SYLLABUS[1]

1. **Information about the Program**

1.1 Higher education institution	Politehnica University of Timişoara
1.2 Faculty[2] / Department[3]	Automation and Computers/ Computers
1.3 Chair	-
1.4 Domain of study	Computers and Information Technology
1.5 Study level	Bachelor
1.6 Study programme / Qualification	Computers / engineer

2. Information about the Course

2.1 Course			**System theory and automatization**				
2.2 Lecturer			Prof. dr. ing. Radu-Emil Precup				
2.3 Academic staff for seminars/labs			, Assist. lect. dr. ing. Mircea-Bogdan Rădac, Asist. lect. dr. ing. Claudia-Adina Dragoş				
2.4 Study year	2	2.5 Semester	1	2.6 Assessment type	D	2.7 Course type	Mandatory

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

3.1 Hours / week	4	of which:	3.2 lecture hours	2	3.3 seminar/lab hours	2
3.4 Total curriculum hours	121	of which:	3.5 lecture hours	28	3.6 seminar/lab hours	28
Time distribution						hours
Study using manuals, support materials, bibliography and notes						14
Supplementary documentation in library, speciality electronic platforms and on site						19
Supplementary preparation for seminars/labs, homeworks, reviews, portofolios and essays						14
Tutoring activities						7
Exams						3
Other						

3.7 Total - hours of individual study	65
3.8 Total - hours per semester	113
a. **Credits**	4

4. Prerequisites (if appropriate)

4.1 curriculum	• It is not the case
4.2 competencies	• Knowledge on algebra and mathematical analysis

5. Conditions (if appropriate)

5.1 for lectures	• Big classroom, Supporting devices: laptop, video projector, blackboard.
5.2 for seminars/labs	• Laboratory: classrooms with 10 + 10 computers, blackboard, laboratory equipment in the two laboratories of the teaching team with appropriate hardware and software (Matlab)

1 Formularul corespunde Fişei Disciplinei promovată prin OMECTS 5703/18.12.2011 (Anexa3);

2 Se înscrie numele facultăţii care gestionează programul de studiu căruia îi aparţine disciplina;

3 Se înscrie numele departamentului căruia i-a fost încredinţată susţinerea disciplinei şi de care aparţine titularul cursului;

6. Specific competencies acquired

Professional competencies[4]	• Operating with fundamentals of sciences, engineering, and computer science • Problem solving using the instruments of computer science and engineering • Improving the performance of hardware, software and communication system • Designing intelligent systems
Transversal competencies	• Honorable, responsible and ethical behavior, in the spirit of the law, ensuring the reputation of the profession • Demonstrating initiative and engaging in updating one's professional, economic and organizational knowledge

7. Objectives of the course (issued from the list of the comptenecies acquired)

7.1 Aim	• Gain a "hands-on" working knowledge of several of the main techniques in system theory and control systems and an introduction to some promising directions in their multi-disciplinary, technical and scientific use
7.2 Specific objectives	• The study of the fundamental problems of system theory with focus on continuous-time and discrete-time dynamical systems • Gaining an understanding of the functional operation of a variety of techniques specific to automation with focus on process control • The study of the theoretic foundations of control systems, (4) learning analytical approaches to analyze and study systems properties • Gaining experience in the design and implementation of control systems

8. Content

8.1 Lecture	Hours	Instruction methods
1. Description and general properties of systems 1.1. Physical systems. Mathematical models. Dynamical systems 1.2. Classifications of physical and dynamical systems 1.3. Input-output models 1.4. Graphical modeling by block diagrams 1.5 Introduction to process control	2	Lecture giving, conversation, explanation, exemplification, proof. The lecture material is presented by means of slides, and the students benefit from the electronic form of the lecture support (slides).
2. Mathematical modeling. System identification. Linearization of nonlinear models 2.1. Basics on models. 2.2. Process identification 2.3. Continuous-time linear and nonlinear models. Linearization of nonlinear models	2	
3. Control system structures 3.1. Continuous-time control system structures 3.2. Discrete-time control system structures. Aspects concerning the discrete-time models of continuous-time systems	1	
4. Transfer function-based characterization of linear time-invariant systems 4.1. Laplace transform 4.2. Z-transform 4.3. Typical deterministic input signals and sequences 4.4. Initial conditions. Specific regimes. Analytical computation of system responses 4.5. Transfer functions and transfer function matrices 4.6. Relation between state-space models and input-output models 4.7. Relation between input-output models and state-space models. State-space realizations of transfer functions. Equivalent state-space realizations 4.8. Special expression of discrete-time models	2	
5. Discrete-time models of continuous-time processes 5.1. Zero-order hold 5.2. Computation of discrete transfer functions	2	

[4] Aspectul competenţelor profesionale va fi tratat cf. Metodologiei OMECTS 5703/18.12.2011. Se vor prelua competenţele care sunt precizate în Registrul Naţional al Calificărilor din Învăţământul Superior RNCIS (http://www.rncis.ro/portal/page?_pageid=117,70218&_dad=portal&_schema=PORTAL) pentru domeniul de studiu de la pct. 1.4 şi programul de studii de la pct. 1.6 din această fişă.

