SYLLABUS[1]

1. Information about the program

1.1 Higher education institution	Politehnica University of Timisoara
1.2 Faculty[2] / Department[3]	Automation and Computers / Automation and Applied Informatics
1.3 Chair	—
1.4 Field of study (name/code[4])	Systems Engineering / 60
1.5 Study cycle	Masters
1.6 Study program (name/code/qualification)	Automatic Systems Engineering / 20

2. Information about the discipline

2.1 Name of discipline			Intelligent Control Systems				
2.2 Coordinator (holder) of course activities			Prof.dr.ing. Radu-Emil Precup				
2.3 Coordinator (holder) of applied activities [5]			Lect.dr.ing. Mircea-Bogdan Rădac				
2.4 Year of study[6]	I	**2.5** Semester	2	**2.6** Type of evaluation	E	**2.7** Type of discipline	Compulsory

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

3.1 No. of hrs. / week	3.5 , of which:	**3.2** course	2	**3.3** seminar/laboratory/ project/training	1.5
3.4 Total no. of hrs. in the education curricula	49 , of which:	**3.5** course	28	**3.6** applied activities	21
3.7 Distribution of time for individual activities related to the discipline					hrs.
Study using a manual, course materials, bibliography and lecture notes					14
Additional documentation in the library, on specialized electronic platforms and on the field					14
Preparation for seminars / laboratories, homeworks, assignments, portfolios, and essays					14
Tutoring					14
Examinations					5
Other activities					
Total hrs. of individual activities					61

3.8 Total hrs. / semester[7]	110
3.9 No. of credits	7

4. Prerequisites (where applicable)

4.1 Curriculum	• It is not the case.
4.2 Competencies	• Knowledge on basic mathematics.

5. Conditions (where applicable)

[1] The form corresponds to the Syllabus promoted by OMECTS 5703/18.12.2011 (Annex3).
[2] The name of the faculty which manages the educational curriculum to which the discipline belongs.
[3] The name of the department entrusted with the discipline, and to which the course coordinator / holder belongs.
[4] Fill in the code provided in GD no. 493/17.07.2013.
[5] The applied activities refer to: seminar (S) / laboratory (L) / project (P) / practice/training (Pr).
[6] The year of study to which the discipline is provided in the curriculum.
[7] It is obtained by summing up the number of hrs. from 3.4 and 3.7.

5.1 of the course	• Low-medium size classroom, support materials: laptop, overhead projector, blackboard.
5.2 to conduct practical activities	• Laboratory with 15-20 computers, Matlab & Simulink, black board, control equipment.

6. Specific competencies acquired

Professional competencies[8]	• Apply knowledge in mathematics, physics, measurement, technical drawing, mechanical engineering, chemistry, electronics and power electronics in systems engineering. • Using fundamental knowledge in automation, modeling, simulation, identification and process analysis, computer-aided design. • Development of applications and implementation of automatic control structures using project management principles, programming environments, microcontroller based environments, signal processing, programmable logic controllers, embedded systems.
Transversal competencies	• Apply (in legal context) intellectual property rights (including through technological transfer), certification methodology and principles, norms and values of professional ethics insider rigorous working strategies, efficiency and responsibility. • Identification of roles and responsibilities inside multi-specialized teams, decision making and work assessment, based on efficient team working techniques. • Identification of continuous advancement, efficient exploitation of resources and learning techniques for self development.

7. Objectives of the discipline (based on the grid of specific competencies acquired)

7.1 General objective of the discipline	• Gaining a "hands-on" working knowledge of several of the main techniques in intelligent control systems and an introduction to some promising research directions in intelligent control systems.
7.2 Specific objectives	• The study of dynamical properties of intelligent control systems. • Gaining an understanding of the functional operation of a variety of techniques specific to intelligent control systems. • The study of their control-theoretic foundations. • Learning analytical approaches to study properties. • Gaining experience in computer-aided design of intelligent control systems. • Acquiring competence and knowledge in the development of hardware and software applications for intelligent control systems using actual informatics technologies.

