Faculty of Mechanical Engineering / MECHATRONICS / MECHATRONIC SYSTEMS

Course:	MECHATRONIC SYSTEMS			
Course ID	**Course status**	**Semester**	**ECTS credits**	**Lessons** (Lessons+Exercises+Laboratory)
9210	Mandatory	4	6	3+1+1
Programs	MECHATRONICS			
Prerequisites	None			
Aims	On completion of this course, students should be able to analyze and model mechatronic systems using system approach; to understand the principles, modeling, interfacing and signal conditioning of motion sensors, actuators and drive systems; to integrate components with controls of mechatronic systems; and to realize control mechanisms of real-time closed-loop mechatronic systems.			
Learning outcomes	On completition of this course student should be able: 1. To explain principles of development of mechatronic system in line with guidelines of standard VDI 2206. 2. To analyse and to model structure of simple mechatronic systems at the level of basic components, energy, matter and information flows. 3. To explain use of geometric transformation in kimematics and use of generalized coordinates, virtual work and Lagrangian equations in dznamics of mechanical systems. 4. To solve direct and inverse kinematic and dynamic problem of simple mechanical systems.ž 5. To explain principle of functioning and to apply adequate electromechanical models to describe behaviour of different actuators. 6. To choose adequate actuator for mechanical system drive. 7. To explain working principles of motion sensors and techniques of motion control in closed loop. 8. To design simple motion control system with closed loop of mechatronic system and to integrate it with sensors, actuator and mechanical part of a system.			
Lecturer / Teaching assistant	Prof. dr Milanko Damjanović, mr Aleksandar Tomović			
Methodology	Lectures, exercises and laboratory exercises.			
Plan and program of work				
Preparing week	Preparation and registration of the semester			
I week lectures	Introduction into Mechatronic systems: application of mechatronic systems in the daily life; basic structure of mechatronic systems; definition; integration of new functionality and system intelligence; resulting system behaviour; design of mechatronic sy			
I week exercises	Introduction into Mechatronic systems: application of mechatronic systems in the daily life; basic structure of mechatronic systems; definition; integration of new functionality and system intelligence; resulting system behaviour; design of mechatronic sy			
II week lectures	System analysis: system components; flow of energy, material and information; classification (source, storage, converter, transformer, sink), two-terminal / four terminal network of components; effort/flow classification; fundamental equation of process e			
II week exercises	System analysis: system components; flow of energy, material and information; classification (source, storage, converter, transformer, sink), two-terminal / four terminal network of components; effort/flow classification; fundamental equation of process e			
III week lectures	System analysis: energy balance equation for lumped parameter systems; introduction of energy bonds; modelling of simple mechatronic systems; analogies between mechanical and electrical systems; examples			
III week exercises	System analysis: energy balance equation for lumped parameter systems; introduction of energy bonds; modelling of simple mechatronic systems; analogies between mechanical and electrical systems; examples			
IV week lectures	Kinematics of mechanical systems: mechanisms for motion transmission (gears, belt and pulley, screw mechanisms, rack and pinion, linkages, cams); kinematic structures (serial / parallel); transformation (rotation /translation, EULER-angles); solving the d			
IV week exercises	Kinematics of mechanical systems: mechanisms for motion transmission (gears, belt and pulley, screw mechanisms, rack and pinion, linkages, cams); kinematic structures (serial / parallel); transformation (rotation /translation, EULER-angles); solving the d			
V week lectures	Dynamics of mechanical systems: force and torque transmission through mechanisms; Newton-Euler and Lagrange methods in modelling the dynamical behaviour of rigid multi-body systems with mobile masses; examples			
V week exercises	Dynamics of mechanical systems: force and torque transmission through mechanisms; Newton-Euler and Lagrange methods in modelling the dynamical behaviour of rigid multi-body systems with mobile masses; examples			

