COURSE SYLLABUS AND COURSE REQUIREMENTS
ACADEMIC YEAR ... SEMESTER ...

Course title	*INTELLIGENT CONTROL SYSTEMS*
Course Code	*IVM194ANMI*
Hours/Week: le/pr/lab	2/0/2
Credits	6
Degree Programme	Computer Science Engineering MSc
Study Mode	
Requirements	*Exam (with grade)*
Teaching Period	2022/2023 1.
Prerequisites	-
Department(s)	*Department of Technical Informatics*
Course Director	Dr Ildikó JANCSKÁRNÉ ANWEILER, associate professor
Teaching Staff	

COURSE DESCRIPTION

A short description of the course (max. 10 sentences).
Neptun: Instruction/Subjects/Subject Details/Basic data/Subject description

This course presents some fundamental knowledge of classic and modern control systems, focusing on intelligent control algorithms: Introduction to control engineering. Basics of classical control theory, I/O models, system responses, stability, PID control. Control performance meters. Introduction to fuzzy sets: The uncertain and inexact nature of the real world: ideas and examples; fuzzy membership functions. Basic concept and properties of fuzzy logic. Introduction to fuzzy inference: Fuzzy inference principles; fuzzy decision making; approximate reasoning. Introduction to fuzzy rule base: If-Then rules; general format of fuzzy rule base; establishment of fuzzy rule base. Introduction to fuzzy control systems: Basic fuzzy control principle: example of set-point tracking; open-loop and closed-loop fuzzy control systems; fuzzy PID controller design.

SYLLABUS

Neptun: Instruction/Subjects/Subject Details/Syllabus

1. GOALS AND OBJECTIVES

Goals, student learning outcome.
Neptun: Instruction/Subjects/Subject Details/Syllabus/Goal of Instruction

This course presents some fundamental knowledge of classic and modern control systems, focusing on intelligent control algorithms. Upon completion of this course the student should be:

- able to understand basic knowledge of control systems
- able to understand basic knowledge of open and closed loop control systems
- able to understand classical PID control algorithms
- able to apply basic knowledge of fuzzy information representation and processing
- able to apply basic fuzzy inference and approximate reasoning
- able to understand the basic notion of fuzzy rule base
- able to apply basic fuzzy PID control systems.

2. COURSE CONTENT

Neptun: Instruction/Subjects/Subject Details/Syllabus/Subject content

		TOPICS
LECTURE	1.	Introduction to control principles. Open loop, closed loop control examples. elements of the control loops. Graphical representation of control loops: P&ID diagrams, Block diagrams.
	2.	Properties and descriptions of SISO systems. Steady state & transient responses. Stability of I/O systems. First order and second order systems, dead time.
	3.	Higher order system model reduction to FOPTD.
	4.	Closed loop control: on/off controller and control performance.
	5.	Closed loop control II: continuous control; control performance meters.

	6.	PID controller. Saturation of the final control element.
	7.	Properties of :P-controller, I-controller, PI-controller, PID-controller.
	8.	Tuning of PID-controller in time domain: open-loop methods and closed-loop methods.
	9.	Cascade control, Feedforward and feedback control. Model-based controls.
	10.	Fuzzy sets and fuzzy logic.
	11.	Fuzzy control: introduction. Rule-based systems.
	12.	Fuzzy control examples, IF…THEN rules, fuzzification, activity factor of rules.
	13.	Fuzzy controller outputs, defuzzification methods.
	14.	From digital PI control to fuzzy PI control.
	15.	DC motor fuzzy control.
	16.	LabVIEW fuzzy system designer.
PRACTICE	1.	Drawing P&ID diagrams and block diagrams.
	2.	Approximation FOPDT model parameters of three tank step response.
	3.	Drawing a Control Loop demo program in LabVIEW: 1. simulation a FOPDT controlled process.
	4.	Drawing a Control Loop demo program in LabVIEW: 1. writing on/off control algorithm. Testing the control loop. (Step reference change.)
	5.	Modell system PID control: writing PID control algorithm.
	6.	Testing the control loop. (Step reference change.) Performance comparison.
	7.	Fuzzy set manipulation
	8.	Fuzzy controller design
	9.	Fuzzy controller design in LabVIEW and performance testing.
	10.	Presentation of a scientific paper
	11.	Presentation of a Labview control demo program

