SYLLABUS

1. Information regarding the programme

1.1 Higher education institution	Universitatea Babes–Bolyai, Cluj–Napoca
1.2 Faculty	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	**Advanced Process Control – CME7322**						
2.2 Course coordinator	Prof.dr.ing.Paul Serban Agachi						
2.3 Seminar coordinator	Prof.dr.ing.Paul Serban Agachi						
2.4. Year of study	I	2.5 Semester	2	2.6. Type of evaluation	WE	2.7 Type of discipline	Compulsory

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)	28
Preparation for seminars/labs, homework, papers, portfolios and essays	28
Tutorship	3
Evaluations	3
Other activities:	6

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	• Basic Process control, Basic Chemical Egineering
4.2. competencies	• engineering

5. Conditions (if necessary)

5.1. for the course	• Presence at classes is part of the final notation
5.2. for the seminar /lab activities	• Minimum average allowed for entering the examination is 5 • All lab hours and seminar are compulsory

6. Specific competencies acquired

Professional competencies	• capacity of conceiving a control system dedicated to a specific process, capacity of conceiving and writing a mathematical model of high complexity dedicated to a certain specific process, capacity of choosing a an appropriate control solution based on the analysis of the process model, economic analysis of efficiency of the chosen control solution, capacity of operating a complex plant
Transversal competencies	• ability of systemic thinking, holistic thinking, critical thinking, argumentative, problem solving orientation, high level of computer skills, analysis of a process based on a mathematical model.

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

7.1 General objective of the discipline	• To make the student understand the behavior of a complex process based on a mathematical model and to implement a control scheme
7.2 Specific objective of the discipline	• To develop a control system adequate to a specific process

8. Content

8.1 Course	Teaching methods	Remarks
8.1.1. **Cascade control. Feedforward control. Examples.** Basic concepts, key words: controllability, cascade, disturbance, parameters' tuning, energy consumption saving.	Lecture Computer simulations Power point presentations Interactive exercises	
8.1.2. **Feedforward control, Ratio control , Inferential control. Examples.** *Basic concepts, key words*: Feedforward, ratio, inferential control, economic justification.	Lecture Computer simulations Power point presentations Interactive exercises	
8.1.3. **Automatic control of the main process parameters. Examples.** *Basic concepts, key words*: temperature control, pressure control, level control, flow control, concentration control.	Lecture Computer simulations Power point presentations Interactive exercises	
8.1.4. **Chemical reactors' control. Types of reactors. Thermal instability of the reactors. Temperature control for the thermally unstable and stable reactors. Examples.** *Basic concepts, key words*: reaction kinetics, reaction rate, conversion, equilibria, enthalpy, thermal instability, Continuous Stirred Tank Reactor, Plug Flow Reactor, Mass Transfer Reactor, Electrochemical Reactor.	Lecture Computer simulations Power point presentations Interactive exercises	

8.1.5. **Chemical reactors' control.** *Basic concepts, key words*: steady state mathematical model, continuous /batch stirred tank reactors, plug flow reactors, mass transfer reactors, electrochemical reactors, microreactors, control design scheme.	Lecture Computer simulations Power point presentations Interactive exercises	
8.1.6. **pH control. Control of the distillation/rectification processes.** *Basic concepts, key words*: pH, instability. Economic considerations of the distillation processes, high value product recovery, material and energy balances.	Lecture Computer simulations Power point presentations Interactive exercises	
8.1.7. **Control of the distillation/rectification processes.** *Basic concepts, key words*: Material and energy balances, control schemes, continuous/batch distillation.	Lecture Computer simulations Power point presentations Interactive exercises	
8.1.8. **Control of absorption/ desorption processes. Control of extraction processes.** *Basic concepts, key words*: Absorption/ desorption, mathematical model, exothermal processes, liquid- liquid extraction, solid-liquid extraction, separation interface.	Lecture Computer simulations Power point presentations Interactive exercises	
8.1.9 **Control of the evaporation processes. Control of the crystallization processes.** *Basic concepts, key words*: single and multiple effect evaporators, crystallization germs, crystallization kinetics, nucleation, mathematical model, control schemes.	Lecture Computer simulations Power point presentations Interactive exercises	
8.1.10. **Control of the drying process.** *Basic concepts, key words*: relaticve and absolute humidity, psychometric method, adiabatic drying.	Lecture Computer simulations Power point presentations Interactive exercises	
8.1.11. **Control of the cement manufacturing process.** *Basic concepts, key words*: clinker, grinding, mixing, burning, gas filtration, mathematical models.	Lecture Computer simulations Power point presentations Interactive exercises	
8.1.12. **Control of bioprocesses.** *Basic concepts, key words*: biochemical reactors, biomass, drying at low temperatures, mathematical model, sensitivity, control schemes.	Lecture Computer simulations Power point presentations Interactive exercises	
8.1.13. **Control of the thermally integrated processes. Steady state and the dynamics of the thermally integrated processes.** *Basic concepts, key words*: heat exchangers networks,	Lecture Computer simulations Power point presentations Interactive exercises	

pinch analysis, exergy, energy consumption.		
8.1.14. **Control of the thermally integrated processes.** *Basic concepts, key words*: controllability, instability, thermally integrated systems dynamics, economic analysis.	Lecture Computer simulations Power point presentations Interactive exercises	

