AGH UNIVERSITY OF SCIENCE AND TECHNOLOGY

Module name: Actuating, sensing and control mechatronic systems

Academic year: 2013/2014 Code: RMS-1-501-s ECTS credits: 14

Faculty of: Mechanical Engineering and Robotics

Field of study: Mechatronics with English as instruction languagege Specialty: —

Study level: First-cycle studies Form and type of study: Full-time studies

Lecture language: English Profile of education: Academic (A) Semester: 5

Course homepage: —

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Description of learning outcomes for module

MLO code	Student after module completion has the knowledge/ knows how to/is able to	Connections with FLO	Method of learning outcomes verification (form of completion)
Social competence			
M_K001	is aware of the responsibility for own work and readiness to comply with the rules of team work and accepting responsibility for projects and experiments performed collectively	MS1A_K04	Execution of a project, Execution of laboratory classes, Involvement in teamwork
M_K002	is able to correctly set priorities for the realization of a specific project or performing an experiment	MS1A_K05	Execution of a project, Execution of laboratory classes
Skills			
M_U001	ability to use catalogs, data sheets, application notes and other sources to select appropriate actuators and sensors for the mechatronic devices and for design of electronic circuits	MS1A_U01, MS1A_U13	Project

M_U002	is able to properly select actuators and sensors for mechatronic devices for various applications, taking into consideration the given functional and economic criteria	MS1A_U12	Project
M_U003	is able to develop documentation related to the completion of a project or experiment, also in the form of presentation or report	MS1A_U03, MS1A_U09, MS1A_U04	Presentation, Project, Report
M_U004	can design, build, bring into operation and test a simple combinatorial and sequential electronic circuit	MS1A_U20, MS1A_U17	Project
M_U005	is able, using a properly selected tools, to build a model of electric drive, experimentally identify its parameters, synthesize a control system and verify by simulation parameters of thus developed servo	MS1A_U07, MS1A_U20, MS1A_U16, MS1A_U12, MS1A_U08, MS1A_U09	Project, Report
M_U006	is able to work individually or in team; able to develop and complete a schedule of works and meet the deadlines	MS1A_U02	Project, Execution of a project, Execution of laboratory classes, Involvement in teamwork
M_U007	can use datasheets, application notes, manuals and similar documents in English	MS1A_U05	Project, Execution of a project, Execution of laboratory classes
M_U008	observes health and safety rules during working with actuators, sensors and electronic circuits	MS1A_U19	Execution of a project, Execution of laboratory classes
M_U009	is able to use high-level programming languages to develop programs for microcontroller or microprocessor based controllers of mechatronic systems	MS1A_U14	Project, Execution of laboratory classes
Knowledge			
M_W001	knows and understands the methodology of selecting actuators for mechatronic devices; knows computer tools supporting selection and simulation of actuators in mechatronic devices	MS1A_W12	Project, Report, Execution of laboratory classes
M_W002	knows and understands the methodology of designing simple combinatorial and sequential circuits; knows computer tools for the design and simulation of these circuits	MS1A_W12	Test, Project, Report, Execution of laboratory classes
M_W003	knows the basic health and safety rules for working with drives, sensors and electronic circuits	MS1A_W15	Execution of a project, Execution of laboratory classes
M_W004	knows and understands the methods of measuring basic mechanical, electrical quantities and temperature	MS1A_W07	Examination, Test, Report, Execution of laboratory classes

M_W005	well-ordered knowledge of the construction, operation and software of microprocessor systems	MS1A_W10	Examination, Test, Project, Report
M_W006	knows and understands the construction and operation of a servo drive control system	MS1A_W09, MS1A_W06, MS1A_W10	Examination, Test
M_W007	knows operation principles of selected non-electrical quantities sensors, including MEMS sensors applied in mechatronic systems	MS1A_W06	Examination, Test, Project
M_W008	knows the principles of operation and characteristics of selected electrical, pneumatic and unconventional actuators	MS1A_W06, MS1A_W04	Examination, Test, Report
M_W009	have a basic knowledge of relevant sensor parameters and their impact on application in mechatronic devices	MS1A_W06	Examination, Test, Project
M_W010	knowledge of the current state and recent development trends of sensors, electric drives and digital electronics	MS1A_W13	Examination

FLO matrix in relation to forms of classes

MLO code	Student after module completion has the knowledge/ knows how to/is able to	Form of classes										
		Lectures	Auditorium classes	Laboratory classes	Project classes	Conversation seminar	Seminar classes	Practical classes	Others	Fieldwork classes	Workshops	E-learning
Social competence												
M_K001	is aware of the responsibility for own work and readiness to comply with the rules of team work and accepting responsibility for projects and experiments performed collectively	-	-	+	+	-	-	-	-	-	-	-
M_K002	is able to correctly set priorities for the realization of a specific project or performing an experiment	-	-	+	+	-	-	-	-	-	-	-
Skills												
M_U001	ability to use catalogs, data sheets, application notes and other sources to select appropriate actuators and sensors for the mechatronic devices and for design of electronic circuits	-	-	-	+	-	-	-	-	-	-	-