VI week lectures	Dynamics of mechanical systems: force and torque transmission through mechanisms; Newton-Euler and Lagrange methods in modelling the dynamical behaviour of rigid multi-body systems with mobile masses; examples
VI week exercises	Dynamics of mechanical systems: force and torque transmission through mechanisms; Newton-Euler and Lagrange methods in modelling the dynamical behaviour of rigid multi-body systems with mobile masses; examples
VII week lectures	Electric actuators: solenoids; DC motors and drives; AC motors and drives; step motors; linear motors; actuator selection and sizing;
VII week exercises	Electric actuators: solenoids; DC motors and drives; AC motors and drives; step motors; linear motors; actuator selection and sizing;
VIII week lectures	Analysis of electromechanical systems: modelling of electrical actuators; differential equation of the dynamic behaviour; modelling of DC motor and gear box configurations, modelling of DC motor-driven manipulator arm, introduction of block diagrams to de
VIII week exercises	Colloquium I
IX week lectures	Motion Control: closed loop control, PID control; cascaded control; Position/speed control; sensors (position, velocity), sensor principles (encoder, resolver, tachogenerator); examples.
IX week exercises	Motion Control: closed loop control, PID control; cascaded control; Position/speed control; sensors (position, velocity), sensor principles (encoder, resolver, tachogenerator); examples.
X week lectures	Control & Actuators: motion controller hardware and software; single axis motion, coordinated axis motion; coordinated motion application; graphical programming for scalable motion control applications.
X week exercises	Control & Actuators: motion controller hardware and software; single axis motion, coordinated axis motion; coordinated motion application; graphical programming for scalable motion control applications.
XI week lectures	Control techniques: model-based control; adaptive control; fuzzy logic control; centralised / decentralised control; networking of embedded control; examples.
XI week exercises	Control techniques: model-based control; adaptive control; fuzzy logic control; centralised / decentralised control; networking of embedded control; examples.
XII week lectures	Sensing & Control: feedforward control; feedback control; external sensors (distance measurement, object position/orientation detection, tactile sensing, force/torque sensing); application examples: object detection, contour tracking, object recognition
XII week exercises	Sensing & Control: feedforward control; feedback control; external sensors (distance measurement, object position/orientation detection, tactile sensing, force/torque sensing); application examples: object detection, contour tracking, object recognition
XIII week lectures	Case studies: Examples for modelling, control and design of mechatronic systems with LabView and Matlab Simulink
XIII week exercises	Case studies: Examples for modelling, control and design of mechatronic systems with LabView and Matlab Simulink
XIV week lectures	Case studies: Examples for modelling, control and design of mechatronic systems with LabView and Matlab Simulink
XIV week exercises	Case studies: Examples for modelling, control and design of mechatronic systems with LabView and Matlab Simulink
XV week lectures	Case studies: Examples for modelling, control and design of mechatronic systems with LabView and Matlab Simulink
XV week exercises	Colloquium II
Student workload	2 hours lectures 1 hour exercises 1 hours laboratory 4 hours self learning

Per week	**Per semester**
6 credits x 40/30=8 hours and 0 minuts 3 sat(a) theoretical classes 1 sat(a) practical classes 1 excercises **3 hour(s) i 0 minuts** of independent work, including consultations	Classes and final exam: **8 hour(s) i 0 minuts x 16 =128 hour(s) i 0 minuts** Necessary preparation before the beginning of the semester (administration, registration, certification): **8 hour(s) i 0 minuts x 2 =16 hour(s) i 0 minuts** Total workload for the subject: **6 x 30=180 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) **36 hour(s) i 0 minuts**

			Workload structure: **128 hour(s) i 0 minuts (cources), 16 hour(s) i 0 minuts (preparation), 36 hour(s) i 0 minuts (additional work)**			
Student obligations			Attendance at lectures and exercises			
Consultations			2 times / week			
Literature			1. Isermann, R., Mechatronic Systems: Fundamentals, Springer, 2005, ISBN 1852339306 2. Bishop, R.,(Ed.), Mechatronic Systems, Control, Logic and Data Acquisition, CRC Press Taylor & Francis Group, LLC, 2008, ISBN 978-0-8493-9260-3 3. Cetinkunt, S.,			
Examination methods			Project task 30 points, - 2 colloquiums: 20 points each, - Exam: 30 points. A passing grade is obtained if at least 50 points are accumulated cumulatively.			
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