5.3. Computation of discrete state-space models 5.4. Computation of discrete-time models by numerical integration of differential equations		
6. Frequency domain analysis 6.1. Frequency response of continuous-time systems 6.2. Analytical computation and graphical representation of frequency response functions 6.3. Hints for the experimental computation of frequency response plots	2	
7. Subsystems and connections. Transfer elements 7.1. Connections of (sub)systems 7.2. Technical aspects concerning the connection of physical systems 7.3. Detailed structure and transfer functions of control loops. Categories of control loops 7.4. Continuous-time system benchmarks 7.5. Discrete-time system benchmarks 7.6. Block diagram-based system analysis. 7.7. Derivation of state-space models for complex systems on the basis of block diagrams	2	
8. System stability 8.1. Concept of stability 8.2. Basic definitions for stability of continuous-time linear systems 8.3. Criteria for stability analysis of continuous-time linear systems 8.4. Basic definitions for stability of discrete-time linear systems 8.5. Criteria for stability analysis of discrete-time linear systems 8.6. Aspects concerning the stability analysis of control loops with continuous-time processes and discrete-time controllers	3	
9. Control system structures and design 9.1. Control system structures 9.2. Problem setting in control system design	2	
10. Control algorithms 10.1. Typical continuous-time control algorithms. Quasi-continuous discrete-time implementations 10.2. Guidelines to use typical control algorithms 10.3. Additional functions in structures of typical control algorithms	3	
11. Steady-state system analysis. Performance indices 11.1. Operating regimes of control systems 11.2. Computation of steady-state values of control systems 11.3. Effects of controller types on steady-state behavior of control systems 11.4. Artificial static coefficients and output coupled systems 11.5. Performance indices for control systems design	3	
12. Design methods for control systems 12.1. Frequency domain design 12.2. Modulus Optimum method and Symmetrical Optimum method 12.3. Experiment-based tuning of controllers 12.4. Controller design for time delay systems	4	

References

1. K. J. Åstrőm, R. M. Murray, *Feedback Systems: An Introduction for Scientists and Engineers*, Princeton University Press, Princeton, NJ, 2008
2. R. C. Dorf, R. H. Bishop, *Modern Control Systems, 11th edition*, Prentice-Hall, Upper Saddle River, NJ, 2008
3. S. H. Żak, *Systems and Control*, Oxford University Press, New York, NY, 2003
4. R.-E. Precup, S. Kovács, S. Preitl, E. M. Petriu, Editors, *Applied Computational Intelligence in Engineering and Information Technology*, Topics in Intelligent Engineering and Informatics, vol. 1, Springer-Verlag, Berlin, Heidelberg, New York, 2012

8.2 Seminar/lab	Hours	Instruction methods
1. Laboratory 1. Mathematical modeling of systems. Examples of mathematical models of controlled processes	3	Laboratory: presentation, conversation, explanation, exemplification, case studies, simulations, experiments. The students apply the theoretical aspects taught during the lectures by means of several sets of computations, digital
2. Laboratory 2 Steady-state analysis of control systems	2	
3. Laboratory 3. Algebraic stability analysis of control systems	2	
4. Laboratory 4. Matlab and Simulink basics. Modeling and simulation of systems. Connections of systems	8	
5. Laboratory 5. Frequency domain analysis and design of control systems	5	
6. Laboratory 6. Empirical performance indices. Sampling period	2	

effects on the behavior of control systems with digital controllers		simulations and experiments. The students solve case studies and problems that apply and assist in the process of gaining an understanding of the theoretical aspects taught during the lectures,
7. Laboratory 7. Control system design for a laboratory application	6	

References

1. K. J. Åstrőm, R. M. Murray, *Feedback Systems: An Introduction for Scientists and Engineers*, Princeton University Press, Princeton, NJ, 2008
2. R. C. Dorf, R. H. Bishop, *Modern Control Systems, 11th edition*, Prentice-Hall, Upper Saddle River, NJ, 2008
3. S. H. Żak, *Systems and Control*, Oxford University Press, New York, NY, 2003
4. R.-E. Precup, S. Kovács, S. Preitl, E. M. Petriu, Editors, *Applied Computational Intelligence in Engineering and Information Technology*, Topics in Intelligent Engineering and Informatics, vol. 1, Springer-Verlag, Berlin, Heidelberg, New York, 2012

9. Correlation between the course content and the requirements of the specialists in the field and the expectations of the main employers

- The systems, automation and control knowledge are important for many courses in the field
- The majority of companies in the domain require not only computers knowledge but also modeling, control, simulation and automation knowledge

10. Assessment

Activity type	10.1 Assessment criteria	10.2 Assessment methods	10.3 Weight in final mark
10.4 Lecture	Solving the theoretical part (two subjects, one hour) and the application one (one subject, two hours)	Written exam	66 %
10.5 Seminar /labs	Solving the problems and homeworks given at lectures and laboratories	Presentation of the reports with problems and homeworks, questions answering	34 %
10.6 Minimal performance standards (minimal specific knowledge required for passing the exam, the means to assess mastering the specific knowledge)			
• Passing both final assessment and laboratory efforts with the minimum grade 5 • Showing experience in Matlab and Simulink • The understanding, manipulation and application of the basic concepts in system theory and process control			

11. **International compatibility**

- California Institute of Technology, Pasadena, CA, USA http://www.cds.caltech.edu/~macmardg/wiki/index.php?title=CDS_101/110a,_Fall_2012
- Lund University, Sweden http://www.control.lth.se/Education/engineering-program/FRT010_ED.html
- University of Newcastle, Australia http://www.newcastle.edu.au/course/ELEC4400.html
- Otto von Guericke University of Magdeburg, Germany http://ifatwww.et.uni-magdeburg.de/syst/education/courses/isth/index.shtml

Date	Signature of the course instructor	Signatures of the academic staff for seminars/labs
09.10.2013	Prof. dr. Ing. Radu-Emil PRECUP ……	Assist. lect. dr. ing. Mircea-Bogdan RĂDAC, Asist. lect. dr. ing. Claudia-Adina DRAGOŞ ……

Date of approval in the Department

Signature of the Department Director

Prof. dr. Ing. Vladimir Ioan CREŢU

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