Faculty of Electrical Engineering / AUTOMATICS AND INDUSTRIAL ELECTROTECHNICS / Optimal control

Course:	Optimal control			
Course ID	**Course status**	**Semester**	**ECTS credits**	**Lessons** (Lessons+Exercises+Laboratory)
12787	Mandatory	2	5	3+1+0
Programs	AUTOMATICS AND INDUSTRIAL ELECTROTECHNICS			
Prerequisites	None			
Aims	The objectives of the course are to familiarize students with the basic concepts of optimal automatic control systems, the characteristics of such systems, and their practical applications.			
Learning outcomes	After passing this exam, the student will be able to: determine the performance criterion for optimality; for a given model and established performance criterion, find the optimal solution (linear quadratic regulator); analyze the performance of the obtained system in real conditions, where not all state variables are available for measurement; synthesize a suboptimal controller that will closely approximate the ideal optimal solution in real circumstances; model and simulate automatic control systems using computer support (Matlab, Simulink, etc.).			
Lecturer / Teaching assistant	Žarko Zečević, Luka Martinović			
Methodology	Lectures, exercises, consultations, independent study			
Plan and program of work				
Preparing week	Preparation and registration of the semester			
I week lectures	Introduction. Definitions of basic terms.			
I week exercises	Introduction. Definitions of basic terms.			
II week lectures	Dynamic programming. Bellmans principle of optimality.			
II week exercises	Dynamic programming. Bellmans principle of optimality.			
III week lectures	Quadratic performance criterion. Discrete LQR controller.			
III week exercises	Quadratic performance criterion. Discrete LQR controller.			
IV week lectures	Hamilton-Jacobi equation. Continuous LQR controller.			
IV week exercises	Hamilton-Jacobi equation. Continuous LQR controller.			
V week lectures	Properties of solutions based on the linear quadratic state regulator.			
V week exercises	Properties of solutions based on the linear quadratic state regulator.			
VI week lectures	Optimal controllers with a predicted degree of stability.			
VI week exercises	Optimal controllers with a predicted degree of stability.			
VII week lectures	Synthesis of H2 and H∞ controllers.			
VII week exercises	Synthesis of H2 and H∞ controllers.			
VIII week lectures	Synthesis of optimal controllers using linear matrix inequalities (LMI).			
VIII week exercises	Synthesis of optimal controllers using linear matrix inequalities (LMI).			
IX week lectures	Midterm exam.			
IX week exercises	Midterm exam.			
X week lectures	Introduction to random variables.			
X week exercises	Introduction to random variables.			
XI week lectures	Optimal state estimation for continuous and discrete systems. Kalman-Bucy and Kalman filters.			
XI week exercises	Optimal state estimation for continuous and discrete systems. Kalman-Bucy and Kalman filters.			
XII week lectures	Nonlinear state estimation. Extended Kalman Filter (EKF).			
XII week exercises	Nonlinear state estimation. Extended Kalman Filter (EKF).			
XIII week lectures	Unscented Kalman Filter.			
XIII week exercises	Unscented Kalman Filter.			

XIV week lectures	Stochastic optimal control. Linear-Quadratic-Gaussian (LQG) regulator.					
XIV week exercises	Stochastic optimal control. Linear-Quadratic-Gaussian (LQG) regulator.					
XV week lectures	Midterm exam (make-up).					
XV week exercises	Midterm exam (make-up).					
Student workload						
Per week			**Per semester**			
5 credits x 40/30=6 hours and 40 minuts 3 sat(a) theoretical classes 0 sat(a) practical classes 1 excercises **2 hour(s) i 40 minuts** of independent work, including consultations			Classes and final exam: **6 hour(s) i 40 minuts x 16 =106 hour(s) i 40 minuts** Necessary preparation before the beginning of the semester (administration, registration, certification): **6 hour(s) i 40 minuts x 2 =13 hour(s) i 20 minuts** Total workload for the subject: **5 x 30=150 hour(s)** Additional work for exam preparation in the preparing exam period, including taking the remedial exam from 0 to 30 hours (remaining time from the first two items to the total load for the item) **30 hour(s) i 0 minuts** Workload structure: **106 hour(s) i 40 minuts (cources), 13 hour(s) i 20 minuts (preparation), 30 hour(s) i 0 minuts (additional work)**			
Student obligations			Regular attendance at classes, appropriate behavior, attending knowledge tests.			
Consultations			after lectures and by appointment.			
Literature			B. Anderson, J. Moore: Linear optimal control, Prentice Hall, razna izdanja Dan Simon: Optimal State Estimation: Kalman, H Infinity, and Nonlinear Approaches			
Examination methods			Project 10 points Midterm exam 40 points Final exam 50 points			
Special remarks						
Comment						
Grade:	F	E	D	C	B	A
Number of points	less than 50 points	greater than or equal to 50 points and less than 60 points	greater than or equal to 60 points and less than 70 points	greater than or equal to 70 points and less than 80 points	greater than or equal to 80 points and less than 90 points	greater than or equal to 90 points