DETAILED SYLLABUS AND COURSE SCHEDULE

LECTURE

week	**Topic**	**Compulsory reading; [1] page number (from … to …)**	**Required tasks (assignments, tests, etc.)**	**Completion date, due date**
1.	Introduction to the course.	1 – 30. suggested reading for Quiz 1:[2]		
2.	Introduction to control principles. Open loop, closed loop control examples. Graphical representation of control loops: P&ID diagrams, Block diagrams: elements of the control loops.	[1] 1 – 42. and [3]	Quiz 1	Upload into moodle until end of week 3.
3.	Properties of SISO systems. Steady state & transient responses; first order second order systems, dead time. Higher order system model reduction to FOPTD. Integral type transfer characteristic. PID controller.	[1] 43 – 62. [4] Ch.14-3 PROCESS DYNAMICS		
4.	Closed loop control: on/off controller and control performance. continuous control. Saturation of the final control element.	146 – 150.		
5.	Properties of: P-controller, I-controller, PI-controller, PID-controller.	155 – 196. [4] Ch.15-3 DISCRETE-MODE CONTROLLERS		
6.	Tuning of PID-controller in time domain: open-loop methods and closed-loop methods. Model-based control. Cascade control, feedforward - feedback control. Model-based controls.	[1] 197 – 223. 224 – 236. [4] Ch.15 Process Controllers and Loop Tuning 15-11 Advanced Control Systems	Quiz 2.	

7.	Fuzzy sets and fuzzy logic. Rule-based systems.	238 – 242 [4] Ch.17 Fuzzy Logic		
8.	Fuzzy control: introduction.Fuzzy control examples. Fuzzy controller development. DC motor fuzzy control. IF…THEN rules, fuzzification, activity factor of rules. From digital PI control to fuzzy PI controller.	[1] 242 – 247. [5]		
9.	-	-		
10.	Fuzzy controller outputs, defuzzification methods	248 – 263.	Quiz 3.	
11.	Fuzzy PI-controller development and testing.	[1] 264 – 276.		
12.	LabVIEW fuzzy system designer.	[6] all		
13.	Missing task replacement			

PRACTICE, LABORATORY PRACTICE

week	**Topic**	**Practice description file in Moodle**	**Required tasks (assignments, tests, etc.)**	**Completion date, due date**
1.	-			
2.	Control loop examples. Drawing P&ID diagrams and block diagrams.			
3.	Approximation FOPDT model parameters of three tank step response.	Practice_1.pdf	Report.	end of next week
4.	Explaining a Control Loop demo program in LabVIEW: simulation of a FOPDT process and on/off controller. Modell system on/off control: writing on/off control algorithm. Testing the control loop. (Step reference change.)	Practice_2….pdf	Program and report.	Upload into moodle: one week after practice.
5.	Complete the Control Loop demo program in LabVIEW: writing a PID control algorithm.	Practice_3….pdf		
6.	Testing the control loop. (Performances of Step reference change.) Controller parameters by 1.Lambda-tuning method 2. Z-N method 3. loopshaping method.		Program and report.	one week after practice
7.	Tuning & Testing cascade control loop.	Practice_4_cascade.pdf	Report.	
8.	Fuzzy set manipulation	Pr_5_fuzzy_sets_practice_1.docx	Fulfilled practice report.	
9.				
10.	Fuzzy controller design example: DC motor fuzzy control. .	Practice_6.pdf		one week after practice
11.	Fuzzy controller output calculation.		Fulfilled practice report.	
12.	Fuzzy controller design in LabVIEW and performance testing.	Practice_7_fuzzy controller development_FOPDT.docx	.fs file and report.	one week after practice
13.	Missing task replacement			

3. ASSESSMENT AND EVALUATION

(Neptun: Instruction/Subjects/Subject Details/Syllabus/Examination and Evaluation System)

ATTENDANCE

In accordance with the Code of Studies and Examinations of the University of Pécs, Article 45 (2) and Annex 9. (Article 3) a student may be refused a grade or qualification in the given full-time course if the number of class absences exceeds 30% of the contact hours stipulated in the course description.

Attending is required all classes. Unexcused absences will adversely affect the grade, and in case of absence from more than 30% of the total number of lesson will be grounds for failing the class. In the case of an illness or family emergency, the student must present a valid excuse, such as a doctor's note.