8. Content

8.1 Course	No. of hours	Teaching methods
Introduction to Soft Computing: Soft computing constituents and conventional artificial intelligence; Neuro-fuzzy and soft computing characteristics; Soft computing in intelligent systems and intelligent control systems.	2	Lecture supported by ppt presentation, conversation, explanation, exemplification.
Fuzzy Sets and Fuzzy Information Processing: Basic definitions and terminology; Set-theoretic operators; Membership function formulation and parameterization; Fuzzy inference mechanisms and	4	Lecture supported by ppt presentation, conversation,

[8] The professional competencies and the transversal competencies will be treated according to the Methodology of OMECTS 5703/18.12.2011. The competencies listed in the National Register of Qualifications in Higher Education [Registrul Naţional al Calificărilor din Învăţământul Superior RNCIS] (http://www.rncis.ro/portal/page?_pageid=117,70218&_dad=portal&_schema=PORTAL) will be used for the field of study from 1.4 and the program of study from 1.6 of this form, involving the discipline.

rule bases; Defuzzification.		explanation, exemplification.
Structures of Fuzzy Control Systems and Fuzzy Inference Systems: Mamdani fuzzy controllers; Takagi-Sugeno fuzzy controllers; Mathematical characterizations; Measures to modify the input-output maps of fuzzy controllers.	4	Lecture supported by ppt presentation, conversation, explanation, exemplification.
Typical and Special Fuzzy Controllers: Fuzzy controllers without and with dynamics; Mamdani fuzzy controllers; Takagi-Sugeno fuzzy controllers; Tsukamoto fuzzy models; Classes of PD-, PI- and PID-fuzzy controllers; Design methods dedicated to fuzzy controllers; Stability and sensitivity analysis of fuzzy control systems; Applications.	4	Lecture supported by ppt presentation, conversation, explanation, exemplification.
Basics of Neural Networks. Architectures: Dynamics; Learning and adaptation; Training neural networks and fuzzy systems with least squares and gradient methods; Hybrid learning rules; Supervised and unsupervised learning neural networks.	4	Lecture supported by ppt presentation, conversation, explanation, exemplification.
Neuro-fuzzy Systems: Adaptive hybrid neuro-fuzzy control systems; Adaptive neuro-fuzzy inference systems; ANFIS as universal approximator; Data clustering algorithms; Applications.	4	Lecture supported by ppt presentation, conversation, explanation, exemplification.
Nature-inspired Optimization and Applications to Control and Modeling: Genetic algorithms; Simulated annealing; Random search; Downhill Simplex search; Particle Swarm Optimization; Gravitational Search Algorithms; Charged System Search algorithms; Optimal tuning of parameters of controllers; Optimal tuning of parameters of models; Applications.	6	Lecture supported by ppt presentation, conversation, explanation, exemplification.

Bibliography[9] 1. R.-E. Precup, St. Preitl, Fuzzy Controllers, Editura Orizonturi Universitare, Timisoara, 1999.

2. J.-S. R. Jang, C.-T. Sun, E. Mizutani, Neuro-Fuzzy and Soft Computing. A Computational Approach to Learning and Machine Intelligence, Prentice Hall, Upper Saddle River, NJ, 1997.

3. 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.

4. R.-C. David, Contributions to Modeling and Optimization of Fuzzy Control Systems, Editura Politehnica, Timisoara, 2015.

5. St. Preitl, R.-E. Precup, Editors Design Techniques for Automatic Control Structures. Applications (in Romanian: Tehnici de proiectare a structurilor de reglare automata. Aplicatii), Editura Orizonturi Universitare, Timisoara, 2008.

[9] At least one title must belong to the department staff teaching the discipline, and at least 3 titles must refer to national and international works relevant for the discipline, and which can be found in the Politehnica University Library.

6. St. Preitl, R.-E. Precup, Editors, Controllers for Servo Systems: Design Methods (in Romanian: Regulatoare pentru servosisteme: metode de proiectare), Editura Orizonturi Universitare, Timisoara, 2007.

