AGH UNIVERSITY OF SCIENCE AND TECHNOLOGY

Module name: Control theory fundamentals

Academic year: 2013/2014 Code: RMS-1-302-s ECTS credits: 6

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: 3

Course homepage: —

Responsible teacher: prof. dr hab. inż. Kowal Janusz (jkowal@agh.edu.pl)

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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)
Skills			
M_U001	The student is capable of: -evaluating the performance of a feedback control system, -carrying out the synthesis of a control system and select parameters of regulators, -evaluating the static and dynamic quality of a control system.	MS1A_U10, MS1A_U11	Activity during classes, Examination, Test, Report, Execution of exercises, Execution of laboratory classes
M_U002	He/she is able to apply the Matlab/Simulink environment to the simulation of automatic control systems.	MS1A_U08	Activity during classes, Report, Execution of laboratory classes
M_U003	The student acquires the necessary oral and written language skills that enable him/her to understand and communicate basic automatic control terminology.	MS1A_U05	Activity during classes, Examination, Test, Report
Knowledge			

M_W001	The student has knowledge in: -the use of the Laplace transform method, -the modelling of dynamic systems (mechanical, electrical and electromechanical), -block diagrams and their transformations, -the properties of time and frequency characteristics, -stability analysis of linear systems, -analysis and synthesis of regulators and their applications	MS1A_W09	Examination, Test, Report, Execution of exercises, Execution of laboratory classes, Activity during classes
M_W002	The student has the necessary knowledge that enables him/her to carry out the analysis and synthesis of a linear control system.	MS1A_W09	Activity during classes, Examination, Test, Report, Execution of exercises, Execution of laboratory classes

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
Skills												
M_U001	The student is capable of: -evaluating the performance of a feedback control system, -carrying out the synthesis of a control system and select parameters of regulators, -evaluating the static and dynamic quality of a control system.	+	+	+	-	-	-	-	-	-	-	-
M_U002	He/she is able to apply the Matlab/Simulink environment to the simulation of automatic control systems.	-	-	+	-	-	-	-	-	-	-	-
M_U003	The student acquires the necessary oral and written language skills that enable him/her to understand and communicate basic automatic control terminology.	+	+	+	-	-	-	-	-	-	-	-
Knowledge												

M_W001	The student has knowledge in: -the use of the Laplace transform method, -the modelling of dynamic systems (mechanical, electrical and electromechanical), -block diagrams and their transformations, -the properties of time and frequency characteristics, -stability analysis of linear systems, -analysis and synthesis of regulators and their applications	+	+	-	-	-	-	-	-	-	-	-
M_W002	The student has the necessary knowledge that enables him/her to carry out the analysis and synthesis of a linear control system.	+	+	-	-	-	-	-	-	-	-	-

Module content

Lectures

1. Introduction to automatic control. Classification of control systems.
2. Mathematical models of mechanical, electrical and electromechanical dynamic systems.
3. Static and dynamic linearization.
4. Input/output equations. The Laplace transform. The tranfer function.
5. State-space description of plants – state and output equations. State-space models of dynamical systems.
6. The block diagrams of automatic control systems. Block diagram transformations. Signal-flow graphs and Mason’s rule.
7. Time- and frequency characteristics of basic control links.
8. Lyapunov stability of dynamic systems. Stability criteria for linear systems: the Hurwitz and the Nyquist stability criterion. Gain and phase margin.
9. Control systems, their tasks and structure. The evaluation of the quality of control; static accuracy and static error.
10. Basic control algorithms: P, I, PI, PD and PID.
11. Introduction to digital control. The Z-transform. Basic digital-control algorithms.
12. A case study of a mechatronic control system.

Auditorium classes

1. The Laplace transforms and their properties; calculation of the inverse Laplace transform by the partial-fraction method.
2. The solution of simple differential equations by operational method.
3. The governing equations of mechanical, electrical and electromechanical dynamical systems.
4. The determination opf the transfer functions of SISO and MIMO systems.
5. Examples of the state-space equations.
6. The properties of block diagrams and their reduction. Examples of signal-flow graphs and the application of Mason’s rule.
7. Examples of the determination of the time and frequency characteristics.
8. Application of the Hurwitz criterion to the study of the stability of linear systems.

9. The Nyquist stability criterion for feedback control systems.
10. Static accuracy and the calculation of the static error.
11. The calculation of the response of regulators and the analysis of their properties.

Laboratory classes

1. Introduction to Matlab and Simulink.
2. Solving differential equations in Matlab and Simulink.
3. The modelling of a DC motor and the determination of its dynamic characteristics.
4. State-space models of dynamical systems.
5. Basic structures of linear controllers.
6. Parametric synthesis of controllers.
7. Stability analysis of a feedback control system.

Method of calculating the final grade

The final grade is calculated as a weighted average of the marks of the exam (E), classes (Cl) and laboratory (L), and is calculated using the formula:
Final grade=05• [E] + 0.3• [Cl] + 0.2• [L].

Prerequisites and additional requirements

Positive final grade from the subject Mathematics.
Good knowledge of the contents of subjects: Physics and Mechanics.

Recommended literature and teaching resources

1. G.F. Franklin, J.D. Powell, E. Emami-Naeini “Feedback control of dynamic systems”, Prentice Hall, New York, 2006.
2. K. Ogata “Modern control engineering”, Prentice Hall, New York, 1997.
3. R.H. Cannon “Dynamics of physical systems”, Mc-Graw Hill, 1967 (available in Polish as: R.H. Cannon “Dynamika układów fizycznych”, WNT, Warszawa, 1973).
4. J. Kowal “Podstawy automatyki”, v.1 and 2, UWND, Kraków, 2006, 2007 (in Polish).
5. W. Pełczewski “Teoria sterowania”, WNT, Warszawa, 1980 (in Polish).

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

Additional scientific publications not specified

Additional information

None

Student workload (ECTS credits balance)

Student activity form	Student workload
Participation in lectures	30 h
Realization of independently performed tasks	50 h
Participation in auditorium classes	30 h
Preparation for classes	30 h
Participation in laboratory classes	15 h
Preparation of a report, presentation, written work, etc.	10 h
Examination or Final test	8 h
Contact hours	10 h
Summary student workload	183 h
Module ECTS credits	6 ECTS