M_U002	is able to properly select actuators and sensors for mechatronic devices for various applications, taking into consideration the given functional and economic criteria	-	-	+	+	-	-	-	-	-	-	-
M_U003	is able to develop documentation related to the completion of a project or experiment, also in the form of presentation or report	-	-	+	+	-	-	-	-	-	-	-
M_U004	can design, build, bring into operation and test a simple combinatorial and sequential electronic circuit	-	-	+	+	-	-	-	-	-	-	-
M_U005	is able, using a properly selected tools, to build a model of electric drive, experimentally identify its parameters, synthesize a control system and verify by simulation parameters of thus developed servo	-	-	+	+	-	-	-	-	-	-	-
M_U006	is able to work individually or in team; able to develop and complete a schedule of works and meet the deadlines	-	-	-	+	-	-	-	-	-	-	-
M_U007	can use datasheets, application notes, manuals and similar documents in English	-	-	+	+	-	-	-	-	-	-	-
M_U008	observes health and safety rules during working with actuators, sensors and electronic circuits	-	-	+	+	-	-	-	-	-	-	-
M_U009	is able to use high-level programming languages to develop programs for microcontroller or microprocessor based controllers of mechatronic systems	-	-	+	+	-	-	-	-	-	-	-
Knowledge												
M_W001	knows and understands the methodology of selecting actuators for mechatronic devices; knows computer tools supporting selection and simulation of actuators in mechatronic devices	+	-	-	+	-	-	-	-	-	-	-

M_W002	knows and understands the methodology of designing simple combinatorial and sequential circuits; knows computer tools for the design and simulation of these circuits	+	-	-	+	-	-	-	-	-	-	-
M_W003	knows the basic health and safety rules for working with drives, sensors and electronic circuits	-	-	+	-	-	-	-	-	-	-	-
M_W004	knows and understands the methods of measuring basic mechanical, electrical quantities and temperature	+	-	-	-	-	-	-	-	-	-	-
M_W005	well-ordered knowledge of the construction, operation and software of microprocessor systems	+	-	-	-	-	-	-	-	-	-	-
M_W006	knows and understands the construction and operation of a servo drive control system	+	-	-	-	-	-	-	-	-	-	-
M_W007	knows operation principles of selected non-electrical quantities sensors, including MEMS sensors applied in mechatronic systems	+	-	-	-	-	-	-	-	-	-	-
M_W008	knows the principles of operation and characteristics of selected electrical, pneumatic and unconventional actuators	+	-	-	-	-	-	-	-	-	-	-
M_W009	have a basic knowledge of relevant sensor parameters and their impact on application in mechatronic devices	+	-	-	-	-	-	-	-	-	-	-
M_W010	knowledge of the current state and recent development trends of sensors, electric drives and digital electronics	+	-	-	-	-	-	-	-	-	-	-

Module content

Lectures

The power supplies and power drivers of electric motors

DC motors

AC motors

Stepper motors and direct drives

Pneumatic actuators

Piezoelectric actuators

Combinational and sequential circuits

Semiconductor memories

Microprocessors

Embedded systems

Software for microprocessor systems

Basic properties of sensors, the role of sensors in mechatronic systems

Strain gauges and encoders

Temperature sensors

Other sensors

MEMS Sensors

Laboratory classes

Simple combinatorial and sequential circuits

Electric motor controllers

Pneumatic motor control by means of relay systems

DC motor Model

Hardware closed-loop control of a DC motor

Software control of a stepper motor with the use of an embedded system

Project classes

Electric circuits

Combinational circuits synthesis

Sequential circuits synthesis

Selection of DC motors

Selection of linear direct drives

Selection of motors and sensors for the selected device or mechatronic system

Method of calculating the final grade

weighted average of the exam, laboratory and project grades

Prerequisites and additional requirements

Ability to solve simple RLC circuits;
Knowledge of magnetism and electricity;
Knowledge of basic methods of measurement of electrical quantities;
Knowledge of the basic operating principles of semiconductor devices and the ability to solve simple circuits containing these devices;
Basic knowledge of automation;
The ability to design a simple control system;
Ability to work in a package Matlab / Simulink;
Ability to program in C;

Recommended literature and teaching resources

Literature:

1. Janocha H. [red.]: Actuators: Basics and Applications, Springer, Berlin, 2004
2. Frank, R.: Understanding Smart Sensors. Artech House, Norwood, 2000
3. Weinheim: Sensors: a Comprehensive Survey. New York, 1989
4. Beeby S., Ensell G., Kraft M., White N.: MEMS Mechanical Sensors. Artech Hause, Norwood, 2004
5. Lisowski W. [red.]: Introduction to robotics, Wydawnictwa AGH, Kraków, 2004
6. Smith R.J., Dorf R.C.: Circuits, devices and systems: a first course in electrical engineering, Wiley, Nowy Jork, 1992
7. Elementy i układy elektroniczne, Kuta S. [red.], Wyd. AGH, Kraków, 2000
8. Stallings W., Organizacja i architektura systemu komputerowego. Projektowanie systemu a jego wydajność, WNT, Warszawa, 2004
9. Baranowski J., Kalinowski B., Nosal Z., Układy elektroniczne Część III Układy i systemy cyfrowe, WNT, Warszawa, 2006
10. Majewski W., Układy logiczne, WNT, Warszawa, 200311.