8.2 Applied activities[10]	No. of hours	Teaching methods
Seminar: Development of a fuzzy control system application.	2	Presentation of theme, discussion, questions, computer-aided solving of problems, program coding.
Seminar: Development of a neural control system application.	1	Presentation of theme, discussion, questions, computer-aided solving of problems, program coding.
Seminar: Development of a neuro-fuzzy control system application.	2	Presentation of theme, discussion, questions, computer-aided solving of problems, program coding.
Seminar: Development of a nature-inspired optimization modeling and control application.	2	Presentation of theme, discussion, questions, computer-aided solving of problems, program coding.
Project: The development of several intelligent control systems for specific applications. Tasks: - problem setting – 2 hours; - analysis of control system structures – 2 hours; - design and tuning – 4 hours; - implementation of control system structures – 4 hours; - analysis of the effect of several structures and parameters on the control system performance indices – 2 hours. The students have to review one recent paper (from the current year or from the last year) that deals with theory / applications in the field of Intelligent Control Systems, chosen by the students themselves from a well-acknowledged journal, and to make an approx. 15-minute presentation using Power Point in MS Office 2003 with the equations edited making use of Microsoft Equation Editor 3.0. The students carry out the tasks given above, and they can also use other sources of information (texts or papers) to provide for an appropriate background for the points of the chosen paper.	14	Presentation of theme, discussion, questions, computer-aided solving of problems, program coding.

[10] The types of applied activities are those specified in footnote 5. If the discipline contains several types of applied activities, then these will be written consecutively in the lines of the table below. The type of activity will be written in a distinct line, as „Seminar:", „Laboratory:", „Project:" and/or „Practice/Training:".

Bibliography [11]

1. R.-E. Precup, St. Preitl, Fuzzy Controllers, Editura Orizonturi Universitare, Timisoara, 1999.

2. J.-S. R. Jang, C.-T. Sun, E. Mizutani, Neuro-Fuzzy and Soft Computing. A Computational Approach to Learning and Machine Intelligence, Prentice Hall, Upper Saddle River, NJ, 1997.

3. 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.

4. R.-C. David, Contributions to Modeling and Optimization of Fuzzy Control Systems, Editura Politehnica, Timisoara, 2015.

5. St. Preitl, R.-E. Precup, Editors Design Techniques for Automatic Control Structures. Applications (in Romanian: Tehnici de proiectare a structurilor de reglare automata. Aplicatii), Editura Orizonturi Universitare, Timisoara, 2008.

6. St. Preitl, R.-E. Precup, Editors, Controllers for Servo Systems: Design Methods (in Romanian: Regulatoare pentru servosisteme: metode de proiectare), Editura Orizonturi Universitare, Timisoara, 2007.

9. Corroboration of the content of the discipline with the expectations of the main representatives of the epistemic community, professional associations and employers in the field afferent to the program

- Knowledge on intelligent control, modeling and optimization is important for many jobs related to automation, software and hardware and also supports other courses in these fields.
- Control systems are present in all systems applications.
- The majority of companies require knowledge on both automation and informatics and on the computer-aided analysis and design of control systems.

10. Evaluation

Type of activity	**10.1** Evaluation criteria	**10.2** Evaluation methods	**10.3** Share of the final grade
10.4 Course	Two questions at the final oral assessment, the students have access to the graphics material taught during the course.	Oral examination.	34 %
10.5 Applied activities	**S:** Solving the tasks specific to the seminars.	Presentation of tasks solved, programs and results obtained in the seminars, answers to questions.	33 %
	L:		
	P: Solving the tasks specific to the project.	Oral examination on the basis of the ppt presentation.	33 %
	Pr:		

10.6 Minimum performance standard (minimum amount of knowledge necessary to pass the discipline and the way in which this knowledge is verified)

- Passing both course efforts and final assessment.
- Mastering the operation with Matlab & Simulink.
- Application of control, modeling and optimization algorithms.

Date of completion **Course coordinator** **Coordinator of applied activities**

[11] At least one title must belong to the staff teaching the discipline.

	(signature)	**(signature)**
07.12.2015		
	.....	.....
Head of Department	**Date of approval in the Faculty Council**[12]	**Dean**
(signature)		**(signature)**
.....		.....

[12] Avizarea este precedată de discutarea punctului de vedere al board-ului de care aparţine programul de studiu cu privire la fişa disciplinei.