Method for monitoring attendance *(e.g.: attendance sheet / online test/ register, etc.)*

Attendance sheet

ASSESSMENT

Each student is expected to do quizzes, homework assignments and submit the project reports.

Course-unit with final examination

Mid-term assessments, performance evaluation and their weighting as a pre-requisite for taking the final exam

TYPE	ASSESSMENT, POINT	*WEIGHTING AS A PROPORTION OF THE PRE-REQUISITE FOR TAKING THE EXAM*
1. *QUIZ 1 P&ID*	*20*	
2. *QUIZ 2 PID CNTR.*	*20*	
3. *QUIZ 3 FUZZY CNTR.*	*20*	
4. *PRACTICE 1 FOPDT APPROX.*	*10*	
5. *PRACTICE 2 ON/OFF CNTR.*	*20*	
6. *PRACTICE 3 PI CNTR.*	*30*	
7. *PRACTICE 4. CASCADE CONTROL*	*20*	
8. *PRACTICE 5 FUZZY SETS*	*10*	
9. *PRACTICE 6 FUZZY SYSTEM*	*10*	
10. *PRACTICE 7 FUZZY CNTR. PRGR.*	*40*	
11. *SUM OF MID-TERM ASSESSMENTS*	*200*	*100%*

Requirements for the end-of-semester signature

(Eg.: mid-term assessment of 40%)

Mid-term assessment of 40%.

Re-takes for the end-of-semester signature (PTE TVSz 50§(2))

The specific regulations for grade betterment and re-take must be read and applied according to the general Code of Studies and Examinations. E.g.: all the tests and the records to be submitted can be repeated/improved each at least once every semester, and the tests and home assignments can be repeated/improved at least once in the first two weeks of the examination period.

The tests and home assignments can be repeated/improved once in the study period and the first two weeks of the examination period.

Type of examination *(written, oral): written.* Offered exam grade can be obtained, calculated from the sum of the results of all mid-term assessments.

Otherwise the exam is successful if the result is minimum 40%.

Calculation of the grade *(TVSz 47§ (3))*

Offered exam grade can be obtained, calculated from the mid-term assessments.

Calculation of the final grade based on aggregate performance in percentage.

Course grade	Performance in %
excellent (5)	85 % …
good (4)	70 % ... 85 %
satisfactory (3)	55 % ... 70 %
pass (2)	40 % ... 55 %
fail (1)	below 40 %

The lower limit given at each grade belongs to that grade.

4. SPECIFIED LITERATURE

In order of relevance. (In Neptun ES: Instruction/Subject/Subject details/Syllabus/Literature)

COMPULSORY READING, AVAILABILITY IN (NEPTUN MS)

[1] Intelligent Control Systems_Jancskarne_2020.pdf
[2] R. C. Dorf, R. H. Bishop, Modern control systems, 12.ed. Prentice Hall, 2011.
[3] Process Control Fundamentals P ID.pdf
[4] Jan Jantzen: Tutorial On Fuzzy Logic: Jantsen - Tutorial On Fuzzy Logic.pdf
[5] L. A. Bryan, E. A. Bryan, PROGRAMMABLE CONTROLLERS, THEORY AND IMPLEMENTATION, An Industrial Text Company Publication, Atlanta • Georgia • USA, 1997, ISBN 0-944107-32-X
[6] LabVIEWfuzy toolbook.pdf

RECOMMENDED LITERATURE AND AVAILABILITY

[7] Nise: Control system engineering. Wiley, 2011
[8] Timothy J. Ross: Fuzzy Logic with Engineering Applications, Wiley, 2010. ISBN-13: 978-0470743768
[9] Kevin M. Passino and Stephen Yurkovich, Fuzzy Control, Addison Wesley Longman, Menlo Park, CA, 1998 (later published by Prentice-Hall). http://eewww.eng.ohio-state.edu/~passino/FCbook.pdf
[10] Standard Isa - Instrumentation Symbols And Identification.pdf
[11] E.A. Parr, Programmable Controllers, An engineer's guide, Newnes, 2003, ISBN 0 7506 5757 X
[12] Kevin M. Passino and Stephen Yurkovich, Fuzzy Control, Addison Wesley Longman, Menlo Park, CA, 1998 (later published by Prentice-Hall).

Additional papers for reading will be uploaded into Neptun MS by the instructor.