Bibliography

1. Paul Serban Agachi – *Automatizarea Proceselor Chimice*, Ed. Casa Cărţii de Stiinţă, Cluj-Napoca, 1994.
2. F. Greg Shinskey - *Process Control Systems Application, Design and Tuning*, Ed. Mc.Graw Hill, New York, 1996.
3. William Luyben – *Plantwide dynamic simulators in chemical processing and control*, Ed. Marcel Dekker Inc., Basel, 2002.
4. P.S. Agachi, Z.K. Nagy, M.V. Cristea, A. Imre-Lucaci – *Model Based Control, Case studies in process engineering*, Ed. Wiley-VCH, Weinheim, 2006.
5. Gregory McMillan, Douglas Considine - *Process/ Industrial Instruments and Controls Handbook*, 5th Edition, Ed. Mc.Graw Hill, New York, 2000.
6. Stanley I. Sandler – *Chemical Engineering Thermodynamics*, Ed. John Wiley & Sons, 1998.
7. I Bâldea – *Cinetică chimică şi mecanisme de reacţie. Baze teoretice şi aplicaţii*, Presa Universitară Clujeană, Cluj-Napoca, 2002.
8. S.Agachi, M.Cristea, *Automatizarea proceselor chimice. Caiet de lucrari practice*, Universitatea "Babes-Bolyai" Cluj, 1996
9. F. Greg Shinskey – *Distillation control for productivity and energy conservation*, McGraw-Hill Book Company, 1984
10. Kai Sundmacher, A. Kienle, A.Seidel-Morgenstern, *Integrated Chemical Processes- Synthesis, Operation, Analysis and Control*, Wiley-VCH, 2005
11. Steven H. Strogatz, *Nonlinear Dynamics and Chaos –With Applications to Physics, Biology, Chemistry and Engineering*, Perseus Books, 1994
12. P. Serfelis, M.C. Georgiadis, *The Integration of Process Design and Control*, Elsevier, 2004
13. Mustafa Özilgen, *Food Process Modeling and Control-Chemica Engineering Applications*, Gordon and Breach Science Publishers, 1998
14. J. Ingham, I.J. Dunn, E. Heinzle, J.E. Prenosil, J. B. Snape, *Chemical Engineering Dynamics*, Wiley-VCH, 2007
15.P.S. Agachi – Process dynamics and Control, EOLSS UNESCO Encyclopaedia, Chapter Chemical Engineering, 2011

Nota: titles can be accessed at the Library of the Department of Chemical Engineering of the Faculty of Chemistry and Chemical Engineering, at the Central University Library "Lucian Blaga" and at the Library of the Technical University of Cluj

8.2 Seminar / laboratory	Teaching methods	Remarks
8.2.1. Cascade and ratio control. *Basic concepts, key words*: temperature cascade control, flow ratio control, parameters tuning.	Practical laboratory Seminar Interactive discussions	
8.2.2. Feed forward of a CSTR. *Basic concepts, key words*: disturbance, disturbance transducer, disturbance controller, stability.	Practical laboratory Seminar Interactive discussions	
8.2.3. Feedforward control of a distillation column.	Practical laboratory Seminar	

Basic concepts, key words: heat transfer, mass transfer, impulse transfer, feed disturbance, stability.	Interactive discussions	
8.2.4. Automatic control of a binary distillation column. *Basic concepts, key words*: mass, heat and impulse transfer, analytical mathematical model, fitting, dynamics and steady state, control schemes, control solutions.	Practical laboratory Seminar Interactive discussions	
8.2.5. Automatic control of a binary distillation column. *Basic concepts, key words*: mass, heat and impulse transfer, analytical mathematical model, fitting, dynamics and steady state, control schemes, control solutions..	Practical laboratory Seminar Interactive discussions	
8.2.6. Seminar mathematical models of a fermentaion bio-reactor. *Basic concepts, key words*: bioreactor, mass of reaction, bio-mass, reaction kinetics, analysers.	Practical laboratory Seminar Interactive discussions	
8.2.7. Control of the bio-reactor *Basic concepts, key words*: bioreactor, mass of reaction, bio-mass, reaction kinetics, analyzers, control schemes.	Practical laboratory Seminar Interactive discussions	

Bibliografy

1.S.Agachi, M.Cristea, Automatizarea proceselor chimice. Caiet de lucrari practice, Universitatea "Babes-Bolyai" Cluj, 1996
2.Paul Serban Agachi – Automatizarea Proceselor Chimice, Ed. Casa Car□ii de □tiin□ă, 1994
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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

- Curriculum was elaborated after consultancy with the PC groups from the universities in Iasi, Bucuresti, Ploiesti and Timisoara
- Process Engineering was introduced based on a WB program of Computer Aided Process Engineering (1998-2002)

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Share in the grade (%)
10.4 Course	Understanding of the processes discussed Specificity of the answers Holistic thinking and approach	Open source written examination	40
	Capacity of using different sources of information	Open source written examination	10
10.5 Seminar/lab activities	Understanding of the processes discussed Specificity of the answers Holistic thinking and approach	Practical examination at the site	40
	Capacity of using different sources of information	Practical examination at the site	10
10.6 Minimum performance standards			
➢ 5 is the minimum average accepted for both types of examination			

Date

15 mai 2014

Signature of course coordinator

Signature of seminar coordinator

Date of approval

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Signature of the head of department

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