Pomoce naukowe: przenośna pamięć masowa (pendrive)

Scientific publications of module course instructors related to the topic of the module

1. Petko M., Wybrane metody projektowania mechatronicznego, Wyd. Nauk. Inst. Technologii Eksploatacji, Kraków; Radom 2008, ISBN 978-83-7204-709-0
2. Uhl T., Petko M., Karpiel G., Klepka A.: Real time estimation of modal parameters and their quality assessment, Shock and Vibration, vol. 15, no. 3,4, 2008, pp. 299-306
3. Petko M., Karpiel G.: Implementation of Control Algorithms in Field Programmable Gate Arrays. W: AIM2007: proceedings of the 2007 IEEE/ASME International Conference on Advanced Intelligent Mechatronics, IEEE, Zurich 2007, ISBN: 1-4244-1264-1
4. Petko M., Karpiel G.: Mechatroniczne projektowanie robota równoległego do frezowania. W: Kubik J., Kurnik W., Nowacki W.K. (red.): I Kongres Mechaniki Polskiej: materiały kongresowe, Warszawa 2007
5. Petko M., Karpiel G., Implementation of Control Algorithm in System-on-a-Programmable-Chip, w: ICM 2006: IEEE 3rd International of Conference on Mechatronics: proceedings, IEEE, Budapest 2006, s. 306-311, ISBN: 1-4244-9713-4
6. Petko M., Karpiel G., Uhl T., Neural Control of a Parallel Robot – Design and Implementation in FPGA, w: Mechatrinics 2006: 4th IFAC – Symposium on Mechatronic Systems: Preprints, VDI, 2006, s.145-150
7. Petko M., Karpiel G., Hardware/Software Co-design of Control Algorithms, w: Proceedings of the 2006 IEEE International Conference on Mechatronics and Automation, IEEE 2006, pp. 2156-2161, ISBN: 1-4244-0466-5.
8. Petko M., Uhl T., Smart sensor for operational load measurement, Transactions of the Institute of Measurement and Control, 26, 2 (2004) pp. 99–117
9. Petko M., Karpiel G., Controller for a prismatic robot link with friction – design and implementation, w: Kaszyński R. [red.], Proceedings of the 9th IEEE International Conference on Methods and Models in Automation and Robotics, vol.2, pp. 1027-1032, Wyd. Uczelniane Pol. Szcz., Szczecin, 2003, ISBN: 83-88764-77-2
10. Petko M., Karpiel G., Semi-Automatic Implementation of Control Algorithms in ASIC/FPGA, w: ETFA 2003: 2003 IEEE Conference on Emerging Technologies and Factory Automation: proceedings, vol. 1, pp. 427-433, IEEE, Lisbon, 2003, ISBN: 0-7803-7937-3
11. Petko M., Hardware fuzzy controller for the robot link with friction, w: Ruano, A. E. [red.], Intelligent Control Systems and Signal Processing 2003, Elsevier, 2003, s.167-172, ISBN: 0-08-044088-6
12. Acceleration of parallel robot kinematic calculations in FPGA / Maciej PETKO, Konrad GAC, Grzegorz KARPIEL, Grzegorz GÓRA // W: ICIT 2013 [Dokument elektroniczny] : 2013 IEEE International Conference on Industrial Technology : Cape Town, South Africa, 25–28 February 2013. — Wersja do Windows. — Dane tekstowe. — [Piscataway : IEEE], cop. 2013. — Dysk Flash. — e-ISBN: 978-1-4673-4568. — S. 34–39
13. Trajectory tracking controller of the hybrid robot for milling / Maciej PETKO, Grzegorz KARPIEL, Konrad GAC, Grzegorz GÓRA, Konrad KOBUS, Janusz OCHOŃSKI // W: Mechatronics: Ideas for industrial applications [Dokument elektroniczny] : international conference : May 11–13, 2015 Gdańsk, Polska / Gdańsk University of Technology, PIAP. — Wersja do Windows. — Dane tekstowe. — [Gdańsk: s.n.], [2015]. — Dysk Flash. — S. [1-10]

Additional information

The condition of taking the exam is to get credits from the project and laboratory.

Student workload (ECTS credits balance)

Student activity form	Student workload
Realization of independently performed tasks	75 h
Participation in lectures	65 h
Participation in laboratory classes	60 h
Participation in project classes	44 h
Examination or Final test	1 h
Preparation for classes	60 h
Completion of a project	50 h
Preparation of a report, presentation, written work, etc.	30 h
Summary student workload	385 h
Module ECTS credits	14 ECTS