases of how PI has been applied and what was gained from the process are presented.

8. Content

8.1 Course	Teaching methods	Remarks
1. *Basic concepts, key words:* A bit of history, Process intensification (PI) definitions, PI benefits, PI tools, PI potential problems	Explanation, Conversation, Description, Problematization	
2. *Basic concepts, key words:* PI characteristics, Process-Intensifying Equipment, Process-Intensifying Methods	Explanation, Conversation, Description, Problematization	
3. *Basic concepts, key words:* Process System Engineering, Process Integration, Process Intensification (definition, comparison, scale, advantages, challenges, disadvantages)	Explanation, Conversation, Description, Problematization	
	Explanation,	

4. *Basic concepts, key words:* Microreactors	Conversation, Description, Problematization	
5. *Basic concepts, key words:* Modeling of microreactors (General aspects, Flow Distributions, Heat Transfer, Mass Transfer and Mixing, Hydrodynamic Dispersion, Chemical Kinetics, Reacting channel flows models, Heat-exchanger Reactors)	Explanation, Conversation, Description, Problematization	
6. *Basic concepts, key words:* Chemical Microprocess Engineering	Explanation, Conversation, Description, Problematization	
7. *Basic concepts, key words:* PI Using Operational Techniques, PI using intrusive methods	Explanation, Conversation, Description, Problematization	
8. *Basic concepts, key words:* PI using external forces, PI in process separation systems	Explanation, Conversation, Description, Problematization	
9. *Basic concepts, key words:* Reactive/reaction-separation systems, Membrane and Hybrid-Separation Systems, Process-Solvent Systems	Explanation, Conversation, Description, Problematization	
10. *Basic concepts, key words:* Equipment Summary-Finding your way in PI (Heat exchangers, Heat exchanger methods, Reactors, Separators, Columns, Centrifuges, Membranes, Electrically enhanced separations, Extraction, Mixers, Miscellaneous)	Explanation, Conversation, Description, Problematization	
11. *Basic concepts, key words:* Modeling and Simulation of Unsteady-state-operated trickle-flow Reactors (Influence factors on the trickle-bed reactor performance, Modeling of trickle-bed reactors, Dynamic trickle-bed reactor model, Advantages and drawbacks)	Explanation, Conversation, Description, Problematization	
12. *Basic concepts, key words:* Modeling of ultrasound reactors (Fundamentals of Ultrasonics, Bubble Behavior in Acoustic Fields, Equations for the Motion of the Bubble Wall, Modeling for the Motion of the Bubble Wall, Cavitation Thresholds, Transient bubbles, Ultrasound related properties, Sonochemical Effects, Discriminationof Sound Fields, Examples of Sound Fields in Ultrasound Reactors, Examples of Sound Fields in Ultrasound Reactors)	Explanation, Conversation, Description, Problematization	
13. *Basic concepts, key words:* Minimization of wastes from chemical processes through Process Intensification and Process Integration	Explanation, Conversation, Description, Problematization	
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)

8.2 Seminar / laboratory	Teaching methods	Remarks
1. *Basic concepts, key words:* Introduction in "CAD" and "Computational Fluid Dynamics", Specific software: Solid Edge, Gambit, Fluent – Part 1	Explanation, Conversation, Description, Problematization	
2. *Basic concepts, key words:* Introduction in "CAD" and "Computational Fluid Dynamics", Specific software: Solid Edge, Gambit, Fluent – Part 1	Explanation, Conversation, Description, Problematization	
3. *Basic concepts, key words:* Introduction in "CAD" and "Computational Fluid Dynamics", Specific software: Solid Edge, Gambit, Fluent – Part 2	Explanation, Conversation, Description, Problematization	
4. *Basic concepts, key words:* Introduction in "CAD" and "Computational Fluid Dynamics", Specific software: Solid Edge, Gambit, Fluent – Part 2	Explanation, Conversation, Description, Problematization	
5. *Basic concepts, key words:* Introduction in "Aspen"	Explanation, Conversation, Description, Problematization	
6. *Basic concepts, key words:* Introduction in "Aspen"	Explanation, Conversation, Description, Problematization	
7. *Basic concepts, key words:* Modeling and simulation of microreactors	Explanation, Conversation, Description, Problematization	
8. *Basic concepts, key words:* Modeling and simulation of microreactors	Conversation, Description, Problematization	
9. *Basic concepts, key words:* Modeling and simulation of unsteady state trickle bed reactors	Conversation, Description, Problematization	
10. *Basic concepts, key words:* Modeling and simulation of unsteady state trickle bed reactors	Conversation, Description, Problematization	
11. *Basic concepts, key words:* Modeling and simulation of membrane reactors	Conversation, Description, Problematization	

12. *Basic concepts, key words:* Modeling and simulation of membrane reactors	Conversation, Description, Problematization	
13. *Basic concepts, key words:* Modeling and simulation of ultrasound reactors	Conversation, Description, Problematization	
14. *Basic concepts, key words:* Modeling and simulation of ultrasound reactors	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)

9. Corroborating the content of the discipline with the expectations of the epistemic community, professional associations and representative employers within the field of the program

- Process Intensification deals with novel, radically different technologies which have the potential to revolutionise the way chemical plants are designed and operated. The ultimate aim of Process Intensification methods is to build a chemical plant small enough to sit on a desk-top with no loss of productivity. Using the concepts developed in this module, it will also be possible to design the process plants of the future, which will deliver improved product quality, be responsive to market needs and be able to create a sustainable environment.

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Share in the grade (%)
10.4 Course	Acquiring and understanding of the course content information	Examen	65%
		Attendance	5%
10.5 Seminar/lab activities	Fairness issues - learning and understanding of issues addressed in the seminar / laboratory	Assignments (3)	15%
	Quality of the prepared project	Project	15%
10.6 Minimum performance standards			
➢ Understanding of the concept and framework of Process Intensification ➢ Demonstrate knowledge and understanding of application of intensification techniques to a basic range of processes related to heat and mass transfer.			

Date	Signature of course coordinator	Signature of seminar coordinator
31.03.2015	.....	.....

Date of approval	Signature of the head of department
.....	.....